SCHOOL OF ECONOMICS & MANAGEMENT LISBON

MASTER

MONETARY AND FINANCIAL ECONOMICS

MASTER FINAL WORK

DISSERTATION

MORTGAGE DEBT AND DELEVERAGING: CROSS-SECTIONAL EVIDENCE FROM THE U.S. GREAT DEPRESSION

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SUPERVISOR:

PEDRO ALEXANDRE REIS CARVALHO LEÃO

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All errors are mine.

ABSTRACT

This work assesses the role of leverage and of the balance sheet channel in the performance of the U.S. economy during the Great Depression of 1929-1933. I use a cross-sectional approach at the state level and measure the impact of farm and house values and of loan-to-value ratios in personal income, debt, wages, employment, and the number of banks. The results show that the more leveraged states experienced sharper contractions. This result gives additional support to the link between leverage and the business cycle.

JEL Codes: E2, E3, E4, E5, N12, R2

Keywords: Great Depression, debt, deleveraging, mortgage

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1. Introduction

The role of over-indebtedness in the household sector appears repeatedly in the literature about the causes of the Great Recession of 2008-2009. However, it was only recently that authors came to apply that concept to the study of the Great Depression. This is a good historical episode to search for such evidence not only because of the credit expansion during the 1920s, but also because the debt-to-income ratio has never reached such high levels, except at the onset of the Great Recession (Mian and Sufi, 2010, p. 1). The aim of this work is to contribute to the debate on the importance of leverage and balance sheet distress in explaining deep recessions.

The aggregate U.S. data shows the potential importance of debt in the Great Depression. Total debt-to-income ratio[1] climbed from 148% to 186%, from 1920 to 1929. In 1933 it was 314% due to the abrupt fall in income. The output components[2] that experienced the largest fall in nominal terms, between 1929 and 1933, were the nonfarm and farm residential investment (86.8% and 75.0%, respectively), and the durables investment and consumption (73.2% and 62.0%, respectively), which are the categories that mostly rely on debt financing. Additionally, it was the farm sector that suffered the sharpest fall, decreasing 52.6%. Gjerstad and Smith (2013, p. 10) note that housing investment was the category that reached a higher growth during the 1920s and a subsequent larger drop[3]. Regarding the decrease in nominal debt[4], the farm productive and the

[1] Nominal GDP fell 46% from 1929 to 1933. Source: Historical Statistics of the United States Colonial Times to 1970 in tables F1-9 and X393-409.
[2] Source: Source: Historical Statistics of the United States Colonial Times to 1970 - tables F1-9, F36-46.
[3] Accordingly, in 1933 housing was 12.5% of its 1929 level and 7.5% of its peak level in 1925.

consumption credit sectors were the ones that deleveraged the most. They fell 46.2% and 45.1%, in nominal terms, respectively. Also, the data shows that the years preceding the Depression were characterized by a credit boom particularly in consumption and nonfarm mortgage. Between 1920 and 1928, consumer and mortgage credit rose 110.0% and 153%, respectively. On the contrary, the farm mortgage credit was already falling in that period (3.9%). (See Appendices B and E)

A closer look to the nonfarm housing market reveals that it was already distressed when the Depression burst[5]. The number of new nonfarm dwelling units rose 332% from 1920 to its peak in 1925. The house prices also peaked in 1925, and both began to fall thereafter. The accumulation of mortgage debt during the 1920s, combined with the fall in housing prices, led to the increase in the loan-to-value ratios of households. Accordingly, the ratio of nonfarm residential mortgage debt to residential wealth rose during the decade, climbing from 10.2% in 1920 to 27.2% in 1929. Regarding the farm sector[6], it was more levered than the nonfarm: the mortgage debt to farm value ratio climbed from 30.7% to 40.6%, from 1920 to 1925; in 1930 the sector was already deleveraging as that ratio had fallen to 37.3%; from 1920 to 1930, farm values decreased by 25.2%. (See Appendix C)

This work studies the impact of leverage and of falling farm and house values in the Great Depression of 1929-1933. As far as I could infer, this work has not yet been conducted. Gartner (2013) discussed the role of high mortgage debt-to-

[4] Source: Historical Statistics of the United States Colonial Times to 1970 in tables X393-409
[5] Source: Grebler et al. (1956), Tables B-1, C-1, and L-6
[6] Source: Census of Agriculture 1920, 1925, and 1930.

income ratios on the onset of the Great Depression but did not consider the leverage relatively to asset values[7]. Brocker and Hanes (2012) studied the role of increasing house values, construction, and ownership rates in the 1920s but did not measure their impact on aggregate macroeconomic variables.

Using a cross-sectional approach, I measure the impact of mortgage debt to asset value ratio and of farm and house values in personal income, debt, wages, employment, and the number of banks. The overall results show that the more leveraged states experienced stronger contractions.

Particularly, I reach four conclusions. First, the states where the mortgage debt to farm value was greater in the years before the Great Depression, suffered a larger fall in personal income, wages, and employment. There is also evidence that higher leverage in the farm sector influenced bank failures and debt between 1930 and 1933. Second, the states where farm values decreased the most between 1920 and 1930 saw greater declines in personal income, wages and employment. Third, using a proxy for leverage, I show that the states where the number of owned houses was greater in 1930 experienced stronger losses in personal income and wages; the impact of leverage on personal income is greater than in the farm sector which is consistent with the fact that the household mortgage debt represented a higher share of total net debt relatively to farm mortgage debt. Fourth, the states where the house values dropped the most between 1920 and 1930 had higher unemployment in the non-manufacturing sector and deleveraged more between 1930 and 1933.

[7] The author uses the ratio of mortgage debt-to-income. Mortgage debt is real estate debt in commercial and mutual savings banks.

The results are robust to state-level control variables for productivity, industrial composition, and monetary policy. Combined with recent literature about the Great Recession of 2008-2009, the results suggest that leverage and the balance sheet channel are important components of the explanation of deep recessions and cannot be neglected by the monetary policy.

The rest of the work is structured as follows. Section 2 reviews the literature about the role of debt in the Great Depression, focusing the recent developments in this area of research. Then, in section 3, I discuss my new dataset and the methodology. Section 4 presents the results for several estimation equations and discusses the econometric issues. Section 5 concludes and resumes the main findings.

2. Literature review and the role of debt in the Great Depression

If one concludes that the housing market developments that took place before the banking panics had a decisive negative impact on the economic performance, then one must challenge the general explanation of the Great Depression, given by Friedman and Schwartz (1963). According to the authors, it was the fact that the Federal Reserve System failed to provide the liquidity needed to avoid the widespread bank runs that caused the money supply and consequently income to contract. Their theory is based on the idea of a reserves gap which led some banks into bankruptcy, while others, struggling to protect themselves, reduced the credit to the economy. However, this thesis is subject to two criticisms: the member banks' reserves balances have only fallen later in the

Depression in 1931 and 1932; additionally, the reserves of Federal Reserve Banks did not actually fall. (See Appendix D)

Temin (1976) argued that the monetarist explanation disregards the money demand and concluded that if the reserves gap of 1930 was so sharp, then it should have had occurred an interruption in the downward trend of short-term rates which has not. Instead, Temin believes that the fall in money demand was caused by an autonomous decrease in consumption. He observed that «the decline in consumption in 1930 was unusually large» which is «consistent with the hypothesis that household balance sheets were stressed before the monetary collapse in 1931» (Gjerstad and Smith, 2013, p. 7). As Field (2013, p. 5) noted, if the monetary expansion conducted in the recent Great Recession «will not have avoided the (…) output loss over the years 2008-2017, we must reconsider whether (…) massive monetary accommodation in 1929-33 would have avoided most of the output loss».

The study of debt in financial crisis is not a new issue and it was first proposed by Fischer (1933), who argued that whenever «a state of over-indebtedness exists, this will tend to lead to liquidation, through the alarm either of debtors or creditor or both» (Fisher, 1933, p. 341-342). Besides other effects, the liquidation leads to the fall in the price level, which increases debt in real terms. Eventually, banks realize that people won't be able to repay their debt so they contract the credit to the economy. Hence, the output falls and the price level drops again, which further increases the real debt burden, reinforcing the debt-

deflation cycle[8]. King (1994, p. 442) described it as «a propagation mechanism which multiplies small shocks into potentially large changes in aggregate demand and output». Although Fisher's theory goes back to the 1930s, it was generally forgotten, and even in the 1930s it «was not well received by the critics» (King, 1994, p. 428).

It was only after the 1970s when a new financial crisis burst that authors began to build on Fisher's theory. Tobin (1980) discussed that debt redistribution between lenders and borrowers affects the economy and argued that «aggregation would not matter if (…) marginal propensities to spend from wealth were the same for creditors and debtors» (Tobin, 1980, p. 10). Since debtors have a higher marginal propensity to spend, debt service constitutes a larger share of debtors' incomes than of creditors', and the effect on aggregate demand is not neutral[9]. Olney (1999, 2012) argued that highly indebted consumers reduced consumption in order to avoid default. King (1994, p. 419), notes that «in the early 1990s the most severe recessions occurred in those countries which had experienced the largest increases in private debt burdens» before the crisis.

Mishkin (1978) discussed the negative wealth and liquidity effects deriving from the stock market decline and argued that it affected households' balance sheets thus constraining consumption.

[8] Fisher believed that the negative cycle could have been avoided by reflation (expansionary policy in order to bring prices up).
[9] This effect is greater than the Pigou effect according to which, during periods of deflation consumption would rise due to the rise in the real balances of wealth which would stimulate the output and employment.

After the Japanese crisis in the 1990s and the Great Recession of 2008-2009, the issue of over-indebted households has come to the spotlight[10]. Many authors have modelled the impact of a credit tightening shock on over-indebted consumers[11]. In general they conclude that after the shock, consumers are forced to deleverage which depresses aggregate demand, and that the economy is driven into a liquidity trap. In a slightly different approach, Koo (2009) asserted that the deleveraging process of both the Great Recession and the Great Depression was a voluntary action by borrowers as they became aware of their own over-indebtedness. He believes that after the asset prices shock, households and firms began to pay down their debts, i.e. minimizing debt, which made both the aggregate demand and the money supply to fall[12].

As far as the empirical literature is concerned, Mian et al. (2010, 2011, 2012) used a cross-sectional analysis to show that the counties where households were most leveraged prior to the Great Recession, were the ones where the contraction has been heavier[13]. Following this literature, and applying it to the

[10] See for instance, Chapter 3 of the IMF report (2012), the McKinsey report on Debt and Deleveraging (2010), and the articles by Glick et al. in FRBSF Economic Letter (2009, 2010).
[11] Guerrieri and Lorenzoni (2011) conclude that consumers deleverage by increasing their savings as a precautionary behaviour. Hall (2011) explains that when economies stuck at the zero-lower bound markets don´t clear after a shock and the economy will remain below full employment as long as there is excess durable goods and debt. In Eggertson and Krugman (2011) households start to deleverage after they became aware that they are highly indebted. Midrigan and Philippon (2011) show that the regions where leverage was higher on the onset of the crisis, were the ones where the output and employment decreased the most.
[12] The author defends the existence of two types of economy. In the Yang economy, firms maximize profits and balance sheets are healthy; government intervention can crowd out private investment; monetary policy is effective because companies have high demand for funding. In the Yin economy, firms minimize debt and have balance sheet problems due to a fall in asset prices; companies start to pay down their debts and monetary policy is ineffective because private-sector demand for funds is small; the government should borrow and spend the savings that are generated by the private sector because there is no danger of crowding out of private investment. Koo also asserts that bank reserves didn't fall and so it cannot explain the fall in the money supply.
[13] Mian and Sufi (2010) showed that the debt-to-income ratio as at 2006 helps to explain both the timing and severity of the 2007-2009 recession. Mian and Sufi (2012) go further in trying to

Great Depression, Gartner (2013) presents evidence that the states that had higher mortgage debt-to-income ratios in 1929 were the ones that experienced a slowest recovery after 1933.

Despite the recent developments in the literature, the study of mortgage debt in the Great Depression is still in an early stage, surely because «residential construction and mortgage credit were poorly measured» (Snowden, 2013, p. 1). As Snowden (2013) notes, a crucial limitation is the fact that the amount of home mortgage was taken off the 1930 Census of Population. Therefore, the loan-to-value ratio of the nonfarm mortgages is not precisely known. After the foreclosure crisis in the 1930s, the government perceived the lack of information and, in 1935, conducted the Financial Survey of Urban Housing (FSUH), which questioned a sample of individuals about the value of their houses and mortgage in the years of 1930, 1933, and 1934. Despite the survey, the information is still fragmented, and while for 1920 one can rely in the Population Census which gathers information at the national level, the FSUH was only conducted in about 50 cities.

Despite these limitations in the data, several authors have been studying the housing market of the 1920s. An important question on the table is how the housing market distress could have been transmitted to the economy, especially in the mortgage credit conditions of the 1920s: mortgages usually required 50% down payment, were usually of five years maturity, and had low loan-to-value ratios, thus the sector was much less levered than today (Field, 2013, p. 9).

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explain unemployment using the household's deleveraging process. They conclude that the «job losses in the non-tradable sector from 2007 to 2009 are significantly higher in high leverage counties» (p. 2).

Snowden (2010, p. 7) refers that in 1920 only 41% of nonfarm houses were owner-occupied, and from those only 40% were mortgaged; additionally, mortgages «were structured as straight or partially-amortized balloon loans (…) and were typically renewed one or more times before being fully repaid».

The most accepted view is that the housing cycle may have affected the general economy through multiplier effects from the fall in the construction sector which declined by a larger fraction of GDP than nowadays: according to Field (2013, p. 41), the construction share of GDP fell from 6% in 1925 to 1% in 1933.

However, some authors believe that the wealth effects arising from the declining house prices and foreclosures could have had major consequences. According to Gjerstad and Smith (2013), the indicators of a housing crisis were present well before the first banking crisis[14]. Specifically, as house prices fell[15] and the debt burden was fixed, households cut on consumption, particularly on durables which made firms reduce production and consequently, wages and employment fell. Therefore, households became more distressed and eventually failed to pay their mortgages which deteriorated banks' balance sheets thus making them reduce credit. This theory complements Temin's belief in an autonomous fall in consumption, and challenges Friedman and Schwartz (1963) because it implies an explanation for the fall in the money stock based on the demand rather than on the supply side. Brocker and Hanes (2012) performed a cross-sectional

[14] Residential mortgage debt rose 268% from 1919 to 1929, mainly financed by mortgage bonds but began to fall in 1929. House sales and prices began to fall after their 1926 peak, and mortgage bond defaults, mortgage delinquency and foreclosures started to rise before 1929.
[15] The fall in housing prices was the result of a Minsky moment: long periods of growth and asset appreciation induce borrowers to accumulate high levels of debt, beyond their ability to repay. Once the value of the assets stops increasing, borrowers that had been borrowing against collateral can no longer do it.

analysis, and conclude that the cities that were «more affected by the residential real estate boom[16] (…) suffered greater declines in perceived house values and higher foreclosure rates» (p. 33).

3 Measuring the effects of leverage on the economic performance between 1929 and 1933

In this section, I explore the wealth channel through which the decrease in property values and the level of leverage could have impacted on the economic developments during the Depression. I study the effect of leverage in six economic indicators, at the state level, using an OLS cross-sectional model. The objective is to check whether the states with higher leverage and where the properties' values decreased the most in the previous years of the Depression were those that experienced deeper contractions between 1929 and 1933. The six economic indicators I study are personal income (INC), debt (DEBT), wages (WAGES), manufacturing and non-manufacturing employment (EMPMAN and EMPNMAN), and the number of banks within each state (BANK). Except for employment, variables are computed in per capita terms.

The equations include several control variables, chosen according to the previous literature, particularly, Gartner (2013), Garret and Wheelock (2006), and Mian and Sufi (2010). First, I include $PCINC_{s;1929}$ which is the per capita income in each state in 1929 because «states that entered the Depression with relatively low per capita incomes tended to suffer larger percentage declines in per capita income than did high income states» (Garret and Wheelock, 2006, p.

[16] Accordingly, those cities that experienced higher increases in housing units, home values, homeownership, and mortgage indebtedness.

1). Second, I include three variables that control for the sectorial composition of each state, $FARM_{s;1929}$, $MANUF_{s;1929}$, and $WHOLRETAIL_{s;1929}$. These variables account for the sectors that represent the largest shares in personal income and some of the most affected sectors at national level namely, farm, manufacturing and wholesale and retail sectors. According to existing literature, there is a «statistically significant impact of industry structure on state per capita income growth» (Garret and Wheelock, 2006, p. 16). Finally, I include $RESDEP_{s;1929}$ which accounts for differences in the monetary policy between states. I use the reserves in each of the 12 Federal Reserve Banks and I aggregate states in accordance with the Federal Reserve Board Report of 1933: whenever a state belongs to two different Federal Districts, it is assigned to the District in which the larger number of its population is in. In order to make numbers comparable, I divide by total deposits in each of the 12 geographical areas[17]. I chose this variable because Friedman and Schwartz (1963) argued that a reserves gap restrained the credit availability causing income to collapse. Additionally, total reserves in 1929 represent very well its future behaviour in the period 1930-33, for each of the 12 Districts (correlation coefficient of 97.8% between reserves in 1929 and the average reserves in 1930-33). This approach, however, entails one limitation because it does not include reserves in other banks than the Federal Reserve Banks. Nevertheless, that data is not available at the state level.

I divide my analysis into two sections. One deals with the farm sector and the other with the nonfarm sector. Although the farm sector is not usually analysed when studying the housing boom of the 1920s, my aim is to study the impact of

[17] I also performed the estimated equations with the ratio of reserves per capita but the results do not differ significantly.

leverage in the economic performance and not the housing boom itself. Additionally, the farm sector provides instructive evidence for two main reasons. First it is largely free from the influence of the monetary policy of the 1920s as the value of farm properties was already falling during the decade because of specific sector problems: during the World War I, U.S. farmers supplied European countries with farm products; when the European countries restarted their production, U.S. farmers were left with over-supply, which led to the fall in farm prices; the fall in farm income, combined with heavy debt burdens lead to a farm crisis during the 1920s. Second, farm property values fell in a much higher scale than the nonfarm sector: it is estimated that between 1920 and 1930, the farm property values decreased 25.2%, on average; in a much less extend, nonfarm house prices declined by 9.7% between the same years[18]. Therefore, the balance sheet of the farm sector must have been affected by wealth effects, before and to a higher extend, than the nonfarm sector. However in 1929, farm debt represented only 6.4% of total net debt, and the farm mortgage only 5.0%, while the household mortgage was 16.3% of total net debt in 1929[19]. Before proceeding into the methodology, in the next section I discuss the dataset.

3.1 Data description

I have compiled my own dataset which relies in a variety of sources: the Census of Population, the Census of Agriculture, the Mortgages on Homes, the All

[18] Farm and nonfarm properties' values computed from average data at the state level, from the Census of Agriculture 1920 and 1930, Mortgages on homes 1920, and Census of Population 1930.
[19] Data is from the Historical Statistics of the United States Colonial Times to 1970, series X393-409.

Banks Statistics 1896-1955, the Banking and Monetary Statistics 1914-1941, the State Personal Income, and previous work developed by Wallis (1989). The dataset contributes to bring together fragmented information at the state level, about mortgage debt and farm and house values. As it was mentioned above, information about mortgages in the nonfarm sector in 1930 does not exist. Therefore, when constructing the dataset I had to search for variables, at the state level, that could be used as a proxy for the leverage in the household sector. This task was time consuming because most of the data is not in digital format.

The dataset includes information for 48 U.S. states plus the District of Columbia[20]. For the years between 1929 to 1933, it gathers information at annual frequency about personal income (INC), wages (WAGES), debt (DEBT), manufacturing and non-manufacturing employment (EMPMAN and EMPNMAN), and the number of banks (BANK). Additionally, it includes data on properties' values (FARMVAL and HOUSEVAL), the mortgage loan to farm value (LTVfarm), and owned houses (OWNED) in the years 1920, 1925, and 1930, whenever that data exists. The summary statistics is presented in Appendix A.

The data for the per capita personal income (PCINC) and wages (WAGES) was taken from State Personal Income 1929-99 which is an updated version of Schwartz and Graham (1956). It compiles annual data for personal income and its disaggregation by industry, at state level, since 1929. Personal income does not equal GDP. However, between 1929 and 1933, the total personal income per

[20] Alaska and Hawaii only became U.S. states in 1959.

capita has a correlation coefficient of 99.9% with nominal GDP per capita[21]. This source also includes disaggregated data for earnings by industry which I have used to compute the control variables that account for the percentage of earnings coming from the farm (FARM), manufacturing (MANUF), and wholesale and retail (WHOLRETAIL) sectors. The data regarding the amount of loans (DEBT) and number of banks (BANKS) was collected from the All Banks Statistics 1896-1955 which has annual data for all states. Loans correspond to the total amount of loans in National and State Commercial Banks, and in Mutual Savings Banks[22]. Total loans proxy well the fluctuations in total net debt outstanding at national level, with a correlation coefficient of 98.5% between 1929 and 1933[23]. This publication has also data on real estate loans for those two categories of banks; however, before 1934 they are estimated with ratios based on reported data for 1926 and 1932; also, mortgage loans in commercial and mutual savings banks were not the only sources of mortgage debt[24]. Additionally, this source disaggregates the assets and liabilities into other main categories particularly investments, cash, deposits, and capital accounts. I use the data about the deposits to compute the control variable RESDEP. The data for employment is from Wallis (1989) who constructed three indexes for total, manufacturing and non-manufacturing employment at state level. The indexes are calculated from surveys on firms conducted by the Bureau of Labor Statistics (BLS). The figures for reserves in Federal Reserves Banks were taken

[21] Source for GDP per capita is NBER Macrohistory Database.
[22] Figures are as of June 30, or nearest available data.
[23] Source for net debt is Historical Statistics of the United States Colonial Times to 1970, table X393-409
[24] According to Grebler et al. (1956), table N-3, commercial banks plus mutual savings banks held 26.0% of nonfarm residential mortgage debt in 1929, and 29.6% in 1933; considering the data in All Banks Statistics 1896-1955, those percentages are 40% and 39%, respectively.

from the Banking and Monetary Statistics 1914-1941 which was published by the Board of Governors of the Federal Reserve System to compile data related to the operations of the Federal Reserve System. When computing per capita variables, I have relied on population estimates provided in the State Personal Income and, on the Census of Population for the year 1920.

The mortgage loan to farm value ratios in 1925 and 1930, and the farm values in 1920 and 1930 were collected from the Census of Agriculture 1920, 1925, and 1930. Farm values include the value of buildings and loans of owned properties. Regarding the per capita owned houses in 1920 and 1930 in the nonfarm sector, data was collected from the Census of Population of 1930. As to the nonfarm house values, I relied in the Mortgages on Homes 1920 and in the Census of Population of 1930. However, in 1920 it was reported the average house value for mortgaged properties, whereas in 1930 the Census reports median values for both mortgaged and non-mortgaged properties. One must also note that the properties' values are estimates of the respective owners and not actual sale prices. Despite the fact that homeowners generally overestimate the value of their houses, in the post-war era «changes in homeowners' estimates are strongly correlated with changes in actual sale prices»[25].

3.2 Methodology: farm sector

For the farm sector I define three estimation equations. In the first and second, I use the mortgage debt to farm value ratio (LTVfarm) as the main explanatory variable. This ratio measures the extent to which the farm owners with

[25] Brocker and Hanes (2012, p. 9)

mortgage debt where indebted in terms of their property value. First, I use the ratio as in 1925. The reason is that between 1920 and 1925 farm values had already decreased by 21.7% despite the increase in mortgages of 12.7%[26]. Therefore, there was already in 1925 some distress from the loss in properties' value. Additionally, I use the LTVfarm ratio as in 1930, which reflects the leverage condition on the onset of the Depression. Between 1925 and 1930, farm values decreased an additional 4.5% and mortgages declined 9.7%[27]. The estimation equations are the following:

$$\Delta Y_{s;1929\,33} = \alpha + \beta_1 LTVfarm_{s;1925} + \beta_2 PCINC_{s;1929} + \beta_3 FARM_{s;1929} + \beta_4 MANUF_{s;1929} + \beta_5 WHOLRETAIL_{s;1929} + \beta_6 RESDEP_{s;1929} + \varepsilon_s \quad (1)$$

$$\Delta Y_{s;1930\,33} = \alpha + \beta_1 LTVfarm_{s;1930} + \beta_2 PCINC_{s;1929} + \beta_3 FARM_{s;1929} + \beta_4 MANUF_{s;1929} + \beta_5 WHOLRETAIL_{s;1929} + \beta_6 RESDEP_{s;1929} + \varepsilon_s \quad (2)$$

The error term is assumed to be well behaved, and s stands for state. ΔY_s represents the change in each of the dependent variables mentioned above; therefore, each one of the estimation equations is performed for 6 dependent variables. In equation (2) the dependent variable only accounts for changes from 1930 to 1933. I exclude the year 1929 because I am interested in measuring the effects of the LTVfarm ratio in the following years, i.e. the impact that leverage imposes on future macroeconomic variables.

[26] Farm and mortgages values computed from average data at state level, from the Census of Agriculture 1920 and 1925.
[27] Farm and mortgages values computed from average data at state level, from the Census of Agriculture 1925 and 1930.

I also conduct a third regression. Brocker and Hanes (2012) state that a fall in the value of the property affects the owner´s balance sheet. The fall in the asset's value leads to «defaults on mortgage debt as homeowners abandon negative-equity properties or are unable to refinance balloon-payment mortgages» (p. 3). Additionally, defaults affect the credit supply as it damages lenders' balance sheets, and besides that may decrease consumer spending through wealth effects. Therefore, I estimate the following regression which seeks to analyse if the decrease in the value of farm properties (FARMVAL) between 1920 and 1930 has had any impact in the economic performance of the later years:

$$\Delta Y_{s;1930\,33} = \alpha + \beta_1 FARMVAL_{s;1920\,30} + \beta_2 PCINC_{s;1929} + \beta_3 FARM_{s;1929} + \beta_4 MANUF_{s;1929} + \beta_5 WHOLRETAIL_{s;1929} + \beta_6 RESDEP_{s;1929} + \varepsilon_s \quad (3)$$

3.3 Methodology: nonfarm sector

There is no data on LTV ratios for the household sector, at the state level, for 1925 or 1930. That poses a problem to my analysis and I am forced to change my methodology. Brocker and Hanes (2012) have concluded that the increase in ownership rates in the household sector in the 1920s conducted to higher rates of foreclosure during the 1930s. The increase in ownership in the 1920s may only have caused higher foreclosure rates through the inability to pay down mortgage debt. So, the increase in ownership during the 1920s must have been at least partly financed with mortgage debt. When observing my dataset I find evidence of that relation: the percentage variation in the per capita number of houses owned from 1920 to 1930 has a correlation coefficient of 66.9% with the

variation in real estate bank loans between the same years, in each state. Although real estate loans in banks do not account for the overall mortgage loans in the country, they exhibit a correlation of 98.8% with total mortgage debt between 1920 and 1930, at national level[28]. This result allows me to assume that the increase in ownership was largely financed with mortgage debt and therefore, I use the percentage of per capita owned houses in 1930 as a proxy for the level of leverage in the housing sector in that year, in each state:

$$\Delta Y_{s;1930\,33} = \alpha + \beta_1 OWNED_{s;1930} + \beta_2 PCINC_{s;1929} + \beta_3 FARM_{s;1929} + \beta_4 MANUF_{s;1929} + \beta_5 WHOLRETAIL_{s;1929} + \beta_6 RESDEP_{s;1929} + \varepsilon_s \quad (4)$$

Like in the farm sector, I also estimate the impact of the decrease in the value of households' homes between 1920 and 1930 in the economic performance between 1930 and 1933:

$$\Delta Y_{s;1930\,33} = \alpha + \beta_1 HOUSEVAL_{s;1920\,30} + \beta_2 PCINC_{s;1929} + \beta_3 FARM_{s;1929} + \beta_4 MANUF_{s;1929} + \beta_5 WHOLRETAIL_{s;1929} + \beta_6 RESDEP_{s;1929} + \varepsilon_s \quad (5)$$

4 Estimation results

4.1 Farm sector

A simple graphical analysis shows the potential relation between the LTV ratio in the farm sector in 1925 and the economic developments during the

[28] Real estate loans rose 113.6% from 1920 to 1930 (All Bank Statistics 1896 – 1955). In the same period, total mortgage loans in the residential sector rose even more 222.6% (Grebler et al., 1956).

contraction. There is a negative relation between that ratio in 1925 and the fall in total personal income in the state (Figure 1). Decomposing the data into states with high and low LTV[29], one can observe that those with higher debt ratios suffered a deeper fall in all the variables (Figure 2).

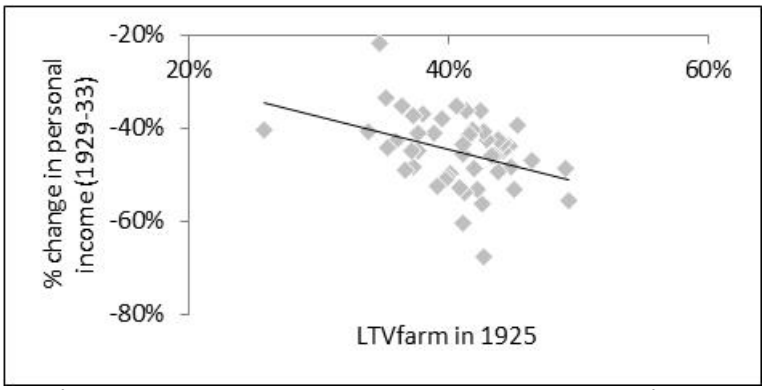

Figure 1 – LTV in farm sector 1925 and percentage change in personal income 1929-33

Source: State Personal Income (1999) and Census of Agriculture 1925

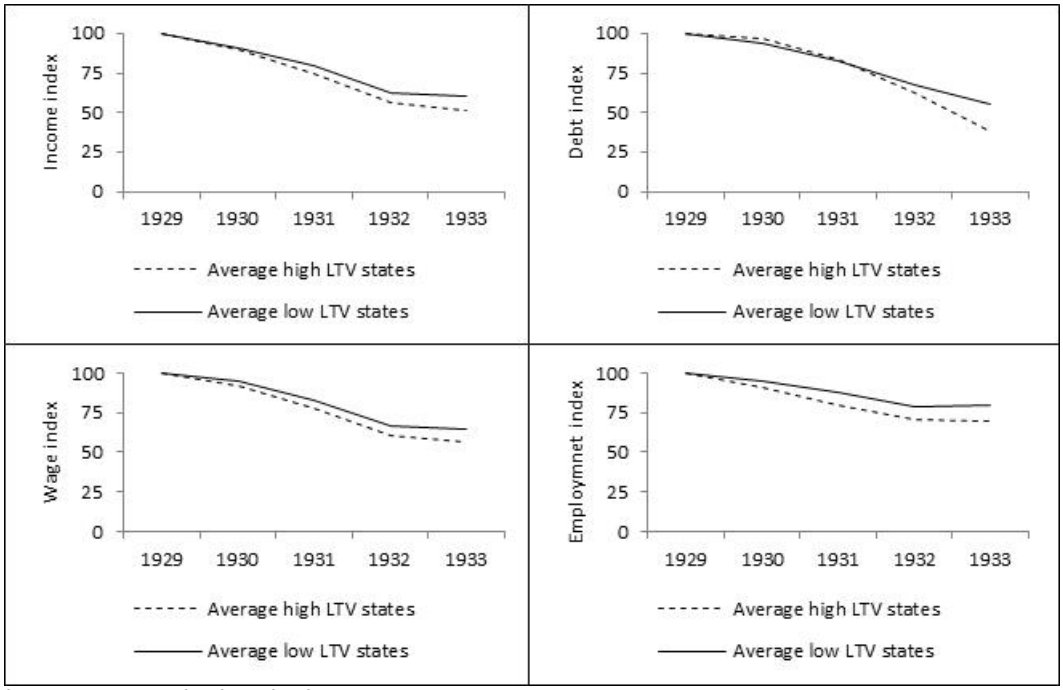

Figure 2 – Variation in income, debt, wages, and employment between 1929 and 1933 (1929=100)

Source: State Personal Income (1999), All Bank Statistics 1896 – 1955, Census of Agriculture 1925, and Wallis (1989)

[29] States are divided according to percentiles; there are 9 high LTV states which are in the 15% percentile, while the 8 low are the ones in the bottom 15% percentile. For the unemployment index presented in Figure 6, District of Columbia is excluded since that Wallis (1989) does not provide data for it.

I explore this relation with equation (1) and table I presents the results[30]. The regression is estimated with heteroskedasticity-robust standard errors. The results confirm the graphical relation presented above. They show that the higher the indebtedness in the farm sector relatively to the farm value in 1925, the higher was the fall in per capita income and wages, and in employment, from 1929 to 1933. On average, 10.0 percentage points increase in the LTVfarm ratio translates into 3.2 to 8.0 percentage points decrease in per capita income and wages, and in employment growth rates[31]. Those coefficients are statistically significant at least at the 10 per cent level[32]. Additionally, the expected negative relation between income and some of the most affected sectors, namely farm and wholesale and retail, is found and it is statistically significant at 1% level of confidence. The Federal Bank's reserves coefficient does not appear to influence the latter developments on income since that the coefficients are not statistically significant. However in general they present the expected sign.

[30] The Wallis index for employment does not have data on the District of Columbia, and so N is equal to 48.
[31] All the regressions include level variables: for example, per capita income growth between 1929 and 1933 in Alabama is -0.49 and not log (inc_{33})-log (inc_{29}).
[32] Regarding the F-test, the null hypothesis can be rejected for all specifications at a 5% level of confidence, except for in specifications (3) and (6). Additionally, the VIF test does not identify multicollinearity.

Table I
Regression results for mortgage debt to farm value in 1925

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta INC_{s\ 1929\ 33}$	$\Delta DEBT_{s\ 1929\ 33}$	$\Delta WAGE_{s\ 1929\ 33}$	$\Delta EMPMAN_{s\ 1929\ 33}$	$\Delta EMPNMAN_{s\ 1929\ 33}$	$\Delta BANK_{s\ 1929\ 33}$
$LTVfarm_{s\ 1925}$	-0.315*	-0.453	-0.382**	-0.601**	-0.798*	-0.553
	(0.172)	(0.622)	(0.155)	(0.245)	(0.463)	(0.577)
$PCINC_{s\ 1929}$	-0.000**	0.000*	-0.000	-0.000***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$FARM_{s\ 1929}$	-0.551***	0.123	0.075	-0.122	0.422	0.281
	(0.118)	(0.283)	(0.133)	(0.186)	(0.339)	(0.305)
$MANUF_{s\ 1929}$	-0.194	0.525	-0.117	0.033	0.813**	0.454
	(0.136)	(0.427)	(0.138)	(0.279)	(0.339)	(0.441)
$WHOLRETAIL_{s\ 1929}$	-1.230***	-0.838	-0.805**	-2.124***	0.009	-2.310**
	(0.349)	(0.851)	(0.342)	(0.431)	(0.699)	(0.996)
$RESDEP_{s\ 1929}$	0.427	-0.868	0.332	0.705	0.242	-0.534
	(0.497)	(1.260)	(0.431)	(0.785)	(0.990)	(1.227)
Constant	-0.007	-0.442	-0.166	0.341**	0.140	0.029
Specification	OLS	OLS	OLS	OLS	OLS	OLS
N	49	49	49	48	48	49
R^2	0.586	0.293	0.239	0.472	0.230	0.213

Note: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Standard errors are heteroskedasticity-robust.

Now I proceed to the second estimation for the farm sector and observe if the LTVfarm ratio in 1930 affects the economic developments in the period from 1930 to 1933. Table II presents the results and this time all the coefficients are statistically significant at least at a 10% level of confidence, except for the non-manufacturing employment[33]. On average, an increase of 10.0 percentage points in the LTVfarm ratio in 1930 translates into a decrease of 3.4 percentage points in per capita income growth rate between 1930 and 1933. Additionally, the deleveraging coefficient is now significant and has a high magnitude. For a 10.0 percentage points increase on LTVfarm in 1930, there is a 10.8 decrease on per capita leverage in the next years. This is evidence of deleveraging and it is

[33] Regarding the F-test, the null hypothesis can be rejected for all specifications at a 5% level of confidence, except for specification (5). The VIF test does not identify multicollinearity.

statistically significant at a 5% level of confidence. Regarding the impact on bank failures, for each 10.0 percentage points increase on farm leverage in 1930, there is a decrease of 11.1 percentage points on the growth rate of per capita number of banks between 1930 and 1933. At a 5% level of confidence, this is evidence supporting the fact that high leverage in the farm sector, influenced bank failures. Wages and employment are also affected by the level of leverage in 1930, however to a smaller extend. For 10.0 percentage point increase on the LTVfarm ratio, wages per capita and manufacturing employment decrease an additional 2.2 and 4.2 percentage points, respectively. The coefficient on Federal Bank's reserves is also not statistically significant in this specification.

Table II
Regression results for mortgage debt to farm value in 1930

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta INC_{s\ 1930\ 33}$	$\Delta DEBT_{s\ 1930\ 33}$	$\Delta WAGE_{s\ 1930\ 33}$	$\Delta EMPMAN_{s\ 1930\ 33}$	$\Delta EMPNMAN_{s\ 1930\ 33}$	$\Delta BANK_{s\ 1930\ 33}$
$LTVfarm_{s\ 1930}$	-0.339**	-1.083**	-0.219*	-0.422*	-0.271	-1.105**
	(0.130)	(0.441)	(0.115)	(0.246)	(0.339)	(0.514)
$PCINC_{s\ 1929}$	-0.000***	0.000	-0.000	-0.000***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$FARM_{s\ 1929}$	-0.426**	0.169	0.003	-0.125	0.249	0.387
	(0.184)	(0.264)	(0.097)	(0.177)	(0.304)	(0.270)
$MANUF_{s\ 1929}$	-0.043	0.674	-0.027	0.319	0.649**	0.730
	(0.122)	(0.436)	(0.106)	(0.300)	(0.306)	(0.462)
$WHOLRETAIL_{s\ 1929}$	-1.279***	-0.406	-0.717***	-1.571***	0.231	-1.569
	(0.276)	(0.984)	(0.248)	(0.466)	(0.542)	(1.191)
$RESDEP_{s\ 1929}$	0.527	-1.468	0.214	0.546	0.224	-0.590
	(0.429)	(1.036)	(0.339)	(0.691)	(0.910)	(1.049)
Constant	0.052	-0.226	-0.171***	0.251*	-0.298	0.119
Specification	OLS	OLS	OLS	OLS	OLS	OLS
N	49	49	49	48	48	49
R^2	0.555	0.348	0.275	0.469	0.169	0.254

Note: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Standard errors are heteroskedasticity-robust.

Before proceeding to the third estimation equation of the farm sector, I conduct

a simple graphical analysis like it was performed above: I decompose the data into states with high and low farm value appreciation[34]. Once again, one can observe that the states with larger farm value depreciation suffered a deeper fall particularly in personal income, debt, and employment (Figure 3).

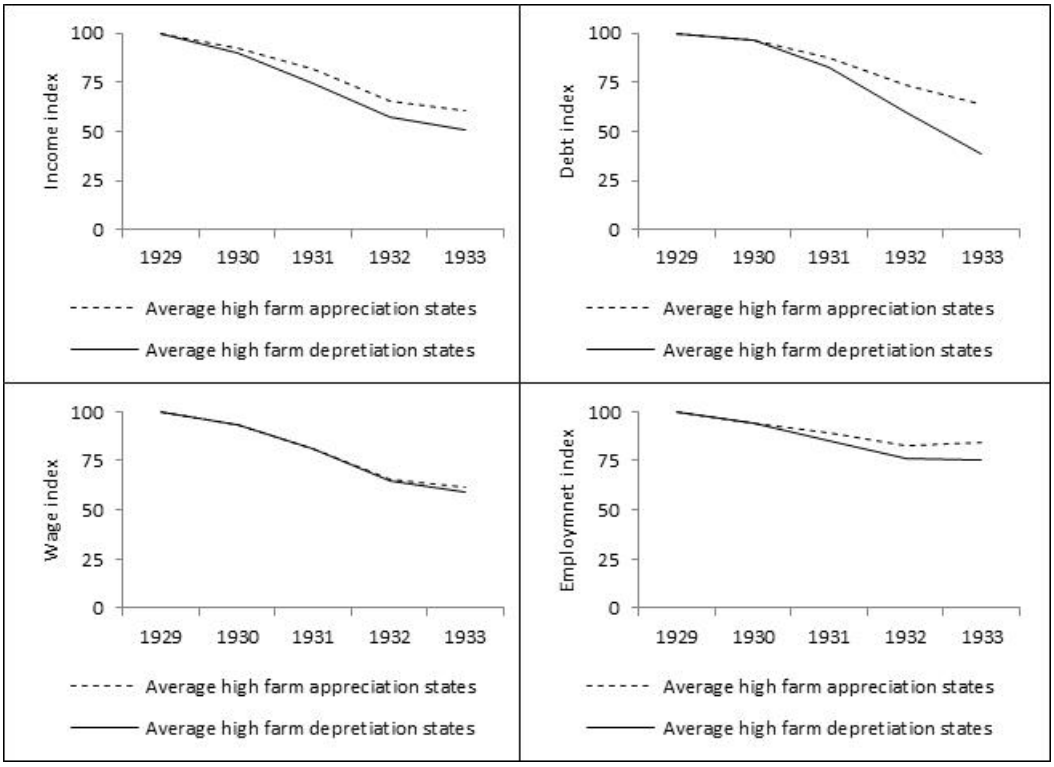

Figure 3 – Variation in income, debt, wages, and employment between 1929 and 1933 (1929=100)
State Personal Income (1999), All Bank Statistics 1896 – 1955, Census of Agriculture 1920 and 1930, and Wallis (1989)

Table III presents the results of the third estimation equation regarding this impact. The decrease in the farm value is statistically significant at a 5% level of

[34] States are divided according to percentiles; there are 8 high farm value appreciation which are in the 15% percentile, while the 7 low are the ones in the bottom 15% percentile. For the unemployment index, District of Columbia is excluded since that Wallis (1989) does not provide data for it.

confidence in all specifications, except in specifications (2) and (6)[35]. The results point towards a decrease of 0.5 to 1.6 percentage points in the dependent variables, resulting from a decrease of 10.0 percentage points in the farm value between 1920 and 1930. Therefore, there is evidence that the states where the loss in the farm value was higher were also the states where income, wages, and employment fell most. Particularly, the coefficient on income is significant at a 1% level of confidence.

Table III
Regression results for farm value variation between 1920 and 1930

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta INC_{s\ 1930\ 33}$	$\Delta DEBT_{s\ 1930\ 33}$	$\Delta WAGE_{s\ 1930\ 33}$	$\Delta EMPMAN_{s\ 1930\ 33}$	$\Delta EMPNMAN_{s\ 1930\ 33}$	$\Delta BANK_{s\ 1930\ 33}$
$FARMVAL_{s\ 1920\ 30}$	0.078***	0.125	0.049**	0.093**	0.157**	0.097
	(0.028)	(0.079)	(0.023)	(0.038)	(0.063)	(0.094)
$PCINC_{s\ 1929}$	-0.000***	0.000	-0.000	-0.000***	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$FARM_{s\ 1929}$	-0.390**	0.057	0.022	-0.089	0.442	0.217
	(0.168)	(0.265)	(0.109)	(0.194)	(0.352)	(0.320)
$MANUF_{s\ 1929}$	-0.137	0.312	-0.089	0.202	0.592**	0.345
	(0.118)	(0.409)	(0.096)	(0.250)	(0.263)	(0.439)
$WHOLRETAIL_{s\ 1929}$	-1.002***	-0.250	-0.550**	-1.250***	0.951	-1.588
	(0.308)	(1.097)	(0.259)	(0.413)	(0.656)	(1.265)
$RESDEP_{s\ 1929}$	0.696	-1.049	0.321	0.752	0.457	-0.191
	(0.423)	(1.207)	(0.328)	(0.690)	(0.739)	(1.294)
Constant	-0.102	-0.569**	-0.268***	0.064	-0.528***	-0.194
Specification	OLS	OLS	OLS	OLS	OLS	OLS
N	49	49	49	48	48	49
R^2	0.585	0.292	0.302	0.487	0.282	0.180

Note: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Standard errors are heteroskedasticity-robust.

4.2 Nonfarm sector

Like in the farm sector, I conduct a simple graphical analysis to check if there is

[35] Regarding the F-test, the null hypothesis can be rejected for all specifications at a 5% level of confidence, except for specification (6). The VIF test does not identify multicollinearity.

a potential relation between the percentage of owned homes in each state in 1930 and the economic developments in the following years. This simple approach reveals that such a relation exists (Figure 4).

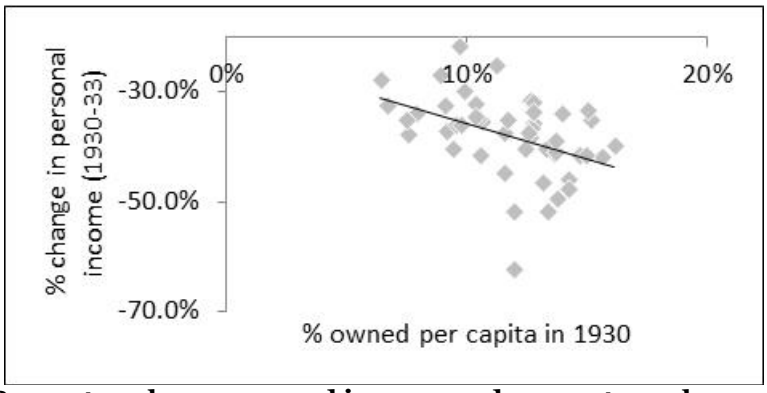

Figure 4 – Percentage homes owned in 1930 and percentage change in personal income 1930-33
Source: State Personal Income (1999) and Census of Population 1930

I then proceed to the respective estimation equation to check if this relation is robust against the inclusion of the control variables (Table IV). The percentage of per capita owned houses in 1930 is only statistically significant in specifications (1) and (3)[36]. However it is statistically significant at 1% and 5% levels of confidence, respectively. For an additional 10.0 percentage points increase on per capita owned houses in 1930, there is a decrease of 10.8 and 5.7 percentage points on the growth rate of per capita income and wages, respectively, between 1930 and 1933. In this specification, the coefficient of RESDEP is statistically significant at 10% level of confidence. On average, for an additional increase of 10.0 percentage points in the reserves-to-deposits ratio, there is an increase of 7.3 percentage points in per capita income growth between 1930 and 1933. One must note that the impact on per capita income and wages is greater in the nonfarm sector. That is consistent with the fact that

[36] Regarding the F-test, the null hypothesis can be rejected for all specifications at a 5% level of confidence, except for specifications (5) and (6). The VIF test does not identify multicollinearity.

the household mortgage debt represented a higher share of total net debt, relatively to farm mortgage debt. Therefore, a larger sector must have had a higher impact on the economic performance.

Table IV
Regression results for percentage of houses owned in 1930

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta INC_{s\ 1930\ 33}$	$\Delta DEBT_{s\ 1930\ 33}$	$\Delta WAGE_{s\ 1930\ 33}$	$\Delta EMPMAN_{s\ 1930\ 33}$	$\Delta EMPNMAN_{s\ 1930\ 33}$	$\Delta BANK_{s\ 1930\ 33}$
$OWNED_{s\ 1930}$	-1.078***	-0.371	-0.566**	-0.624	0.396	-1.051
	(0.228)	(0.843)	(0.263)	(0.525)	(0.641)	(0.909)
$PCINC_{s\ 1929}$	-0.000**	0.000	-0.000	-0.000***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$FARM_{s\ 1929}$	-0.486***	-0.152	-0.041	-0.229	0.155	0.087
	(0.152)	(0.244)	(0.099)	(0.171)	(0.326)	(0.279)
$MANUF_{s\ 1929}$	-0.108	0.274	-0.078	0.202	0.552	0.363
	(0.102)	(0.421)	(0.095)	(0.266)	(0.333)	(0.436)
$WHOLRETAIL_{s\ 1929}$	-1.171***	-0.876	-0.681***	-1.610***	0.042	-1.871
	(0.259)	(0.986)	(0.212)	(0.417)	(0.491)	(1.125)
$RESDEP_{s\ 1929}$	0.726*	-1.132	0.330	0.722	0.253	-0.181
	(0.395)	(1.248)	(0.333)	(0.726)	(0.945)	(1.280)
Constant	0.028	-0.406*	-0.191***	0.195	-0.369*	-0.042
Specification	OLS	OLS	OLS	OLS	OLS	OLS
N	49	49	49	48	48	49
R^2	0.646	0.255	0.327	0.458	0.165	0.183

Note: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Standard errors are heteroskedasticity-robust.

Regarding the impact of the decrease in house values between 1920 and 1930, figure 5 shows the simple graphical analysis[37], and the results of equation (5) are shown in table V. The variation in the value of houses of the household sector is statistically significant at 10% and 5% levels of confidence in specifications (2) and (5), respectively[38]. On average, 10.0 percentage point's decrease in the

[37] States are divided according to percentiles; there are 8 high house value appreciation states which are in the 15% percentile. The 9 high house value depreciation states are the ones in the bottom 15% percentile. For the unemployment index, District of Columbia is excluded since that Wallis (1989) does not provide data for it.
[38] Regarding the F-test, the null hypothesis can be rejected for all specifications at a 10% level of confidence, except for specification (6). The VIF test does not identify multicollinearity.

house prices between 1920 and 1930, leads to an additional fall in the growth rate of loans and of non-manufacturing employment of 3.0 and 2.7 percentage points, respectively. This is evidence that the decrease in house prices led to deleveraging and to lower employment in some sectors of the economy, and gives some support for the wealth channel described.

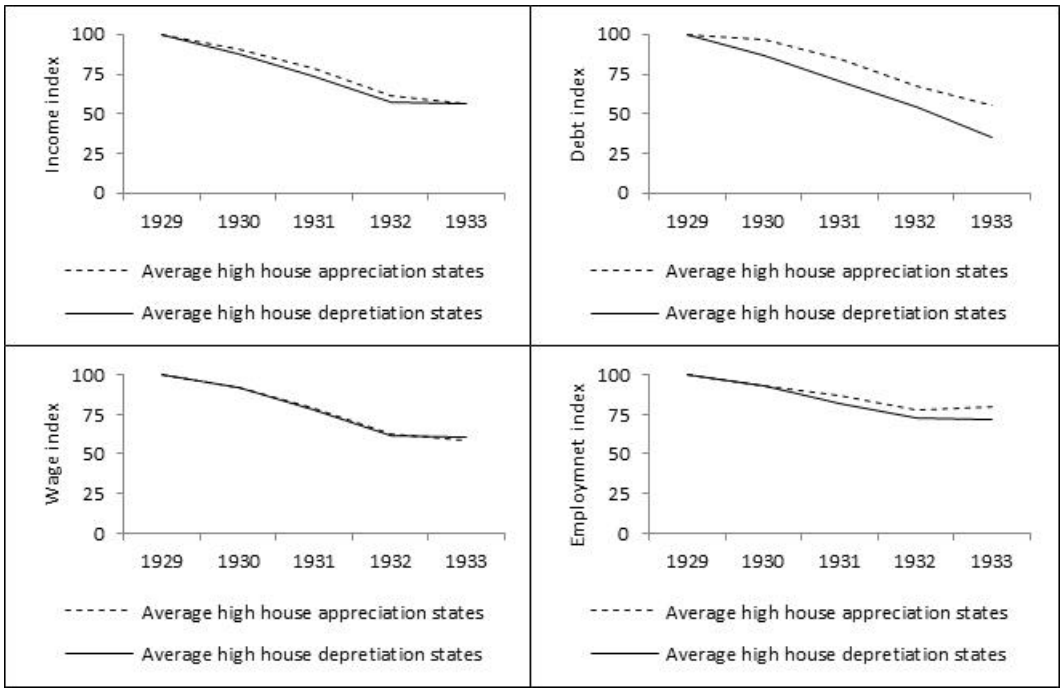

Figure 5 – Variation in income, debt, wages, and employment between 1929 and 1933 (1929=100)
State Personal Income (1999), All Bank Statistics 1896 – 1955, Mortgages on Homes 1920, Census of Population 1930 and 1930, and Wallis (1989)

Table V
Regression results for house value variation between 1920 and 1930

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta INC_{s\ 1930\ 33}$	$\Delta DEBT_{s\ 1930\ 33}$	$\Delta WAGE_{s\ 1930\ 33}$	$\Delta EMPMAN_{s\ 1930\ 33}$	$\Delta EMPNMAN_{s\ 1930\ 33}$	$\Delta BANK_{s\ 1930\ 33}$
$HOUSEVAL_{s\ 1920\ 30}$	0.021	0.296*	0.023	-0.098	0.269**	-0.002
	(0.049)	(0.163)	(0.044)	(0.106)	(0.112)	(0.177)
$PCINC_{s\ 1929}$	-0.000***	-0.000	-0.000*	-0.000***	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$FARM_{s\ 1929}$	-0.536***	-0.234	-0.070	-0.222	0.092	0.043
	(0.167)	(0.240)	(0.088)	(0.160)	(0.322)	(0.294)
$MANUF_{s\ 1929}$	-0.202	-0.132	-0.143	0.344	0.127	0.300
	(0.171)	(0.426)	(0.143)	(0.271)	(0.255)	(0.449)
$WHOLRETAIL_{s\ 1929}$	-1.497***	-1.549*	-0.876***	-1.491***	-0.553	-2.146**
	(0.327)	(0.913)	(0.259)	(0.441)	(0.516)	(1.006)
$RESDEP_{s\ 1929}$	0.611	-1.313	0.263	0.697	0.183	-0.283
	(0.449)	(1.070)	(0.362)	(0.748)	(0.893)	(1.247)
Constant	0.013	-0.109	-0.186**	0.056	0.047	-0.080
Specification	OLS	OLS	OLS	OLS	OLS	OLS
N	49	49	49	48	48	49
R^2	0.512	0.317	0.229	0.451	0.253	0.157

Note: standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Standard errors are heteroskedasticity-robust.

4.3 Econometric considerations

4.3.1 Simultaneity

When estimating the impact of LTV ratios, property values, and the percentage of per capita owned houses on the economic performance of the state, one must be alert to the fact that those variables are simultaneously determined. The explanatory variables used, however, refer to previous years relatively to the dependent variables: while the LTV ratios, property values, and the percentage of per capita owned houses are for the years between 1920 and 1930, the independent variables correspond in general to the early 1930s. This type of estimation helps to overcome the possibility of simultaneity between the variables since that it is hard to argue that the lagged values in the 1920s were

influenced by shocks in the 1930s.

4.3.2 Omitted variable

One could also argue that the explained and explanatory variables are influenced by an omitted variable that creates the illusion of correlation between them. One could argue for instance that it was the monetary expansion conducted in the 1920s that influenced the housing market bubble, boosting high levels of leverage, and that the monetary contraction of the 1930s lead to the Depression. However, controlling for the reserves in Federal Reserve Banks does not seem to have much impact on the estimation equations. Besides, regarding farm properties' values, its collapse during the 1920s was most certainly the consequence of specific sectorial distress. Additionally, within the housing sector, White (2009) finds little evidence supporting the fact that the mortgage interest rates fuelled the housing boom of the 1920s because of the «very small declines and the lower rates that persisted before the founding of the Federal Reserve» (p. 28)[39]. More data is needed to understand what led to differences in leverage and house prices within the states in the 1920s, in order to understand the factors behind the differences in economic performance during the 1930s[40].

4.3.3 Spatial correlation

[39] However, if one sees stability as easing monetary policy, then the Federal Reserve may have contributed to the boom. White (2009) also points other potential causes for the housing boom such as the diffusion of the use of the automobile, the financial innovations and new intermediaries, and the lack of housing units because of the First World War. These factors could have affected the house prices and leverage in the states differently.

[40] Authors are still discussing the causes of the housing boom of the 1920s. See for instance White (2009), and Brocker and Hanes (2012). Regarding the Great Recession, Mian and Sufi (2011) relate the house price increase to the housing supply elasticity in each region. However this kind of index is not available for the 1920s.

The economic performance in one state may affect the performance in the neighbour states, i.e. spatial correlation. If spatial correlation exists, then the OLS estimators can be inconsistent. Garret and Wheelock (2006) found evidence «that state income growth was also influenced by the income growth of its neighbors» (p. 17) during the Great Depression. This may represent a limitation to the present work and future research on this field should try to overcome it. However, according to econometric manuals, spatial correlation is usually ignored:

> *While standard estimation methods—such as ordinary least squares and two-stage least squares—can usually be applied in these cases, the asymptotic theory needs to be altered. (…) spatial correlation is often ignored in applied work because correcting the problem can be difficult. (…) If the correlation arises mainly through the explanatory variables (…) then (…) nothing needs to be done. (…) When the unobservables are correlated across nearby geographical units, OLS can still have desirable properties—often unbiasedness, consistency, and asymptotic normality can be established—but the asymptotic arguments are not nearly as unified as in the random sampling case, and estimating asymptotic variances becomes difficult.*
>
> In Wooldridge (2002), p.6, p. 134

Accordingly, the work that has been developed on the role of debt at state or county level, has not taken into account spatial correlation (for example, Mian et al., 2011; Brocker and Hanes, 2012). Such an assessment would need an extensive approach beyond the scope of this work, and usually it has been

conducted in studies that focus the spatial correlation (Heitfield et al., 2010).

5 Conclusion

This work studies the impact of higher leverage and of higher losses in house and farm values, during the Great Depression, at the state level. The results point towards a relation between the level of leverage in the 1920s and the economic performance in the 1930s for both the farm and the household sectors. The results are stronger for the farm sector, although the magnitude is usually smaller. I have studied the impact in six macroeconomic variables and the main conclusions are as follows.

First, the states where the mortgage debt to farm value was higher in 1930, suffered a larger fall in personal income, debt, wages, manufacturing and non-manufacturing employment, and in the number of banks; specifically, 10 percentage points increase in that ratio, translates into an additional decrease of 3.4 p.p., 10.8 p.p., 2.2 p.p., 4.2 p.p., and 11.1 p.p., respectively. Therefore there is evidence that higher indebtedness in the farm sector led to worst performance in the macroeconomic variables studies.

Second, the states where farm values dropped the most between 1920 and 1930 experienced deeper declines in personal income, wages and both manufacturing and non-manufacturing employment; particularly, 10 percentage points increase in that ratio, translates into an additional decrease of 0.8 p.p., 0.5 p.p., 0.9 p.p., and 1.6 p.p., respectively. Accordingly, the higher the decrease in wealth from the decline in farm values, the lower was income, wages, and employment.

Third, using the proxy for leverage in the household sector, I show that the states where the number of owned houses was greater in 1930 went through sharper losses in personal income and wages; 10 percentage points increase in that variable, translates into an additional decrease of 10.8 p.p. and 5.7 p.p., respectively; the impact of leverage on personal income and wages is greater in the household sector than in the farm sector. Hence, using this proxy, there is evidence that higher indebtedness in the household sector led to larger drops in income and wages.

Fourth, states that experienced the larger decreases in house values between 1920 and 1930 had higher unemployment in the non-manufacturing sector and reduced debt more between 1930 and 1933; 10 percentage points increase in that ratio, translates into an additional decrease of 2.7 p.p. and 3.0 p.p., respectively. Finally, the higher the decrease in wealth from the decline in house values, the lower was debt and employment.

The results are consistent with King (1994), Gjerstad and Smith (2013), and with the findings in Brocker and Hanes (2012). These results coupled with similar conclusions regarding the Great Recession of 2008-2009, suggest that monetary policy should be alert to the development of housing bubbles since that they have the potential to constrain consumption expenditure once the house values stop increasing. If the aggregate consumption expenditure is driven downwards because of high leverage households, then the additional high powered money provided by the monetary authorities is not sufficient to stimulate demand because households cannot afford additional leverage.

However, there are some limitations in this work which should be addressed in later research. First, when measuring the deleveraging between 1929 and 1933, it was only considered the total deposits in commercial and mutual savings banks; however the main share of mortgage debt was concentrated in the life insurance companies, in the Building & Loans Associations, and in the non-institutional lenders (Snowden, 2010, p. 5); therefore additional data, if and when available, should be included in this analysis. Second, because of the inexistence of the mortgage debt to house value ratio in 1930 in the nonfarm sector, I proxy leverage with the number of owned houses; however, that is hardly the same and the number of owned houses does not capture the extent to which households are indebted. Third, house values in 1920 and in 1930 are not exactly comparable but they are the best information available; as was mentioned, the values in 1920 reflect the average for mortgaged houses while in 1930 it refers to median values for both mortgaged and non-mortgaged houses; new estimates about the housing prices can help to unveil the real magnitude of the impact on the balance sheets[41]. Fourth, this work does not consider spatial correlation because it is beyond its scope; additional research should focus in this particularity in order to confirm if the results hold.

Concluding, the results are consistent with the following description: farmers and households whose mortgage debt was a higher share of their property value, i.e. more indebted, before the Great Depression, became constrained when farm and house values ceased to rise and started to fall. The decrease in wealth,

[41] A note should be given in this regard: usually scholarships rely on the house price index developed by Grebler et al. (1956). However, Fishback and Kollman (2013) claim that it understates the house price appreciation of the 1920s and overstates the house price recovery in the 1930s; hence the deterioration of households' balance sheets could have been greater than usually considered, and consequently, the impact on consumption could have been larger.

which was prior to the beginning of the Great Depression, combined with falling income and prices after 1930, created pressure on their balance sheets. Consequently, they cut on consumption expenditure, leading firms to cut on production and employment. Eventually, the distress in farmers and households balance sheets led to default and foreclosures which contributed to higher deleveraging in more indebted states.

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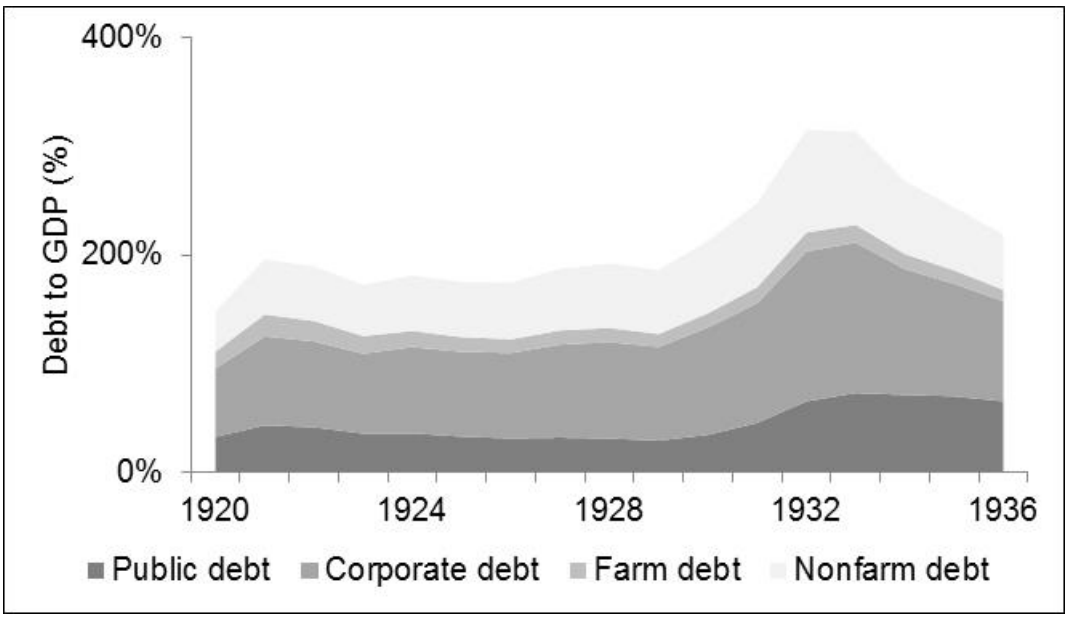
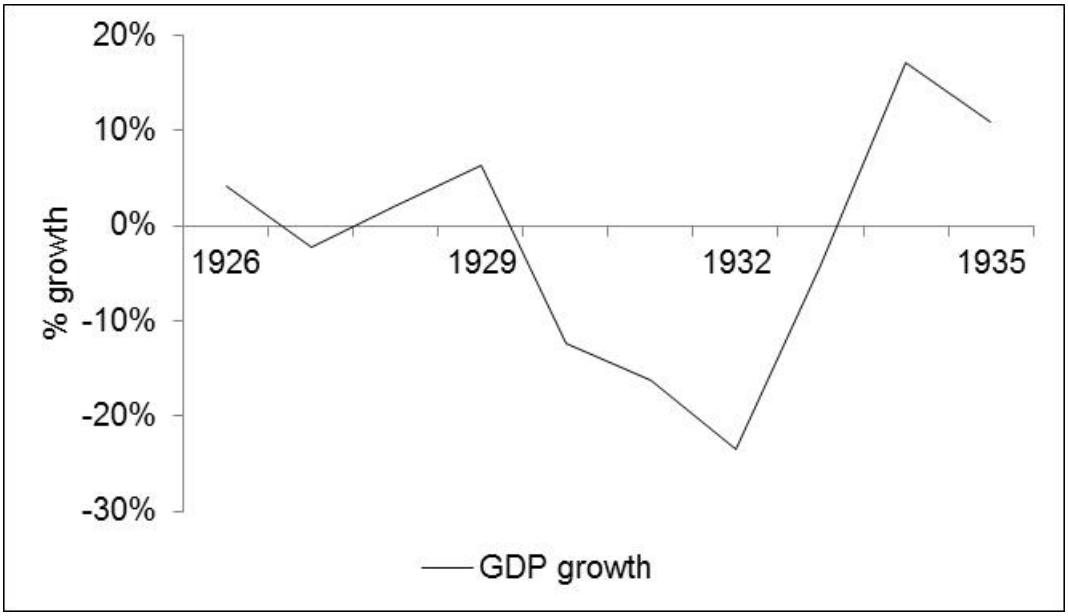
Appendix A: summary statistics

	N	Mean	Min	Max	sd	10^{th}	90^{th}
Dependent variables (per capita, except for employment index)							
Δ $INC_{s\ 1929\ 33}$	49	-0.47	-0.68	-0.28	0.07	-0.54	-0.38
Δ $DEBT_{s\ 1929\ 33}$	49	-0.57	-0.88	-0.23	0.15	-0.73	-0.37
Δ $WAGE_{s\ 1929\ 33}$	49	-0.43	-0.52	-0.27	0.05	-0.48	-0.37
Δ $EMPMAN_{s\ 1929\ 33}$	48	-0.33	-0.54	-0.04	0.10	-0.42	-0.20
Δ $EMPNMAN_{s\ 1929\ 33}$	48	-0.19	-0.56	0.06	0.12	-0.33	-0.04
Δ $BANK_{s\ 1929\ 33}$	49	-0.41	-0.71	-0.05	0.15	-0.56	-0.19
Control variables							
$PCINC_{s\ 1929}$	49	624.20	266.00	1273.00	237.99	338.00	956.00
$FARM_{s\ 1929}$	49	0.15	0.00	0.41	0.10	0.02	0.30
$MANUF_{s\ 1929}$	49	0.16	0.02	0.34	0.08	0.05	0.29
$WHOLRETAIL_{s\ 1929}$	49	0.14	0.08	0.19	0.02	0.12	0.17
$RESDEP_{s\ 1929}$	49	0.06	0.04	0.10	0.02	0.04	0.08
Independent variables							
$LTVfarm_{s\ 1925}$	49	0.41	0.26	0.49	0.04	0.36	0.45
$LTVfarm_{s\ 1930}$	49	0.37	0.23	0.50	0.05	0.31	0.43
$OWNED_{s\ 1930}$	49	0.12	0.06	0.16	0.02	0.09	0.15
$FARMVAL_{s\ 1920\ 30}$	49	-0.07	-0.61	0.64	0.33	-0.43	0.30
$HOUSEVAL_{s\ 1920\ 30}$	49	-0.12	-0.70	0.30	0.22	-0.37	0.15

Appendix B: debt-to-income ratio and GDP growth

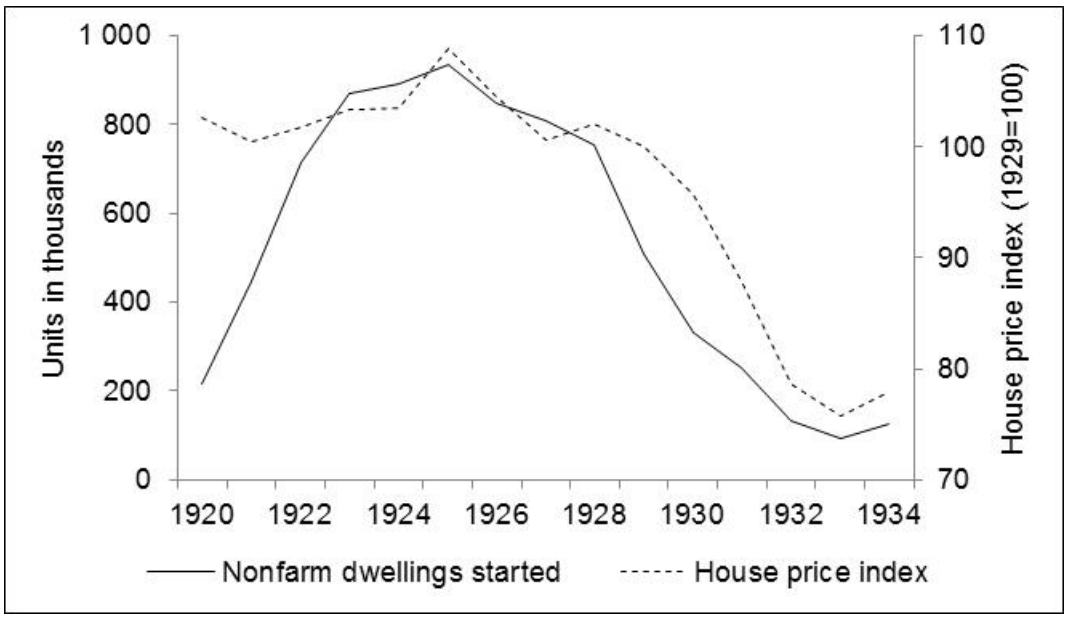


Debt to GDP ratio, nominal, annual
Source: Historical Statistics of the United States Colonial Times to 1970 in tables F1-9 and X393-409



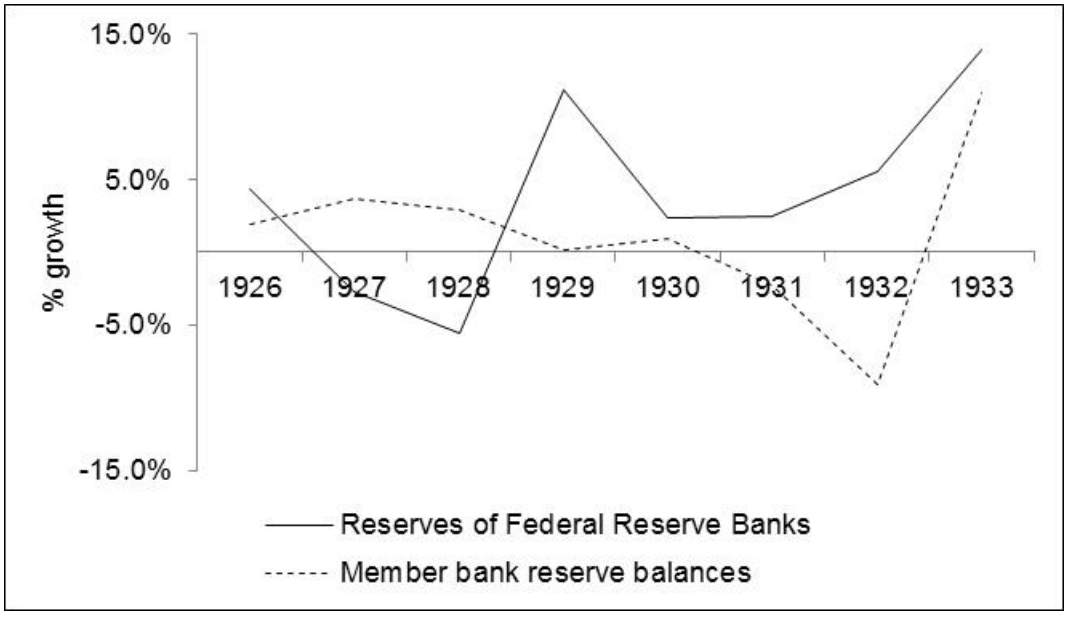
GDP growth rate, annual
Source: Historical Statistics of the United States Colonial Times to 1970 in tables F1-9

Appendix C: Housing starts and house price index



Nonfarm dwelling units started and nominal house price index (22 cities), 1929=100
Source: Grebler et al. (1956), Tables B-1 and C-1

Appendix D: reserves at Federal Reserve Banks and Member Banks



Growth rate of reserves at 12 Federal Reserve Banks and member banks
Source: Banking and Monetary Statistics 1914-1941, Table 87 and 101

Appendix E: variation in main categories and sectors of GDP; variation in debt components

Variation in main categories and sectors of GDP from 1929 to 1933 (no data prior to 1929 from this source)

GDP component	% nominal variation between 1929 to 1933	% of GDP in 1929
Nonfarm residential investment	-86,8%	3,7%
Farm residential investment	-75,0%	0,2%
Durables investment	-73,2%	5,4%
Durables consumption	-62,0%	8,9%
Non durables consumption	-40,8%	36,6%
Services consumption	-33,7%	29,4%
GDP sectors		
Farm	-52,6%	9,4%
Nonfarm	-48,1%	82,8%
Households	-41,4%	2,8%

Source: Historical Statistics of the United States Colonial Times to 1970 - tables F1-9, F36-46

Variation in debt components

Debt components	% nominal variation between 1920 to 1928	% variation between 1929 to 1933
Nonfarm - mortgage	153.0%	-15.7%
Nonfarm - consumer	110.0%	-45.1%
Corporate (long-term)*	49.2%	1.3%
Nonfarm - commercial	11.9%	-21.4%
Farm - mortgage	-3.9%	-19.8%
Farm - production	-30.8%	-46.2%
Corporate (short-term)	na	-30.3%

Source: Historical Statistics of the United States Colonial Times to 1970 in tables X393-409
(*) For the period 1920-28, corporate debt includes both short and long term

Appendix F: mortgage loan to farm value ratios, 1925 and 1930; farm value variation 1920-1930; by states, ordered by largest percentage loss in farm value

State	LTVfarm 1925	Rank 1925	LTVfarm 1930	Rank 1930	ΔFarm value 1920-30
Montana	44.7%	6	39.5%	14	-61.5%
South Dakota	42.7%	15	38.6%	21	-59.5%
North Dakota	41.1%	25	38.1%	26	-58.3%
Iowa	49.2%	1	48.5%	2	-48.5%
Missouri	44.6%	7	45.4%	3	-45.0%
Minnesota	43.6%	12	44.6%	4	-43.1%
Idaho	45.0%	5	39.1%	19	-42.6%
Illinois	40.8%	28	43.8%	5	-41.4%
Colorado	42.6%	16	38.4%	22	-39.9%
Nebraska	42.2%	19	38.7%	20	-37.0%
Indiana	39.8%	31	40.2%	9	-36.5%
Oklahoma	39.7%	32	33.6%	37	-33.5%
Wyoming	44.2%	9	33.5%	39	-31.3%
Kentucky	43.3%	13	38.4%	24	-29.0%
Arkansas	40.1%	30	38.2%	25	-28.4%
South Carolina	40.6%	29	40.1%	10	-28.3%
Georgia	41.8%	21	39.8%	11	-28.2%
Arizona	36.7%	42	31.2%	45	-26.2%
Wisconsin	49.0%	2	50.2%	1	-24.5%
Kansas	39.0%	34	35.4%	33	-24.2%
New Mexico	37.1%	41	30.6%	47	-24.0%
Michigan	42.5%	17	41.5%	8	-19.2%
Tennessee	41.0%	27	38.4%	23	-18.5%
Ohio	43.8%	11	42.9%	6	-13.8%
Texas	35.3%	45	32.7%	41	-8.4%
Utah	44.2%	8	34.8%	34	-2.4%
Mississippi	41.2%	24	37.2%	29	-0.4%
Vermont	46.4%	3	42.7%	7	1.1%
Louisiana	42.9%	14	38.1%	27	2.5%
Washington	37.2%	39	32.7%	42	9.6%
Maryland	42.4%	18	39.3%	17	11.4%
Virginia	35.1%	46	31.6%	43	11.5%
Oregon	37.7%	37	34.4%	35	11.7%
New Hampshire	39.5%	33	36.1%	32	12.0%
Nevada	45.2%	4	39.4%	16	12.1%
New York	41.6%	22	39.2%	18	12.1%
Maine	41.3%	23	33.8%	36	14.2%
Alabama	41.9%	20	39.7%	12	15.0%
West Virginia	35.9%	44	31.1%	46	18.7%
Pennsylvania	41.1%	26	39.5%	15	21.2%
Delaware	43.8%	10	39.7%	13	23.9%
California	33.8%	48	31.2%	44	25.1%
Connecticut	37.6%	38	33.6%	38	25.8%
North Carolina	36.4%	43	37.2%	30	29.3%
Massachusetts	37.2%	40	36.1%	31	33.3%
Florida	25.8%	49	27.1%	48	57.9%
New Jersey	38.9%	35	37.2%	28	59.1%
District of Columbia	34.7%	47	23.3%	49	61.0%
Rhode Island	38.0%	36	33.2%	40	64.3%

Appendix G: percentage of per capita owned houses, 1930; house value variation 1920-1930; by states, ordered by largest percentage loss in house value

	% houses owned per capita 1930	ΔHouse value 1920-30
New Mexico	12.7%	-69.8%
South Carolina	6.4%	-45.1%
Arizona	10.6%	-45.0%
Florida	10.5%	-44.0%
Nevada	12.6%	-37.3%
Georgia	6.7%	-37.1%
Montana	13.3%	-34.4%
Oklahoma	9.4%	-34.1%
Louisiana	7.9%	-34.1%
Wyoming	11.7%	-31.9%
Arkansas	9.1%	-31.1%
Mississippi	7.5%	-30.9%
Idaho	13.3%	-27.7%
North Dakota	11.9%	-25.6%
South Dakota	11.9%	-25.5%
Virginia	11.2%	-24.8%
Texas	9.5%	-22.4%
North Carolina	8.8%	-22.3%
Alabama	7.5%	-21.9%
Tennessee	10.3%	-19.1%
Iowa	13.8%	-16.3%
West Virginia	9.7%	-16.0%
Utah	13.7%	-14.9%
Colorado	12.7%	-14.5%
Kansas	14.2%	-12.2%
Nebraska	13.1%	-11.0%
Indiana	14.6%	-8.3%
Delaware	12.6%	-6.7%
Maine	15.0%	-5.4%
Minnesota	13.6%	-4.0%
Kentucky	15.1%	-3.5%
Michigan	14.2%	-2.4%
New Hampshire	13.9%	0.6%
Oregon	16.1%	0.6%
Missouri	12.6%	3.2%
Ohio	13.7%	3.8%
Washington	15.6%	5.5%
Pennsylvania	12.4%	7.0%
Connecticut	10.6%	8.6%
New York	9.1%	9.3%
Wisconsin	14.9%	10.6%
California	12.7%	11.7%
Massachusetts	10.3%	13.8%
Illinois	11.6%	14.2%
Vermont	14.7%	18.7%
Maryland	12.7%	21.2%
Rhode Island	9.8%	21.4%
New Jersey	11.6%	21.7%
District of Columbia	9.7%	30.0%

Appendix H: percentage loss in main variables, per capita, 1929-33, by states, ordered by largest percentage loss in personal income

Per capita	ΔIncome 1929-33	ΔDebt 1929-33	ΔWages 1929-33	ΔEmployment 1929-33	Δ# Banks 1929-33
South Dakota	-67.6%	-65.7%	-37.5%	-17.2%	-46.5%
North Dakota	-60.3%	-64.9%	-45.6%	-20.0%	-55.3%
Michigan	-56.2%	-79.3%	-51.6%	-31.9%	-65.0%
Iowa	-56.0%	-77.1%	-43.3%	-22.1%	-67.7%
Idaho	-54.6%	-69.3%	-44.6%	-28.1%	-39.5%
Mississippi	-54.4%	-64.0%	-46.3%	-32.5%	-33.2%
Illinois	-53.9%	-66.4%	-50.7%	-29.6%	-53.9%
Nebraska	-53.4%	-69.3%	-39.0%	-23.4%	-54.5%
Kansas	-52.6%	-54.7%	-41.7%	-15.0%	-27.7%
Indiana	-51.6%	-67.8%	-49.5%	-33.4%	-51.3%
Oklahoma	-51.4%	-58.8%	-47.1%	-28.1%	-38.2%
Wisconsin	-50.5%	-61.7%	-48.0%	-33.4%	-59.9%
Ohio	-50.0%	-61.0%	-48.3%	-28.1%	-40.9%
Arkansas	-49.8%	-72.3%	-42.5%	-31.9%	-53.4%
Montana	-49.8%	-68.1%	-49.1%	-42.5%	-39.3%
Washington	-49.4%	-54.6%	-48.6%	-30.6%	-48.0%
Alabama	-48.8%	-60.8%	-46.9%	-27.4%	-42.4%
Arizona	-48.5%	-71.0%	-48.5%	-55.8%	-55.8%
New Mexico	-48.3%	-67.0%	-39.3%	-31.0%	-32.3%
Minnesota	-48.0%	-48.0%	-40.5%	-21.3%	-40.1%
Kentucky	-47.8%	-53.5%	-42.4%	-19.8%	-29.0%
Vermont	-46.7%	-33.2%	-44.6%	-18.3%	-17.8%
Oregon	-46.5%	-65.2%	-46.3%	-21.1%	-55.5%
Texas	-46.5%	-52.6%	-41.5%	-27.5%	-32.7%
Tennessee	-46.2%	-53.8%	-41.6%	-26.5%	-35.6%
Missouri	-46.2%	-59.5%	-43.2%	-22.2%	-53.3%
Utah	-46.1%	-53.1%	-45.1%	-33.8%	-35.8%
Pennsylvania	-45.8%	-49.8%	-45.7%	-25.3%	-36.3%
New York	-45.5%	-39.0%	-44.5%	-14.1%	-30.5%
Delaware	-45.3%	-38.4%	-41.7%	-16.3%	-6.8%
Wyoming	-45.0%	-47.5%	-43.6%	-34.3%	-28.7%
Louisiana	-44.9%	-64.7%	-39.9%	-27.7%	-41.1%
California	-44.9%	-38.8%	-40.7%	-24.9%	-40.6%
Florida	-44.3%	-78.8%	-41.5%	-8.2%	-48.9%
Colorado	-44.2%	-62.5%	-43.6%	-38.0%	-49.2%
West Virginia	-43.8%	-53.5%	-42.7%	-13.5%	-46.9%
Nevada	-43.0%	-87.9%	-44.0%	-35.6%	-70.5%
Connecticut	-42.9%	-25.2%	-45.1%	-23.0%	-19.4%
New Jersey	-42.9%	-45.7%	-44.7%	-20.3%	-31.8%
Georgia	-41.3%	-51.7%	-36.7%	-20.2%	-28.1%
New Hampshire	-39.2%	-23.0%	-40.0%	-14.8%	-10.8%
Maryland	-39.0%	-63.7%	-37.5%	-16.3%	-45.5%
Maine	-38.1%	-47.0%	-36.5%	-6.2%	-41.0%
Massachusetts	-38.1%	-31.3%	-39.9%	-19.5%	-14.4%
North Carolina	-37.9%	-71.5%	-36.0%	1.2%	-55.7%
Rhode Island	-35.9%	-27.6%	-38.7%	-16.8%	-4.8%
South Carolina	-35.7%	-83.0%	-29.8%	-8.5%	-49.7%
Virginia	-34.5%	-45.0%	-32.1%	-15.4%	-33.7%
District of Columbia	-28.4%	-58.2%	-26.7%	na	-55.5%