HOUSEHOLD DEBT IN EMPIRICAL MACROECONOMICS: A SURVEY

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What is the role of household debt over the business cycle? A common finding of the literature is that household debt expansions predict long and deep recession. However, what lies behind the statistical relationship is still a matter of debate. Motivated by this puzzle, this survey paper is a journey into the post-2007 empirical literature on the relationship between household debt expansions, economic cycles, and crises. In order to do so, several nested or encompassing models of such a relationship are constructed and presented to encompass the approaches proposed by the literature. Accordingly, the reader can easily move through the reviewed papers and quickly identify variables, methods, and channels of transmission from debt to the business cycle. It turns out that the post-2007 literature can be organized in three big sections: panel-data models for output and consumption; cross-sectional models for output and consumption during the Great Recession; multi-variate auto-regression models of credit aggregates, business cycle, and monetary policy.

INTRODUCTION

What is the role of household debt over the business cycle? In order to address such a question, this paper documents the relationship between household debt and economic fluctuations by way of a survey of the post-crisis empirical contributions in macroeconomics. In the last decade, interest has grown in searching for the links between household and mortgage credit expansions and contractions in economic activity. An influential research program disclosed an empirical regularity according to which household debt expansions, although boosting output growth in the short run, are followed by sharp contractions in economic activity in the medium-run. However, a number of interpretations have been proposed for such an empirical result. They will be exposed throughout the survey.

Certainly, debt and financial crises are not recent phenomena. Economic history is a record of episodes of boom-and-bust in credit aggregates, speculations, banking and financial crises, and deep recessions. The 1720 bubble of the South Sea Company, the 1760s credit expansion

and the 1772 panic in Europe, the explosion of commercial papers backed by claims on the North America Western lands and the subsequent panic in 1796-97 are clear historical examples. In macroeconomic research, debt and financial factors generally peek out after great and protracted contractions in economic activity. The Great Depression led Fisher (1933) to develop the debt-deflation theory. Likewise, Kindleberger (1978), and Minsky (1986) formulated original theories of fluctuations driven or amplified by debt expansions. Their scholarship influenced several researchers to revisit, update, and extend their pioneering contributions. Some examples are the real cost of credit intermediation channel of the Great Depression (Bernanke, 1983), the liquidity hypothesis and the role of households' balance sheet (Mishkin, 1978; Mishkin et al., 1977), the debt-deflation theory and the early 1990s recession in U.K. and U.S. (King, 1994), and the debt-driven business cycle hypothesis (Palley, 1994).

The response of macroeconomic research to the impact of the Great Financial Crisis and the Great Recession confirms the aforementioned trend. The post-2007 state of macroeconomics testifies a revival of the research on debt and business cycle, in both theoretical and empirical research.[1] Therefore, this survey focuses on a subset of such revival, namely the empirical study of the relationship between household debt and business cycle using aggregate data. Albeit the contributions produced on this topic are several, the survey can be considered a representative sample and it covers most of the empirical specifications employed as well as most of the competing interpretations of the observed relationship. Moreover, it is motivated by two main reasons: organize the existing literature, and attempt to provide a view on the state-of-art of it. In order to do so, along the survey, several encompassing models of the relationship between debt, consumption and output will be constructed to encompass the various approaches provided by the literature. As a result, the reader will easily move through the various contributions. A rather common finding of the literature is that household debt expansions are followed by long and deep recessions, thus suggesting a role for credit cycles for the business cycle. However, the reason why such a correlation is observed is still a matter of debate. Therefore, the nested models offer a conceptual framework through which to reflects about the variables used by and the diverse channels of transmission highlighted by the literature.

It is useful to introduce a toy example to get familiarity with nested models.[2] Suppose that two researchers are independently working on measuring the variation in some variable y. Each researcher has a different theory about which explanatory to choose. Alice selects the model $y = \alpha_1 + \alpha_2 x_1 + u$ while Bob selects the model $y = \beta_1 + \beta_2 x_2 + v$. Bob's model can not be viewed as a restricted version of Anne's one, and vice-versa. They are non-nested models. However, to compare the relative performance of Alice's and Bob's model in fitting the data a nested or encompassing model can be constructed. In this case, the encompassing model would be $y = \gamma_0 + \gamma_1 x_1 + \gamma_2 x_2 + \varepsilon$, which contains both non-nested models as special cases when γ_1 and γ_2 are restricted to zero, respectively. In order to test for the best model,

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1 An account of the several theories of financial factors in economic fluctuations is not the scope of this paper. However, the interested reader might find useful the extensive surveys in Hein (2017) and Brunnermeier et al. (2012) which provide different perspective on the role of finance in macroeconomics. An older but still classic survey on the topic is Gertler (1988). Moreover, this paper does confront neither with the literature on the finance-growth nexus nor with the literature on household debt and spending using household-level data (for which a fundamental reference on the latter is Dynan et al., 2012).

2 This example is borrowed from Brooks (2019) and adapted here.

tests of significance of γ_1 and γ_2 can be conducted. This is the philosophy that inspired the construction of nested models to sum-up the literature in this survey.

The post-crisis empirical literature on household debt in macroeconomics can be divided into three categories. The first category covers panel-data studies which study the relationship between household debt and macroeconomics mostly for advanced countries in the last five decades. The second category collects the cross-sectional studies on the Great Recession. The third category comprehends vector auto-regressions studies on the U.S. relationship between credit aggregates, real activity, and monetary policy. The encompassing models reveals that output and consumption dynamics can be explained by a combination of variables which are then organized in Credit, Housing, Real Activity, Wealth, and Openness blocks. Hence, each model in the reviewed papers can be viewed as a restricted version of a more general model. Accordingly, household leverage variables, results, and channels of transmission which explain the negative relationship between debt growth and economic activity are presented, compared, and discussed.

The remained of the paper is organized as follows. Section 1 builds two encompassing models to encompass the contributions studying the output and consumption effects of household debt using single regression specifications on panel data. Section 2is devoted to empirical models of the Great Recession which exploit the cross-section variation in growth of private credit to explain the harshness of the economic contraction. Therefore, two encompassing models are constructed. The first is a cross-country encompassing model while the second one models the U.S. cross-regional evidence on household mortgage debt, housing net worth, and durable consumption during the Great Recession. In Section 3, a encompassing vector auto-regression model for the U.S. economy is proposed as encompassing the literature on credit aggregates, real activity, and monetary policy. Finally, the last section is dedicated to some concluding remarks.

1 PATTERNS OF HOUSEHOLD DEBT AND BUSINESS CYCLE ACROSS TIME AND SPACE

This section deals with studies that focus on the relationship between household debt expansions and economic aggregates across time and space. Strictly speaking, the reviewed literature investigate such relationship by employing panel data analysis at country level. Moreover, it is possible to distinguish studies with a focus on the effects of household debt on GDP fluctuations from those that concentrate on changes in aggregate consumption. The former group will be analyzed first. It is essential to recall that the encompassing models presented in this and other sections of the paper are intended as tools through which organize the variables that the literature consider as being relevant for the relationship between household debt and consumption. To dispel any possible doubt, none of the encompassing model will be estimated. They should be used an instrument for an exploration of the literature on the topic.

1.1 *Faster Debt Booms, Slower Recoveries*

The model in equation 1 summarizes the post-2007 literature on the GDP effects of household debt expansions. The model nests the diverse empirical specifications in Mian et al. (2017), Drehmann et al. (2018), Jordà et al. (2016), and Bridges et al. (2017). Hence, the panel regression

in 1 spans the business cycles in mostly advanced economies throughout the last five decades. In such hypothetical model, the dependent variable, $\Delta_h \ln y_{i,t+h}$ with $h = 0, \ldots, H$, measures the h-year changes of log real GDP, for country $i = 1, \ldots, N$ in year $t = 1, \ldots, T$. The model regresses the h-year change of log real GDP on Real Activity, Credit, Openness, Housing, and Wealth variables with the independent variables lagged relative to the left hand side. Stacking the independent variables by their belonging group, it is possible to organize them into five matrices of dimension $(NT \times K)$ with K being the number of regressors in each block. Tables 1 and 2 disclose the independent variables in each block and link them to their original papers. Therefore, $\boldsymbol{\beta}'_1, \ldots, \boldsymbol{\beta}'_5$ are vectors of parameter. For example, the vector $\boldsymbol{\beta}'_1$ contains the parameters for the variables in the Real Activity block, and so on.

$$\Delta_h \ln y_{i,t+h} = \underset{(N \times 1)}{\boldsymbol{\alpha}} + \boldsymbol{\beta}_1 \times \underset{(NT \times 13)}{\textbf{Real Activity}} + \boldsymbol{\beta}_2 \times \underset{(NT \times 15)}{\textbf{Credit}} + \boldsymbol{\beta}_3 \times \underset{(NT \times 3)}{\textbf{Openness}}$$
$$+ \boldsymbol{\beta}_4 \times \underset{(NT \times 1)}{\textbf{Housing}} + \boldsymbol{\beta}_5 \times \underset{(NT \times 1)}{\textbf{Wealth}} + \varepsilon_{i,t+h} \qquad (1)$$

The Credit block in Table 1 encompasses the credit variables considered by the literature. The block distinguishes between household, non-financial firm, and government sectors. Focusing on the household sector only, Table 1 reveals that there is no consensus on which is the most appropriate measure of household leverage. One can assess household leverage by looking at the outstanding credit to the household sector comprising both loans and debt securities financed by domestic and foreign financial institutions (Bridges et al., 2017; Mian et al., 2017), or alternatively, to mortgage loans by banks (Jordà et al., 2016). Indeed, home mortgage are by far the largest item in total bank mortgages. Otherwise, new borrowing can be used as a proxy for household debt (Drehmann et al., 2018). New borrowing identifies the flow of funds from lenders to borrowers, namely the change in the total stock of bank, non-bank, and cross-border credit to households plus amortization. Moreover, further discords arise on whether the level (Bridges et al., 2017; Drehmann et al., 2018) or the growth (Bridges et al., 2017; Jordà et al., 2016; Mian and Sufi, 2009) of household debt is the most appropriate proxy to gauge household leverage.

At the light of such disagreement on household debt variables, the encompassing model in equation 1 includes the 3-year change in household debt and non-financial firm debt-to-GDP (Mian et al., 2017), the level of new borrowing and debt service-to-GDP (Drehmann et al., 2018), the annual change of mortgage and non-mortgage credit accumulated in the expansion as share of GDP in percentage point per year and in deviation from a country-specific historical mean (Jordà et al., 2016), the 3-year change in household and non-financial firm debt-to-GDP as well as the level of household and non-financial firm debt-to-GDP, all measured during the expansion and in deviation from a country-specific historical mean (Bridges et al., 2017).

Apart from the sector-based debt measures, the Credit block comprehends others credit-related indicators and variables as determinants of GDP fluctuations (see Table 1). To identify the effects of changing costs of servicing debts, changes of the interest rate on the stock of household debt are incorporated into the specification in equation 1. In order to seize the business cycle effects of changing cost of access to credit, the spread between the 3-month money market rate and the prime mortgage lending interest rate is included. The inclusion of changes in loan loss provisions is intended to capture potential pro-cyclicality between risk

in financial markets and credit supply over the business cycle.[3] Corporate credit spreads are included as indicators of tightness in non-financial business financing. The spread is obtained as a difference between a general corporate bond index and the weighted average of the 5- and 10-year government bond yields from Krishnamurthy and Muir (2017). Indeed, changes in credit spreads have predictive power for economic activity during financial crises, namely crises characterized by bank runs, credit crunches, large losses in bank equity, and widespread bankruptcies. Krishnamurthy and Muir (2017) study forty episodes of financial crises and find that they are regularly preceded by periods of high credit growth and low credit spreads. This is suggestive of *(i)* shifted credit supply, *(ii)* froth in financial markets, and *(iii)* financial instability (Kindleberger, 1978; Minsky, 1986). In fact, Krishnamurthy and Muir (2017) show that investors' risk-neutral probability of a large loss (that is the true probability of a large loss weighted by the risk premium) negatively correlates with credit growth in the years preceding a financial crisis. Hence, during credit expansions markets are froth; if lenders were correctly pricing risk, higher fragility, as measured by high leverage, would negatively correlates with changes in credit spreads. Moreover, as the economy enters into a crisis-stage, credit spreads spike and risk aversion spreads out. For example, in U.S. rising corporate credit spreads suggests "a reduction in the effective risk-bearing capacity of the financial sector and, as a result, a contraction in the supply of credit" (Gilchrist and Zakrajšek, 2012, p. 1693).

The Real Activity block encompasses the conventional macroeconomic indicators of economic activity. Real Activity variables cover GDP growth, investment, interest rates on government securities, inflation, labor market conditions, and labor productivity (see Table 2). Among other indicators, it includes a term spread between the long-term and short-term yield on government bonds. The term spread is the steepness of the yield curve and, historically, it is informative about inflation expectations and future movements in interest rates. Moreover, albeit the specification in model equation 1 is referred to advanced countries, there are sizable differences in the length and intensities of both economic expansions and contractions across countries. For this reason, the average growth of GDP per capita in the ten years preceding the recession events is included in the panel specification as a proxy of trend growth.

The Openness block comprises both the level and variation of current account-to-GDP and changes in the real effective exchange rate. As Mian et al. (2017) show, the medium run negative effects on output growth of household debt expansions are sharper when the country is running increasing current account deficits. During household debt expansions, consumption rises and private investment stagnates. At the same time, household debt booms coincide with shrinking net exports and growing imports. However, household debt booms also predict a subsequent improvement in net exports which is driven by a drop in imports of consumption goods rather than by an increase in exports. Such an evidence would suggests two interpretations of the relationship between household debt booms and international trade (Mian et al., 2017). Firstly, the observed reversal in the balance of trade would corroborate the hypothesis of consumption-driven business cycle induced by a shift in the supply of credit. Secondly, from an international finance perspective, this evidence echoes the existence of an

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3 Loan loss provisions are essentially reserves stored by banks to reduce the costs associated with potential loan losses, debtor defaults, and other adverse expected events related to the lending activity. Accordingly, changes in loan loss provisions are informative of two important phenomena. On the one hand, changing loan loss provisions provide an indication of the state of health of loans in the bank portfolio. On the other hand, they are an indicator of macroprudential policy when the loan loss provisions are explicitly required by regulators.

international transmission mechanism through which the effects of debt booms spillover across countries, as Kindleberger (1978) had foreseen.

The Housing and the Wealth blocks include the growth rate of real residential property prices and the real net worth of the household sector, respectively. The former is an indicator of variations in the value of collateral, mostly houses. Accordingly, rising house prices boost housing net worth since houses are the main source of wealth for households. In turn, the quantity and the price of credit that households can borrow through home equity loans will vary too. As a result, consumption and output might be sensitive to changes in house prices and housing wealth. These mechanisms are reminiscent of the external finance premium and of the financial accelerator (Bernanke and Gertler, 1986; Kiyotaki and Moore, 1997).

The encompassing model in equation 1 captures the empirical regularity revealed by the non-nested models in Mian et al. (2017), Drehmann et al. (2018), Bridges et al. (2017) and Jordà et al. (2016). While household and mortgage debt booms positively correlate with contemporaneous GDP growth, the correlation turns negative as GDP growth in projected further into the future. Indeed, the specification in equation 1 is well suited to be estimated with local projections (Jordà, 2005) and this is the estimation strategy chosen by the non-nested models. Through local projections, it is possible to build impulse response functions. Therefore, the local projection impulse response to a household leverage shock is the sequence of estimated parameters $\{\hat{\beta}_i^1, \ldots, \hat{\beta}_i^h, \ldots, \hat{\beta}_i^H\}$ for each time horizon $h = 0, \ldots, H$ and for country $i = 1, \ldots, N$. Thus, the $\hat{\beta}^h$ associated to a given household debt variable is positive for very low values of h but is turns negative as the horizon h increases. In contrast, GDP fluctuations are unresponsive or their response is negligible to non-financial firm debt shocks (Drehmann et al., 2018; Mian et al., 2017). Furthermore, if the model 1 is transformed into a crisis regressions, that is if the GDP response to household debt shocks is conditioned to a recession event, it turns out that faster pre-recession mortgage credit booms are associated with longer and sluggish recoveries (Jordà et al., 2016).[4]

What does drive the observed relationship between household debt and output fluctuations? The model in equation 1 can be used as a frame for the three mechanisms identified by the literature and through which rising debt could ultimately depress output.

A potential mechanism driving the observed relationship between household debt and business cycle is the credit-driven household demand channel (Mian and Sufi, 2018). This view conceives an outward shift in the supply of credit as the ultimate force generating expansions and contractions in economic activity. Potential drivers of the shift can be an influx of foreign capital in the country, financial liberalizations which spur competition between intermediaries, and the advent of securitization though which intermediaries can increase the number of loans, sell them, and transfer the risk to other market participants. In addition, a credit supply shock can materialize as a relaxation of lending standards with lenders being more willing

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4 In this case, the response of GDP growth to household debt shocks are is measured starting from the first period of recession. While, the household debt shock is measured as the growth of leverage from a given period to the eve of the recession. Jordà et al. (2016) use synthetic control methods, and link the difference between the path of the economy in a normal recession and the path in a financial crisis recession to differences in observable characteristics of the two types of recessions (financial and normal recession). This strategy is employed in order to account for the endogeneity of credit booms and to link the difference in the paths of the economy to the growth of mortgage debt, which is observable. Thus, the authors identify the effects of run-ups in mortgage and non-mortgage debt *in the neighborhood* of turning points in the business cycle. A similar regression equations is estimated by Bridges et al. (2017).

to lend to marginal borrowers. A favorable credit market sentiment may induce a further and endogenous shift in the supply of credit, possible detached from evaluations of market fundamentals. As the supply of credit shifts, interest rates fall and house prices rise. Over the boom, credit-induced rising house prices amplify the response of they economy as they encourage the growth of the construction sector and of further borrowing. In turn, the credit expansion spills over into the real economy by supporting household demand in contrast to business investment.[5] The large expansion in household leverage and in economic activity turns into a recession as some negative shock hits household demand. The emergence of such shock is uncertain but it raises the real burden of debt and reduces the spending capacity of households. Heterogeneous marginal propensities to consumer across lenders and borrowers as well as between borrowers along the wealth, income, and leverage distribution (Mian et al., 2013), the zero lower bound on nominal interest rates (Eggertsson and Krugman, 2012), price rigidity determined by fixed exchange rate regimes (Alter et al., 2018; IMF, 2017), foreclosures, potential credit crunches in conjunction with banking crises, and falling house prices (Igan et al., 2013) make the recession following a debt expansion harsher and protracted.

Another propagation mechanism from household debt cycles to business cycles goes through the slowdown in labor productivity. Indeed, periods of high private debt growth are followed by a substantial rise in unemployment and by a sizable drop in the level of labor productivity during the recession. Remarkably, the effects on unemployment rates and on productivity are persistent (Bridges et al., 2017). Such persistence suggests that periods of shortfall in aggregate demand observed after strong deleveraging events might induce an endogenous slowdown in productivity.

Finally, a different perspective on the mechanism underlying the observed relationship between debt and the business cycle is provided by Drehmann et al. (2018). Due to the nature of household debt contracts, new borrowing entails a particular schedule for the debt service. While new borrowing stimulates the economic expansion, as time goes on, it pushes up the debt service on the outstanding stock of debt which in turn depresses output growth. Thus, the lead-lag relationship between new borrowing and debt service implies that the observed medium-run downturn of GDP growth can be largely attributed to the delayed increase in debt service implied by the initial boom in new borrowing.

1.2 *The Mixed Evidence on Consumption*

In the midst of the Great Recession, Glick and Lansing (2010) found that countries with the largest upswings in household debt relative to disposable income in the period 1997-2007 were likely to experience the quickest increase in house prices over the same period and the biggest downturn in household consumption during the housing burst. Despite that, the global evidence on the consumption effects of household leverage is mixed. In fact, estimating the consumption response of household indebtedness at country level entails the estimation of an aggregate consumption function. Bearing this in mind, the model in equation 2 nests the aggregate consumption functions in Stockhammer and Wildauer (2016), Apergis (2019) and

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5 The predominance of the household sector as opposed to the business one is a crucial features of the credit-driven household demand channel. During household debt booms consumption-to-GDP ratios rise, the expenditure in durables, non-durables, and services grows, imports of consumption goods rise too whereas business investment-to-GDP remains flat (Mian and Sufi, 2018).

Hansen and Torstensen (2016). It regresses the *h*-year change of log private consumption, $\Delta_h \ln C_{i,t+h}$ with $h = 0, \ldots, H$, for country $i = 1, \ldots, N$ in year $t = 1, \ldots, T$, over a set of independent variables. Therefore, the independent variables are stacked into Real Activity, Credit, Housing, and Wealth variables such that it is possible to organize them into five matrices of dimension $(NT \times K)$ with K being the number of regressors in each block. Table 3 discloses the independent variables in each matrix and link them to their original papers. Therefore, $\beta'_1, \ldots, \beta'_4$ are vectors of parameters and each vector, say β'_2 contains the parameters associated to the variables in the Credit block. Moreover, analogously to the encompassing model in the previous section, equation 2 allows the estimation of local projections impulse response functions. With the same specification, private consumption can be alternatively replaced with durable or non-durable consumption.

$$\Delta_h \ln C_{i,t+h} = \underset{(N\times1)}{\alpha} + \beta_1 \times \underset{(NT\times7)}{\textbf{Real Activity}} + \beta_2 \times \underset{(NT\times4)}{\textbf{Credit}}$$
$$+ \beta_3 \times \underset{(NT\times6)}{\textbf{Housing}} + \beta_4 \times \underset{(NT\times3)}{\textbf{Wealth}} + \varepsilon_{i,t+h} \qquad (2)$$

The Credit block in Table 3 gathers all the credit variables considered in the aforementioned papers. They are the yearly change in the log of real household debt defined as the liability side of the household sector (Stockhammer and Wildauer, 2016), the debt service ratio defined as the ratio between the flow of interest payments plus amortization and the flow of income (Apergis, 2019), and the average growth of household debt-to-GDP in the five years preceding a recession (Hansen and Torstensen, 2016). Following Jordà et al. (2016), Hansen and Torstensen (2016) measure the response of consumption to household debt expansions using local projections and conditioning on having a recession event.

The Real Activity block encompasses some macroeconomic indicators pertinent to aggregate consumption functions as real GDP, labor income, and the lagged change in consumption to capture persistence and habits formation. The block also includes the wage share and the top 1% income share in order to seize the effects of functional and personal income inequality on consumption dynamics.

The Housing and Wealth blocks have important implications for the estimated aggregate consumption function. For example, the Housing block includes current and lagged changes in house prices as well as changes in the residential investment share of GDP. These variables might be of primary importance for consumption dynamics. For example, (Leamer, 2007) claims that the U.S. business cycle is highly dependent on housing dynamics. While, the Wealth block consists of a stock price indicator to grasp the influence of financial wealth and of stock markets dynamics on consumption.

The aforementioned papers highlight a mixed evidence on proper sign of the coefficient capturing the consumption effects of household debt expansions. While change in household debt and pre-recession household debt growth are associated with deep and long consumption slowdowns (Hansen and Torstensen, 2016; Stockhammer and Wildauer, 2016), changes in debt service ratios positively affect consumption growth (Apergis, 2019). To some extent and analogously to the findings in the previous section, the relationship between household debt and consumption is time-varying. For example, Hansen and Torstensen (2016) use local projection to estimate the dynamic response of consumption during recessions to previous

household debt expansions. The response of consumption during the earliest quarters of the recession is approximately null if not positive. However, as consumption is projected into the future as to cover the full length of the recession, coefficients turns negative and significant. Moreover, the consequences of household debt expansions are more pervasive and persistent when durable consumption is considered. In contrast, non-durable consumption is almost unaffected by the pre-recession growth of debt (Hansen and Torstensen, 2016).

A straightforward question is why measuring the consumption response to household debt expansions provides mixed results. On first assessment basis, there are two possible answers. On the one hand, measuring the consumption effects of household debt implies estimating an aggregate consumption function. Hence, it implies the estimation of a structural relationship where structural is here intended as deriving from a theoretical model of consumption. Indeed, Stockhammer and Wildauer (2016) and Apergis (2019) are transparent about such a choice. While Stockhammer and Wildauer (2016) estimate a consumption function building on an extension of Bhaduri and Marglin (1990), Apergis (2019) estimate a standard permanent income/life-cycle consumption function augmented with a debt service variables. Therefore, as Table 3 shows, they consider different independent variables and their choice is mostly driven by the theory of consumption underlying the empirical model. On the other hand, the non-nested models span highly heterogeneous countries and periods. Apergis (2019) consider aggregate household data for 32 advanced and emerging countries in the period 1999-2017; Stockhammer and Wildauer (2016) use a panel of 18 advanced countries in the period 1990-2013; Hansen and Torstensen (2016) build a panel of 64 recessions in 21 countries from 1970 to 2014. That is to say that the relationship between debt and consumption might be mediated by some institutional factors which are country-specific and evolving over time. For example, the characteristics of the housing finance system, ownership rates, the design and choice of mortgage contracts, the possibility of home equity extractions are factors which might affect the response the debt and wealth shocks (Campbell, 2012).

2 PATTERNS OF HOUSEHOLD DEBT AND BUSINESS CYCLE DURING THE GREAT RECESSION

A different strand of research program on the macroeconomic consequences of rising household debt exploits the cross-sectional variation in the growth of private and mortgage debt to explain the severity and length of the Great Recession. At a rough estimate, a first divide is possible between studies with a focus on the cross-regional variation and studies that concentrate on the cross-country variation. Not surprisingly, the first group evaluates the post-crisis performance of consumption whereas the second one focuses on output. Hence, this section is devoted to the identification of patterns of household debt, output, and consumption using the lens of cross-sectional studies at regional and international level. The cross-country studies will be analyzed first.

2.1 *Debt, International Trade, and the Great Recession Worldwide*

A common finding of the literature in this subsection is that the cross-country variation in the level of pre-crisis private and mortgage debt explains the intensity of the downturn in GDP growth during the Great Recession. Thus, in order to shed light on which credit variables

explain the most severe post-war downturn in worldwide economic activity, the model in equation 3 nests the empirical specifications proposed by Lane and Milesi-Ferretti (2011), Berkmen et al. (2012) and Zhang and Bezemer (2015). The encompassing model regresses the growth loss, $y_{i,\bar{0}9-09}$, defined as the difference between the growth forecast for 2009 ($\hat{0}9$) and the actual growth registered in that year, for country $i = 1, \ldots, N$, on Real Activity, Credit, and Openness variables. Table 4 displays the independent variables in each block and links them to their original models.

$$y_{i,\bar{0}9-09} = \underset{(N \times 1)}{\boldsymbol{\alpha}} + \boldsymbol{\beta}_1 \times \underset{(N \times 7)}{\textbf{Real Activity}} + \boldsymbol{\beta}_2 \times \underset{(N \times 6)}{\textbf{Credit}} + \boldsymbol{\beta}_3 \times \underset{(N \times 8)}{\textbf{Openness}} + \varepsilon_{i,\bar{0}9-09} \qquad (3)$$

The Credit block comprehends the private and mortgage expansion measures used in the literature as well as measures for the pre-crisis leverage of the banking system. They are 2004-2007 change in the private credit-to-GDP ratio where private credit is defined as credit issued by banks and other financial institutions to the private sector (Lane and Milesi-Ferretti, 2011), the 2007 domestic credit-to-deposit ratio (Berkmen et al., 2012; Zhang and Bezemer, 2015), the 2003-2007 cumulative bank credit growth (Berkmen et al., 2012), the 2003-2007 annual average change in total credit-to-GDP, and the 2003-2007 annual average change in mortgage credit-to-total credit (Zhang and Bezemer, 2015). The Credit block also includes a financial deregulation index to account to financial and banking sector liberalizations.[6]

The Real Activity block encompasses the pre-crisis trends in GDP growth and indicators of the economic structure of the country like the 2007 manufacturing output share of GDP. Finally, the Openness block is undoubtedly the richest set of variables and it encapsulates the current account-to-GDP ratio, the relevant exchange rate regime, and the external debt position. In addition it includes proxies for the country's position in the international trade and in the global value chain like the 2007 manufacturing output as share of exports.

The non-nested models proposed by the literature highlight that the pre-2007 growth rather than the level of private and mortgage debt predicts the sluggish output growth during the Great Recession. In terms of model parameters, the $\hat{\beta}$ associated to the credit growth variables in the Real Activity block is positive, since the effect of the crisis is measured through the growth loss. Moreover, running large current account deficits in the eve of the crisis robustly predicts the severity of the recession. Such a model would be capable to explain the cross-country variation in GDP growth during the Great Recession by pivoting on the international trade channel. In this context, the crisis spilled-over to manufacturing and export-oriented emerging countries through the contraction of global demand. Such contraction was mainly driven by slackening demand in advanced countries which were running increasing private and mortgage debt-to-income ratios at the eve of the recession.

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6 A remark about the measurement of the impact of the crisis, namely the left hand side of equation 3, is needed. Lane and Milesi-Ferretti (2011) use the GDP growth during 2008-2009 whereas Berkmen et al. (2012) use the difference between actual GDP growth in 2009 and GDP growth forecast issued by the IMF-WEO for that year. Thus, the latter essentially estimates the forecast error. Zhang and Bezemer (2015) use the difference between April 2008 IMF-WEO GDP growth forecast for 2009 and actual GDP growth for that year - growth loss. Hence, growth loss corresponds to the negative forecast error. Lane and Milesi-Ferretti (2011) focus on the growth rate between 2008 and 2009. However, it is hard to believe that the right hand side of the regression is exogenous to the crisis. That the April 2008 IMF-WEO forecast for 2009 did not discount the turmoils ongoing in financial markets worldwide is highly debatable. As a matter of fact, the IMF already incorporated the signals about the crisis in that growth forecasts (see IMF, 2008, p. xii).

Nevertheless, a potential discordance emerges since the non-nested models use different set of countries. Lane and Milesi-Ferretti (2011) argues that the negative relationship between pre-crisis debt growth and economic performance during the recession is essentially a high-income country phenomenon. In contrast, Berkmen et al. (2012) find the same robust relationship for low-income and emerging countries. However, the latter countries entered in recession later, starting from the third quarter of 2008. The low-income and emerging countries had a substantial manufacturing export-oriented sector and registered very poor GDP growth between 2008 and 2009. Thus, a possible reconciliation between these evidences would resort on the international trade channel as a catalyst of the Great Recession, from advanced to emerging economies. As a matter of fact, originated in U.S., the crisis first hit Ireland and Iceland which were characterized by large financial vulnerabilities such as high mortgage debt-to-GDP ratios and inflated house prices. Additionally, banks in Iceland and Ireland were much more integrated in the wholesale funding system. Next, Western European countries were affected too. Most of emerging countries entered only later in recession, "when the collapse in global demand led to a contraction in global trade" (Claessens et al., 2010, p. 275). At the light of this, the economic slowdown in low-income and emerging countries might have resulted from the combination of high private debt growth and the backlash resulting from the drop in global demand.

2.2 *Household Debt and Consumption: evidence from U.S. Regional Data*

The use of cross-state and cross-county variations in economic outcomes provides abundant information on fluctuations which might be overlooked by using aggregate time series. The encompassing model introduced in this section speaks to extensive research on the geographical dimension of the Great Recession. Indeed, the household debt expansion, the housing cycle as well as the unprecedented downturn in employment and production unevenly hit U.S. states and counties. Mian and Sufi (2010) and Mian et al. (2013); Mian and Sufi (2009) pioneered the employment of state and ZIP-code level data to infer the dynamics of household debt and its implications for the observed downturn.

Therefore, the model in equation 4 nests the models in Mian and Sufi (2010) and Mian et al. (2013) which can be thought as representative of this strand of literature.[7] The model regresses the 2006-2009 change in auto sales as proxy for durable consumption, $\Delta C_{i,06-09}$ for county/ZIP-code $i = 1, \ldots, N$ on a set of independent variables which can be distinguished in three blocks, namely Real Activity, Credit, and Housing.[8] Table 5 displays the independent variables in each matrix and link them to the original models.

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7 Obviously, many other studies exploit geographical variations to explain the dynamics of debt and business cycle during the Great Recession. For example, Mian and Sufi (2014) focus on varying household balance sheet conditions and debt across U.S. counties to explain the rise in unemployment between 2007 and 2009; using state-level data Albuquerque and Krustev (2018) find that the 2007-2012 decline in consumption can be explained by a combination of deleveraging and debt overhang effects. However, due to the similarity between the correlates used, they are not included in the encompassing model.

8 Mian and Sufi (2010) use quarterly data and measure auto sales from the last quarter of 2006 to the second quarter of 2009 whereas Mian et al. (2013) use annual data. Moreover, Mian and Sufi (2010) concentrate on counties whereas Mian et al. (2013) use ZIP-code level data.

$$\Delta C_{i,06-09} = \underset{(N \times 1)}{\alpha} + \beta_1 \times \underset{(N \times 7)}{\textbf{Real Activity}} + \beta_2 \times \underset{(N \times 6)}{\textbf{Credit}} + \beta_3 \times \underset{(N \times 8)}{\textbf{Housing}} + \varepsilon_{i,06-09} \qquad (4)$$

The Credit block encompasses measures of household leverage, housing leverage, default rates, and credit scores. Although the model in equation 4 shows less heterogeneity in the choice of proper proxies for household debt variables, it is still possible to identify some remarkable differences. For example, Mian and Sufi (2010) make use of both the 2002Q4-2006Q4 change in household debt-to-income and the 2001Q4 level of household debt-to-income, whereas Mian et al. (2013) construct a housing leverage variable as the sum of mortgage and home equity divided by the home value. The housing leverage variable mimics a loan-to-value ratio for owner-occupied houses. The same block collects other credit variables which are relevant for the dynamics of durable consumption. They are the fraction of subprime borrowers in 2001, the default rate in 2001 and in 2006, and the credit card utilization rate in 2006, all measured at county level.

The Real Activity block encompasses the variables on counties and ZIP-codes unemployment in 2001 and in 2006 as well as employment shares in sectors which are likely to be influenced by the expansion of mortgage debt and housing, e.g. the construction and real estate sectors. Income per household at ZIP-code level is also included. Finally, the Housing block comprises indicators of home ownership and home value. In the U.S., home value has been an important driver of consumption of indebted households given that home equity withdrawal is a diffused practice. Moreover, for the same home value decline, borrowing constraints, e.g. credit card limits, are more binding for indebted households with few collateral in their dwellings (Mian et al., 2013).

The evidence provided by Mian and Sufi (2010) and Mian et al. (2013) shows a negative and statistically significant relationship between the growth of household leverage in 2002-2006 and the change in durable consumption from the last quarter of 2006 to 2009. The authors interpret exceptional growth of household debt at the beginning of the 2000s as an outward shift in the credit supply which was unconnected neither to positive income expectations nor to productivity growth. In turn, the credit supply shock originated the boom-and-bust cycle in debt. The credit expansion involved the extensive margin as well as the intensive margin. In other words, new mortgages for home purchase were granted to marginal borrowers while existing homeowners exploited rising house prices to finance consumption and home improvements through home-equity based borrowing. The expansion of mortgages boosted house prices through a self-reinforcing spiral that skyrocketed house prices well beyond any reasonable fundamental value. However, in 2007, the bubble busted, default rates accelerated and house prices growth reversed. In the face of falling household demand, firms started to laid workers off and by December 2007 the country slipped into recession.

What does explain the drop slowdown consumption and the rise of unemployment in the aftermath of the debt boom? Mian and Sufi (2014) claim that the decline in employment during the recession has been triggered by a severe reduction in the housing net worth which depressed households demand. However, consumption fell more in regions where households were highly indebted, had lower net worth, and had higher marginal propensity to consume relative to less indebted households (Mian et al., 2013). Moreover, foreclosures worsened the fall of house prices, the drop of residential investment, and the generalized contraction of aggregate

demand (Mian et al., 2015). In sum, lacking aggregate demand rendered the household debt expansion and the house price bubble unsustainable and triggered the recession.[9]

3 PATTERNS OF HOUSEHOLD DEBT AND BUSINESS CYCLE ACROSS TIME

The encompassing models and the contributions surveyed in the former sections rely on the use of single equation specifications on panel and cross-section data. Skipping the issues related to the identification of causal effects, most of the literature previously introduced displays some limits.[10] Central banks' economists constantly look at the dynamics of large amount of data and the decision about the monetary policy stance depends on credit market conditions, expected inflation, interest rates, and other variables. Therefore, it is legitimate to think that the coefficients estimated in panel and cross-sectional models might have been mediated by the response of (monetary and fiscal) policy to the conditions and expected conditions of the economy. Moreover, regulatory frameworks (e.g., regulations on lending standards, loan-to-values, down-payments) as well as the institutional features of the housing finance system inevitably affect the interaction between household debt expansions and the business cycle. In fact, some recent research show that both country specific factors and worldwide trends in banking and financial activity play a role for the dynamics and composition of credit aggregates (Jordà et al., 2017; Müller, 2018).

To a certain degree, the encompassing model in equation 5 addresses the first aforementioned limit by modeling the interaction between household debt, business cycle, and monetary policy in a multi-variate environment. The model nests the models in Brunnermeier et al. (2018), Guerini et al. (2018), Kim (2016), Juselius and Drehmann (2016), and Den Haan and Sterk (2010) into a country-level structural vector auto-regression model of the business cycle. The model spans the U.S. business cycle in

The vector **y** contains the endogenous variables, the matrix B_0 maps the contemporaneous relationships among endogenous variables, the vector c contains constants, the matrix B_j determines the lagged relationships between endogenous variables up to the pth lag, and the vector ε_t contains structural shocks. Obviously, the model in equation 5 serves only as a framework for the variables and channels of transmission between variables as highlighted by the literature.

$$B_0 \mathbf{y}_t = c + \sum_{j=1}^{p} \mathbf{B}_j \mathbf{y}_{t-j} + \varepsilon_t \tag{5}$$

According to the usual classifications of variables, the vector **y** contains Real Activity, Credit, Housing, and Wealth variables. Therefore the model in equation 5 can be rephrased as in

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9 Mian and Sufi (2017) provide an exhaustive account of the credit supply view of the Great Recession and of the debate surrounding the role and features of the mortgage debt expansion. While Kim (2017) compares the Mian and Sufi's narrative with the post-Keynesian framework suggesting unforeseen similarities and non-trivial differences.

10 Although of primary importance for a proper evaluation of business cycle effects of household debt expansions, a discussion of the identification problems that afflict the surveyed empirical contributions is beyond the scope of this survey. Among the contributions in this survey, Mian et al. (2013) tackle the reverse causality problem via an instrumental variable approach while Jordà et al. (2016) use synthetic control methods. At the same time, all the encompassing models introduced across this survey are not immune to the risks represented by confounding factors and reverse causality. To the extent that the constructions of encompassing models is intended as a pedagogical exercise, overlooking identification is legitimate. Nevertheless, a good reference on the issue of identification in empirical macroeconomics is Nakamura and Steinsson (2018).

equation 6 where the endogenous variables have been stacked according to their belonging groups. Tables 6 and 7 elucidate on the content of each sub-vector in equation 6.

$$
\underset{(27\times27)}{B_0}
\begin{bmatrix}
\underset{(13\times1)}{\text{Real Activity}} \\
\underset{(11\times1)}{\text{Credit}} \\
\underset{(1\times1)}{\text{Housing}} \\
\underset{(2\times1)}{\text{Wealth}}
\end{bmatrix}_t
= \underset{(27\times1)}{c} + \sum_{j=1}^{p} \underset{(27\times27)}{B_j}
\begin{bmatrix}
\underset{(13\times1)}{\text{Real Activity}} \\
\underset{(11\times1)}{\text{Credit}} \\
\underset{(1\times1)}{\text{Housing}} \\
\underset{(2\times1)}{\text{Wealth}}
\end{bmatrix}_{t-j}
+ \underset{(27\times1)}{\varepsilon_t}
\tag{6}
$$

Certainly, the encompassing SVAR model in 6 represents a small sample of the vast literature on this topic. For example, it overlooks the numerous monetary policy VAR augmented with credit market variables. However, such models are focused on the effects of monetary policy changes on real and credit variables whereas the model in equation 6 highlights the real effects of household debt expansions and monetary policy is considered more as a response rather than as a shock.[11]

The Credit block gathers several measures of household leverage. In particular, household sector leverage can be gauged by the sum of commercial bank real estate and consumer credit (Brunnermeier et al., 2018), real mortgage debt, and real consumer debt (Den Haan and Sterk, 2010; Guerini et al., 2018; Kim, 2016). Juselius and Drehmann (2016) build ad-hoc variables, namely leverage gap and debt service burden gap. The former is defined as the ratio between total credit and total private assets for the non-financial sector, in deviation from its long-run level. The latter is defined as the ratio between aggregate service payment and income, in deviation from its long-run level too. Other credit aggregates encompass the public debt and non-financial firms sector debt (see Table 7). The Credit block also includes a corporate bond spread from Gilchrist and Zakrajšek (2012), a TED spread, and a composite lending rate. The TED spread is the defined as the 3-month Eurodollar over the U.S. Treasury yield spread and proxies the liquidity conditions in the inter-bank market. Moreover, the TED spread is highly sensible to changes in the federal funds rate due to its role in the bank lending channel of monetary policy. Instead, the composite lending rate is a weighted average of long-term lending rates for households and non-financial firms.

The Real Activity block encompasses the variables on output measures, industrial production, prices, and spreads (see Table 6). Moreover, it includes all GDP components and households' durable expenditure. The Housing and Wealth block includes the growth rate of real residential property prices and the real household sector net worth, respectively (see Table 7). Therefore, the encompassing VAR model can be considered a classical monetary policy VAR augmented with Credit, Housing, and Wealth blocks. Augmenting a monetary policy VAR with credit, house prices, and housing investment variables offers a chance for evaluating the role of

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[11] Several contributions study the monetary policy implications of household debt and housing market dynamics. Iacoviello and Minetti (2008) highlight the transmission mechanism of monetary policy in several countries with a special focus on the housing market; Gambetti and Musso (2017) estimate a time-varying parameter SVAR model with stochastic volatility to evaluate the effects of credit supply shocks on the business cycle; Hofmann and Peersman (2017b) estimate the response of housing investment and of mortgage debt and its component to U.S. monetary policy shocks accounting for the structural break in mid-1980s; Alpanda and Zubairy (2018) use local projections to find that the U.S. monetary policy transmission mechanism is impaired during periods of high household debt; Bernardini and Peersman (2018) use state-dependent local projections to find that government purchase multipliers are significantly larger in high private debt states.

the housing sector in the transmission of monetary policy. In this regard, McCarthy and Peach (2002), Hofmann and Peersman (2017b), and Hofmann and Peersman (2017a) estimate tractable monetary VAR models augmented with housing finance-related variables and find that response of both mortgages and housing investment to monetary policy shocks is more persistent and sharper in post-1980s U.S. data.

How do real variables, as industrial production and GDP growth, respond to a household debt shock? The non-nested models in equation 6 provide mixed results on such a relationship. This should not be a surprise since the several assumptions imposed on a VAR model, such as choice of variables, lag structure, shocks identification schemes, and choice of lag length. For example, the structural shocks are recovered via different identification schemes, like identification-through-heteroskedasticity (Brunnermeier et al., 2018), independent component analysis (Guerini et al., 2018), and classical recursive identification (Den Haan and Sterk, 2010; Juselius and Drehmann, 2016; Kim, 2016). However, the general results according to which household and mortgage debt expansions are followed by contractions in economic activity in the medium-run is partially saved. In a VAR jargon, a shock to household credit pushes industrial production and GDP growth up for some quarters. After the peak response of industrial production and GDP growth, the expansionary effect fades away and the real activity variables come back to their pre-shock level or even to lower levels.[12] This dynamics is disclosed by Brunnermeier et al. (2018), Guerini et al. (2018) and partly by Kim (2016). Other models find that, after the mid-1980s, a negative shock to the volume of home mortgages implies a negative and persistent response of residential investment; on the contrary, GDP growth and durable spending remain approximately flat in response to the same shock (Den Haan and Sterk, 2010). For what concerns shocks to non-financial firm debt, there is no cycle observed and the real variables response is presumably flat.

What is the transmission mechanism underlying the observed response of real variables to household debt shocks? Juselius and Drehmann (2016) find that when the debt service ratio is way higher than its long-run level, private consumption and investment are pushed down, with detrimental effect of output growth. In fact, for households, increasing debt service ratios translates into less disposable income to be used for private consumption. If the cost of debt service can be altered by monetary policy through its impact on the term structure of interest rates and on adjustable-rate mortgages, this result can be interpreted through the lens of the debt-service channel of monetary policy (Hofmann and Peersman, 2017a). Since debt is unevenly distributed in the economy, changes in the debt service ratio have distributive and aggregate macroeconomic outcomes. Indeed, changes in the debt service

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12 The literature is not clear on what a household debt/credit shock really is. It can be reasonably considered in the realm of credit shocks. However, credit shocks are generally considered as propagation and amplification mechanism of other shocks (e.g., monetary policy) rather than as independent, fundamental, and economic meaningful shocks (Ramey, 2016). For example, on the supply side, the lending activity of banks to households depends, among other factors, on the state of bank capital which can endogenously change in response to exogenous factors that affect their balance sheet (e.g., a sudden drop in the value of loans in portfolio). In this case, the credit supply shock can not be considered purely exogenous unless it hits all the equations in the VAR system (e.g., a war is an exogenous shock that hits all the relationship in the system and cause an endogenous response by all equations). By the same token, on the demand side, a household credit demand shock can be considered as an endogenous response to various exogenous shocks, e.g. changes in risk aversion, unexpected shocks to income, change in regulation in the mortgage sector, change in credit policies. In other words, from the surveyed contributions, it is not clear what a household debt shock really is (e.g., a shift of supply vs. a shift of demand of credit) and whether it has be considered purely exogenous or endogenous to other structural shocks.

ratio imply a redistribution of income from borrowers to savers. The consumption effects of such a redistribution do not wash out in the aggregate because the marginal propensity to consume is heterogeneous between borrowers and lenders as well as between borrowers with different debt levels. Hence, if monetary tightening is able to persistently increase the effective lending rate for indebted households, monetary policy can have detrimental effects on aggregate demand. However, this channel can be at work for given characteristics of the housing finance system and of mortgage contracts.

Brunnermeier et al. (2018) shift the focus from credit market distresses to monetary policy. A shock to household credit pushes industrial production and inflation up. Accordingly, policy engineered increases of interest rate are responsible for the observed deleveraging and for the output downturn in the years following the expansion. Credit shocks do not move neither the corporate bond spread nor TED spread which suggests that the observed decline in industrial production should be ascribed to a monetary tightening rather than to credit market distresses. In this sense, household credit expansions per se do not predict economic contractions. Rather, monetary policy reacts to inflation pressures generated by the credit expansion toward households. Without the monetary tightening, industrial production would continue to growth at the cost of higher and more persistent inflation. The transmission mechanism claimed by Brunnermeier et al. (2018) apparently contrast the narrative by Mian et al. (2017) which also provide impulse response analysis for a small scale quarterly SVAR model with GDP, household debt-to-GDP, and non-financial firm debt-to-GDP. However, a closer examination shows that the two results do not exclude each other (this is claimed also by Brunnermeier et al. (2018)). In fact, while Mian et al. (2017) estimate a small scale model with country fixed effects on a sample of 30 countries, Brunnermeier et al. (2018) estimate a large 10-variables U.S. monthly model over the last fifty years. Thus, the outliers captured by the VAR and by the single regression specification in Mian et al. (2017) might have been soften in a larger monthly model (Brunnermeier et al., 2018, p. 18).

Summing up, the VAR-based evidence on the response of real activity variables to household debt shocks is contrasting. The household debt-driven business cycle hypothesis is neither confirmed nor rejected. In particular, since the household debt-driven business cycle hypothesis is mostly a result of small scale models, it is possible that it is an outlier which large scale models damps down. Moreover, the VAR models highlight the role of monetary policy and its response to inflation generated by household debt expansions as opposed to explanations based on the fragility of an indebted household sector. Certainly, disentangling these two puzzle presented by literature is a fruitful direction for future research.

4 CONCLUDING REMARKS

What is the role of household debt over the business cycle? To take stock of the post-2007 empirical literature in macroeconomics, this paper surveyed some representative works which study the relationship between household debt expansions and economic activity. Many of the models proposed by the literature measure the response of output and of consumption to household debt expansions. However, the measure for household debt expansion vary across the contribution. Hence, the model proposed by each contribution can be viewed as a non-nested version of a model general model which explain the variation in consumption and output using an extended set of covariates. Therefore, each non-nested model can be viewed

as a restricted version of the general encompassing model. All contributions have been firstly classified according to the econometric techniques and dependent variables, respectively. As a result, it has been possible to organize the existing literature in three macro-groups: panel-data studies for output and consumption response to household debt, cross-section studies for output and consumption during the Great Recession, and vector auto-regression studies for real activity, credit aggregate and monetary policy. The survey unveiled a wide set of covariates which the literature considers to explain fluctuations in output and consumption, other than debt variables.

This survey of the literature highlighted that household debt expansions can feed business cycles along different channels of transmission. Mian et al. (2017) and (Mian and Sufi, 2018) propose the so-called credit-driven household demand channel which claims that *(i)* outward shifts in credit supply are the ultimate force generating expansions and contractions in economic activity, *(ii)* the real effects of the credit expansions materialize by supporting household demand in contrast to business investment, and *(iii)* lacking household demand triggers the recession. Since recessions preceded by high debt growth are characterize by sharp rise in unemployment and by considerable drops in the level of labor productivity, (Bridges et al., 2017) suggests that the shortfall in aggregate demand observed after strong deleveraging crises might induce an endogenous slowdown in productivity. Drehmann et al. (2018) explain the negative relationship between debt growth and economic activity by looking at the lead-lag relationship between new borrowing and debt service according to which the medium-run downturn in GDP growth can be attributed to the delayed increase in debt service implied by the initial boom in new borrowing. Finally, Brunnermeier et al. (2018) attributes the observed deleveraging in household debt and the contraction of economic activity after large positive household debt shocks to monetary policy which raises interest rates in response to accelerating inflation.

There are some conclusions to be drawn. Firstly, panel and cross-sectional studies reveal a general relationship between the magnitude of household debt expansions and the severity and length of the subsequent recessions. In this respect, household debt booms statistically predicts contractions in economic activity. Secondly, vector auto-regression models based on U.S. data barely support the existence of a household-debt driven business cycle. Moreover, when a credit-induced expansion is disclosed by the model, the authors shift the attention to the reaction of monetary policy to accelerating inflation to explain the observed downturn in economy activity. Research advocating the use of single index warning signals should confront with this last point if credit growth has to be considered to forecast future economic activity. Undoubtedly, much research is needed on this issue and on disentangling the role of monetary policy from the role of household financial fragility in determining output downturns. Thirdly, and in connection to the former point, there is no consensus about the causal mechanism, if any, under the blanket of such predictive relationship. Many potential causal interpretations have been proposed. Many of them echo the legacy of Irving Fisher, Charles Kindleberger, and Hyman Minsky. While, other interpretations emphasize the role of monetary policy. Hopefully, the construction of encompassing models to goes in the direction of helping the reader in orienting him/herself among the numerous contributions. Fourthly, there is no consensus neither on how household leverage should be measured nor on which item of household debt really matters for the business cycle. Evaluating the relative importance of mortgages, auto

loans, student loans, consumer credit, and other component of total household debt for the business cycle is a further research objective, given the increasing availability of refined data.

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Table 1: CROSS-COUNTRY ENCOMPASSING MODEL OF BUSINESS CYCLE (CREDIT BLOCK)

Dependent Variable	$\Delta_h \ln y_{i,t+h}$			
Independent Variables	Mian et al. (2017)	Jordà et al. (2016)	Drehmann et al. (2018)	Bridges et al. (2017)
Credit				
3-year change in household debt/GDP	✓			
3-year change in firm debt/GDP	✓			
3-year change in government debt/GDP	✓			
Mortgage credit boom variable		✓		
Non-mortgage credit boom variable		✓		
New borrowing/GDP			✓	
Debt service/GDP			✓	
Lending spread on mortgages			✓	
Change of int rate on household debt			✓	
Change in loan loss provision			✓	
Corporate credit spread			✓	
Pre-recession 3-year change in household debt/GDP				✓
Pre-recession household debt/GDP				✓
Pre-recession 3-year change in Non-financial firm debt debt/GDP				✓
Pre-recession non-financial firm debt/GDP				✓

Notes: The dependent variable is the h-year changes of log real GDP, $\Delta_h \ln y_{i,t+h}$ with $h = 0, \ldots, H$, for country $i = 1, \ldots, N$ in year $t = 1, \ldots, T$. Mortgage (Non-mortgage) credit boom variable is the annual change of mortgage (non-mortgage) credit accumulated in the expansion as share of GDP in p.p.y. an in deviation from country-specific historical mean; New borrowing is the change in the stock of debt plus amortization; Debt service is the sum of interest payments and amortizations; Lending spread on mortgages is the difference between the prime lending and the 3-month money market rate; Interest rate on household debt is obtained as ratio between total interest paid by households from National Accounts and the stock of debt; Corporate credit spread is the difference between a general corporate bond index and the weighted average of the 5- and 10-year government bond yields (*Krishnamurthy and Muir, 2017*).

Table 2: Cross-Country Encompassing Model of Business Cycle (Real Activity, Openness, Housing, Wealth blocks)

Dependent Variable	$\Delta_h \ln y_{i,t+h}$			
Independent Variables	Mian et al. (2017)	Jordà et al. (2016)	Drehmann et al. (2018)	Bridges et al. (2017)
Real Activity				
3-year change of log real GDP	✓			
Growth rate of real GDP per capita		✓		
CPI inflation rate		✓		
Growth rate of real I/GDP per capita		✓		
3-m interest rate on gov bonds		✓		
5-y interest rate on gov bonds		✓		
Growth rate of unemployment			✓	
Change in CPI inflation rate			✓	
Growth rate of labor productivity			✓	
Term spread			✓	
Avg trend GDP growth				✓
Central bank policy rate				✓
Output gap (HP filter)				✓
Openness				
3-year change of foreign debt/GDP	✓			
Current account-to-GDP ratio		✓	✓	✓
Change in the real effective exchange rate			✓	
Housing				
Growth rate of real residential property prices			✓	
Wealth				
Real household net worth			✓	

Notes: in the Real Activity block, Term spread is the difference between the 10-year government bond tiled and the 3-month money market rate; Avg trend GDP growth is the average growth in real GDP per capita in the 10 years before each recession. In the Openness block, foreign debt is the sum of CA deficits (over three years). In the Wealth block, real household net worth is the different between assets and liabilities of the household sector from National Accounts.

Table 3: Cross-Country Encompassing Model of Consumption

Dependent Variable	$\Delta_h \ln C_{i,t+h}$		
Independent Variables	Stockhammer and Wildauer (2016)	Apergis (2019)	Hansen and Torstensen (2016)
Real Activity			
Change in log real GDP	✓		
Change in log wage share	✓		
Change in top 1% income share	✓		
1-period lagged change in log private consumption		✓	
Change in log labor income		✓	
1-period lagged change in log labor income		✓	
Avg GDP growth from $t-5$ to t			✓
Credit			
Change in log level of real household debt	✓		
FD of change in log level of real household debt	✓		
Change in log debt service ratio		✓	
Avg household debt/GDP from $t-5$ to t			✓
Housing			
Change of real residential property prices index	✓		
Change of log house price		✓	
1-period lagged change of log house price		✓	
2-period lagged change of log house price		✓	
Avg house prices/disposable income from $t-5$ to t			✓
Avg growth in HI/GDP from $t-5$ to t			✓
Wealth			
Change of real stock price index	✓		
Change of log real stock price index		✓	
1-period lagged change of log real stock price index		✓	

Notes: The dependent variable is the h-year change of log private consumption, $\Delta_h \ln C_{i,t+h}$ with $h = 0, \ldots, H$, for country $i = 1, \ldots, N$ in year $t = 1, \ldots, T$. In the Real Activity block, the wage share is defined the total economy wage share over GDP at current factor cost. In the Credit Block, FD stands for First Difference; the debt service ratio is the expenditure for interest payments and amortization over income. In the Housing bloc, HI stands for housing (or residential) investment.

Table 4: CROSS-COUNTRY ENCOMPASSING MODEL OF THE GREAT RECESSION

Dependent Variable	$y_{i,09IMF-09}$		
Independent Variables	Lane and Milesi-Ferretti (2011)	Berkmen et al. (2012)	Zhang and Bezemer (2015)
Real Activity			
Average GDP growth, 2005-2007	✓		
Average GDP growth, 1990-2007	✓		
Log GDP per capita, 2007	✓		
Manufacturing output share of GDP, 2007	✓		
Dummy for oil producers	✓		
Average GDP growth per capita, 2003-2007			✓
Real GDP per capita, 2007			✓
Credit			
Change in private credit/GDP, 2004-2007	✓		
Domestic credit/deposit, 2007		✓	✓
Cumulative bank credit growth, 2003-2007		✓	
Annual average change in mortgage/total credit, 2003-2007			✓
Annual average change in total credit/GDP, 2000-2007			✓
Credit market deregulation index, 2007			✓
Openness			
Sum of imports and exports as share of GDP, 2007	✓		
CA/GDP, 2007	✓	✓	
Sum of external financial assets and liabilities as share of GDP, 2007	✓	✓	
Dummy if the country has a de facto peg e.r.r., 2007	✓		
Dummy if the country has an intermediate e.r.r., 2007	✓		
Manufacturing output as share of exports, 2007		✓	
(manufacturing/exports × EM), EM=1 if the country is emerging		✓	
Exchange rate variability index, 2007			✓

Notes: The dependent variable is the growth loss, defined as the difference between the growth forecast for 2009 and the actual growth registered in that year, for country $i = 1, \ldots, N$. In the Credit block, the Credit market deregulation index from the Fraser Institute consists of three components representative of ownership of banks, extension of credit, and presence of interest rate controls/negative interest rates. In the Openness block, e.r.r. stands for exchange rate regime.

Table 5: CROSS-REGION ENCOMPASSING MODEL OF THE GREAT RECESSION

Dependent Variable	$\Delta C_{i,06-09}$	
Independent Variables	Mian and Sufi (2010)	Mian et al. (2013)
Real Activity		
Unemployment rate, 2006:Q4	✓	
Unemployment rate, 2001:Q4	✓	
Employment share in construction, 2006:Q4	✓	
Employment share in real estate, 2006:Q4	✓	
Employment share in finance, 2006:Q4	✓	
Employment share in retail, 2006:Q4	✓	
Employment share in exports, 2006:Q4	✓	
Log of median household income, 2000	✓	
Fraction black, 2000	✓	
Fraction with high school education or less, 2000	✓	
Income per household, 2006		✓
Interaction: income per household $\times$ home value change		✓
Credit		
Change in household debt-to-income, 2002Q4-2007Q4	✓	
Household debt-to-income, 2001Q4	✓	
Subprime (fraction with credit score < 660), 2001Q4	✓	
Default rate, 2001Q4	✓	
Default rate, 2006Q4	✓	
Credit card utilization rate, 2006Q4	✓	
Housing leverage ratio, 2006		✓
Interaction: home value change $\times$ housing leverage ratio		✓
Housing		
Fraction homeowners, 2000	✓	
Log of median home value, 2000	✓	
(Dollar) home value change, 2006-2009		✓

Notes: The dependent variables is the 2006-2009 change in auto sales as proxy for durable consumption, $\Delta C_{i,06-09}$ for county/ZIP code $i = 1, \ldots, N$. In the Credit block, Credit cart utilization rate is defined as the difference between total credit line and borrowed portion; Housing leverage ratio is defined as the sum between mortgage and home equity, divided by home value.

Table 6: Country-Specific Multivariate Encompassing Model of Business Cycle (Real Activity block)

Endogenous Variables	Brunnermeier et al. (2018)	Guerini et al. (2018)	Kim (2016)	Juselius and Drehmann (2016)	Den Haan and Sterk (2010)
Real Activity					
Industrial production	✓				
PCE price index	✓				✓
M1 money supply	✓				
Federal funds rate	✓				✓
Commodity price index	✓				
Term spread	✓				
Real gross investment		✓			
Real personal consumption		✓	✓		
Real GDP		✓	✓		✓
3-month Treasury bill yield		✓			
Real private expenditure (C + I)				✓	
Real other expenditure (G + NX)				✓	
Real durable expenditure					✓

Table 7: Country-Specific Multivariate Encompassing Model of Business Cycle (Credit, Housing, and Wealth blocks)

Endogenous Variables	Brunnermeier et al. (2018)	Guerini et al. (2018)	Kim (2016)	Juselius and Drehmann (2016)	Den Haan and Sterk (2010)
Credit					
Real household debt	✓	✓			
Real non-financial firm debt	✓	✓			
Corporate bond spread	✓				
TED spread	✓				
Real private non-financial sector debt		✓		✓	
Real public debt		✓			
Real mortgage debt		✓	✓	✓	
Real consumer debt			✓		✓
Leverage gap				✓	
Debt service burden gap				✓	
Composite lending rate				✓	
Housing					
Real residential investment					✓
Wealth					
Real household sector net worth			✓		
Aggregate real asset price index				✓	

Notes: Corporate credit spread by Gilchrist and Zakrajšek (2012), defined as ; TED spread is the 3-month Eurodollar over Treasury spread; Leverage gap is defined in per cent deviation from long-run leverage (credit-to-assets ratio); Debt service burden gap is defined as the debt service payments (interest payments plus amortisations) divided by income defined in per cent deviation from long-run debt service; Composite lending rate is based on a smoothed weighted average between the conventional 30-year mortgage rate for households and the prime lending rate for the non-financial corporate sector. In the Wealth block, Real household sector net worth is measured at market value from FED Flow of Funds; Aggregate real asset price index encapsulates residential property, commercial property, and equity prices.