Growth, cycles, and residential investment*

Marcio Santetti†

[CLICK HERE FOR THE LATEST VERSION]

Abstract

The empirical literature on neo-Goodwinian models of growth and distribution still lacks an explicit treatment of capital accumulation. Further, and across different theoretical approaches, residential investment is seen as a critical driver of the business cycle. This paper addresses these two issues. First, through four- and five-dimensional Structural Vector Autoregressive (SVAR) models, cyclical trajectories derived from impulse-response functions confirm profit-led demand and profit-squeeze distribution regimes, in accordance with the cyclical stylized facts in the vein of Goodwin (1967). Second, aggregate investment is then split into its residential and nonresidential categories. Results confirm that residential investment leads the cycle, whereas nonresidential investment lags it. Finally, this study argues that residential investment is, in reality, undertaken by corporations—and not households—, and can therefore not be seen as autonomous to the business cycle, demographics, and financial variables.

Keywords: Cyclical growth; Residential investment; Labor share of income.
JEL Classification: E12; E22; E24; E25; E32.

*I would like to thank Rudiger von Arnim, Michalis Nikiforos, Jenny Schuetz, and Jake Wood for their valuable contributions. All remaining errors are, of course, mine.

†Ph.D. Candidate. Department of Economics, University of Utah. Email: santetti@gmail.com.

1 Introduction

Neo-Goodwinian theory presents a coherent vision of cyclical growth. The theory builds on Goodwin's seminal "growth cycle," published in 1967. The original version features savings-driven investment, and generates a conservative oscillation in labor share and employment rate, where the latter—driven in turn by investment—leads the former. Modern reformulations endogenize the income-capital ratio by incorporating an innovation possibility frontier (Kennedy, 1964; Foley et al., 2019, ch. 9), or alternatively a role for aggregate demand (Skott, 1989; Barbosa-Filho and Taylor, 2006; von Arnim and Barrales, 2015; Barrales et al., 2021). Few of the empirical papers based on these theoretical models consider the accumulation rate explicitly.[1] Basu and Gautham (2020) propose an exception, but in their extended Vector Autoregressive (VAR) model, an identification strategy based on Christiano et al. (1999) is used in order to isolate only the effect of a distributive shock, rather than consider systemic linkages.

This paper fills this gap. First, it motivates and estimates a Structural VAR (SVAR) model in four variables: real output, investment, employment, and the labor share. Since the focus is on cyclical variations rather than trends, it uses Hamilton-filtered time series of these variables to proxy cycles in utilization (u), accumulation (g), employment (e), and labor share (ψ). The theoretical motivation is rooted in standard neo-Goodwinian theory. Second, it disaggregates investment into its residential (g^R) and nonresidential (g^N) components, and estimates a five-variable SVAR. Results for both models conform to the "cyclical stylized facts" (Zipperer and Skott, 2011; Barrales et al., 2021), and thus confirm existing evidence in favor of neo-Goodwinian theory; i.e. profit-led demand and profit-squeeze distribution.

Further, however, results also speak to under-explored issues regarding the role of residential investment in the growth cycle. It is widely recognized that residential investment leads the business cycle (Barbosa-Filho et al., 2008; Leamer, 2015; Fiebiger, 2018), but these insights have not been incorporated in theoretical or empirical approaches within the post-Keynesian literature. This is also relevant in light of recent debates concerning the so-called Sraffian supermultipier (SSM) model (Freitas and Serrano, 2015). The key argument in this approach sustains that the rates of output growth, accumulation, and savings, among others, are led by autonomous and non capacity-generating expenditures (Nikiforos, 2018).

The SSM approach has gained renewed interest by neo-Kaleckian scholars in recent years (Lavoie, 2016; Allain, 2021), since it offers an adjustment mechanism that preserves canonical features such as the paradox of thrift and the paradox of costs. The model is built upon two main assumptions about the growth rate of autonomous expenditures: these are exogenous to the current income-generating process and

[1] The focus here is on what Blecker (2016) calls "aggregative models."

also independent of other macroeconomic factors such as population growth and financial variables. The first is the key supermultiplier mechanism, while the second preserves the separation between growth and distribution in the vein of Garegnani's "second Keynesian position" (Garegnani, 1992). As summarized by Nikiforos (2018), the latter combines the principle of effective demand with classical distribution theory by investment generating the correspondent savings amount through increases in output and productive capacity without any changes in real wages and normal profit rates.

If either assumption is violated, the SSM model does not hold water. For starters, assuming an independent role of autonomous expenditures does not seem convincing. As an example, debt-financed residential investment is highly influenced by financial conditions (see Section 3). Furthermore, these and other expenditures, such as durable goods consumption, government spending, and exports, may be independent of current incomes, but show relevant stock-related effects (e.g., household and government debt accumulation). In addition, systematic interactions between growth and distributive variables has been extensively documented within the (post-)Keynesian literature, as will be shown throughout this paper.

Empirical research on SSM theory is still limited in number. The first big push was made by Girardi and Pariboni (2016), testing causal linkages between output growth and autonomous expenditures. The latter is constructed through a combination of credit-financed household consumption, public expenditures, and exports. While finding a short-run bidirectional Granger causality, the authors find support for a long-run effect of autonomous demand on US GDP growth. A similar setup is adopted in Pérez-Montiel and Erbina (2020), Haluska et al. (2021), and Pérez-Montiel and Manera (2021). Such works find support for these expenditures lagging the business cycle. Nikiforos et al. (2021), on the other hand, provide a critical reassessment of the SSM approach on theoretical and empirical grounds, showing that with the same canonical system variables, investment leads the business cycle, contrary to its predictions.

As previously mentioned, one candidate for non capacity-generating spending is residential investment, whose leading variable is credit-financed housing. Within neoclassical approaches, it is commonly acknowledged that residential and nonresidential investment have different business cycle dynamics. Davis and Heathcote (2005) and Leamer (2015) strongly support that housing is what actually drives the business cycle, while nonresidential expenditures—such as software and equipment purchasing, as well as building nonresidential structures—lag it. In addition, Fisher (2007), building on Real Business Cycle theory, argues that housing size and location are crucial determinants of labor productivity. In this manner, housing is put forth as a key source of "productivity shocks." On the other hand, heterodox approaches concur that household investment leads the business cycle (Barbosa-

Filho et al., 2008; Fiebiger, 2018).

This paper's results confirm that (*i*) aggregate investment leads the cycle; but also that with disaggregated data (*ii*) residential investment is the leading variable, whereas (*iii*) nonresidential investment lags it. While (*iii*) is consistent with SSM theory, this should not be interpreted as evidence in its favor.[2] First, the overall findings confirm neo-Goodwinian theory: systematic interactions between profit-led activity and profit-squeeze distribution to generate cyclical growth. These linkages are, in turn, incompatible with SSM theory. Moreover, residential investment cannot be interpreted as an autonomous expenditure: the overwhelming majority of these expenditures are, in reality, undertaken by (corporate) real estate developers, and are definitively not independent of financial factors or population growth rates. The remainder of this Introduction elaborates on these points.

With the theoretical motivations put above incorporated into the SVAR identifications, Impulse-Response Functions (IRFs) analyze how each endogenous variable reacts to a one-standard deviation structural shock to the other system variables. In addition, this study presents a novel visualization technique, first explored in Nikiforos et al. (2021), from which cyclical trajectories are extracted from IRFs. By using these two tools in conjunction, quarterly data for the US economy over the 1949Q1–2020Q4 period indicate a clockwise cycle in the (u, g) and (u, g^R) planes, thus providing further evidence that aggregate investment and its residential rubric lead the business cycle.

Furthermore, the (u, g^N) plane shows counter-clockwise cyclical trajectories. While this is the only evidence found in favor of the SSM approach, it should not be qualified in isolation. First, all remaining evidence produced in this research confirms the cyclical stylized facts outlined in neo-Goodwinian theory. In addition to these last pairs, both four- and five-variable SVAR estimations find counter-clockwise cycles in the (u, ψ) and (e, ψ) planes, in line with profit-led demand and profit-squeeze distributive regimes. Second, as extensively shown in Section 3, about two-thirds of residential investment are corporate-driven, such as subdivisions of single-family homes and new multifamily buildings. On the other hand, isolated single-family homes built on comission by the owner and remodeling of existing owner-occupied properties indeed are household-level expenditures. These, however, cannot be assumed as (semi-)autonomous, as suggested by Fiebiger (2018): depopulating areas with associated credit constraints have less homeowner improvement projects. Therefore, the remainder of residential investment that can be attributed to households is by no means autonomous. In summary, the Bureau of Economic Analysis' (BEA) methodology defining residential and nonresidential investment is framed by expenditure, and not by agent.

[2] Freitas and Serrano (2015, p. 4) assume that *all* investment expenditures are undertaken by firms, abstracting from residential investment. This point is further discussed in Section 3, but at this stage it is important to observe that residential investment does not exclude spending made by firms.

This paper proceeds as follows. Section 2 lays out the paper's theoretical motivations through a stylized four-variable model in utilization, accumulation, employment, and labor share. Section 3 describes the data sources and the filtering method. Moreover, it distinguishes residential and nonresidential investment, showing that the majority of projects within this rubric is undertaken by corporate agents. Section 4 identifies the four- and five-variable SVAR models. Section 5 discusses the relevant results derived from the estimations, done so through IRFs and cyclical charts derived therefrom. Finally, Section 6 concludes.

2 Theoretical premises

This section theoretically motivates the dynamic interactions involving capital accumulation, economic activity, and income distribution. It puts forth a four-variable model in capacity utilization (u, as a measure of demand), aggregate investment (g), employment (e), and the labor share of income (ψ). Priors are based on Keynesian and neo-Goodwinian theory. Most empirical models in these traditions concentrate on economic activity variables (e.g., capacity utilization, output gap, real GDP, (un)employment rate) and distributive measures (e.g., labor and capital factor income shares), and the present research incorporates accumulation into the analysis through aggregate investment. In Section 4, the latter's role for growth and distribution is further analyzed by disaggregating it into its residential and nonresidential components.

The neo-Goodwinian theory of cyclical growth—also labeled as the theory of the "distributive cycle"—frames labor and capital in antagonistic positions. While having conflicting claims over income distribution, these two share a symbiotic relationship through profit-seeking behavior and the reserve-army mechanism. Higher degrees of capital-intensive production require an elastic labor force at the prevailing real wage. The smaller the share of unemployed individuals, the more pressure workers can put on higher wages. In terms of income factor shares, labor market tightening favors labor and weakens profitability.

In this setting, it has become a consensus that economic activity *leads* the labor share. In detail, (*i*) positive demand shocks increase the labor share only with a lag, while (*ii*) a labor share shock immediately decreases output. This causal chain reflects the labor market adjusting more slowly to its steady state than the goods market. In terms of empirical modeling, an application of the above scenario in Vector Autoregressive (VAR) models implies a contemporaneous effect of the labor share on an activity variable (capacity utilization, output gap, employment rate, among others), but not vice-versa. This "standard causal ordering" for modeling the Goodwin pattern is explicit in Basu and Gautham (2020) and Barrales et al. (2021). This motivation is further discussed in Section 4.

Several works verify the distributive cycle without explicitly accounting for a measure of capital accumulation. In terms of phase trajectories, Veneziani and Mohun (2006), Tavani and Zamparelli (2015), Zipperer and Skott (2011), and von Arnim and Barrales (2015) confirm the Goodwin pattern in the (u, ψ) and (e, ψ) planes at business-cycle frequencies. These last two works also analyze cycles for the (u, e) plane. In both activity-labor share and activity-activity spaces, these works find support for a counter-clockwise pattern at business-cycle frequencies.[3]

In the context of the present research, an explicit inclusion of capital accumulation is relevant for two main reasons. First, as already exposed in the last section, there is a general consensus across standard and alternative macroeconomic theories that investment leads the business cycle, and, therefore, the other aforementioned economic activity variables. Second, as also already outlined in the Introduction, this paper aims to investigate the linkages between disaggregated investment (through nonresidential and residential expenditures) and the other activity and distributive variables. Including and then disaggregating investment allow for a novel empirical scrutiny of cyclical stylized facts and the role played by residential investment within the business cycle.

Based on the theoretical and empirical priors provided by the neo-Goodwinian and post-Keynesian literature, the following four-variable stylized model describes the dynamic interactions connecting capacity utilization, capital accumulation, employment, and the labor share of income. This model describes the setup for the empirical specification outlined in Section 4. Although all these variables are obviously intertwined over the business cycle, these equations only concern contemporaneous and own-feedback effects. In other words, variables appearing on the right-hand side of each equation denote what this study assumes are the covariates that impact the left-hand side variables at time t. This latter point is the requirement for identifying SVAR models, as discussed in more detail in Section 4.

$$u_t = u(u_t, g_t, \psi_t) \tag{1}$$

$$g_t = g(g_t, u_t, \psi_t) \tag{2}$$

$$e_t = e(e_t, u_t) \tag{3}$$

$$\psi_t = \psi(\psi_t, e_t) \tag{4}$$

Equation (1) reflects the "standard ordering" of the Goodwin pattern, in which the activity leads the distributive variable. In terms of contemporaneous impacts, this is reflected through capacity utilization being a contemporaneous function of ψ_t.

[3] In the (u, e) plane, a necessary condition for the counter-clockwise movement is that expansions in production made through new investments decrease with higher unit labor costs. See Rada et al. (2021), Section 3.

As usually assumed within the post-Keynesian literature, the partial derivative of utilization with respect to investment is positive (i.e., $u_g > 0$), while the sign of u_ψ is ambiguous. If $u_\psi > 0$, demand is said to be wage-led: as an effect of a higher labor share, workers increase consumption, causing a positive feedback on investment by raising the rate of utilization. On the other hand, if $u_\psi < 0$, demand is profit-led: an increase in the profit share reduces workers' consumption, but exceeds the latter loss by raising investment demand though a higher profitability (Blecker and Setterfield, 2019). In addition, u_t is also contemporaneously affected by capital accumulation, in line with post-Keynesian demand-investment relationships, where the demand proxy (in this case, u_t) is contemporaneously impacted by both price-distributive and accumulation variables.

Equation (2) explicitly includes accumulation into empirical neo-Goodwinian models that also consider the linkages involving u_t, e_t, and ψ_t. Differently from Basu and Gautham (2020), who assume that investment decisions as solely inherited from the past,[4] this system considers that both the utilization rate and the labor share affect investment at time t. Following a standard accelerator approach, one can represent accumulation as a function of the actual profit rate, r_t, as in Bhaduri and Marglin (1990). By definition, $r_t = (1 - \psi_t)u_t$, with u_t as the income-capital ratio.[5] Thus, both demand and distribution appear as present determinants of accumulation through the profit rate channel. Lastly, this depiction also translates the assumption existing in both standard and alternative macroeconomic theories in which investment leads the business cycle.

In equation (3), the employment rate is a product of the state of the business cycle, here represented by capacity utilization. Following Okun's law, as the economy expands through higher degrees of capacity utilization, the labor market tightens, thus increasing employment. In this equation's context lies the counter-clockwise movement between these two activity variables. Skott (1989) justifies this cyclical motion between demand and unemployment due to the increased adjustment and turnover costs caused by higher employment rates. While workers' bargaining power increases with higher degrees of utilization, future expansion plans by capitalists are undermined, bringing the cycle to a downturn.

Finally, equation (4) reflects a Phillips curve. Its motivation lies in the context of equation (3) increasing the number of employed individuals and, consequently, income distribution in workers' favor. Therefore, the labor share of income responds more rapidly to e_t than to u_t, reflecting a slowly-adjusting labor market and a faster-adjusting goods market. The distribution regime is given by the sign of ψ_e. A positive sign describes a profit squeeze regime: as the economy grows toward full capacity utilization, real wages– and, consequently, the labor share—

[4]According to this paper's approach, this would imply g_t not being a contemporaneous function of any variable.

[5]This definition clearly abstracts from so-called "animal spirits."

increase at the expense of profitability due to labor market tightening. When the sign is negative, the distribution regime reflects a wage squeeze, where increases in economic activity lead to income distribution shifts toward profits, so the present level of investment is held constant.

Given the motivations for this four-dimensional system, the distributive cycle's stylized facts feature profit-led demand and profit-squeeze distribution regimes. This pattern is empirically verified in the recursive VAR analyses of Barbosa-Filho and Taylor (2006), Cauvel (2019), Basu and Gautham (2020), and Barrales et al. (2021); the panel VAR of Kiefer and Rada (2015); the threshold VAR (TVAR) of Carvalho and Rezai (2016); the SVAR of Mendieta-Muñoz et al. (2020); and the Generalized Method of Moments (GMM) model of Ernst et al. (2006).

This paper, then, proposes an analysis of how this extended model behaves vis-à-vis the distributive cycle's stylized facts. In addition to this four-dimensional system, Section 4 also explores a five-variable model where investment is split into residential and nonresidential expenditures. The motivations for such strategy are examined in the next section, which first outlines the data sources and filtering method.

3 Data sources and issues

This section details the data sources and the trend-cycle decomposition method applied to estimate the empirical models presented in the next section. Furthermore, this section also outlines the differences between residential and nonresidential investment, from both project and agent perspectives. Such clarification is essential to understand who undertakes the majority of such expenditures, as residential investment is widely assumed to be the leading variable within the business cycle, although not considering who actually engages in these projects.

3.1 Data description and filtering

Quarterly data for real output, aggregate investment and its residential and nonresidential rubrics come from the National Income and Product Accounts' (NIPA), Table 1.1.3. All variables are indexed as 2012=100. The employment rate is the remainder to 1 of the civilian unemployment rate, obtained from the Federal Reserve Bank of St. Louis Database (FRED, "UNRATE" series). Finally, data for the labor share of income come from the Bureau of Labor Statistics' (BLS) "headline measure" for the non-farm business sector.[6] The sample period is 1949Q1–2020Q4.

[6] For robustness purposes, data for aggregate output and investment obtained from FRED's "GDPC1" and "GPDIC1" series, respectively, were used in the SVAR models. Since *all* results reflect what will be shown with the baseline variables, we leave robustness checks as a separate document, which can be shared under request.

Except for the employment rate, all variables were log-transformed.

In order to focus on the cyclical features of the models' endogenous variables, the Hamilton filter was used for trend-cycle decompositions (Hamilton, 2018). This technique removes cyclical trajectories from a time series using forecasting. In summary, a time series' (e.g, y_t) cyclical component is defined as as how different would its value be at period $t + h$ from the value that one would have expected to observe based on its level at t. On the other hand, y_t's trend component is defined as the smoothed estimate of y_{t+h} from a regression model containing the fitted values from a regression of y_{t+h} on an intercept and the s most recent values of y, as of the actual period t. Equation (5) illustrates:

$$y_{t+h} = \gamma_0 + \gamma_1 y_t + \gamma_2 y_{t-1} + \cdots + \gamma_s y_{t-s} + e_{t+h} \tag{5}$$

where the estimated residual term, $\hat{e}_{t+h}$, is y's cyclical component. Here, s is set to 16 lags, implying 4 years of previous data for a forecast horizon of $h = 8$ quarters, i.e., 2 years.

3.2 Residential investment: Household- or corporate-driven?

Before proceeding, this section clarifies what residential and nonresidential investment are composed of. The Bureau of Economic Analysis' (BEA) NIPA Handbook describes the latter as comprising expenditures in nonresidential structures (new construction and improving existing ones for private businesses and nonprofit institutions), equipment (new or used machinery, furniture, and motor vehicles), and intellectual property goods (purchases or own-production of software, R&D, and artistic originals). The former, on the other hand, is described in the following way:

> "*Residential structures consists of new construction of permanent-site single family and multifamily housing units, improvements (additions, alterations, and major structural replacements) to housing units, expenditures on manufactured homes, brokers' commissions and other ownership transfer costs on the sale of residential property, and net purchases of used structures from government agencies. Residential structures also includes some types of equipment (such as heating and air conditioning equipment) that are built into the structure. Residential equipment consists of equipment, such as furniture or household appliances, that is purchased by landlords for rental to tenants.*"
>
> (BEA, Concepts and Methods of the U.S. National Income and Product Accounts, chapter 6)

This description, however, does not necessarily attribute residential expenditures to households. The assumption of household-led residential investment (especially housing) is a key argument within Sraffian supermultiplier models, as it stands out as one of the so-called autonomous and non capacity-generating expenditures that may bring utilization to a desired long-run "normal" rate. Furthermore, neoclassical models that explicitly account for residential expenditures do not make a clear distinction between what portion of these accrue to households and firms. Consequently, such views may overestimate the role played by households within the business cycle.

Reality nonetheless discredits a household-led view of housing investment. Specifically to the US economy, residential construction may be broken down into four main segments: (*i*) new subdivisions of single-family homes, (*ii*) new multifamily buildings, (*iii*) isolated single-family owner-occupied homes built on commission by the owner, and (*iv*) remodeling of existing owner-occupied properties. While the first two are predominantly built by corporations (land developers and home-builders, most publicly traded), the last two categories, though still containing firm investment, are mainly driven by household expenditures.

Segment (*iii*) represents a smaller portion of new units relative to the overall number of new single-family homes built in subdivisions.[7] Remodeling existing owner occupied homes, however, involves larger dollar volumes. This last category accounts for interior and outside property improvement projects, such as kitchen and bath remodels, roofing, insulation, HVAC system replacements, swimming pools, and disaster repairs. According to Harvard University's Joint Center For Housing Studies, demographic and economic factors are key predictors of household remodeling expenditures. Between 1995 and 2019, the share of total improvement expenditures went from 77.6% to 86.7% (in 2019 US dollars) in metropolitan areas, while this share decreased from 22.4% to 13.3% in non-metropolitan areas. Over the same period, the number of homeowners grew about 38% in the former, while it decreased about 13% in the latter (Joint Center For Housing Studies of Harvard University, 2021).

Furthermore, Harvard University's Joint Center For Housing Studies estimates a short-run perspective of home improvement and repair expenditures for the US economy. The Leading Indicator of Remodeling Activity (LIRA) is an annual rate of change computed through a weighted average of several economic indicators that influence the home improvement industry, and is used to identify business-cycle fluctuations within this sector.[8] Between 1994Q1 and 2019Q4, the Home Price In-

[7] Anecdotal evidence and private exchanges with real estate developers and housing market specialists have informed that new construction planned and executed by households accounts for less than 5% of the total volume in this segment.

[8] These indicators are: the U.S. Census Bureau's Retail Sales at Building Materials and Supplies Dealers; the National Association of Realtors' Existing Single-Family Home Sales; U.S. Census Bureau's Single-Family Housing Starts; Standard & Poor's CoreLogic Case-Shiller National Home Price Index (HPI); the National Association of Realtors' Existing Single-Family Median Sales Price; BuildFax's Residential Remodeling Permits; The Conference Board's Leading Economic Index (LEI); and

dex (HPI), the Leading Economic Index (LEI), and residential remodeling permits show the highest correlation coefficients with home improvement expenditures,[9] while for repair expenditures, the Gross Domestic Product (GDP) shares a contemporaneous correlation of 0.73. Data for both improvement and repair spending come from the American Housing Survey (AHS).

Concerning housing costs, one of the main contributors to cross-region variations is job migration. Workers tend to show higher willingness to move if these are renters, and not homeowners. Despite the falling trend in internal migration across US states over the last 30 years (Molloy et al., 2011), Zabel (2012) analyzes annual data for 277 US Metropolitan Statistical Areas (MSAs) between 1990 and 2006, finding that housing prices respond more strongly to labor demand shocks in high-cost areas. In other words, in regions with higher net migration, the cost of housing is more responsive to workers' mobility. Furthermore, financial factors, such as mortgage and rental rates, are strongly influenced by population dynamics. Jud and Winkler (2002) analyze, though panel data models, 130 metropolitan areas across the US economy, verifying that households face much greater housing prices in heavily populated areas, which in turn affects financing costs. Therefore, there is no autonomous profile to household-led residential investment: not only does it depend on economic and sector-specific factors, but also on population dynamics and financing conditions particular to each region. In summary, the share of residential expenditures with a stronger household participation cannot be considered autonomous, as assumed by the SSM approach.

Households, however, do not build subdivisions and apartment buildings. Thus, segments (*i*) and (*ii*) above are led by corporations, while also involving the largest amount of money within residential investment. The process is straightforward: land developers acquire new land and do all necessary bureaucratic permits. In the case of large subdivisions, these companies also build the surrounding infrastructure, such as sidewalks, roads and sewer lines. Then, developers sell these lots to homebuilders, which construct individual homes for rental or purchase. Given this closer evaluation of gross private fixed investment, one can see that the BEA's methodology is framed by expenditures (either residential or not), without a clear distinction of their underlying agents.

Within this process, the timing of construction and project completion is crucial for understanding these firms' role in the business cycle. Schuetz (2020) brings additional views on corporate-led housing investment and its cyclical behavior. While the process of developing a new construction project involves risk and uncertainty—such as political opposition, changing wages and material prices—, builders try to time completion at the peak of the cycle. For instance, several projects that started

the Bureau of Economic Analysis' Gross Domestic Product (GDP).

[9] The correlation coefficients are 0.8 and 0.72 during the same quarter for HPI and LEI, respectively, and 0.82 for remodeling permits in the third quarter ahead.

during the housing boom of the early 2000s were concluded in the Great Recession, which led builders to sell homes at lower prices. On the other hand, in less unpredictable scenarios, periods of rising employment rates and incomes also imply a higher demand for housing. With consequently higher rental rates, developers then plan on project completion exactly at this point.

Given the data sources and the distinction between residential and nonresidential expenditures, the next section details this paper's econometric methodology.

4 Applied methodology

This section proposes two different empirical models to study the dynamic interactions involving the variables explored in Section 2: capacity utilization, accumulation, employment, and the labor share of income. The starting point is a four-dimensional Structural Vector Autoregressive (SVAR) model. Next, investment is broken down into its residential and nonresidential rubrics, yielding a five-dimensional SVAR through which the effects of household expenditures can be better investigated vis-à-vis business-cycle fluctuations. These outcomes are analyzed in the next section.

4.1 A four-variable system

The dynamic linkages involving the four-dimensional system described by equations (1)–(4) may be represented through a SVAR model as follows:

$$\mathbf{A}\boldsymbol{\nu_t} = \boldsymbol{\alpha} + \sum_{i=1}^{l} \mathbf{A_i}\boldsymbol{\nu_{t-i}} + \mathbf{B}\boldsymbol{\varepsilon_t} \tag{6}$$

where $\boldsymbol{\nu_t} = (u_t, g_t, e_t, \psi_t)'$ is a row vector containing the endogenous variables; $\boldsymbol{\alpha}$ is a vector of intercepts; $\mathbf{A}$, $\mathbf{B}$ and $\mathbf{A_i}$ are matrices containing structural coefficients; $\boldsymbol{\varepsilon_t}$ is a vector of white-noise structural innovations; and l is the model's lag length.

The key estimates are contained in $\boldsymbol{\varepsilon_t}$, since this vector contains the structural shocks that will be used in the impulse-response and cyclical analyses. However, these shocks are not directly observable, requiring the estimation of a reduced-form VAR model as per equation (7):

$$\boldsymbol{\nu_t} = \gamma + \sum_{i=1}^{l} \mathbf{C_i}\boldsymbol{\nu_{t-i}} + \boldsymbol{e_t} \tag{7}$$

where the γ and $\mathbf{C_i}$ vectors are reduced-form intercept and slope coefficients, respectively; and $\boldsymbol{e_t} = \mathbf{A^{-1}B}\varepsilon_t$ is a vector of mutually correlated reduced-form residuals.

The following **A**-**B** representation better illustrates the connections between equations (6) and (7):

$$\mathbf{A}\boldsymbol{e_t} = \mathbf{B}\varepsilon_t = \begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} \\ a_{21} & 1 & a_{23} & a_{24} \\ a_{31} & a_{32} & 1 & a_{34} \\ a_{41} & a_{42} & a_{43} & 1 \end{bmatrix} \begin{bmatrix} e_t^u \\ e_t^g \\ e_t^e \\ e_t^\psi \end{bmatrix} = \mathbf{B} \begin{bmatrix} \varepsilon_t^{\text{demand shock}} \\ \varepsilon_t^{\text{investment shock}} \\ \varepsilon_t^{\text{employment shock}} \\ \varepsilon_t^{\text{wage share shock}} \end{bmatrix} \tag{8}$$

with **B** being a diagonal matrix. The **A** matrix compresses assumptions about the contemporaneous relationships among the system variables. Whenever an a_{ij} entry is left as an unknown value, one assumes that the i^{th} row variable is contemporaneously—that is, at time t—affected by the j^{th} column variable. Conversely, whenever one believes that there is no impact occurring at time t, the a_{ij} entry is set to zero.

These restrictions must be guided by theoretical priors, and since there are $n = 4$ variables in the reduced-form 4-D VAR model, at least $n(n-1)/2 = 6$ restrictions (i.e., zero entries) are required in **A** for an exact system identification. Finally, this study will only impose restrictions on **A**, leaving **B** as an identity matrix. This configuration denotes an A-type SVAR model (Pfaff, 2008).

The system of equations described in equations (1) through (4) reflects the contemporaneous restrictions for each endogenous variable. Translating the above assumptions into model restrictions, the **A** matrix then becomes

$$\mathbf{A} = \begin{bmatrix} 1 & a_{12} & 0 & a_{14} \\ a_{21} & 1 & 0 & a_{24} \\ a_{31} & 0 & 1 & 0 \\ 0 & 0 & a_{43} & 1 \end{bmatrix}, \tag{9}$$

while the rest of equation (8) remains the same.

As outlined on equation (8)'s right-hand side, this four-dimensional SVAR provides four structural shocks of interest. Namely, these are aggregate demand (derived from aggregate output, u_t), investment (derived from aggregate investment, g_t), employment (derived from the employment rate, e_t), and labor share (derived from the labor share of income, ψ_t) structural shocks.

From the SVAR results, one is able to empirically compute how its endogenous variables react to a one-standard deviation structural shock to themselves and other system covariates. Through IRFs, whenever these impacts and their respective confidence intervals do not include zero, responses are considered statistically significant. Furthermore, this study applies a novel visualization technique from which cyclical trajectories can be illustrated through these IRFs (see further details in the next section).

Given the distinction between nonresidential and residential investment, as well as the behavior of corporate capital in the business cycle, the next subsection identifies a five-dimensional SVAR model, accounting for the linkages between these two and the other activity and distributive system variables.

4.2 A five-variable system

The initial four-dimensional model is then reconfigured to compute the effects of residential and nonresidential investment on the other activity and distributive variables. Theoretical specifications from equations (6) and (7) remain the same, and the only change is that aggregate investment g_t is replaced by its residential (g_t^R) and nonresidential (g_t^N) rubrics. The system is thus increased by one dimension, becoming a 5-D SVAR model whose endogenous variables are compressed in the row vector $\boldsymbol{\nu_t} = (g_t^R, g_t^N, u_t, e_t, \psi_t)'$. Consequently, the minimum amount of restrictions to the new $\mathbf{A}$ matrix increases to $n(n-1)/2 = 10$ zero entries.

The following system of equations illustrates this five-variable identification. As with the 4-D system, this stylized model only remarks contemporaneous interactions, including own-feedback effects.

$$g_t^R = g^R(g_t^R, g_t^N, \psi_t) \tag{10}$$
$$g_t^N = g^N(g_t^N, u_t, e_t) \tag{11}$$
$$u_t = u(u_t, g_t^R, \psi_t) \tag{12}$$
$$e_t = e(e_t, g_t^R, u_t) \tag{13}$$
$$\psi_t = \psi(\psi_t, g_t^N, e_t) \tag{14}$$

Equation (10) maintains investment as a function of income distribution, though only from residential expenditures. Here, ψ_t also serves as a proxy for another price-distributive variable, the interest rate. As already presented in the previous section, residential expenditures are not independent of financial conditions.[10]

[10]Preliminary recursive VAR analyses for this study were conducted with different interest rate measures. All results confirmed that residential investment is interest-sensitive, while nonresidential responds positively to interest rate disturbances.

Moreover, the latter are clearly intertwined with Goodwin cycle dynamics: interest rates serve as instruments to restore the labor market and break capital accumulation, as these affect both asset prices and credit provisions. Therefore, high interest rates may induce recessions by discouraging further investment and wage demands. Furthermore, given that the majority of residential expenditures is undertaken by corporations, income distribution in the latter's favor will increase the level of residential investment. Nonresidential spending also contemporaneously affects g_t^R as the realization of projects within the first rubric happens later in the cycle, in conjunction with a downturn in residential projects.

In equation (11), nonresidential investment is contemporaneously impacted by both utilization and employment rates. As residential investment starts the cycle, aggregate demand, here proxied by u_t, is positively affected through a larger utilization of the installed capacity. This fact, consequently, also increases the demand for labor. With firms operating near full capacity, expansion projects through investment in new structures, equipment, and intellectual property follow.

Equations (12) and (13) explicitly account for a contemporaneous impact of residential investment on demand and employment. As assumed throughout this paper, the cycle started by residential expenditures tend to have not only immediate, but also permanent effect on these variables. Furthermore, these relationships also preserve the linkages from the four-variable system.

Lastly, equation (14) adds the contemporaneous linkage between the labor share and nonresidential investment. While ψ_t is a product of the labor-capital conflict captured by the employment rate, this model includes late events in the cycle that also require a considerable number of workers to be realized. In this case, the leading stimulus of residential expenditures is represented by e_t, and g_t^N portrays how the labor share is impacted in post-peak periods, as nonresidential investment projects are materialized.

Then, the **A** matrix for an exactly identified five-dimensional model becomes

$$\mathbf{A} = \begin{bmatrix} 1 & a_{12} & 0 & 0 & a_{15} \\ 0 & 1 & a_{23} & a_{24} & 0 \\ a_{31} & 0 & 1 & 0 & a_{35} \\ a_{41} & 0 & a_{43} & 1 & 0 \\ 0 & a_{52} & 0 & a_{54} & 1 \end{bmatrix}, \tag{15}$$

whose IRFs and cyclical trajectories will be estimated in the same way as for the previous model. The next section details and discusses estimation results.

5 Empirical results

This section presents and discusses results obtained from the two models outlined in the previous section. The 4-D SVAR contains real output, aggregate investment, the employment rate, and the labor share of income as its endogenous variables. The basic difference when estimating the 5-D version is that aggregate investment is split into its residential and nonresidential components.

The 4-D and 5-D SVAR models were estimated with Hamilton-filtered variables and a lag length of 4 and 10 quarters, respectively. These orders guarantee well-specified models, with no serial correlation at a 5% level of significance, according to Lagrange Multiplier (LM)-type tests.

Traditionally, IRFs derived from (S)VAR models are displayed altogether. However, given the dimensionality of the estimated models, this paper introduces a different presentation layout. Since the main interest lies on extracting cyclical trajectories involving the studied variables, IRFs will be shown in pairs. To exemplify, the response of variable x to a structural shock in y will be shown alongside with x's response to its own shock. The same will be done for y's response to a structural shock in x and to its own. Then, in order to visualize cyclical patterns from these figures, each pair of responses to the same structural shock will be combined in a scatter plot, where each data point is sequentially connected over a specified time horizon of 32 quarters. This horizon has proven to be long enough for the variables' levels return to their steady states, such that the responses converge to zero. This novel procedure first appears in Nikiforos et al. (2021), and provides a further assessment of impulse-response analyses.[11] The full IRF charts are available in the Appendix section.

The impulse-response analysis starts with the initial 4-equation model, describing the theoretical priors illustrated in equation (9). Figure 1 brings the interactions between the utilization rate (u_t) and aggregate investment (g_t). For compactness, the "$x \to y$" notation denotes the response of y to a structural shock in x.

Investment's response to an aggregate demand shock is initially negative, then increasing until the 6^{th} quarter. Between the 8^{th} and 14^{th} quarters, responses are negative again, reflecting the cyclical behavior between investment and capacity utilization. On the other hand, utilization responds only positively to an investment shock, being statistically significant for 2 years. On the bottom row, both demand and investment shocks show clear clockwise cycles in the (u, g) plane. This fact corroborates our prior and the widespread view—but contrary to SSM models—of investment leading the business cycle.

[11] As will be seen in the upcoming figures, these cyclical charts do not include error bands. Therefore, the reader is not advised to interpret these isolated from the original impulse-response plots.

[FIGURE 1 ABOUT HERE]

Figures 2 and 3 illustrate the linkages between the labor share of income (ψ_t) and the two activity variables u_t and e_t, respectively. In both cases, the second panels in the top row contain the response of the labor share to activity shocks (demand and employment, respectively). The two responses are positive and significant for 8 and 6 quarters, describing a profit-squeeze distributive pattern: as the economy grows toward full capacity utilization, real wages—and, consequently, the labor share—increase at the expense of profitability due to labor market tightening. Furthermore, the rightmost panels show a reduction in output and employment due to a positive labor share structural shock. Being significant for about 10 quarters, these results configure a profit-led demand regime: redistribution of income towards workers decreases profitability, thus reducing demand for investment.

Profit-led demand and profit-squeeze distribution are confirmed by the cyclical charts shown in the bottom row of the two figures. Clear counter-clockwise cycles are observed for both (u, ψ) and (e, ψ) planes, implying that economic activity leads the labor share over the business cycle. This pattern is evident when considering the responses either to an activity or distributive structural shock. These results are consistent with the other empirical works on the distributive cycle cited in Section 2.

[FIGURES 2 AND 3 ABOUT HERE]

Figure 4 exhibits the interactions between real output and employment, as well as cyclical trajectories in the (u, e) plane. While the employment rate responds positively to an increase in economic activity, aggregate output decreases with a positive employment structural shock. The former remains significant for about 6 quarters, while the latter, for approximately 3 years, denoting a slower adjustment of demand to an increasing labor force. Between the 13^{th} and 16^{th} quarters, the employment rate decreases after the initial upswing resulting from a demand shock. This negative effect, however, is not as strong as the initial increase. The cyclical charts show, once again, clear counter-clockwise cycles, with a much faster convergence to the steady state for a demand shock.

[FIGURE 4 ABOUT HERE]

Moving on to the 5-D SVAR, the previous three results are once again verified. Figures 5 and 6 confirm the profit-led/profit-squeeze pattern, and Figure 7 also captures the cyclical features between real output and the employment rate.

[FIGURES 5, 6, and 7 ABOUT HERE]

The most relevant aspect of the five-dimensional SVAR model regards the separation of aggregate investment into its residential and nonresidential components. Figures 8 and 9 explore the empirical linkages between residential and nonresidential investment, respectively, vis-à-vis a demand shock. These two show opposite cyclical behaviors: while there is a clear clockwise cycle in the (u, g^R) plane, a counter-clockwise movement takes place in the (u, g^N) plane.

Residential investment decreases until the second year, after a positive demand shock. Output, on the other hand, grows as g_t^R increases over the same period. This confirms the view that residential investment—mostly induced by housing expenditures—leads the cycle, as sustained in both standard (Davis and Heathcote, 2005; Fisher, 2007; Leamer, 2015) and alternative macroeconomic approaches (Barbosa-Filho et al., 2008; Fiebiger, 2018).

Responding to a demand shock, nonresidential investment increases within the first year. Between the second and fourth years, it decreases, then showing a slight increase between the 18^{th} and 20^{th} quarters. Output's response to a structural shock in nonresidential investment is slightly negative by the end of the first year, becoming statistically insignificant for the rest of the specified time horizon. Nonresidential investment, therefore, lags the cycle that starts with residential expenditures.

[FIGURES 8 and 9 ABOUT HERE]

Results from the two SVAR procedures may be summarized as follows. Real output and the rate of employment lead the labor share of income. This is illustrated in both 4-D and 5-D systems with the counter-clockwise cyclical pattern in (u, ψ) and (e, ψ). On the other hand, when considering only residential investment—whose crucial component are housing expenditures, mostly undertaken by corporations, and not households—, IRFs and cyclical charts confirm the view that the latter leads the business cycle. This fact implies a clockwise cycle in (u, g^R). On the other hand, nonresidential investment lags the cycle, and features a counter-clockwise cycle in the (u, g^N) plane.

6 Final remarks

The neo-Goodwinian empirical literature tends to focus on employment or output as measures of activity, rather than accumulation. This paper proposes filling this gap by not only studying the dynamic interactions involving the rate of capacity utilization, accumulation, employment, and the labor share of income, but also by disaggregating investment into its nonresidential and residential components.

The role played by residential investment—especially housing—as the leading variable within the business cycle is recognized in diverse literatures. Furthermore, households are assumed to be the key actors making such decisions. One research strand that holds different beliefs on this matter is the Sraffian supermultiplier (SSM) approach, attributing a passive and autonomous role to investment. This paper has shown that these hypotheses do not hold water. Firstly, corporations undertake about two-thirds of total residential investment (mainly building and renewing subdivisions and apartment building units), while households are only responsible for building and remodeling isolated single-family units. Secondly, there is nothing autonomous when it comes to residential expenditures, be that for financial, sector-specific, or demographic reasons. While depopulating areas have experienced lesser volumes of these expenditures, such activities are not independent of financial factors, such as interest rates on mortgages.

Through four- and five-variable SVAR estimations, this paper's results confirm the cyclical stylized facts presented across neo-Goodwinian works: profit-led demand and profit-squeeze distribution. In addition, the inclusion of investment allows for a closer inspection of the role played by this variable within business-cycle fluctuations. Empirical findings confirm that aggregate investment leads the cycle; when disaggregated, its residential component leads, while nonresidential expenditures lag the cycle. These results conform to the widespread view on the cyclical role of residential investment, and contradicts the one of the main SSM predictions, in which residential investment would lag the cycle.

Finally, several questions regarding the cyclical behavior of residential investment remain unanswered. For starters, the microeconomic foundations involving both firms' and households' motivations to engage in such expenditures required further inquiry. On the macroeconomic side, longer-run analyses of these interactions appear as a promising avenue for advancing in this area.

7 Bibliography

Allain, O. (2021). A supermultiplier model of the natural rate of growth. *Metroeconomica 72*(3), 612–634.

Barbosa-Filho, N., C. Rada, L. Taylor, and L. Zamparelli (2008). Trends and cycles in US net borrowing flows. *Journal of Post-Keynesian Economics 30*(4), 626–7.

Barbosa-Filho, N. H. and L. Taylor (2006). Distributive and demand cycles in the US economy—A structuralist Goodwin model. *Metroeconomica 57*(3), 389–411.

Barrales, J., I. Mendieta-Muñoz, C. Rada, D. Tavani, and R. Von Arnim (2021). The distributive cycle: Evidence and current debates. *Journal of Economic Surveys*, 1–36. https://doi.org/10.1111/joes.12432.

Basu, D. and L. Gautham (2020). What is the impact of an exogenous shock to the wage share? VAR results for the US economy, 1973–2018. In *Conflict, Demand and Economic Development: Essays in honor of Amit Bhaduri*, pp. 142–168. Routledge India.

Bhaduri, A. and S. Marglin (1990). Unemployment and the real wage: The economic basis for contesting political ideologies. *Cambridge Journal of Economics 14*(4), 375–393.

Blecker, R. A. (2016). Wage-led versus profit-led demand regimes: The long and the short of it. *Review of Keynesian Economics 4*(4), 373–390.

Blecker, R. A. and M. Setterfield (2019). *Heterodox Macroeconomics: Models of demand, distribution and growth*. Edward Elgar Publishing.

Carvalho, L. and A. Rezai (2016). Personal income inequality and aggregate demand. *Cambridge Journal of Economics 40*(2), 491–505.

Cauvel, M. (2019). The neo-goodwinian model, reconsidered. *FMM Working Paper No. 47*.

Christiano, L. J., M. Eichenbaum, and C. L. Evans (1999). Monetary policy shocks: What have we learned and to what end? *Handbook of macroeconomics 1*, 65–148.

Davis, M. A. and J. Heathcote (2005). Housing and the business cycle. *International Economic Review 46*(3), 751–784.

Ernst, E., P. Flaschel, C. Proaño, and W. Semmler (2006). Disequilibrium macroeconomic dynamics, income distribution and wage-price Phillips curves: Evidence from the US and the Euro Area. *IMK Working Paper No. 4/2006*.

Fiebiger, B. (2018). Semi-autonomous household expenditures as the causa causans of postwar US business cycles: The stability and instability of Luxemburg-type external markets. *Cambridge Journal of Economics 42*, 155–175.

Fisher, J. D. (2007). Why does household investment lead business investment over the business cycle? *Journal of Political Economy 115*(1), 141–168.

Foley, D. K., T. Michl, and D. Tavani (2019). *Growth and distribution*. Harvard University Press.

Freitas, F. and F. Serrano (2015). Growth rate and level effects, the stability of the adjustment of capacity to demand and the Sraffian supermultiplier. *Review of Political Economy 27*(3), 258–281.

Garegnani, P. (1992). Some notes for an analysis of accumulation. In J. Halevi, D. Laibman, and E. J. Nell (Eds.), *Beyond the steady state: A revival of growth theory*, pp. 47–71. Springer.

Girardi, D. and R. Pariboni (2016). Long-run effective demand in the us economy: an empirical test of the sraffian supermultiplier model. *Review of Political Economy 28*(4), 523–544. DOI: 10.1080/09538259.2016.1209893.

Goodwin, R. M. (1967). A growth cycle. In C. Feinstein (Ed.), *Socialism, Capitalism and Growth: Essays presented to Maurice Dobb*, pp. 54–58. Cambridge University Press.

Haluska, G., J. Braga, and R. Summa (2021). Growth, investment share and the stability of the Sraffian supermultiplier model in the US economy (1985–2017). *Metroeconomica 72*(2), 345–364.

Hamilton, J. D. (2018). Why you should never use the Hodrick-Prescott filter. *Review of Economics and Statistics 100*(5), 831–843.

Joint Center For Housing Studies of Harvard University (2021). Improving america's housing. Technical report.

Jud, G. D. and D. T. Winkler (2002). The dynamics of metropolitan housing prices. *The Journal of Real Estate Research 23*(1/2), 29–46.

Kennedy, C. (1964). Induced bias in innovation and the theory of distribution. *The Economic Journal 74*(295), 541–547.

Kiefer, D. and C. Rada (2015). Profit maximising goes global: The race to the bottom. *Cambridge Journal of Economics 39*(5), 1333–1350.

Lavoie, M. (2016). Convergence towards the normal rate of capacity utilization in neo-Kaleckian models: The role of non-capacity creating autonomous expenditures. *Metroeconomica 67*(1), 172–201.

Leamer, E. E. (2015). Housing really is the business cycle: What survives the lessons of 2008–09? *Journal of Money, Credit and Banking 47*(S1), 43–50.

Mendieta-Muñoz, I., C. Rada, M. Santetti, and R. Von Arnim (2020). The us labor share of income: What shocks matter? *Review of Social Economy*, 1–36, DOI: 10.1080/00346764.2020.1821907.

Molloy, R., C. L. Smith, and A. Wozniak (2011). Internal migration in the United States. *Journal of Economic Perspectives 25*(3), 173–96.

Nikiforos, M. (2018). Some comments on the Sraffian supermultiplier approach to growth and distribution. *Journal of Post Keynesian Economics 41*(4), 659–675.

Nikiforos, M., M. Santetti, and R. von Arnim (2021). The Sraffian supermultiplier and cycles: Theory and empirics. *Levy Economics Institute of Bard College Working Paper No. 993*.

Pérez-Montiel, J. A. and C. M. Erbina (2020). Autonomous expenditures and induced investment: A panel test of the Sraffian supermultiplier model in European countries. *Review of Keynesian Economics 8*(2), 220–239.

Pérez-Montiel, J. A. and C. Manera (2021). Is autonomous demand really autonomous in the United States? An asymmetric frequency-domain Granger causality approach. *Metroeconomica*, 1–15. https://doi.org/10.1111/meca.12354.

Pfaff, B. (2008). *Analysis of integrated and cointegrated time series with R*. Springer Science & Business Media.

Rada, C., M. Santetti, A. Schiavone, and R. von Arnim (2021). Post-Keynesian vignettes on secular stagnation: From labor suppression to natural growth. *University of Utah Department of Economics Working Paper No. 2021-05*.

Schuetz, J. (2020). Who's to blame for high housing costs? It's more complicated than you think. Available here.

Skott, P. (1989). Effective demand, class struggle and cyclical growth. *International Economic Review*, 231–247.

Tavani, D. and L. Zamparelli (2015). Endogenous technical change, employment and distribution in the Goodwin model of the growth cycle. *Studies in Nonlinear Dynamics & Econometrics 19*(2), 209–216.

Veneziani, R. and S. Mohun (2006). Structural stability and Goodwin's growth cycle. *Structural Change and Economic Dynamics 17*(4), 437–451.

von Arnim, R. and J. Barrales (2015). Demand-driven Goodwin cycles with Kaldorian and Kaleckian features. *Review of Keynesian Economics 3*(3), 351–373.

Zabel, J. E. (2012). Migration, housing market, and labor market responses to employment shocks. *Journal of Urban Economics 72*(2-3), 267–284.

Zipperer, B. and P. Skott (2011). Cyclical patterns of employment, utilization, and profitability. *Journal of Post Keynesian Economics 34*(1), 25–58.

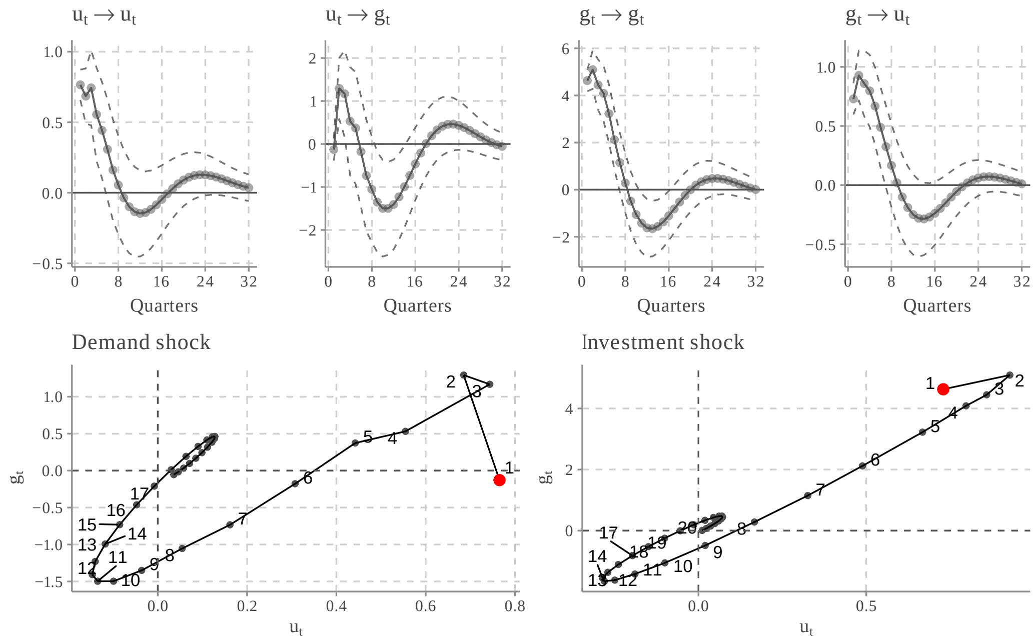

Figure 1: IRFs and cyclical trajectories, (u, g) plane. Top row: solid lines indicate estimated responses, while dashed lines are 95% confidence intervals. Bottom row: red dots denote the starting point, and labels represent 1–32 quarters ahead.

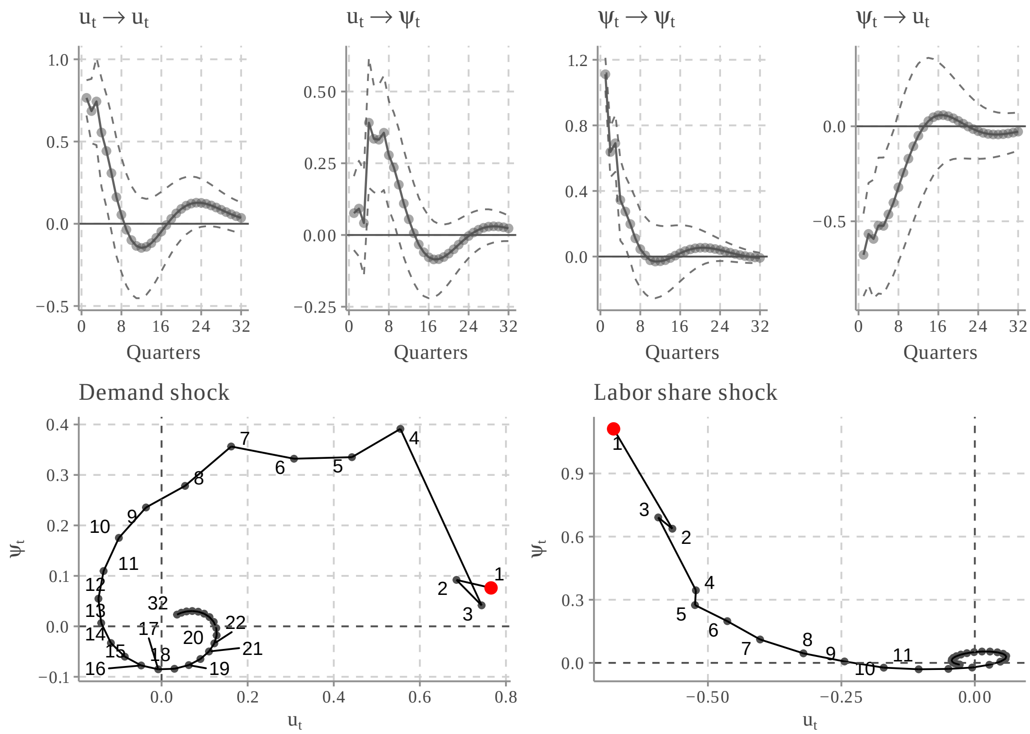

Figure 2: IRFs and cyclical trajectories, (u, ψ) plane. Top row: solid lines indicate estimated responses, while dashed lines are 95% confidence intervals. Bottom row: red dots denote the starting point, and labels represent 1–32 quarters ahead.

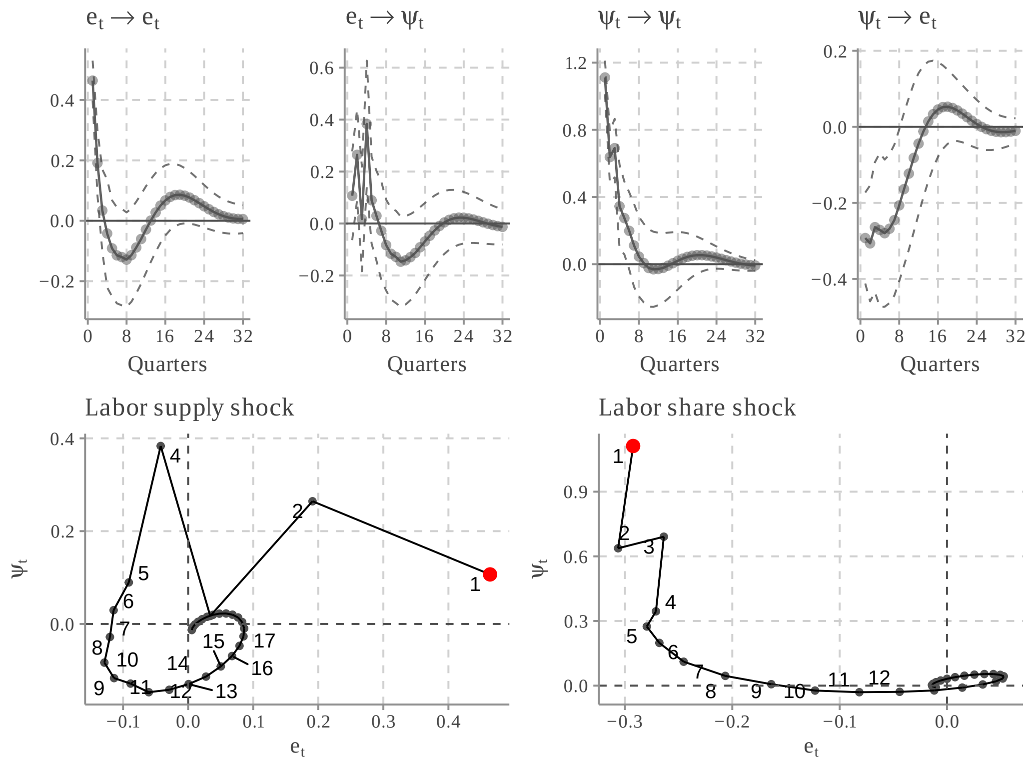

Figure 3: IRFs and cyclical trajectories, (e, ψ) plane. Top row: solid lines indicate estimated responses, while dashed lines are 95% confidence intervals. Bottom row: red dots denote the starting point, and labels represent 1–32 quarters ahead.

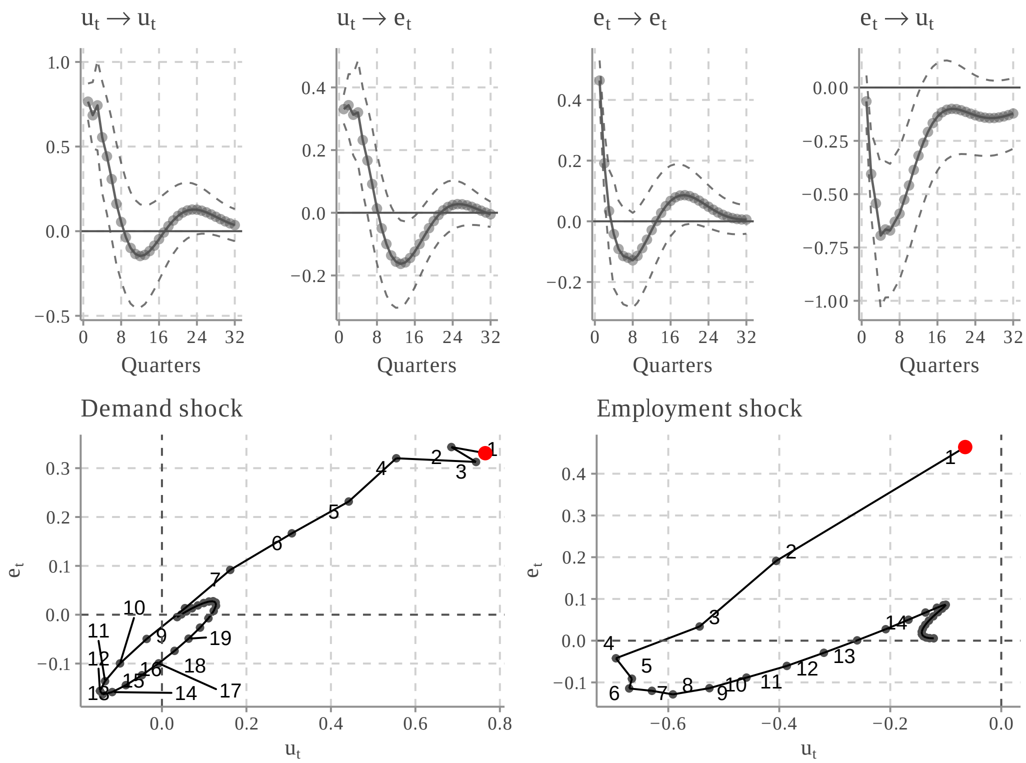

Figure 4: IRFs and cyclical trajectories, (u, e) plane. Top row: solid lines indicate estimated responses, while dashed lines are 95% confidence intervals. Bottom row: red dots denote the starting point, and labels represent 1–32 quarters ahead.

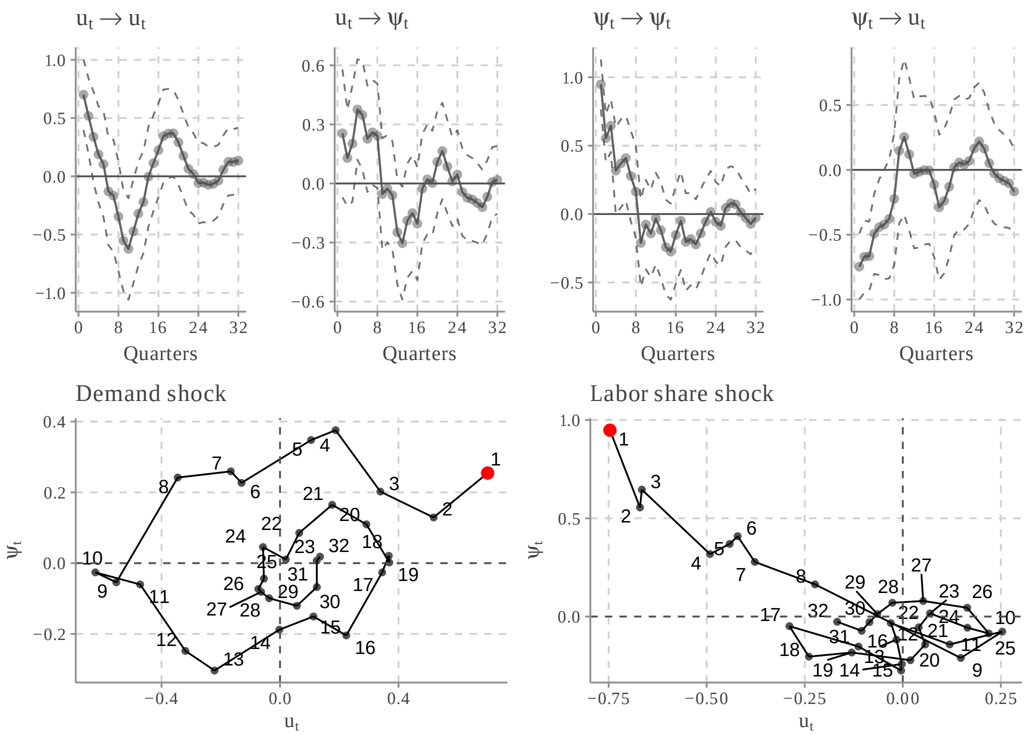

Figure 5: IRFs and cyclical trajectories, (u, ψ) plane, 5-D SVAR. Top row: solid lines indicate estimated responses, while dashed lines are 95% confidence intervals. Bottom row: red dots denote the starting point, and labels represent 1–32 quarters ahead.

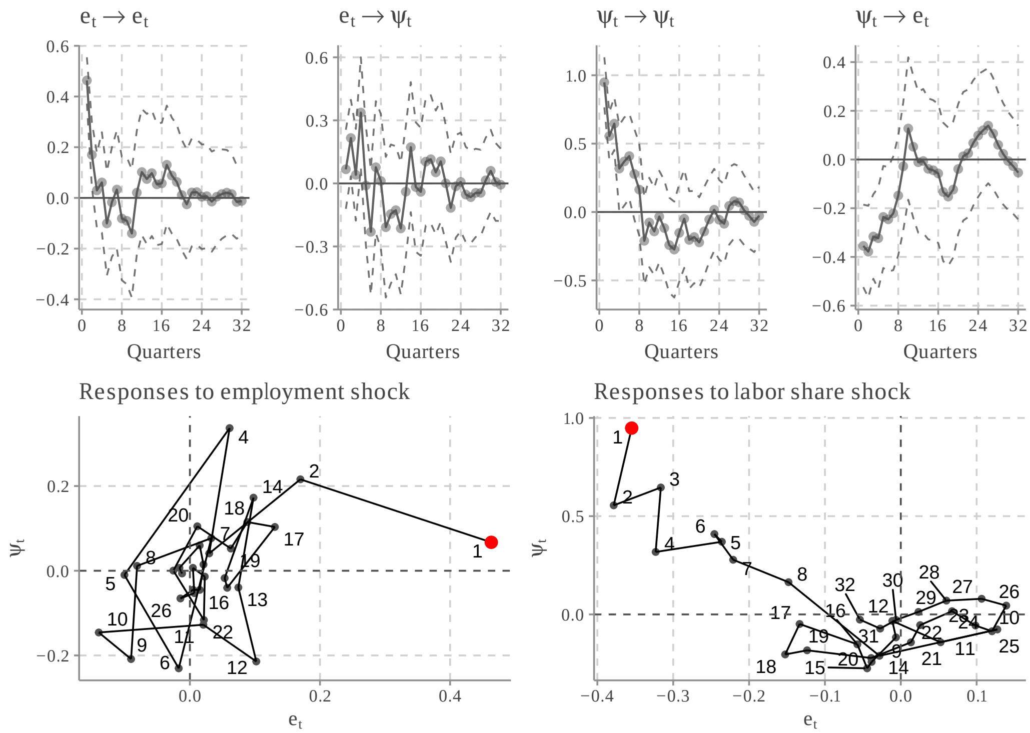

Figure 6: IRFs and cyclical trajectories, (e, ψ) plane, 5-D SVAR. Top row: solid lines indicate estimated responses, while dashed lines are 95% confidence intervals. Bottom row: red dots denote the starting point, and labels represent 1–32 quarters ahead.

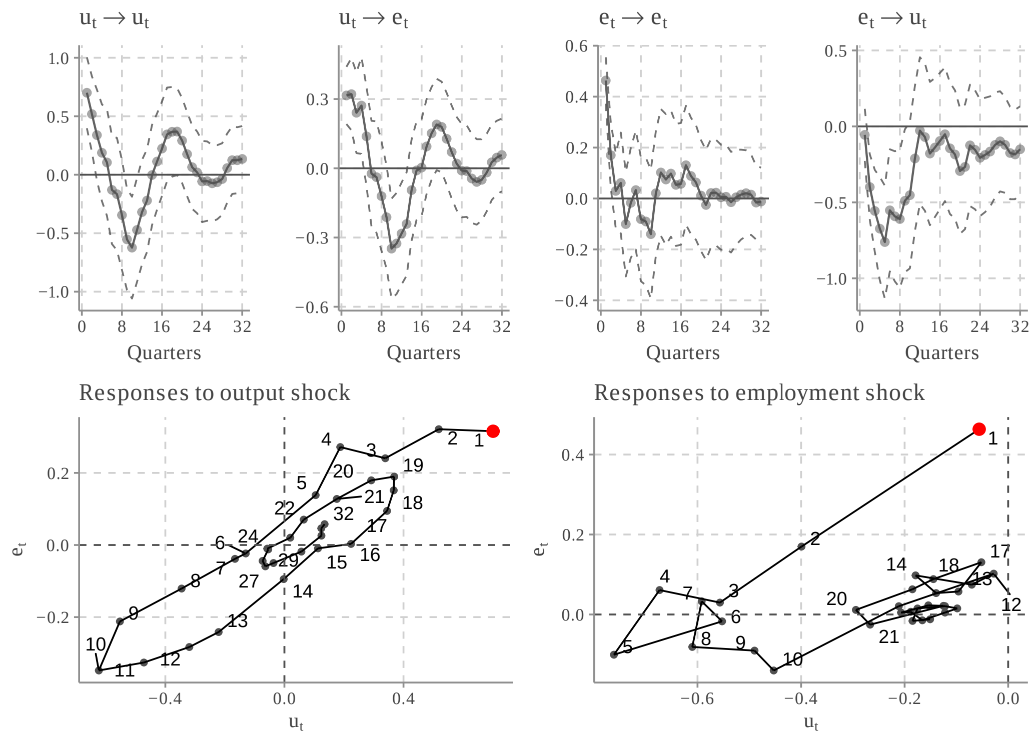

Figure 7: IRFs and cyclical trajectories, (u, e) plane, 5-D SVAR. Top row: solid lines indicate estimated responses, while dashed lines are 95% confidence intervals. Bottom row: red dots denote the starting point, and labels represent 1–32 quarters ahead.

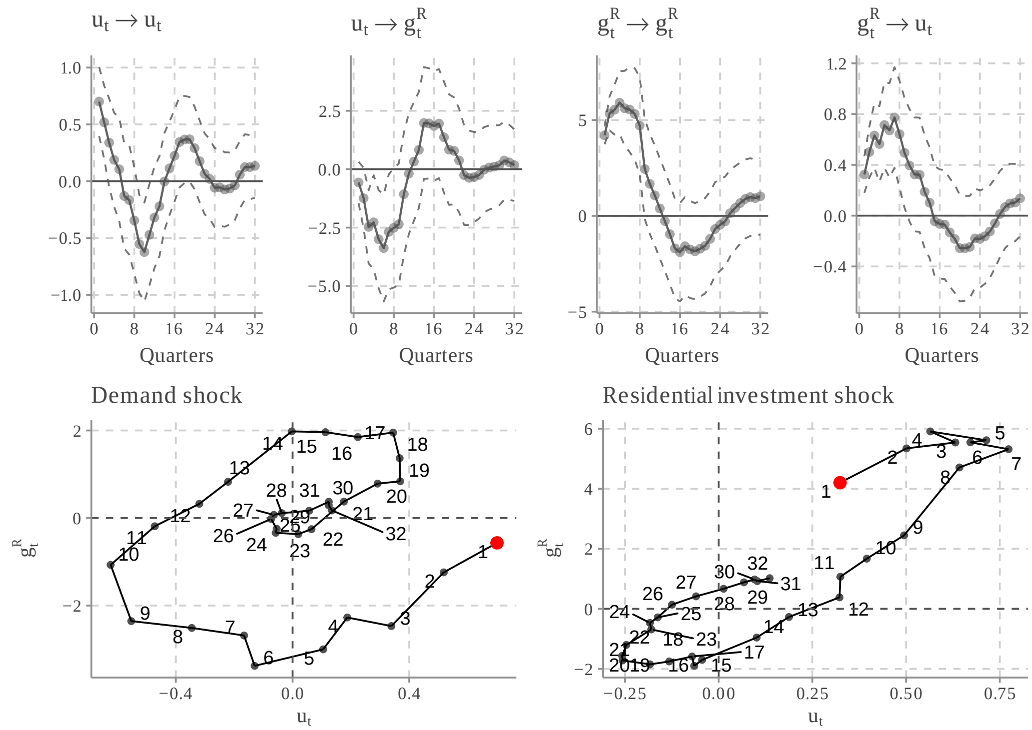

Figure 8: IRFs and cyclical trajectories, (u, g^R) plane. Top row: solid lines indicate estimated responses, while dashed lines are 95% confidence intervals. Bottom row: red dots denote the starting point, and labels represent 1–32 quarters ahead.

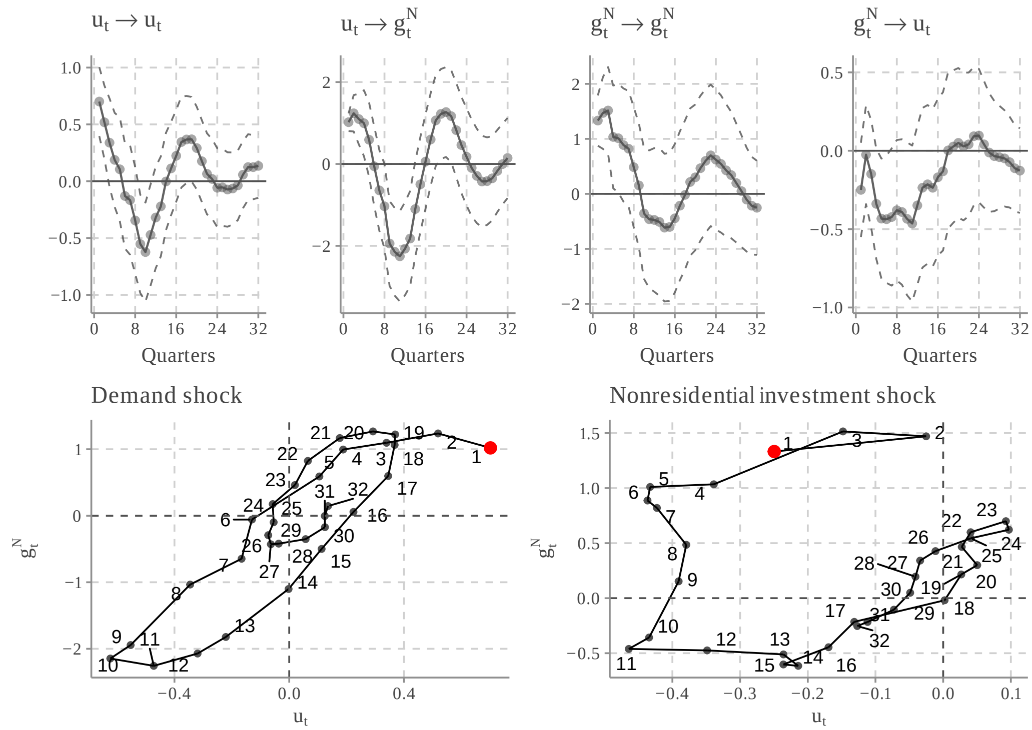

Figure 9: IRFs and cyclical trajectories, (u, g^N) plane. Top row: solid lines indicate estimated responses, while dashed lines are 95% confidence intervals. Bottom row: red dots denote the starting point, and labels represent 1–32 quarters ahead.

A Appendix

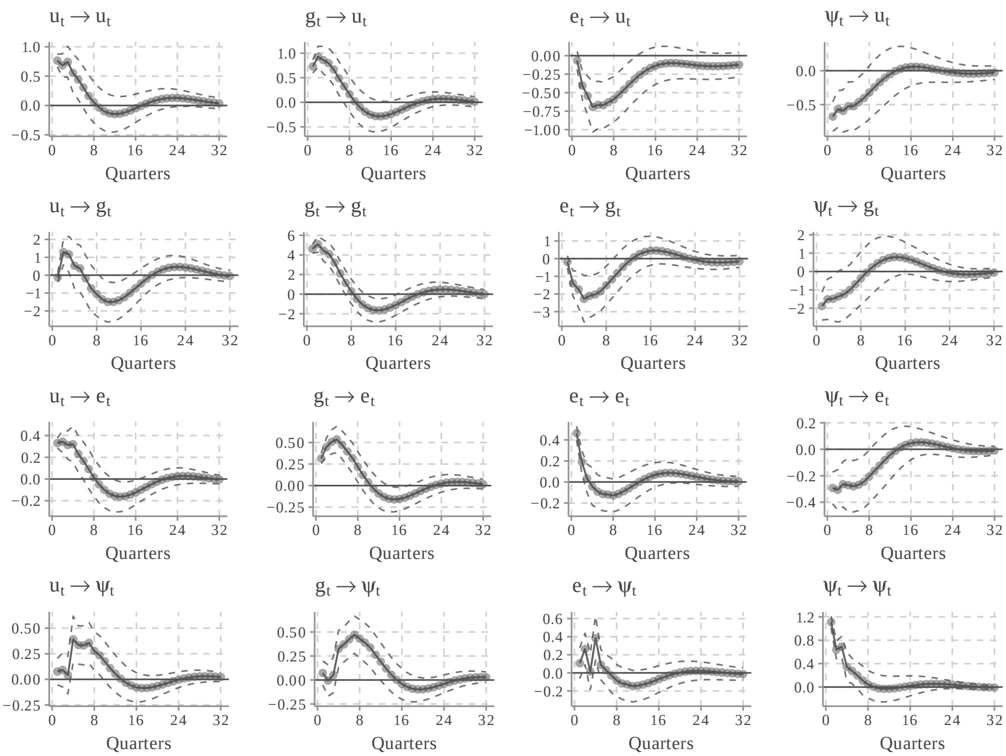

Figure 10: Impulse-response functions, 4-D SVAR. Solid lines indicate estimated responses, while dashed lines are 95% confidence intervals.

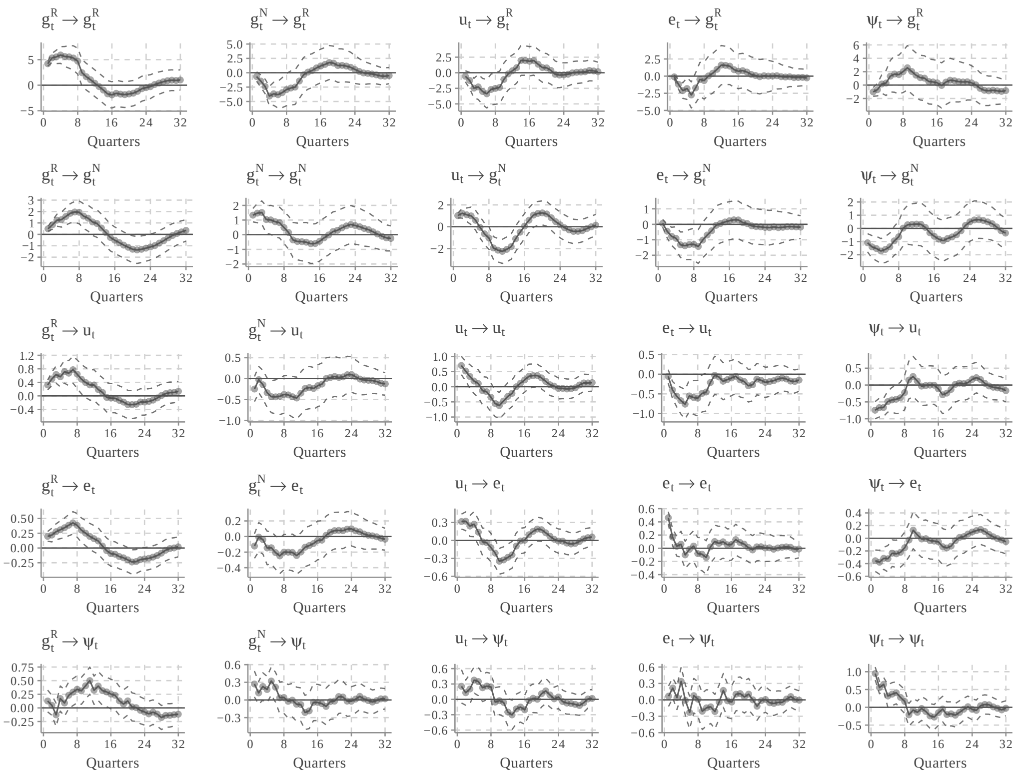

Figure 11: Impulse-response functions, 5-D SVAR. Solid lines indicate estimated responses, while dashed lines are 95% confidence intervals.