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17 January 2022

Online at https://mpra.ub.uni-muenchen.de/111577/
MPRA Paper No. 111577, posted 18 Jan 2022 12:34 UTC

Business Cycle Accounting for the COVID-19 Recession

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January 17th, 2022

Abstract

We apply the Business Cycle Accounting framework to the COVID-19 recession in the Euro Area and the United States. We conclude that the *efficiency wedge* had the most important role in the Euro Area, followed by the *labor* and *investment wedges*. In the United States, the *labor wedge* was most crucial, with the *investment wedge* taking a second place. We present hypotheses, supported by our theoretical framework, for the dichotomy of the role of the *efficiency wedge* between the studied regions.

Keywords: Economics, COVID-19, Business Cycle Accounting, Macroeconomics, Financial Crises, Financial Frictions, Wedges

1. Introduction

The COVID-19 pandemic has objectively left a heavy mark on the world: as of December 2021, 272 million people have been infected by it, and more than 5 million people have deceased due to it, worldwide. The consequences of this pandemic were not only health-related however, as global supply chains were also dismantled, record high uncertainty stroke financial markets, and, to control the spread of the virus, and its consequential loss of life, countries all over the world implement social distancing norms. Most countries, during the initial and most severe phases of the pandemic, set restrictions to non-essential economic activities, thus disrupting consumption channels and labor markets.

Given the unconventional nature of this recession, and the difficulty of comparing its corresponding shocks with past studied events, researchers have struggled to decide which kinds of market frictions to add, when structuring their models. This creates space in covid-related literature to Business Cycle Accounting (BCA) exercises. BCA has its theoretical background on the neoclassical growth model, an area of economics pioneered by Abramovitz (1956) and Solow (1957). More specifically, it builds on Real Business Cycle modeling, introduced by Kydland and Prescott (1982), by deviating from the modelling of perfectly competitive markets with its introduction of wedges, which are representations of distortions of the equilibrium decisions of economic agents.

BCA, first introduced by Chari et al. (2002), is a method to infer which frictions are the most relevant in explaining macroeconomic fluctuations. It consists in two stages: 1) using a *prototype economy* to calculate wedges, and inputting them back in it, individually or in groups, to conclude which have the most quantitative relevance for economic observables; 2) implementing *equivalence theorems*, which are equivalence links between *detailed economies/models* and the *prototype economy*.

This paper applies this type of exercise to the economies of the Euro Area and United States, on the aftermath of the inception of the COVID-19 pandemic (2019:Q4-2021:Q2, in the case of the Euro Area, 2019:Q4-2021:Q3, in the case of the United States). We estimate four wedges: the *efficiency wedge*, the *labor wedge*, the *investment wedge,* and the *government wedge*. Since the literature for this most recent pandemic is still developing, there are no models to prove an *equivalence result* with. Therefore, the focus of this paper is not the investigation of the origins of the economic shock caused by the pandemic, but to infer how each economy absorbed said shocks. Nonetheless, not only this paper adds to the literature by directing interested researchers to the mechanisms most useful to understand fluctuations of economic indicators, but also hypothesizes how these mechanisms played out during the COVID-19 recession and its consequent recovery.

The rest of this paper is structured as follows: first, we summarize the research developments made in the area of BCA; then, we present the theoretical framework behind the used model; subsequently, we delineate the methods and sources used to come to the variables we describe in the theoretical framework; afterwards, we present the results and analyze which wedges perform the best; finally, I conclude by summarizing the points of discussion and suggesting further research.

2. Literature Review

Chari et al. (2002) introduces the first Business Cycle Accounting (BCA) exercise as an approach to model macroeconomic fluctuations using market distortions which were discussed in the literature as useful and realistic additions to the neoclassical growth model. Chari et al. (2005) adds to the BCA literature by introducing a *government wedge*. Chari et al. (2007a) consolidates previous BCA literature and builds on its theoretical framework.

Christiano and Davis (2006) criticizes the BCA exercise presented in Chari et al. (2007a) on two fronts: 1) some spillovers may be left out, since the model only identifies the transmission mechanisms of shocks, not the source of shocks; 2) the *investment wedge*'s involvement, due to its specification, seems to be hindered by environmental changes (sometimes shifting the manifestation of financial shocks to other wedges, for example), with the authors suggesting a new distortion, the *capital wedge*. Chari et al (2007b) responds to these criticisms with three arguments: 1) they prove that changing between the *investment* and *capital wedges* does not change equilibrium allocations; 2) they justify how their theoretical framework has a stronger footing in the literature; 3) using variance decomposition of forecast errors, they prove that the *investment wedge* does, in fact, absorbs a moderate share of a financial shock.

Since Chari et al. (2007a), BCA has been applied to a wide range of periods, countries, and regions[1]. In addition, several alternative BCA methods were introduced, namely: Open-Economy BCA, which introduces distortions related to the international flows of debt, and was pioneered by He et al. (2009) and Otsu (2010b); International BCA, which adds frictions related to international prices and international trade, thus separating net exports from government spending, and was introduced by Otsu (2010a) and Hirata & Otsu (2011); and Monetary BCA, which includes disturbances associated with asset holdings and monetary policy, first applied by Sustek (2011) and Brinca (2013). Brinca et al. (2020) summarizes the theoretical background of these alternative methods and does an extensive review of available BCA literature.

3. Methodology

The BCA exercise proposed by Chari et al. (2007a) can be segmented in two different procedures: the *accounting procedure* and the *equivalence result*.

[1] See **Brinca (2014)** and **Dooyeon and Doblas-Madrid (2012)** for two examples.

The *accounting procedure* is itself constituted by two different processes. The first, focuses in identifying four wedges: the *efficiency wedge*, the *labor wedge*, the *investment wedge,* and the *government wedge*. They were named this way, because at face-value they could be respectively interpreted as productivity, labor income taxes, investment taxes and government consumption. Researchers should, nonetheless, be wary of interpreting the fluctuations of wedges as being caused by the variables referenced in their face-value names, since, for example, Mendoza (2010) shows that input-financing frictions are manifested through the *efficiency*, *labor,* and *investment wedges* and not only through the *investment wedge*. The wedges shouldn't thus be interpreted as identifiers of the origin of a given shock, but rather as a transmission mechanism, a channel through which the economy absorbs the shock. Wedges are calculated using a *prototype economy.* Given the origins of this accounting exercise being so closely linked to the neoclassical growth model, we assume that, inside the boundaries of our *theoretical framework*, agents are rational and that their resource-allocation decision in each period is based on the history of past realizations of said wedges in the economy.

The second process involves inputting the wedges back to the *prototype economy*, either one at a time, or in groups. Since, by construction, the four wedges account for the entirety of macroeconomic fluctuations, feeding them all back would result in the replication of the observed data. The goal of this section is to understand which wedges (or group of wedges) can be the better predictors of some of the main economic indicators: output, labor, investment, and private consumption.

The *equivalence result* consists on the possibility of mapping a *detailed economy* with frictions into a *prototype model* with wedges. These mappings ensure that equilibrium allocations in both economies are the same, making the models observationally equivalent. The usefulness of the procedure is that by understanding which wedge is quantitatively more relevant, the appropriate equivalence theorems (for example between a *detailed economy* with sticky prices and the *prototype economy* with a labor wedge) can guide researchers into introducing additional mechanisms in the proper derivates of a standard Business Cycle Model. Chari et al. (2007a) and Brinca et al. (2016) present theoretical proof of the *equivalence result* between the *prototype economy* and several *detailed economies*.

3.1. The Prototype Economy

Much like Chari et al. (2007) and Brinca et al. (2016), the model I use to represent the *prototype economy* is a stochastic growth model, where in each period t, the economy will be impacted by a finite number of different events, s_t. The historical of all events in the economy up to moment t is denoted by $S^t = (s_0, \ldots, s_t)$. The *economic historical*, S^t, determines current values of economic variables and is considered by the economic agents when predicting future values. The consumer population will maximize their expected lifetime utility:

$$(1)\ \sum_{t=0}^{\infty} \sum_{S^t} \pi_t\,(S^t)\beta^t U(c_t(S^t), l_t(S^t))N_t,$$

Where $\pi_t(S^t)$ is the probability of S^t, β is the discounting factor, $U(.)$ is the utility function of a representative consumer, $c_t(S^t)$ is consumption per capita, $l_t(S^t)$ is labor supplied per capita, and N_t is the population size. The utility function is represented by:

$$(2)\ U\big(c_t(S^t), l_t(S^t)\big) = \ln\,[c_t(S^t)] + \psi \ln\,[1 - l_t(S^t)]\,,$$

where ψ is the time allocation parameter. Each representative consumer's utility will be limited by the following budget constraint:

$$(3)\ c_t(S^t) + (1 + \tau_{x,t}(S^t))\,x_t(S^t) = \Big(1 - \tau_{l,t}(S^t)\Big)\,w_t(S^t)l_t(S^t) + r_t(S^t)k_t(S^t) + T_t(S^t),$$

where $1/(1 + \tau_{tx}\,)$ is the *investment wedge*, x_t is investment per capita, $(1 - \tau_{lx})$ is the *labor wedge*, w_t is the real wage rate, r_t is the real rate of return of capital, k_t is capital holdings per capita and T_t are lump-sum subsidies from the government per capita. In this model, the law of capital accumulation follows the following equation:

$$(4)\ (1+\gamma_N)k_{t+1}(S^t) = (1-\delta)k_t(S^t) + x_t(S^t) + \phi(\frac{x_t(S^t)}{k_{t-1}(S^t)}) ,$$

where δ is the depreciation rate and $\phi(\frac{x_t(S^t)}{k_{t-1}(S^t)})$ is the adjustment cost of capital, which as Brinca et al. (2020):

$$(5)\ \phi\left(\frac{x_t(S^t)}{k_{t-1}(S^t)}\right) = \frac{a}{2}\left(\frac{x_t(S^t)}{k_{t-1}(S^t)} - \delta - \gamma - \gamma_N\right)^2,$$

where a determines the marginal capital adjustment costs, γ is the growth rate of the technical ability of labor and γ_N is the population growth rate. In this economy, there are also firms, which produce according to the following equation:

$$(6)\ y_t(S^t) = A_t(S^t)F(k_t(S^{t-1}), (1+\gamma)^t l_t(S^t)),$$

where $A_t(S^t)$ is the *efficiency wedge* and $F(.)$ is the production function, represented by:

$$(7)\ F\big(k_t(S^{t-1}), (1+\gamma)^t l_t(S^t)\big) = k_t(S^{t-1})^\alpha[(1+\gamma)^t l_t(S^t)]^{1-\alpha},$$

where α is the share of capital. The firms' profit function will be as follows:

$$(8)\ \Pi_t(S^t) = y_t(S^t) - w_t(S^t)l_t(S^t) - r_t(S^t)k_t(S^{t-1}),$$

The equilibrium of the *prototype economy* can then be found with four equations: the production function (6); the national resource constraint:

$$(9)\ y_t(S^t) = c_t(S^t) + g_t(S^t) + x_t(S^t),$$

where $g_t(S^t)$ is the *government wedge*; the function that captures the intra-temporal decision between labor and leisure:

$$(10)\quad -\frac{U_{l,t}(S^t)}{U_{c,t}(S^t)} = \big(1-\tau_{lt}(S^t)\big)A_t(S^t)(1+\gamma)F_{l,t},$$

where $U_{l,t}$ is the first-order derivative of the utility function with respect to labor, $U_{c,t}$ is the first-order derivative of the utility function with respect to consumption and $F_{l,t}$ is the first-order derivative of the production function with respect to labor; and the function that captures the inter-temporal decision between consumption and savings:

$$(11) \quad U_{c,t}(S^t)(1 + \tau_{xt}(S^t)) = \beta \sum_{S^t} \pi_t (S^{t+1}|S^t)[U_{c,t}(S^t)(A_{t+1}(S^{t+1})F_{k,t} + (1-\delta)\left(1 + \tau_{x,t+1}(S^{t+1})\right) + \phi_{k,t+1}],$$

where $\pi_t(S^{t+1}|S^t)$ is the conditional probability of S^{t+1} given S^t and can also be represented by $\pi_t(S^{t+1})/\pi_t(S^t)$, and $\phi_{k,t+1}$ is the first order derivate of the capital adjustment cost function with respect to capital. **Equations 10 and 11** are respectively obtained by the utility and profit maximizing decisions of consumers and firms. Solving each equation for a wedge, we have:

$$(12) \quad \boldsymbol{A_t(S^t)} = \frac{F(k_t(S^{t-1}),(1+\gamma)^t l_t(S^t))}{y_t(S^t)},$$

$$(13) \quad \boldsymbol{g_t(S^t)} = y_t(S^t) - c_t(S^t) - x_t(S^t),$$

$$(14) \quad \left(\boldsymbol{1 - \tau_{l,t}(S^t)}\right) = -\frac{U_{l,t}(S^t)}{U_{c,t}(S^t)A_t(S^t)(1+\gamma)F_{l,t}},$$

$$(15) \quad \frac{\boldsymbol{1}}{(\boldsymbol{1} + \boldsymbol{\tau_{x,t}(S^t)})} = \frac{U_{c,t}(S^t)}{\beta \sum_{S^t} \pi_t(S^{t+1}|S^t)[U_{c,t}(S^t)(A_{t+1}(S^{t+1})F_{k,t}+(1-\delta)\left(1 + \tau_{x,t+1}(S^{t+1})\right)+\phi_{k,t+1}]}$$

To get the equilibrium of the *prototype economy*, we need to do some assumptions. First, we assume:

$$(16) \quad k_0 = x_0,$$

to be able to get a value for capital for period 0. I will also assume values for parameters in the following chapter. With data on l_t, x_t, y_t, g_t and c_t, we can solve equations (12), (13) and (14), but not (15), since it holds an expectation term, $\pi_t(S^{t+1}|S^t)$. Just as Chari et al. (2007a) and Brinca et al. (2016), we will assume that expectations follow a first-order Markov process:

$$(17) \quad \pi_t(s_t|S^{t-1}) = \pi_t(s_t|s_{t-1}),$$

meaning that the conditional probability of s_t is the same whether we are taking in account all the historical events prior to the current period, S^{t-1}, or only the events of the previous period s_{t-1}. Hence, expectations for period $t+1$ can be estimated with only s_t. If we also assume that the events s_t are mapped one-to-one to the wedges:

$$(18) \quad s_t = [A_t, 1 - \tau_{l,t}, \frac{1}{(1+\tau_{x,t})}, g_t],$$

we can create a first-order autoregressive process for s_{t+1}:

$$(19) \quad s_{t+1} = P_0 + Ps_t + \varepsilon_{t+1},$$

where P_0 is a vector of constants, P is a 4x4 matrix of coefficients, and ε_{t+1} is a zero mean, independent and identically distributed, error term vector, which represents randomized exogenous shocks to the economy. The previously referenced stochastic character of the *prototype economy* has its root in this autoregressive process. ε_{t+1}'s covariance matrix, V, is semi-definite positive by construct. This way, there will be spillover effects between the wedges, not only due to the coefficient matrix, P, but also due to the error term's covariance matrix, V. This autoregressive process will be solved by applying a standard maximum likelihood procedure using the log-linear versions of the previously presented decision rules and six final variables which we describe in the next chapter.

4. Data and Application Details

We use quarterly data between 1995:Q1-2021:Q2, for the Euro Area, and 1965:Q1-2021:Q3, for the United States. The estimated periods were solely determined by the intersection of the periods with available data between the used data sources. The fifteen countries included to compute the aggregate values for the Euro Area were also determined by the intersection of the countries with available data, and are available in **Annex I**. Even though

U.S. states are much more synchronized in terms of business cycles than the Euro-Area, the latter also shows a considerable degree of synchronization[2], especially at the core countries, which motivates this comparative exercise.

To be able to simulate the *prototype economy* and estimate the wedges, we use data for the United States and the Euro Area, of the following variables, with the following sources: gross capital formation (investment), GDP (output), private final consumption, government final consumption, exports of goods and services, imports of goods and services, hours worked, total employment and the GDP deflator, from the *OECD Economics Outlook* database, with the exception of exports and imports of goods and services for the Euro Area, which are from the *IMF Data* database; size of population aged between 15-64 from the *OECD.Stat* database; consumption of durable goods from the *OECD National Account Statistics* database; and average tax rate on goods and services from *OECD Data* database. The *IMF Data* database was used to calculate exports and imports out of and to the Euro Area, because it has a feature which discriminates the exports (imports) to (from) the country chosen by the user. This way, we can subtract the goods and services that the Euro Area exports and imports to and from itself from the aggregate values, as well as adjust for the exclusion of some of the Euro Area countries.

Hours worked and total employment will be used to calculate total labor. Net exports will be combined with government expenditure and be considered as one variable, g_t. Therefore, the *government wedge* will also capture fluctuations of the participation of the *prototype economy* in the international market of goods and services. For *equivalence result* purposes, an open economy model can be mapped into a closed economy in which net exports are added with government consumption, as proven in Chari et al. (2005). This also allows the

[2] See **Aguiar-Conraria et al. (2017)**.

study of international transmission of shocks[3]. The GDP deflator will be used as the price level, to obtain the real values of the economic variables.

To approach the economic decisions that most resemble the ones described in the last sub-chapter, we will need to do several adjustments to our variables. We will consider the consumption of durable goods as investment, needing thus to subtract the consumption of durable goods from total consumption and add it to investment. Assuming a depreciation rate, δ_D, and a return rate, r_D, for the stock of consumption durables, we will also add back the depreciation and return values to consumption and, to maintain the resource constraint [**Equation (9)**], to output too. We will also subtract the taxes of goods and services regarding the consumption of durables from investment and will subtract the rest from private consumption. To maintain the resource constraint [**Equation (9)**], total taxes on consumption of goods and services will also be subtracted from output. Finally, the population size aged between 15-64 will be used to obtain the per capita version of the economic variables and population growth rate, γ_N, instead of total population size.

After all initial computations, we remain with five final variables which will be used to solve the maximum likelihood procedure described in the last section: output per capita; investment per capita; hours worked per capita; government consumption per capita; and private consumption per capita. These variables are logged and from them is removed their country/region-specific trend.

Looking at the fluctuation of the final variables during our period of study, during the first half of 2020, we can see a similar pattern in both studied regions: government consumption slightly increases, while the rest of the variables plummet. In spite of this, the recovery of these four indicators in each economy is contrasting: In the Euro Area, after a quick recovery, the

[3] See **Brinca & Costa-Filho (2021a)**.

most affected indicators either stagnate or fluctuate back downwards and upward; In the United States, the recovery process is much more successful, with hours worked being the only variable that couldn't retain its 2019:Q4 value. The initial drop in indicators in both regions, and subsequent drop of private consumption in the Euro Area coincides with the first and third wave of the pandemic, which indicate restrictions of economic activities as its main cause. The hike of U.S. investment can be partially explained by the 30% increase of consumption of durables, but more on that later.

Another interesting differentiation is the initial impact of hours worked, which, out of the initially affected variables. was the one with the smallest drop in the Euro Area, albeit being the most affected in the United States. This may be due to two reasons: 1) the more effective job retention schemes which European countries implemented, which alleviated the impact of the pandemic on the labor market and household income; 2) differentiation in unemployment accounting, as in the U.S., workers in lay-off are considered unemployed, while in the Euro Area, they are not (Anderton et. al 2020). Finally, the United States experienced a major decline of government consumption. This can be explained by net exports since it decreased almost 70% during the studied period.

Table 1 - Model Parameters[a]

<table>
<tr><th>Region/ Country</th><th>γ_N[b]</th><th>γ[b]</th><th>a[b]</th><th>β</th><th>ψ</th><th>δ</th><th>α</th><th>δ_D</th><th>r_D</th></tr>
<tr><td>Euro Area</td><td>0.0003</td><td>0.0026</td><td>16.025</td><td rowspan="2">0.9937</td><td rowspan="2">2.5</td><td rowspan="2">0.0127</td><td rowspan="2">0.3333</td><td rowspan="2">0.0574</td><td rowspan="2">0.01</td></tr>
<tr><td>United States</td><td>0.0027</td><td>0.0045</td><td>12.563</td></tr>
</table>

[b] Rounded to the fourth decimal place.
[b] Endogenous to the model.

The exogenous values of the model parameters [**Table 1**] were taken from Brinca et al. (2016) and chosen such that: the annualized discounting factor, β, is 0.975; the annualized depreciation rate δ, is around 5%; the annualized depreciation rate of durables, δ_D, is 25%; and the annualized return rate of durables, r_D, is close to 4%. Following Bernanke et al. (1999) the parameter which determines the marginal capital adjustment costs, a, is such that the elasticity, $\eta = a(\delta + \gamma + \gamma_N)$, of the price of capital in regard to the investment-capital ratio, $\rho = \frac{1}{1-\phi\prime(.)}$, equals 0.25.

5. Results

In **Table 2**¸ we display the parameters' matrixes regarding **Equation 19,** which are estimated using a maximum likelihood process. The coefficient matrix of the Euro Area presents higher spillover effects between the variables, in comparison with the coefficient matrix of the United States[4].

The rest of this chapter will be divided in three sub-chapters, two analyzing the results of each region, and another discussing said results. The wedges and economic variables presented in this section are all detrended and indexed with the peak quarter as its base, which as reported by the National Bureau of Economic Research, is the fourth quarter of 2019.

Table 2 - Parameters of the Stochastic AR(1) Process (Estimated Using Maximum Likelihood)[a]

Coefficient Matrix, P				**Standard Deviation Matrix, Q ($V = Q.Q'$)**			
B. Euro Area (1995:Q1-2021:Q2)							
0.867	0.280	0.027	0.007	0.016	-0.007	0.011	0.002
0.072	0.956	0.133	-0.003	-0.007	0.005	-0.009	0.001
-0.145	0.0157	0.666	-0.013	0.011	-0.009	-0.004	-0.002
0	-0.167	-0.194	0.976	0.002	0.001	-0.002	0.007
Mean of States[b], $\bar{s_t}$ = [1.088, 0.512, -0.221, 0.182];				P_0 = [-0.1139, 0.0409, -0.0920, 0.0014]			
D. United States (1965:Q1-2021:Q3)							
0.937	0.042	0.045	-0.017	0.010	0.001	0.002	0
-0.033	1	0.054	-0.006	0.001	0.011	-0.004	0.001
0.063	-0.031	0.941	0.015	0.002	-0.004	0.013	0.016
0.090	-0.045	-0.022	1.012	0	0.001	0.016	-0.014
Mean of States[b], $\bar{s_t}$ = [1.144, 0.348, 0.090, 0.165];				P_0 = [-0.0411, -0.0113, 0.0340, 0.0280]			

[a] Rounded to the third decimal place.
[b] Absolute values.

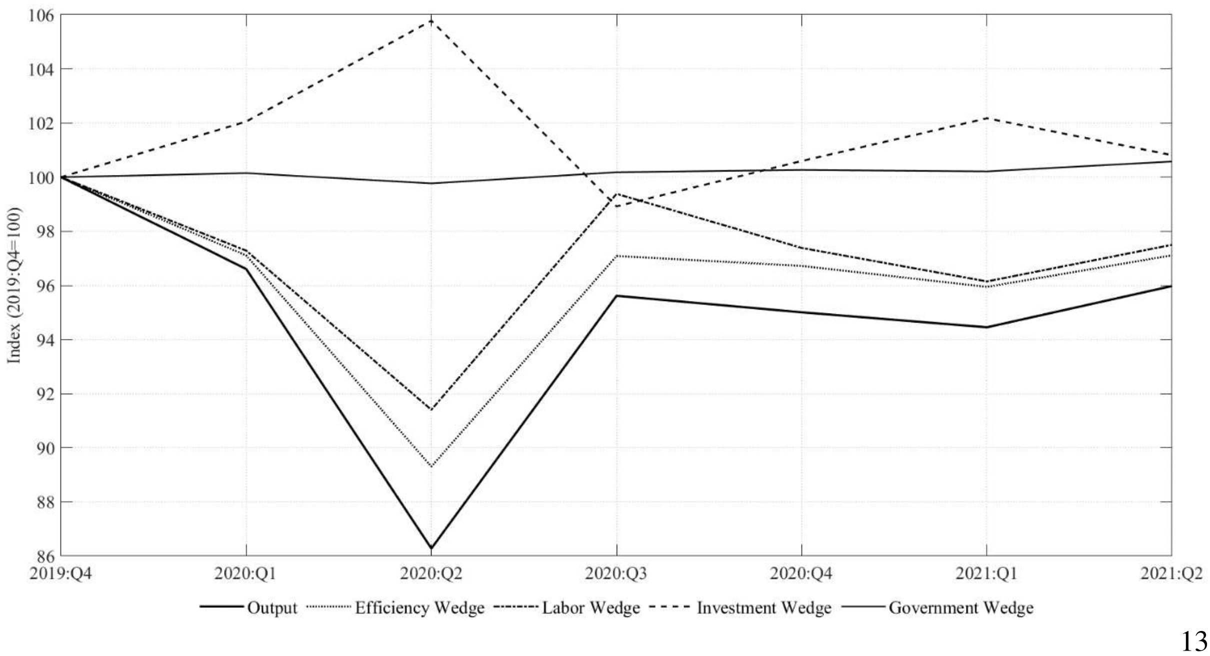
[4] For parameter identification issues, see **Brinca et al. (2022)**.

5.1 Euro Area

The *investment wedge*, contradicting its historical record, has a strong negative correlation with output, seemingly oppositely mirroring its movements. The *government wedge* holds absolutely no correlation with output, although historically it presents a modest negative correlation with output from the two preceding quarters, hinting at a lag of fiscal policy. The *efficiency wedge* is the one which most correlates with output, although its standard deviation is much smaller. The *labor wedge*'s movement mimics that of output the most, due to its strong correlation and close standard deviation with output.

This, however, does not mean that the *labor wedge* is the best predictor of outcome, something that is best exemplified in **Graph 1**, which portrays output and the *prototype economy*'s prediction of output when only inputting a wedge at a time. Actual output was worse than any wedge's prediction. The contribution of the *efficiency wedge*, as in last recessions, seems to be the strongest. Its predicted values of output are the closest to the actual values in all studied periods. Additionally, they virtually perfectly correlate with actual values, and their standard deviation is the closest to that of actual output. If the disturbance mechanism behind it was the only one in the economy, until 2020:Q2 output's decrease would have been 3% lower.

Graph 1 - Output and Modeled Output With One Wedge (Indexed, Euro Area, 2019:Q4-2021:Q2)



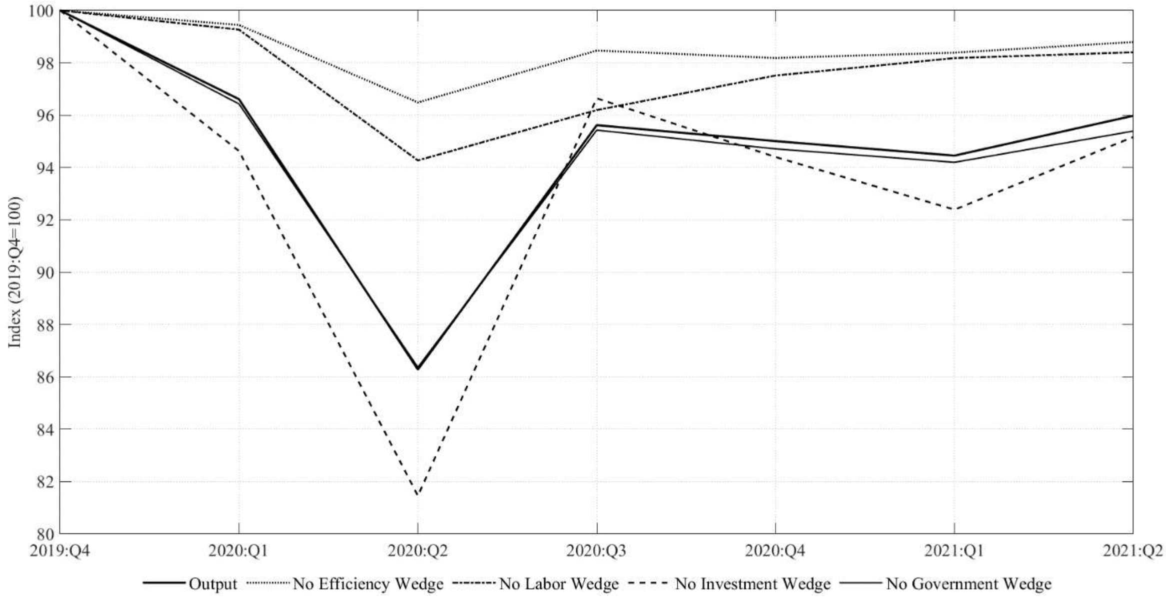
The *labor wedge* also seems to be a good predictor of output as well, as the correlation of its model values with output is 0.95. This, along with the 33% lower standard deviation, is an indication that, if it was the only wedge in the economy, output wouldn't have decreased has much during the first wave of the pandemic, by about 5%.

The *government wedge*'s predicted values present the weakest correlation with and the farthest standard deviation of that of actual output, which is an sign that it doesn't capture any disruption mechanism that is essential to understand to study the economy of the Euro Area during the COVID-19 Recession. Historically, its contribution is negligible as well.

The *investment wedge*'s predicted values differ the most from the real ones, with the correlation between them being -0.84. They also fluctuated significantly less than output, by about 47%. Historically, its correlation with output is mediocre, although its correlation with the prediction values of the *labor wedge* is a very strong -0.91, which can be a sign of a mechanism of decreased savings in bonanzas and increased savings in periods of higher labor uncertainty, or of compensation between labor and capital, when there are market disruptions.

This relation between the *investment wedge*'s predictions and actual output should not lead to any conclusions that disruptions in the investment market are not an important component of output. In **Graph 2**, we display the *prototype economy*'s predicted values of output when we input all but one of the wedges. As we can see, even though when we exclude the *investment wedge,* the model's predictions are the second best, it seems that its inclusion somewhat offsets the excessive negative impact that the combination of the *efficiency* and *labor wedges* have on output. When we exclude it, predicted output falls 4.2% more than actual output during the first half of 2020. The *investment wedge*'s positive impact on outcome seem to

Graph 2 - Output and Modeled Output With All But One Wedge (Indexed, Euro Area, 2019:Q4-2021:Q2)



coincide with the periods associated with the strongest restrictions to economic activity, during the first and third wave of the pandemic. Note also that financial frictions must not necessarily be mapped onto the investment wedge. The financial system has two main functions: channel resources to their most efficient uses and transfer resources across time and states of the world. Obstacles to the latter will show up as distortions to **Equation 11**, and thus, the investment wedge. Nonetheless, the former is essentially a misallocation issue, and as such, it will be captured by the efficiency wedge[5].

The model's predictions when excluding the other wedges were much more predictable: when excluding the *government wedge*, the *prototype economy* nearly perfectly predicts actual values of output, diverging slightly during the last two studied quarters; when excluding the *labor* and *efficiency wedges*, the model's predictions are much more positive, which is a further indication of the negative impact these disruptions had on output during the analyzed period.

To conclude our inference on which wedges most influence output, we will present each model prediction's θ statistic, which as in Brinca et al. (2016):

[5] For an example of a model with financial frictions that show up in the efficiency wedge, see **Brinca and Costa-Filho (2021b)**.

$$\theta_i^Y = \frac{1/\sum_t (Y_t - Y_{t,i})^2}{\sum_j 1/\sum_t (Y_t - Y_{t,j})^2}$$

where Y_t is detrended output and $Y_{t,i}$ is the *prototype economy*'s prediction of output using wedge i (or all wedges with the exception of wedge i). The better the output prediction is, the smaller $(Y_t - Y_{t,i})$ will be, and hence, the closer the θ statistic will be from 1.

Table 3 - The Contribution of Each Wedge in the Variation of Output (Euro Area, 2019:Q4-2021:Q2)[a]

$\boldsymbol{\theta_e^Y}$	$\boldsymbol{\theta_l^Y}$	$\boldsymbol{\theta_x^Y}$	$\boldsymbol{\theta_g^Y}$
One Wedge Economies			
69%	24%	2%	4%
All But One Wedge Economies [b]			
86%	78%	36%	--[c]

[a] Rounded to the second decimal place.
[b] For better interpretation, the All But One Wedge Economies present $(1-\theta)$, instead of θ.
[c] Excluded from the calculation. The predictive power of the model without this wedge was too strong, distorting the θ statistic of other wedges, making them appear to contribute more than they actually do. Table with complete statistics can be found in **Annex II**.

In **Table 3**, we display the θ statistics for the Euro Area. Taking in account one wedge economies, the *efficiency wedge* displays the biggest contribution to output, with the *labor wedge* taking a distant second place. Taking in account all but one wedge economies, however, only the *government wedge* appears to have an unimportant contribution to output. Considering our previous explanation of the dichotomy between the seemingly unimportance of the *investment wedge* in the one wedge economies and the modest contribution in the all but one wedge economies, it takes us to infer that only the *government wedge* had an insignificant effect on output, with the *efficiency wedge* taking center-stage.

In terms of other economic variables, the *labor wedge*, unsurprisingly, is the best predictor of detrended hours worked in one wedge economies. Its predicted values have a correlation of 0.90 with hours worked, only surpassed by the *efficiency wedge*'s, which is 0.99. Nevertheless, the low standard deviation of the predicted values by the *efficiency wedge*, 54% lower than that of hours worked, hints at a weaker impact in the labor market, in comparison with the *labor wedge*. In all but one wedge economies, a similar scenario has in output's modelling happens: the *government wedge* is the only disturbance whose impact is irrelevant, but this time the *labor wedge* takes center stage, with the *investment wedge* on a close second.

Table 4 - The Contribution of Each Wedge in the Variation of Economic Variables (Euro Area, 2019:Q4-2021:Q2)[a]

θ_e^H	θ_l^H	θ_x^H	θ_g^H	θ_e^X	θ_l^X	θ_x^X	θ_g^X	θ_e^C	θ_l^C	θ_x^C	θ_g^C
One Wedge Economies											
36%	50%	4%	11%	62%	27%	2%	9%	29%	36%	50%	4%
All But One Wedge Economies [b]											
26%	94%	81%	--[c]	79%	54%	68%	--[c]	95%	96%	83%	26%

[a] Rounded to the second decimal place.
[b] For better interpretation, the All But One Wedge Economies present $(1-\theta)$, instead of θ.
[c] Excluded from the calculation. The predictive power of the model without this wedge was too strong, distorting the θ statistic of other wedges, making them appear to contribute more than they actually do , Table with complete calculation can be found in **Annex II**.

The *investment wedge* has the same offsetting effect has in output, as detrended hours worked would have decreased 7.5% more than the actual 9% if its fluctuation had been null.

Investment's modelling follows a similar layout as output: in one wedge economies, the *efficiency wedge*'s prediction values are the best, followed by the *labor wedge*, at a far second, while *the investment wedge* looks inconsequential; in all but one wedge economies, only the *government wedge*'s effect is negligible, while the θ statistic indicates that the *investment wedge* contributes more than the *labor wedge*.

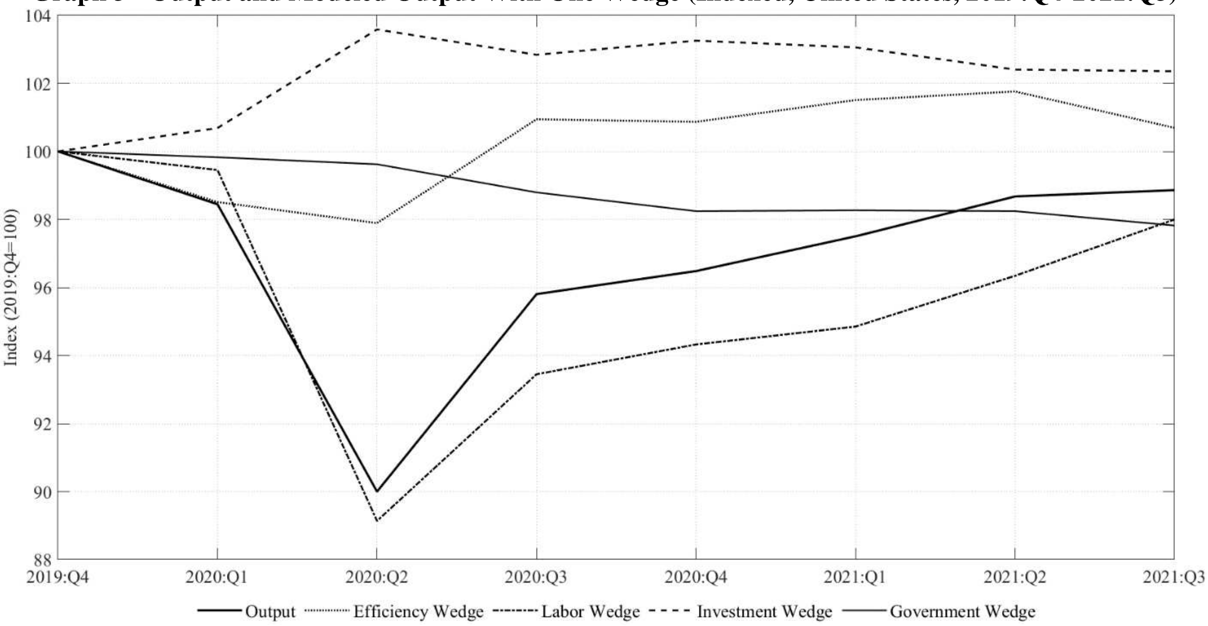
Private consumption's modelling has a varying feature in comparison with the other variables, which is a strong positive correlation between the *investment wedge*'s predictions and actual values, of 0.96, so there is no offsetting mechanism. This, along with the closest standard deviation to actual consumption, makes it the best predictor in one wedge economies, although the contribution of the *labor* and *efficiency wedges* is much more evenly allocated, since their forecasts are the most correlated with actual values. In all but one wedge economies, and considering all wedges, the *prototype economy* manifests its most accurate predictions, although the *government wedge* still has the least vital contribution.

5.2 United States

Generally, we can say that the U.S. wedges are more heterogeneous than the Euro Area ones. Their relative fluctuation is higher too, with average standard deviation being 30% higher than that of its output, while in the Euro Area it is 16% lower. This is due to a more stable output. The *investment wedge*, as in the Euro Area, seems to be oppositely mirroring output, although historically, except during the Great Recession, it has no correlation with it. The *government wedge* has the weakest correlation with output and the standard deviation furthest away from that of output, being 101% higher. The *efficiency wedge,* despite having a moderate correlation with output, barely fluctuates. The *labor wedge* seems to be the one whose motion most closely imitates output, having the highest correlation with it. Historically, it also seems to be the most important wedge.

The argument for the importance of the *labor wedge* continues in **Graph 3**, which presents output along with the one wedge economies' prediction of output. Not only the *labor wedge*'s forecast values correlation of 0.93 with output is high, but its standard deviation only surpasses outputs by 14%. If the labor market's disturbance mechanisms were the only in the economy, output would have decreased only 0.9% more than in reality, albeit it persisted below actual values between 2.3% and 2.6% of the base value, during the proceeding years. This apparent intense contribution to output variation may be due to the record high unemployment, whose rate increased from 4.4% to 14.8%, between March and April 2020[6]. Historically, it

Graph 3 - Output and Modeled Output With One Wedge (Indexed, United States, 2019:Q4-2021:Q3)



[6] See **Annex IV**

fluctuates along real values, having a correlation of 0.77 with them, despite diverging away from them only five years before the base period.

The *government wedge* seems to have a very negligible role in setting up output, as its predicted values decrease very gradually along the entire studied period, stagnating for three quarters, between the end of 2020 and middle of 2021. This is best exemplified by its standard deviation and correlation with output, both the lowest and weakest among the wedges' forecasts, being 73% lower than that of output and -0.18, respectively. Historically, it has a somewhat stronger negative correlation with output, with the 1990s and initial period of the Great Recession showcasing this relation the best.

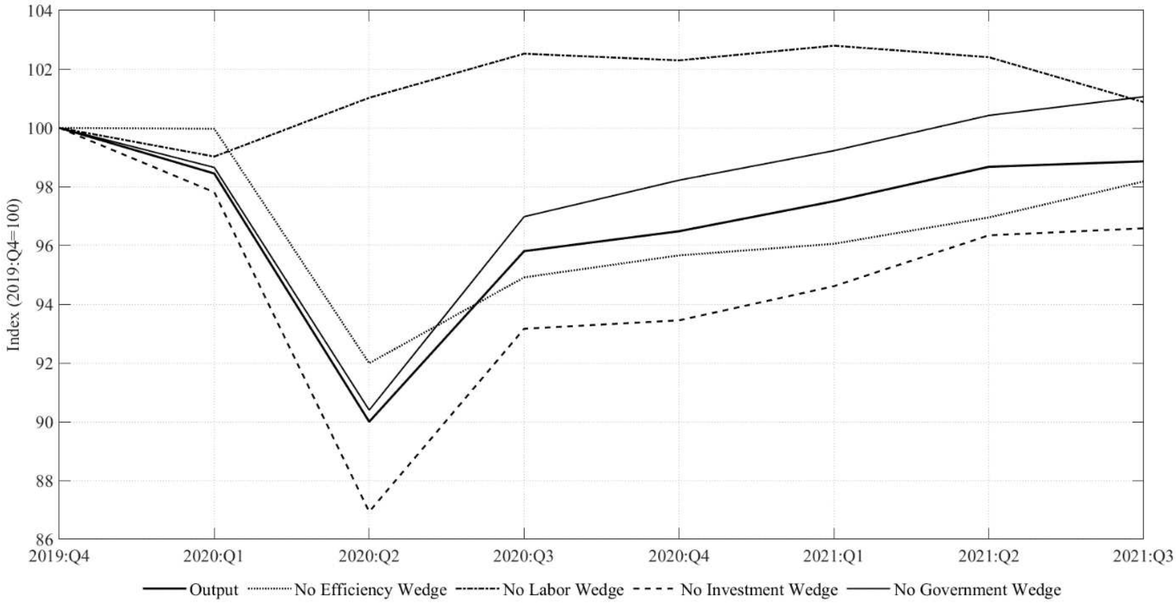
The *investment wedge* also seems to be a poor sole predictor of output: when only inputting it back in the *prototype economy*, it estimates output fluctuations which oppositely mirror actual output, increasing 3.6% until 2020:Q2 and then consistently and slowly decreasing until reaching a value 2.4% higher than the base value. Its negative correlation with output is moderately strong, although its standard deviation is 59% lower than that of output. Historically, it has a negligible correlation with output, although it fluctuated along it during the Great Recession and the preceding years.

The *efficiency wedge*'s contribution to output in the United States contrasts with that of the Euro Area, as it has a much lower correlation with its output and a much lower relative standard deviation, 54.5% lower than that of output. Nonetheless, with the exception of the last studied quarter, it fluctuates similarly as output, although it surpasses and endures above its base value during and after 2020:Q3. Historically, it has the weakest correlation with output, in spite of having the standard deviation most similar to that of output. Just like the *efficiency wedge* its fluctuation matches that of output until the middle of the 1980s decade.

For further examination, we display the estimations of output of all but one wedge economies in **Graph 4**. Excluding the *labor wedge* results in the biggest discrepancy in predictions, in comparison with the actual values. If it wouldn't be for labor market disruptions, detrended output would actually increase 1% over the first half of 2020, reaching its maximum point of 2.8% above its base value, in the first quarter of 2021, before converging back near its 2019:Q4 reference point until the end of the sample. This is an indication that the *labor wedge* is a crucial mechanism to study to be able to understand the COVID-19 Recession in the United States. Historically the *labor wedge* seems unimportant from the 1990s up to the pre-Great Recession period, but the most relevant wedge from the beginning of the sample up the end to of the 1980s, and from the Great Recession until 2017.

Just like in the Euro Area, the *investment wedge* has an offsetting effect on output. In the absence of investment market disturbances, output would have decreased 13.1% until 2020:Q2, 3.1% more than in reality. This divergence from real values continues until the end of the sample. Estimated output does, however, fluctuate similarly as actual output. This can be justified with the hike in credit deferral during the first wave of the pandemic and the subsequent persistence of a reasonable percentage of deferrals. Historically the absence of the *investment wedge* seems to affect output the least out of all wedges.

Graph 4 - Output and Modeled Output With All But One Wedge (Indexed, United States, 2019:Q4-2021:Q3)



On the opposite side, the *government* and *efficiency wedges* have the slightest influence on output: with the absence of government disruptions, output would have barely changed through the first couple quarters of the pandemic, although it overestimates it by a margin of 1.2% to 2.2% until the last quarter of our studied period; with the absence of efficiency disturbances, output would have only decreased 8% until 2020:Q2, although its weaker relative recuperation means it would fall behind actual output by 0.7% and 1.7% until the end of the sample. The *government wedge*'s negative effect on output on the aftermath of the initial economic shock can easily be explained by the strong decrease of net exports depicted in the last chapter.

Table 5 - The Contribution of Each Wedge in the Variation of Output (United States, 2019:Q4-2021:Q3)[a]

θ_e^Y	θ_l^Y	θ_x^Y	θ_g^Y
One Wedge Economies			
12%	67%	5%	16%
All But One Wedge Economies [b]			
55%	98%	87%	61%

[a] Rounded to the second decimal place.
[b] For better interpretation, the All But One Wedge Economies present $(1-\theta)$, instead of θ.

Looking at the θ statistics for one wedge and all but one wedge economies, displayed in **Table 5**, we can support our argument that, in the U.S., the *labor wedge* overwhelmingly provides the biggest contribution in explaining fluctuations in output. At a far second place, we would place the *investment wedge*, whose low θ statistic in one wedge economies can be excused, given the formula's averse character in dealing with values which contrast real output. In reality, the *investment wedge*'s offsetting feature provides strong complementary predictive value to the *labor wedge*. The *government* and *efficiency wedges*, however, seem to have an ineffective conduct during this last recession. Interestingly enough, the *efficiency wedge*, which is found to be the one with least explanatory power, is the wedge which is found to be most important in past literature[7]. This further adds to the unconventional nature of the economic shock caused by the COVID-19 pandemic.

[7] See Brinca et al. (2020)

Table 6 - The Contribution of Each Wedge in the Variation of Other Economic Variables (United States, 2019:Q4-2021:Q3)[a]

θ_e^H	θ_l^H	θ_x^H	θ_g^H	θ_e^X	θ_l^X	θ_x^X	θ_g^X	θ_e^C	θ_l^C	θ_x^C	θ_g^C
One Wedge Economies											
8%	76%	3%	13%	73%	5%	3%	20%	6%	57%	31%	5%
All But One Wedge Economies [b]											
--.-[c]	96%	75%	29%	55%	98.2%	98.1%	49%	50%	95%	94%	62%

[a] Rounded to the second decimal place, for values below 98%, and rounded to the third decimal place, for values above 98%.
[b] For better interpretation, the All But One Wedge Economies present $(1 - \theta)$, instead of θ.
[c] Excluded from the calculation. The predictive power of the economy without this wedge was too strong, distorting the θ statistic of other wedges, making them appear to contribute more than they actually do, Table with complete calculation can be found in **Annex III**.

In terms of estimating other variables, the *labor* and *investment wedges* clearly hold the main predictive power for hours worked, with their forecast values having the biggest correlations with it, of 0.92 and -0.52 respectively, and the standard deviations closest to that of it, being 38% higher and 12.1% lower, respectively. The *labor wedge* seems to be a better estimator though, with the *investment wedge* taking a moderately distant second place. The *efficiency wedge*'s role here is absolutely null, while the *government wedge* seems to have a very slight negative effect as net exports plummeted.

In predicting investment values, an interesting anomaly arises: the *efficiency* and *government wedges*, which look to be the disturbances with the biggest predictive power in one wedge economies, turn out to be the disturbances with the weakest forecasting power in all but one wedge economies. This happens for two reasons: 1) the *labor* and *investment wedges* have very strong contributions of nearly even power, but with much different effects, with labor and investment market disruptions respectively pushing investment downwards and upwards, which results in investment fluctuating around its base value; 2) the forecasts of the *efficiency* and *government wedges* hold low standard deviations, respectively 53% and 81% lower than that of investment, which retains them near their base values, thus resulting in a low $(Y_t - Y_{t,i})^2$, and consequently, a high θ statistic. Interestingly enough, the *efficiency wedge*'s estimation values also hold by far the biggest correlation with investment, of 0.91, although that does not seem to translate into predictive power.

The *labor* and *investment wedges* also seem to be the best predictors of private consumption, with their forecasts holding the highest correlations and the standard deviations closest to actual values. Just as with hours worked, the *labor wedge* hold the strongest predictive power, while the *efficiency* and *government wedges*' contribution is unimportant.

5.3 – Discussion

Comparing the shock-absorption mechanisms of the studied regions, we can start to paint the bigger picture. The pandemic rose unemployment to record levels in recent history[8], not only due to temporary and permanent closures of businesses, as a consequence of restrictions to economic activity, but also due to older laborers leaving the workforce, to avoid the risk of contagion (Coibion et al. 2020). This decrease of labor was heterogeneous between the U.S. and the Euro Area: in the United States, from January 2020 until its peak, seasonally adjusted unemployment surged from 3.5% to 14.8%, while in the Euro Area it only grew from 7.1% to 8.7%[8]. This is due to two reasons: 1) the more effective job retention programs implemented in Europe, since in April, an estimated 32 million workers, which is three times the number of unemployed, were part of these schemes; 2) the different accounting methods between both regions, as, in the U.S., workers in temporary lay-off are considered unemployed, while in the Euro Area, they are not (Anderton et al. 2020). Despite this second point, hours worked decreased 12% in the U.S. (the highest among the main economic variables), in comparison with the 9% of the Euro Area (the lowest among the main economic variables, excluding government consumption). So, although the U.S. also had several job retention schemes, they seem to not have been as effective.

Another important point for the relevance of the *labor wedge* in the U.S. is that two thirds of the of the fall in the growth rate of hours worked, between March and April of 2020,

[8] See **Annex IV.**

can be attributed to labor supply. The reasoning behind this, as hinted before, may be workers wanting to avoid risk of contagion, since sectors with a smaller share of employees working from home experienced the highest labor supply decreases (Brinca et al. 2021).

This is crucial to understand the mechanism behind our wedges. Assuming a production function as in **Equation 6,** faced with a negative shock demand, output, y_t, decreases. If we also assume sticky wages and rental rates, firms' optimal choice would be to decrease the quantity of its inputs, k_t and l_t. This was what happened in the United States, as detrended investment and labor respectively decreased 11.9% and 12% during the first half of 2020, in comparison with output's 10%. Our *prototype economy* then majorly composes the shock through the *labor* and *investment wedges*. In the Euro Area, however, since such a substantial decrease of labor was prevented with job retention programs, for **Equation 6** to hold, capital, k_t, and/or the *efficiency wedge*, A_t, had to compensate.

The *investment wedge*, however, had a positive impact on output of both regions, meaning that, to decrease the capital stock to the firm's optimal level, investment should have dropped even further. The interpretation for this phenomenon may be supported by on one and/or three lines of thinking: 1) given the temporary nature of the recession, firms maintained a higher percentage of their capital stock to be prepared for the reopening of the economy; 2) credit deferral and moratorium programs, which contributed to distort the intertemporal decision between consumption and savings [**Equation 11**]; 3) historically low interest rates, which decreased not only due to the recession, as a consequence of the combination of a decrease in aggregate demand and increase in savings (Jordà et al. 2020), but also due to central banking intervention, as the monetary aggregates were largely increased. The extraordinary increase of the savings rate may be attributed to the consumption channels being blocked due to restrictions to economic activity, but its persistence to remain above pre-pandemic levels, even in periods of economic reopening may be due to record high levels of uncertainty (Baker et al. 2020). In view of investment's reaction, the *efficiency wedge* was forced downwards in the Euro Area.

6. Conclusions and Further Research

This paper intends to provide value added to the BCA literature by guiding researchers to which kinds of disturbances and market frictions they should try to model in order to better examine the economic shock caused by the COVID-19 pandemic, both in the Euro Area and the United States.

Using a *prototype economy* similar as that displayed in Chari et al. (2007a), we estimated wedges which represent disruptions associated with government consumption, labor markets, investment markets and efficiency. We found that in the Euro Area, the *efficiency wedge* had a crucial role, while the *labor wedge* was substantial and the *investment wedge* was relevant, albeit having a relatively smaller influence. In the United States, however, the *labor wedge* was the most important disruption, with the *investment wedge* taking a moderate second place.

Therefore, we suggest researchers, when creating a model of the COVID-19 recession, to consider the following mechanisms: the differences of the effect the *efficiency wedge* in each region seems to be originated in the higher effectiveness of European job retention schemes; The *labor wedge*'s fluctuations were largely influenced by restrictions to economic activity which accompanied the pandemic; The *investment wedge*'s upwards effect on output seems to be rooted by a higher-than-expected capital retention rate, possibly moved by expectations of quick liftings of the restrictions to economic activity, moratorium and credit deferral program, and/or also possibly moved by low interest rates.

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8. Annexes

Annex I

Table 7 – Included countries in the Euro Area aggregate data, excluded countries and the reasons for their exclusion

Included Countries				
Austria	Belgium	Estonia	Finland	France
Germany	Greece	Ireland	Italy	Luxembourg
Netherlands	Portugal	Slovakia	Slovenia	Spain

Not included Countries	
Malta Cyprus	Since they are not part of the OECD, its databases only have incomplete data.
Latvia Lithuania	Their later entry in the Euro Area also means they have a shorter time span of data. Excluded to ensure a timespan of data of at least 20 years, to ensure quality results in the maximum likelihood process.

Table 8 - Investment, Output, Hours Worked, Government Consumption and Private Consumption per Capita (Indexed, Euro Area, 2019:Q4-2021:Q2)

A. Summary Statistics

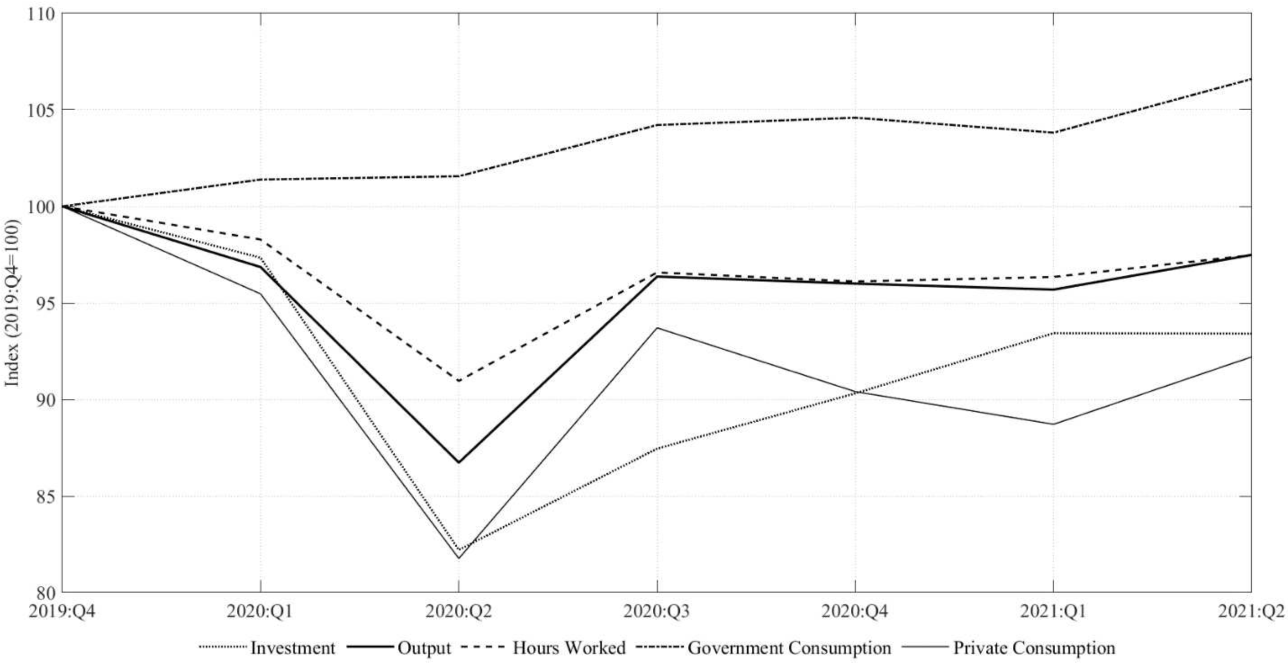
Wedges	$\frac{\sigma_{w_i}}{\sigma_y}$	Cross Correlations of Wedges with Output at Lag $k =$ -2	-1	0	1	2
Efficiency	0.5972	-0.5859	-0.2488	0.9925	-0.0919	-0.5155
Labor	1.1256	-0.4813	-0.4132	0.9679	-0.0741	-0.5038
Investment	1.2264	0.5062	0.5889	-0.8537	-0.0463	0.3149
Government	0.4135	-0.4707	-0.5013	0.0211	0.1095	0.6373

B. Cross Correlations

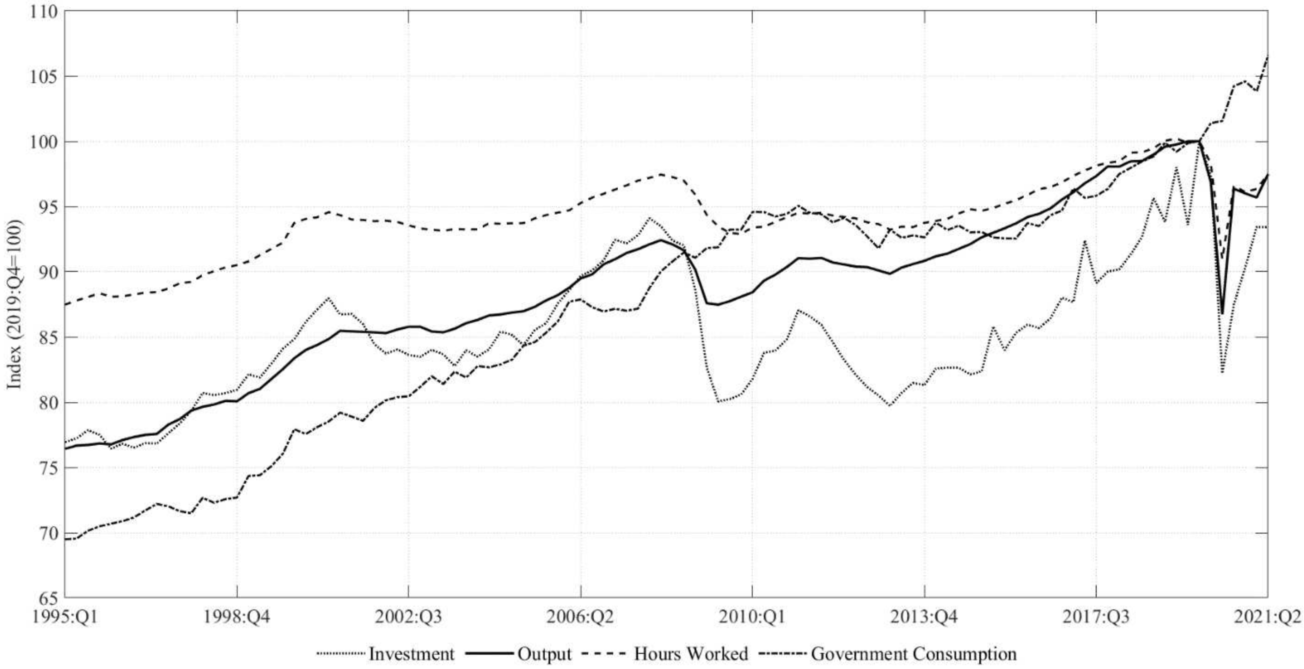
Wedges (X, Y)	Cross Correlation of X with Y at Lag $k =$ -2	-1	0	1	2
Efficiency, Labor	-0.5487	-0.1409	0.9808	-0.3562	-0.4785
Efficiency, Investment	0.3735	-0.0128	-0.9026	0.5278	0.5152
Efficiency, Government	0.5831	0.1907	0.0958	-0.4384	-0.4253
Labor, Investment	0.3759	0.1900	-0.944	0.4687	0.534
Labor, Government	0.4577	0.0586	0.1031	-0.431	-0.4849
Investment, Government	-0.3602	-0.1851	-0.3632	0.2273	0.3121

[a] Rounded to the fourth decimal place.

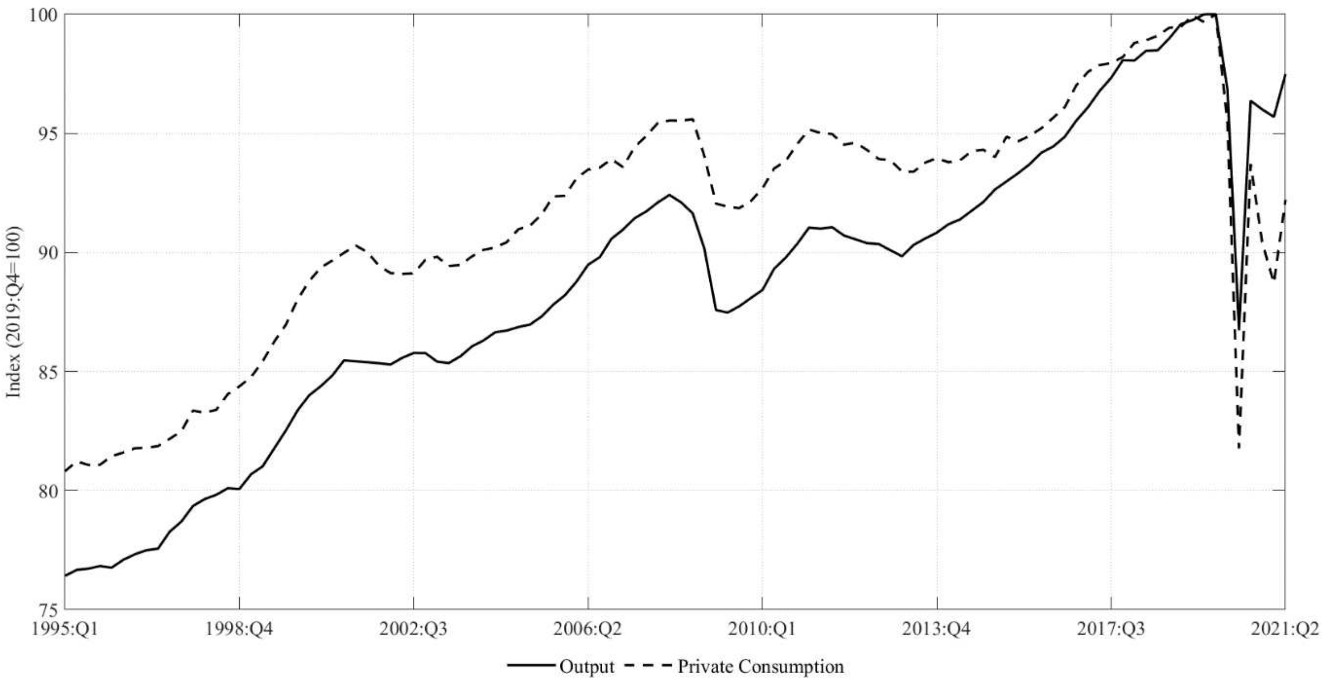
Graph 5 - Investment, Output, Hours Worked, Government Consumption and Private Consumption per Capita (Indexed, Euro Area, 2019:Q4-2021:Q2)



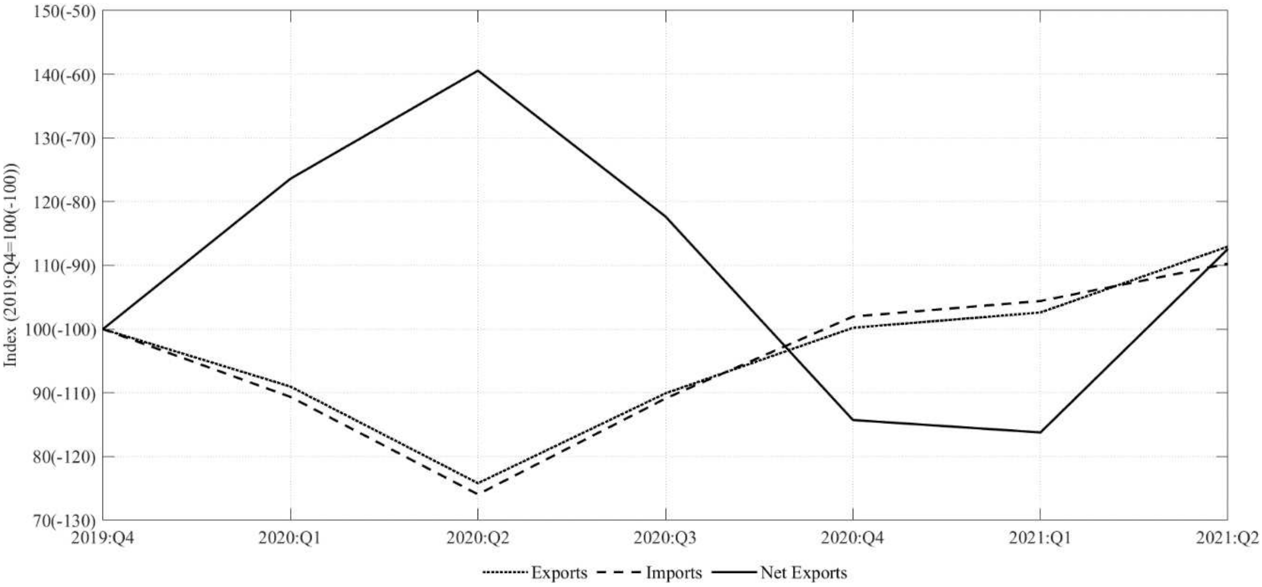
Graph 6 - Investment, Output, Hours Worked and Government Consumption per Capita (Indexed, Euro Area, 1995:Q1-2021:Q2)



Graph 7 - Output and Private Consumption per Capita (Indexed, Euro Area, 1995:Q1-2021:Q2)

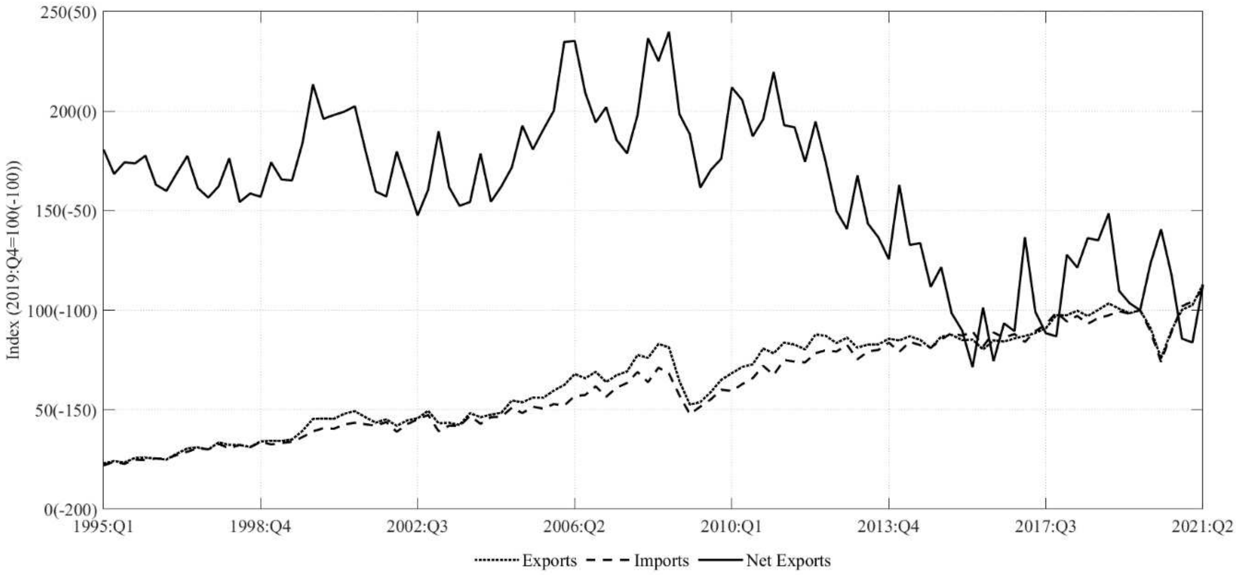


Graph 8 - Exports, Imports and Net Exports [a] (Indexed, Euro Area, 2019:Q4-2021:Q2)



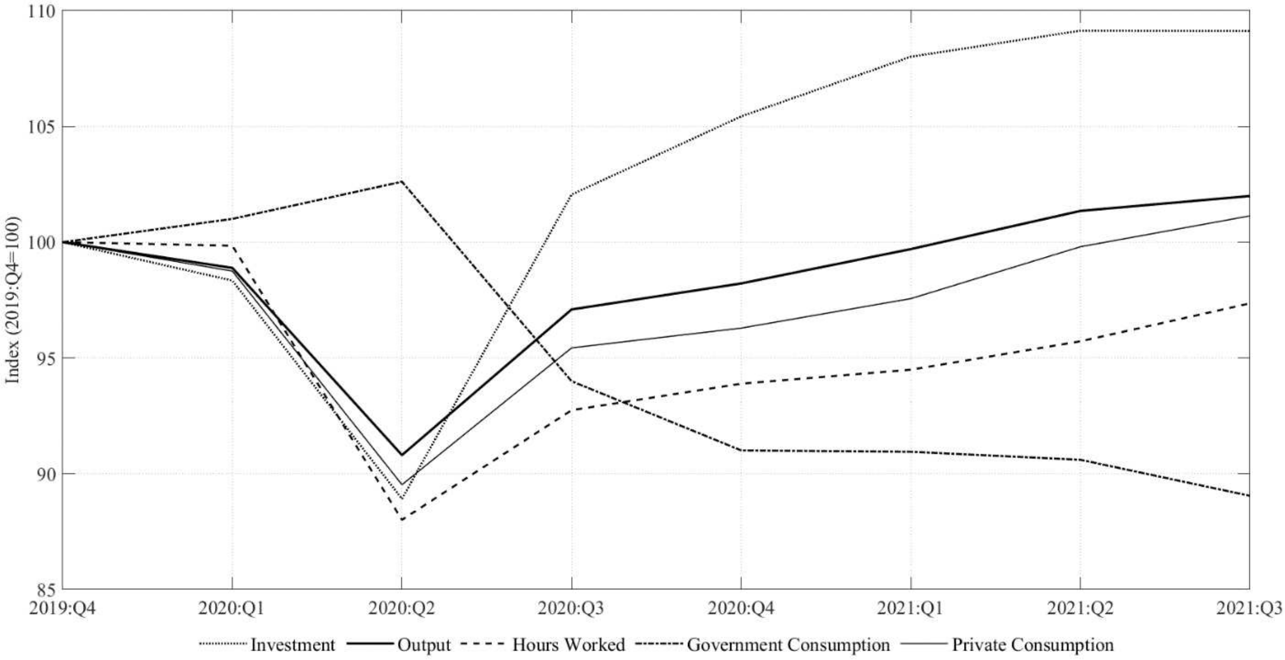
[a] Since Net Exports are negative, they are indexed in reference to 2019:Q4:-100, so as y>0 can be interpreted as positive net exports and y<0 as negative net exports.

Graph 9 - Exports, Imports and Net Exports[a] (Indexed, Euro Area, 1995:Q1-2021:Q2)

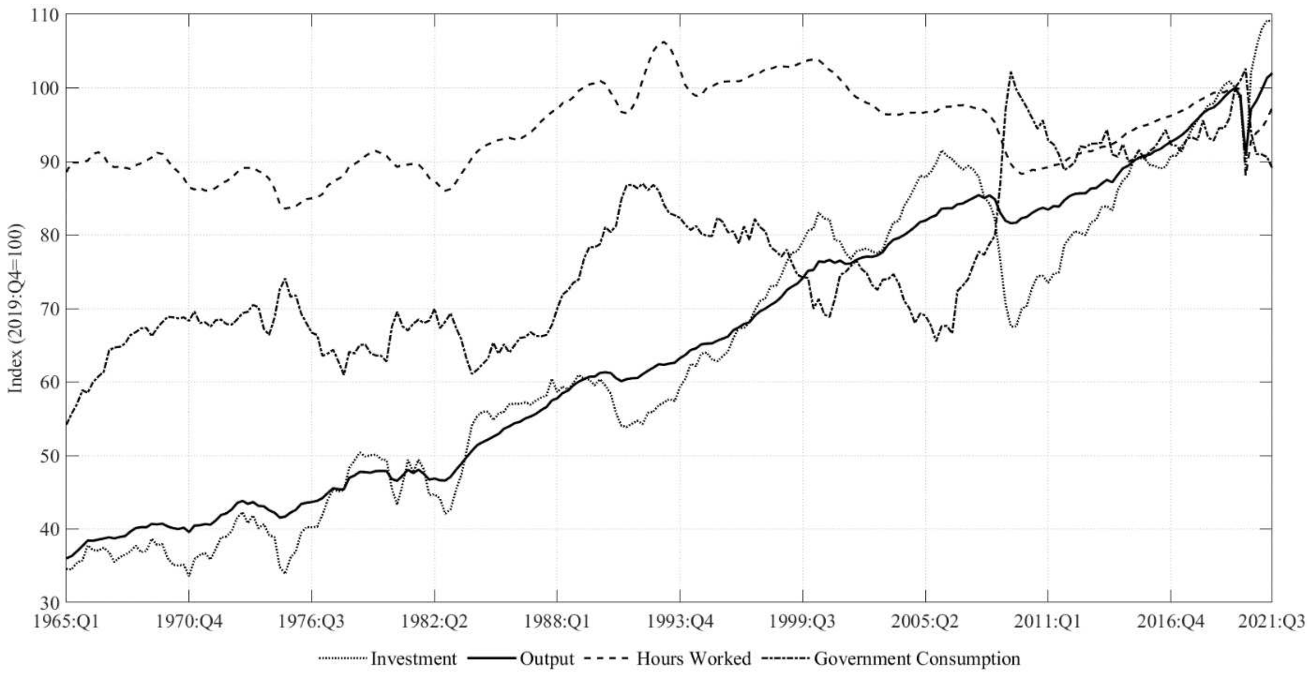


[a] Since Net Exports are negative, they are indexed in reference to 2019:Q4:-100, so as y>0 can be interpreted as positive net exports and y<0 as negative net exports.

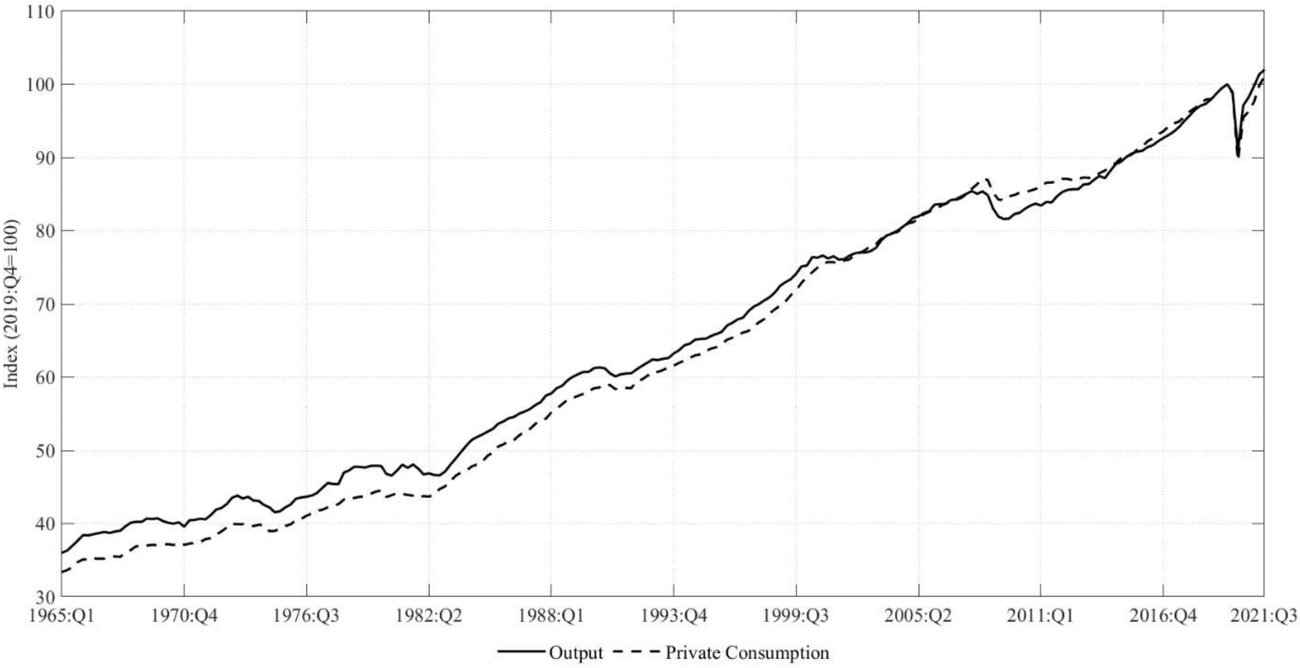
Graph 10 - Investment, Output, Hours Worked and Government Consumption per Capita (Indexed, United States, 2019:Q4-2021:Q3)



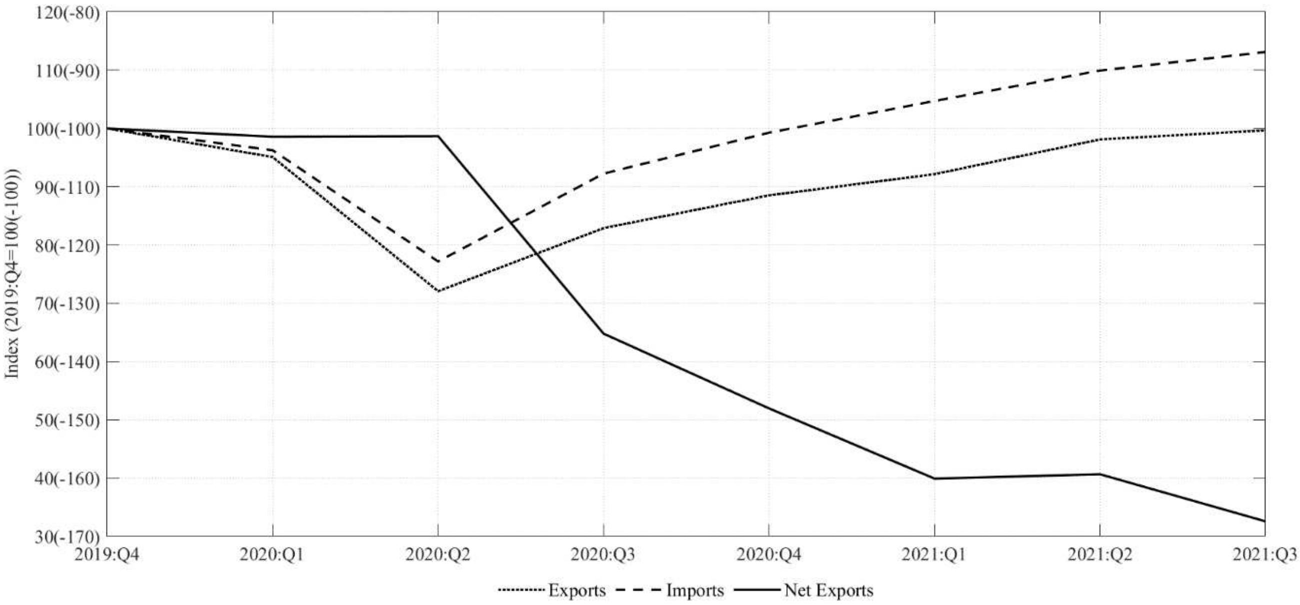
Graph 11 - Investment, Output, Hours Worked and Government Consumption per Capita (Indexed, United States, 1965:Q1-2021:Q3)



Graph 12 - Output and Private Consumption per Capita (Indexed, United States, 1965:Q1-2021:Q3)

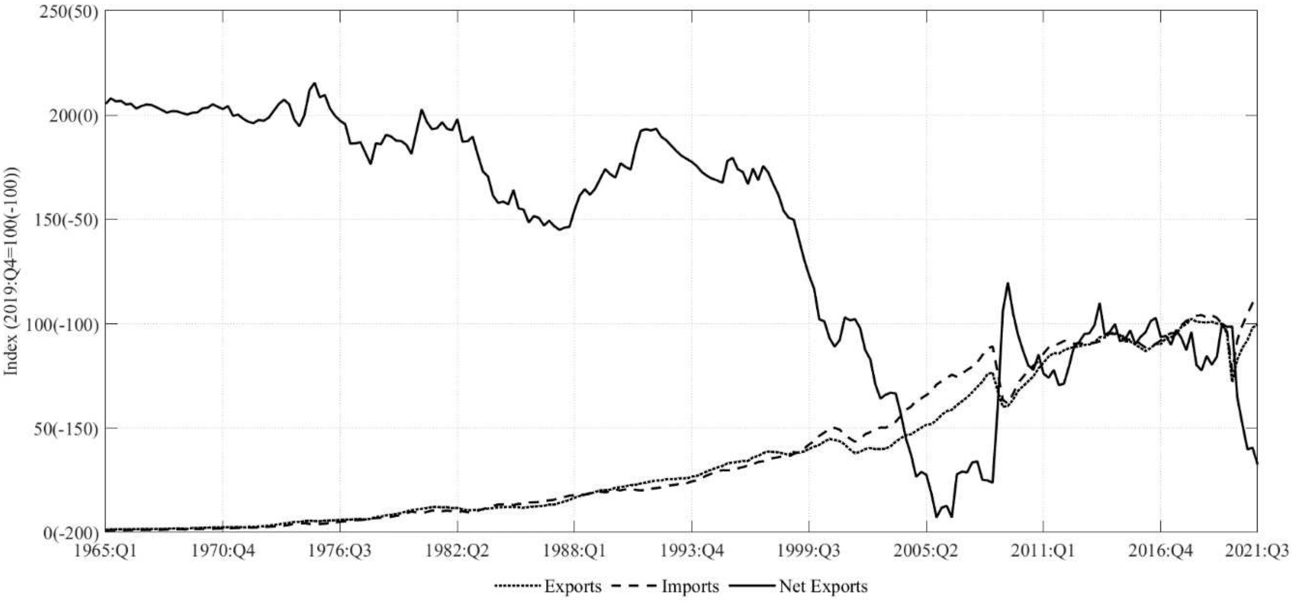


Graph 13 - Exports, Imports and Net Exports[a] (Indexed, United States, 2019:Q4-2021:Q3)



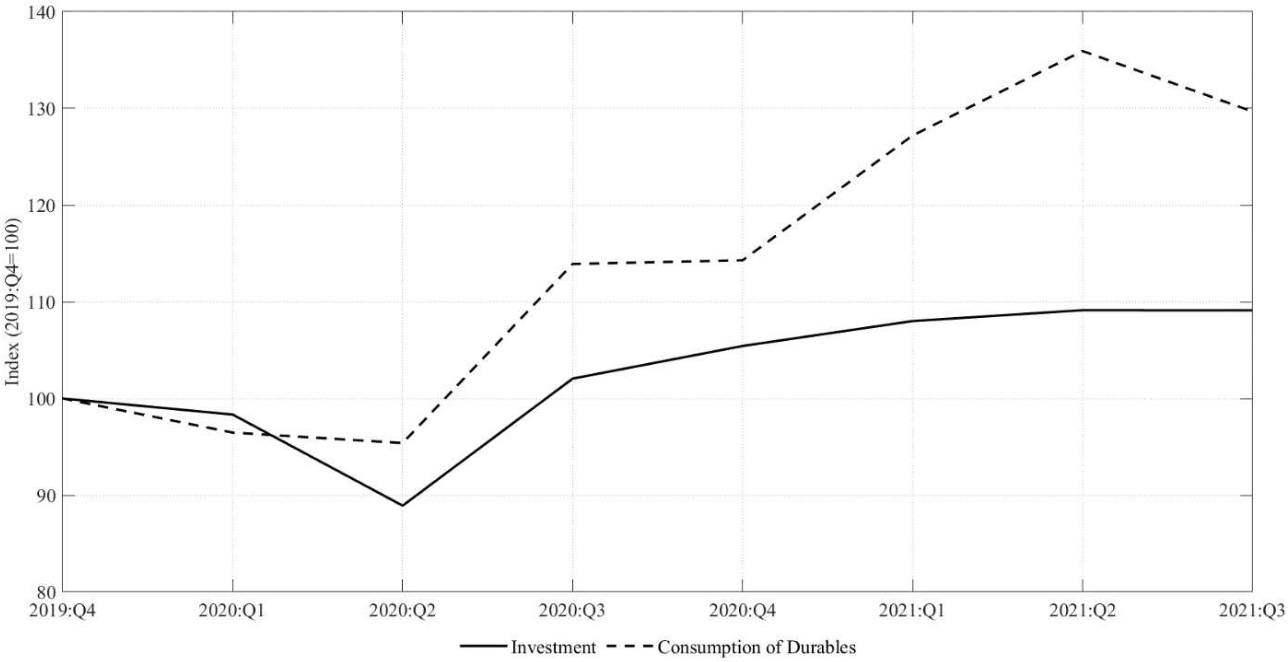
[a] Since Net Exports are negative, they are indexed in reference to 2019:Q4:-100, so as y>0 can be interpreted as positive net exports and y<0 as negative net exports.

Graph 14 - Exports, Imports and Net Exports[a] (Indexed, United States, 1965:Q1-2021:Q3)

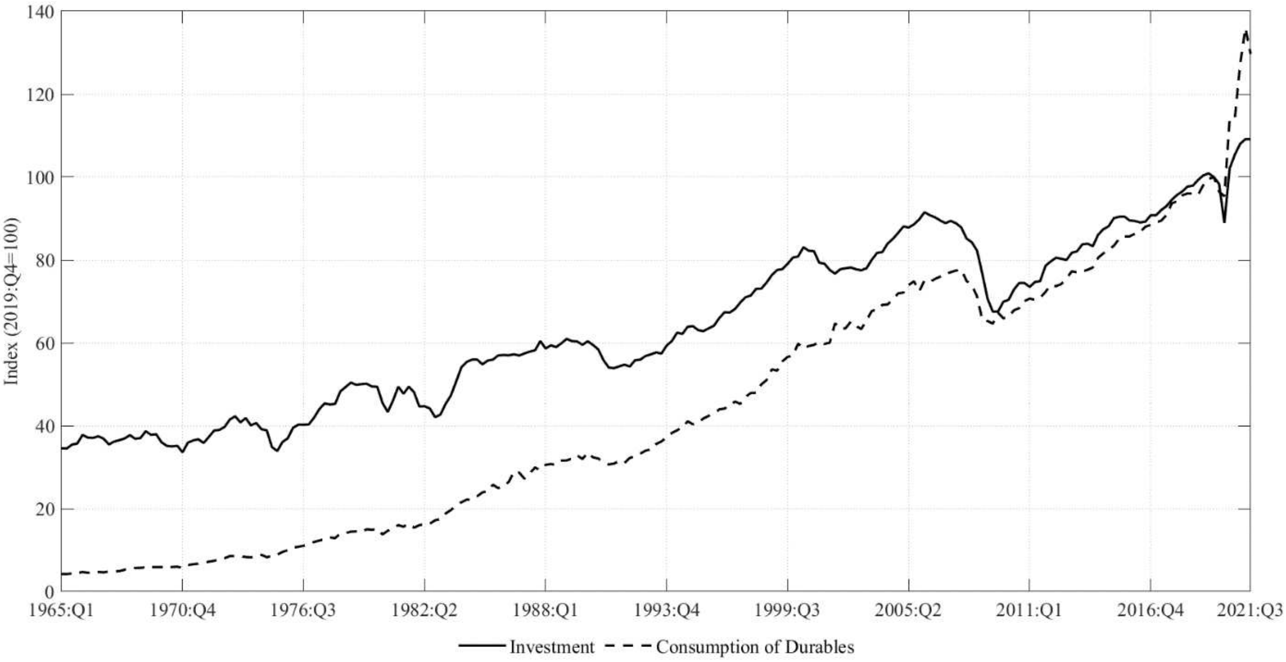


[a] Since Net Exports are negative, they are indexed in reference to 2019:Q4:-100, so as y>0 can be interpreted as positive net exports and y<0 as negative net exports.

Graph 15 - Investment and Consumption of Durables per Capita (Indexed, United States, 2019:Q4-2021:Q3)



Graph 16 - Investment and Consumption of Durables per Capita
(Indexed, United States, 1965:Q1-2021:Q3)



Annex II

Graph 17 – Detrended Output and Wedges (Indexed, Euro Area, 2019:Q4-2021:Q2)

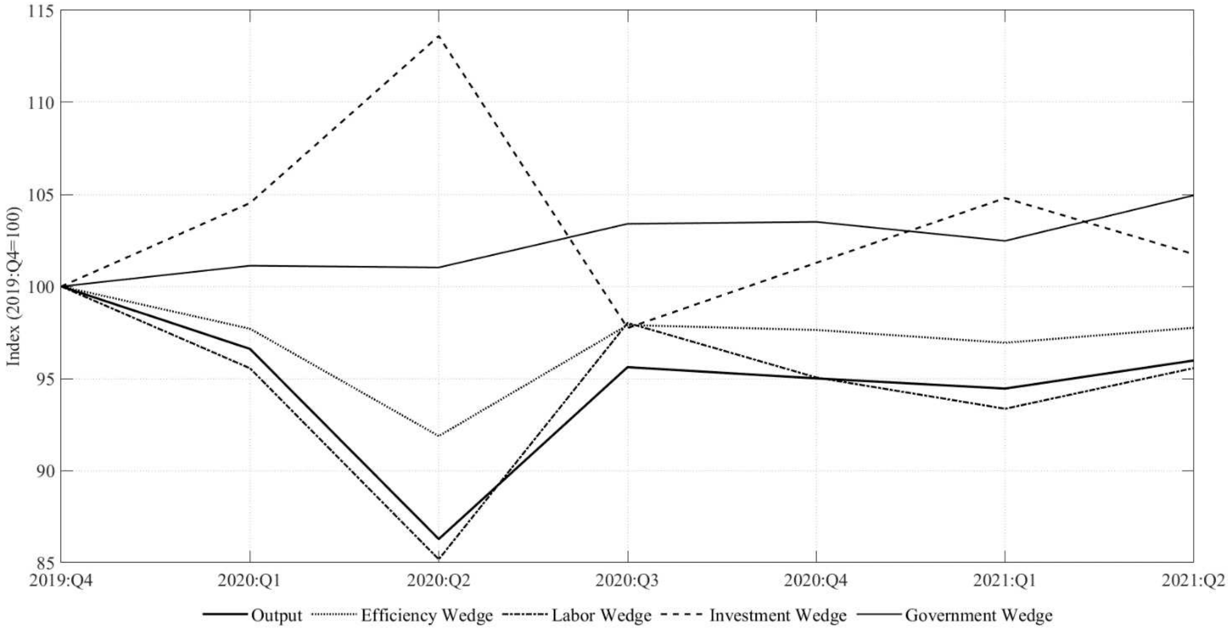


Table 9 – Wedges' Properties in Relation with Output and Themselves (Euro Area, 2019:Q4-2021:Q2)[a]

A. Summary Statistics

Wedges	$\frac{\sigma_{w_i}}{\sigma_y}$	Cross Correlations of Wedges with Output at Lag k = -2	-1	0	1	2
Efficiency	0.5972	-0.5859	-0.2488	0.9925	-0.0919	-0.5155
Labor	1.1256	-0.4813	-0.4132	0.9679	-0.0741	-0.5038
Investment	1.2264	0.5062	0.5889	-0.8537	-0.0463	0.3149
Government	0.4135	-0.4707	-0.5013	0.0211	0.1095	0.6373

B. Cross Correlations

Wedges (X, Y)	Cross Correlation of X with Y at Lag k = -2	-1	0	1	2
Efficiency, Labor	-0.5487	-0.1409	0.9808	-0.3562	-0.4785
Efficiency, Investment	0.3735	-0.0128	-0.9026	0.5278	0.5152
Efficiency, Government	0.5831	0.1907	0.0958	-0.4384	-0.4253
Labor, Investment	0.3759	0.1900	-0.944	0.4687	0.534
Labor, Government	0.4577	0.0586	0.1031	-0.431	-0.4849
Investment, Government	-0.3602	-0.1851	-0.3632	0.2273	0.3121

[a] Rounded to the fourth decimal place.

Graph 18 – Detrended Output and Wedges (Indexed, Euro Area, 1995:Q1-2021:Q2)

Table 10 – Wedges' Properties in Relation with Output and Themselves (Euro Area, 1995:Q1-2021:Q2)[a]

A. Summary Statistics

Wedges	$\frac{\sigma_{w_i}}{\sigma_y}$	Cross Correlations of Wedges with Output at Lag $k =$ -2	-1	0	1	2
Efficiency	1.1036	0.5589	0.6261	0.7309	0.6769	0.6523
Labor	1.5238	-0.0624	-0.0411	0.0777	-0.0266	-0.1041
Investment	1.0692	0.1252	0.0889	-0.1430	-0.0354	0.0488
Government	1.4990	-0.0816	-0.1233	-0.1360	-0.1607	-0.1834

B. Cross Correlations

Wedges (X, Y)	Cross Correlation of X with Y at Lag $k =$ -2	-1	0	1	2
Efficiency, Labor	-0.6325	-0.5804	-0.5187	-0.5718	-0.5776
Efficiency, Investment	0.3909	0.3094	0.2328	0.3510	0.3688
Efficiency, Government	-0.6568	-0.6611	-0.6647	-0.6622	-0.6474
Labor, Investment	-0.7129	-0.7190	-0.8449	-0.6295	-0.5549
Labor, Government	0.4838	0.4881	0.5056	0.4968	0.5146
Investment, Government	-0.2726	-0.2514	-0.2555	-0.2282	-0.2498

[a] Rounded to the fourth decimal place.

Table 11 – Output Models' Properties in Relation with Output and Themselves (Euro Area, 2019:Q4-2021:Q2)[a]

A. Summary Statistics

Components	$\frac{\sigma_{w_i}}{\sigma_y}$	Cross Correlations of Output Models with Output at Lag k =				
		-2	-1	0	1	2
Efficiency	0.7848	-0.5749	-0.2241	0.9957	-0.1113	-0.5212
Labor	0.6700	-0.4739	-0.4756	0.94705	-0.0431	-0.4757
Investment	0.5277	0.4912	0.6159	-0.8401	-0.0635	0.3182
Government	0.0590	-0.4692	-0.1635	0.4810	-0.2246	0.2568

B. Cross Correlations

Components (X, Y)	Cross Correlation of Output Models of Component X with Output Models of Component Y at Lag k =				
	-2	-1	0	1	2
Efficiency, Labor	-0.5089	-0.0864	0.9628	-0.4370	-0.4739
Efficiency, Investment	0.3577	-0.0415	-0.8789	0.5751	0.4980
Efficiency, Government	0.2157	-0.2234	0.5165	-0.1070	-0.4140
Labor, Investment	0.4069	0.2165	-0.9606	0.4545	0.5259
Labor, Government	0.2041	-0.4638	0.4706	-0.0835	-0.3821
Investment, Government	-0.1465	0.4585	-0.5615	-0.05401	0.1791

[a] Rounded to the fourth decimal place.

Graph 19 – Detrended Output and Modeled Detrended Output With One Wedge (Indexed, Euro Area, 1995:Q1-2021:Q2)

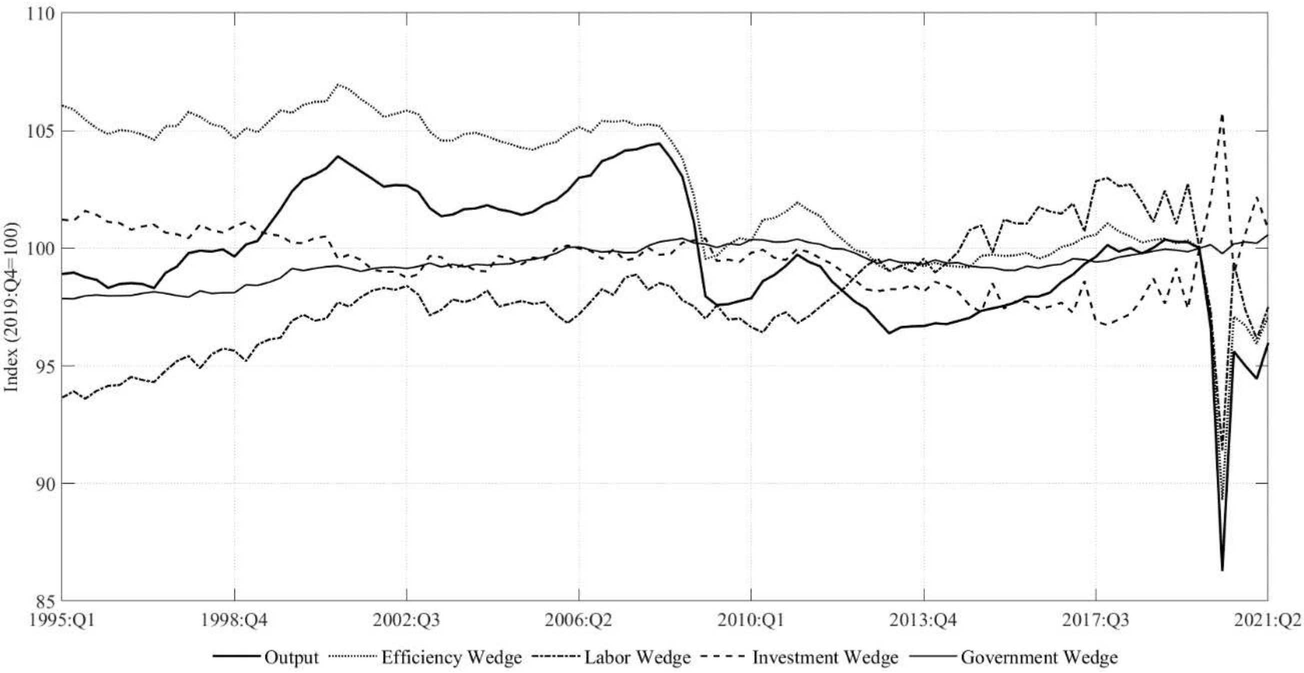


Table 12 – Output Models' Properties in Relation with Output and Themselves (Euro Area, 1995:Q1-2021:Q2)[a]

A. Summary Statistics

Components	$\frac{\sigma_{w_i}}{\sigma_y}$	Cross Correlations of Output Models with Output at Lag k =				
		-2	-1	0	1	2
Efficiency	1.1504	0.6313	0.7081	0.8322	0.7540	0.7154
Labor	0.8602	-0.0918	-0.0672	0.0709	-0.0290	-0.1061
Investment	0.5002	0.1324	0.1006	-0.1170	-0.0220	0.0619
Government	0.2650	0.0476	0.0153	-0.0017	-0.0484	-0.0802

B. Cross Correlations

Components (X, Y)	Cross Correlation of Output Model of Component X with Output Model of Component Y at Lag k =				
	-2	-1	0	1	2
Efficiency, Labor	-0.5059	-0.4427	-0.3695	-0.4539	-0.4657
Efficiency, Investment	0.3481	0.2634	0.1849	0.3279	0.3481
Efficiency, Government	-0.5066	-0.5001	-0.4819	-0.4701	-0.4518
Labor, Investment	-0.7420	-0.7610	-0.9054	-0.6865	-0.6120
Labor, Government	0.4034	0.4070	0.4362	0.4387	0.4558
Investment, Government	-0.2371	-0.2161	-0.2365	-0.2345	-0.2573

[a] Rounded to the fourth decimal place.

Graph 20 – Detrended Output and Modeled Detrended Output Will All But One Wedge (Indexed, Euro Area, 1995:Q1-2021:Q2)

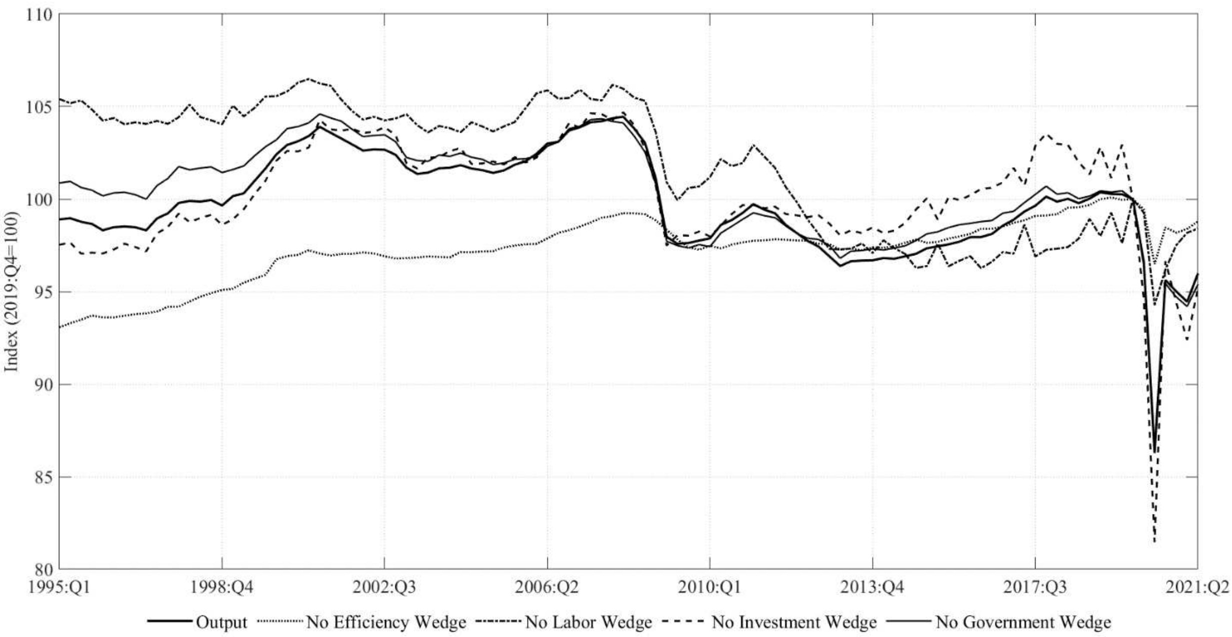


Table 13 – Wedges' Properties in Relation with Other Economic Variables (Euro Area, 2019:Q4-2021:Q2)[a]

A. Hours Worked

Wedges	$\frac{\sigma_{w_i}}{\sigma_h}$	Cross Correlations of Wedges with Output at Lag k = -2	-1	0	1	2
Efficiency	0.8910	-0.5867	-0.3347	0.9670	0.0167	-0.4438
Labor	1.6791	-0.4576	-0.4796	0.9329	0.0115	-0.4303
Investment	1.829	0.4695	0.6536	-0.7848	-0.0946	0.2170
Government	0.6168	-0.4966	-0.5438	-0.0328	0.0347	0.7241

B. Investment

Wedges	$\frac{\sigma_{w_i}}{\sigma_x}$	Cross Correlations of Wedges with Output at Lag k = -2	-1	0	1	2
Efficiency	0.4080	-0.6181	-0.4355	0.8064	0.4602	-0.3865
Labor	0.7691	-0.4393	-0.5198	0.7235	0.4249	-0.3226
Investment	0.8378	0.4100	0.7120	-0.4782	-0.4428	0.0139
Government	0.2825	-0.4840	-0.6128	-0.3164	-0.0135	0.9055

C. Government Consumption

Wedges	$\frac{\sigma_{w_i}}{\sigma_g}$	Cross Correlations of Wedges with Output at Lag k = -2	-1	0	1	2
Efficiency	1.444	0.5831	0.1907	0.0958	-0.4384	-0.4253
Labor	2.7225	0.4577	0.0586	0.1031	-0.4313	-0.4848
Investment	2.9661	-0.3602	-0.1851	-0.3632	0.2273	0.3121

D. Private Consumption

Wedges	$\frac{\sigma_{w_i}}{\sigma_c}$	Cross Correlations of Wedges with Output at Lag k = -2	-1	0	1	2
Efficiency	0.4601	-0.5378	-0.0959	0.9774	-0.3851	-0.5178
Labor	0.8671	-0.4896	-0.2810	0.9975	-0.3360	-0.5254
Investment	0.9447	0.5408	0.4316	-0.9595	0.1885	0.4180
Government	0.3185	-0.4536	-0.4005	0.1300	0.1103	0.4266

[a] Rounded to the fourth decimal place.

Table 14 – Wedges' Properties in Relation with Other Economic Variables (Euro Area, 1995:Q1-2021:Q2)[a]

A. Hours Worked

Wedges	$\frac{\sigma_{w_i}}{\sigma_h}$	Cross Correlations of Wedges with Hours Worked at Lag k = -2	-1	0	1	2
Efficiency	1.0035	-0.6289	-0.5992	-0.5421	-0.5560	-0.5575
Labor	1.3855	0.7584	0.7926	0.8882	0.8530	0.8412
Investment	0.9721	-0.3493	-0.3826	-0.5401	-0.5215	-0.5458
Government	1.3629	0.7022	0.6880	0.6896	0.6592	0.6329

B. Investment

Wedges	$\frac{\sigma_{w_i}}{\sigma_x}$	Cross Correlations of Wedges with Investment at Lag k = -2	-1	0	1	2
Efficiency	0.4831	0.7148	0.7461	0.8168	0.8163	0.7942
Labor	0.6670	-0.4083	-0.3981	-0.3394	-0.3282	-0.3639
Investment	0.4680	0.4518	0.4630	0.3699	0.3166	0.3527
Government	0.6562	-0.3149	-0.3470	-0.3737	-0.3937	-0.4233

C. Government Consumption

Wedges	$\frac{\sigma_{w_i}}{\sigma_g}$	Cross Correlations of Wedges with Government Consumption at Lag k = -2	-1	0	1	2
Efficiency	0.7362	-0.6568	-0.6611	-0.6647	-0.6622	-0.6474
Labor	1.0166	0.4838	0.4881	0.5056	0.4968	0.5146
Investment	0.7133	-0.2726	-0.2514	-0.2555	-0.2282	-0.2498

D. Private Consumption

Wedges	$\frac{\sigma_{w_i}}{\sigma_c}$	Cross Correlations of Wedges with Private Consumption at Lag k = -2	-1	0	1	2
Efficiency	0.9588	0.4517	0.5303	0.6265	0.5235	0.4938
Labor	1.3239	0.1672	0.1783	0.2976	0.1058	0.0082
Investment	0.9289	-0.2309	-0.3067	-0.5890	-0.3452	-0.2310
Government	1.3023	-0.2803	-0.3113	-0.3092	-0.3084	-0.2947

[a] Rounded to the fourth decimal place.

Graph 21 – Detrended Hours Worked and Modeled Detrended Hours Worked With One Wedge (Indexed, Euro Area, 2019:Q4-2021:Q2)

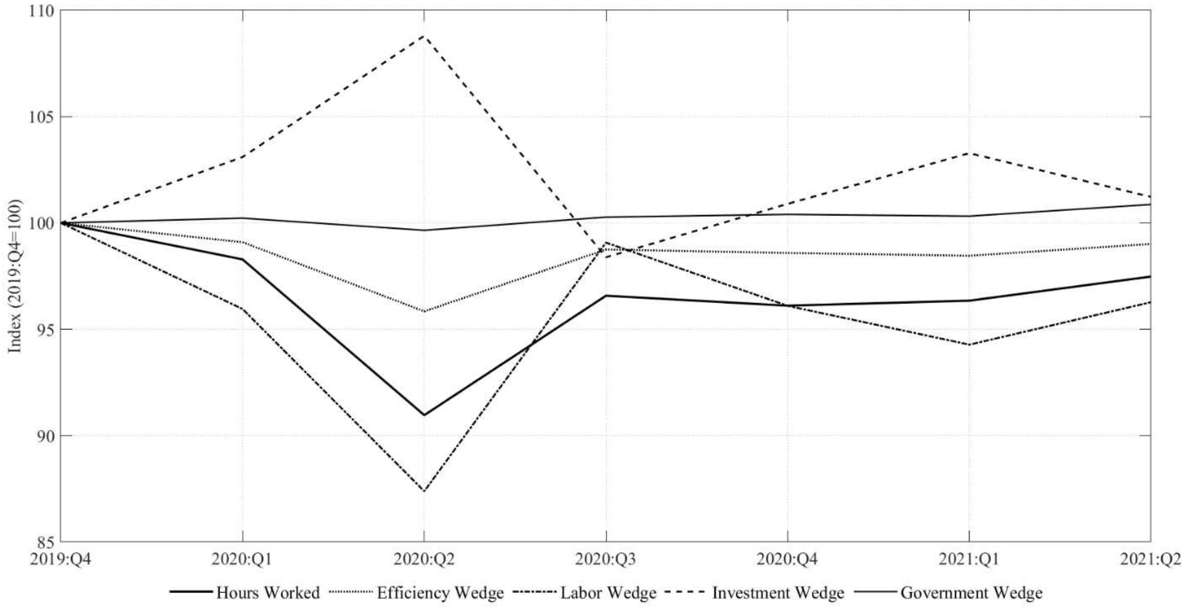


Table 15 – Hours Worked Models' Properties in Relation with Hours Worked and Themselves (Euro Area, 2019:Q4-2021:Q2)[a]

A. Summary Statistics

Components	$\frac{\sigma_{w_i}}{\sigma_h}$	Cross Correlations of Hours Worked Models with Hours Worked at Lag k = -2	-1	0	1	2
Efficiency	0.4599	-0.5539	-0.2288	0.9902	-0.0620	-0.4589
Labor	1.4656	-0.4393	-0.5432	0.9021	0.0360	-0.4010
Investment	1.1954	0.4533	0.6737	-0.7712	-0.1057	0.2194
Government	0.1322	-0.5242	-0.2302	0.4662	-0.1836	0.3483

B. Cross Correlations

Components (X, Y)	Cross Correlation of Hours Worked Model of Component X with Hours Worked Model of Component Y at Lag k = -2	-1	0	1	2
Efficiency, Labor	-0.4660	-0.0344	0.9408	-0.4989	-0.4407
Efficiency, Investment	0.2966	-0.0676	-0.8441	0.6256	0.4643
Efficiency, Government	0.2784	-0.1953	0.5303	-0.1564	-0.4433
Labor, Investment	0.4058	0.2251	-0.9608	0.4469	0.5313
Labor, Government	0.2043	-0.46857	0.4651	-0.0843	-0.3860
Investment, Government	-0.1471	0.4549	-0.5638	-0.0534	0.1784

[a] Rounded to the fourth decimal place.

Graph 22 – Detrended Hours Worked and Modeled Detrended Hours Worked With One Wedge (Indexed, Euro Area, 1995:Q1-2021:Q2)

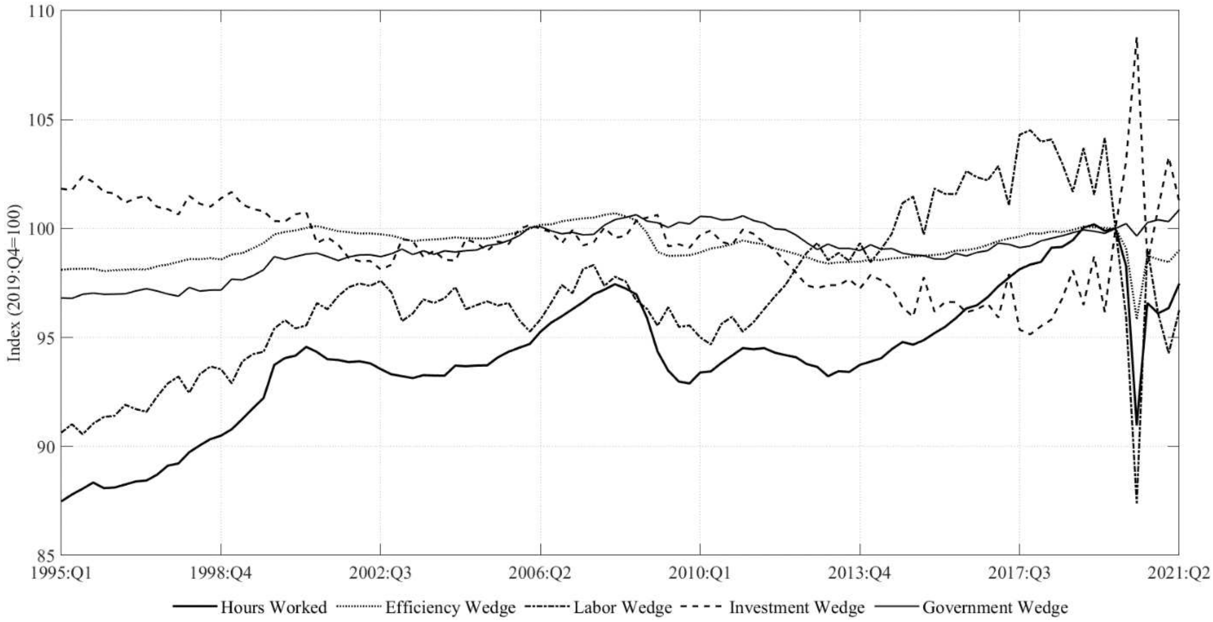


Table 16 – Hours Worked Models' Properties in Relation with Hours Worked and Themselves (Euro Area, 1995:Q1-2021:Q2)[a]

A. Summary Statistics

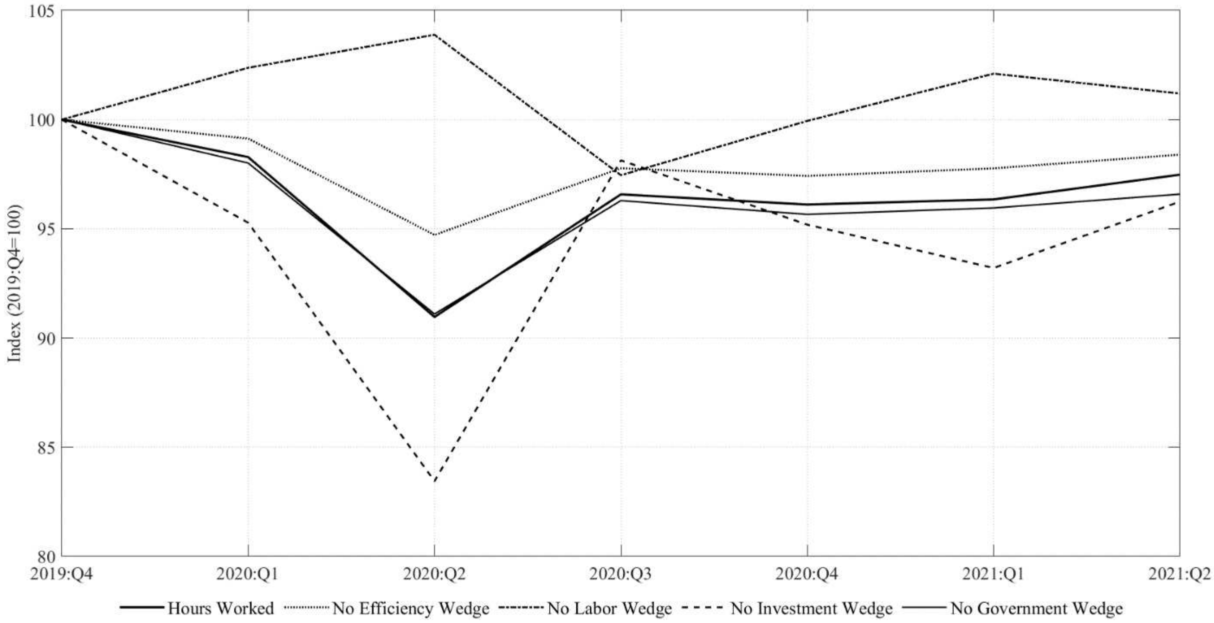
Components	$\frac{\sigma_{w_i}}{\sigma_h}$	Cross Correlations of Hours Worked Models with Hours Worked at Lag k = -2	-1	0	1	2
Efficiency	0.2553	0.4609	0.5328	0.6556	0.5791	0.5488
Labor	1.1620	0.6794	0.7150	0.8215	0.7952	0.7926
Investment	0.6821	-0.3650	-0.3965	-0.5460	-0.5343	-0.5591
Government	0.3599	0.7591	0.7549	0.7590	0.7181	0.6859

B. Cross Correlations

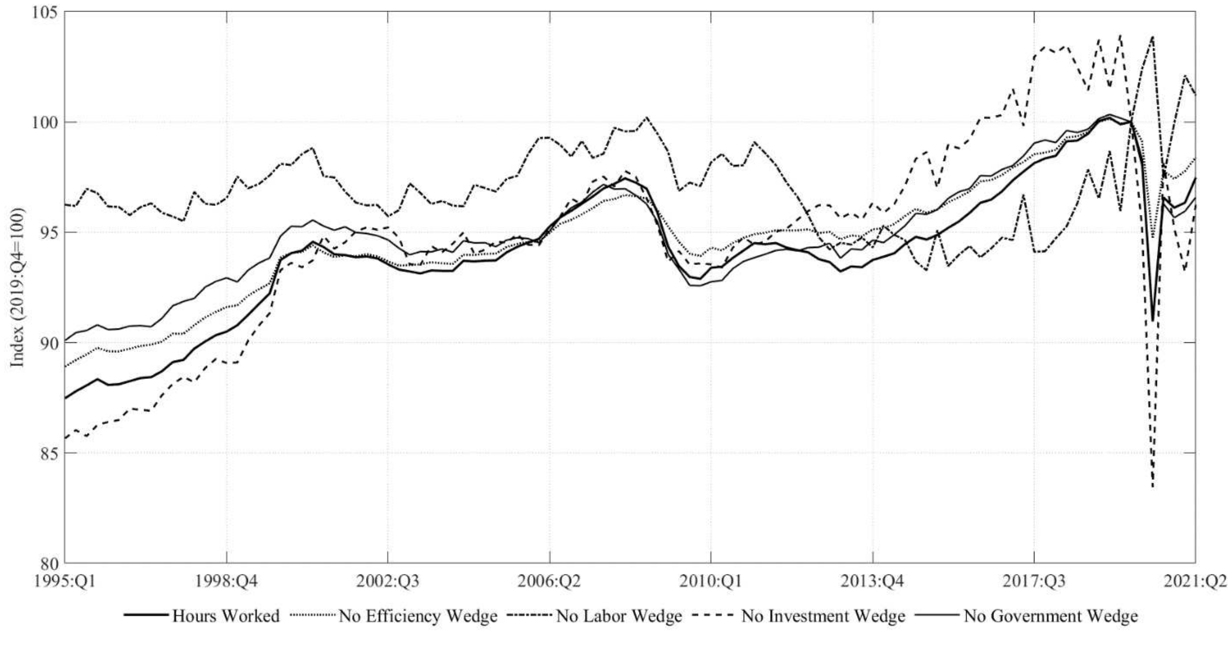
Components (X, Y)	Cross Correlation Hours Worked Model of Component X with Hours Worked Model of Component Y at Lag k = -2	-1	0	1	2
Efficiency, Labor	0.2975	0.3644	0.4622	0.2987	0.2687
Efficiency, Investment	-0.2135	-0.2725	-0.3631	-0.1153	-0.0850
Efficiency, Government	0.3542	0.4007	0.4654	0.4671	0.4899
Labor, Investment	-0.7405	-0.7582	-0.9034	-0.6848	-0.6086
Labor, Government	0.3996	0.4032	0.4326	0.4351	0.4524
Investment, Government	-0.2356	-0.2145	-0.2353	-0.2328	-0.2556

[a] Rounded to the fourth decimal place.

Graph 23 - Detrended Hours Worked and Modeled Detrended Hours Worked With All But One Wedge (Indexed, Euro Area, 2019:Q4-2021:Q2)



Graph 24 – Detrended Hours Worked and Modeled Detrended Hours Worked With All But One Wedge (Indexed, Euro Area, 1995:Q1-2021:Q2)



Graph 25 – Detrended Investment and Modeled Detrended Investment With One Wedge (Indexed, Euro Area, 2019:Q4-2021:Q2)

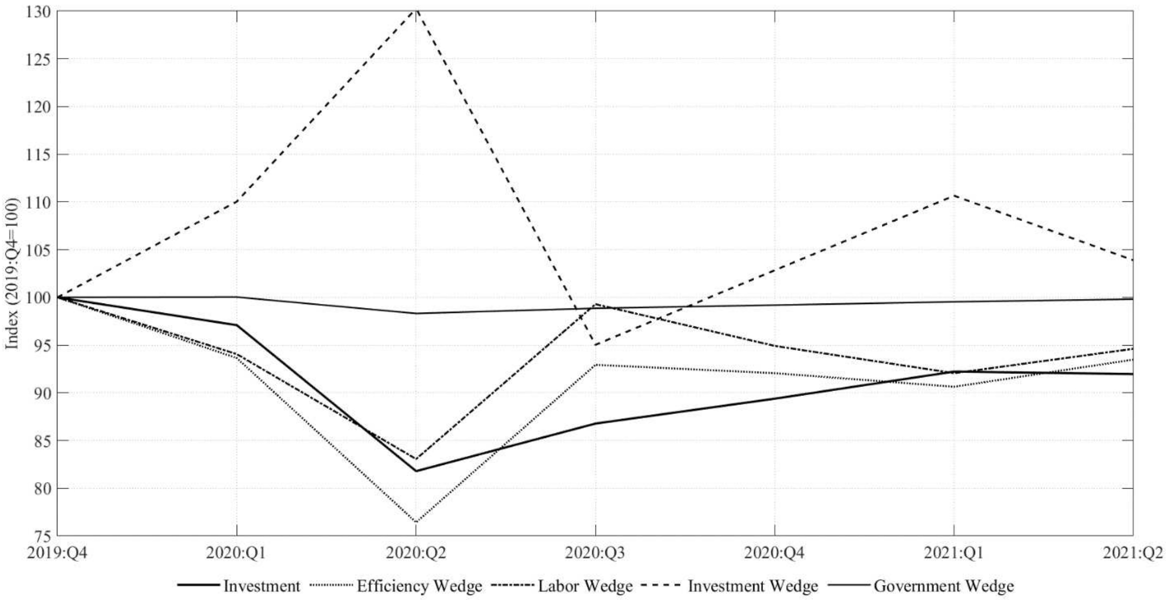


Table 17 – Investment Models' Properties in Relation with Investment and Themselves (Euro Area, 2019:Q4-2021:Q2)[a]

A. Summary Statistics

Components	$\frac{\sigma_{w_i}}{\sigma_x}$	Cross Correlations of Investment Models with Investment at Lag $k =$ -2	-1	0	1	2
Efficiency	1.1748	-0.6137	-0.3672	0.8419	0.4374	-0.4438
Labor	0.9154	-0.3742	-0.625	0.6284	0.4496	-0.2309
Investment	1.8630	0.4118	0.7108	-0.4798	-0.4426	0.0148
Government	0.1046	-0.7072	0.2526	0.9535	0.1507	-0.6919

B. Cross Correlations

Components (X, Y)	Cross Correlation of Investment Model of Component X with Investment Model of Component Y at Lag $k =$ -2	-1	0	1	2
Efficiency, Labor	-0.4938	-0.0311	0.9374	-0.5023	-0.4790
Efficiency, Investment	0.3358	-0.0293	-0.8762	0.5581	0.5188
Efficiency, Government	-0.4767	-0.4641	0.8167	0.4136	-0.3642
Labor, Investment	0.4173	0.2853	-0.9702	0.37890	0.5487
Labor, Government	-0.2254	-0.7196	0.5764	0.4005	-0.1781
Investment, Government	0.2655	0.7821	-0.4765	-0.4104	-0.0438

[a] Rounded to the fourth decimal place.

Graph 26 – Detrended Investment and Modeled Detrended Investment With One Wedge (Indexed, Euro Area, 1995:Q1-2021:Q2)

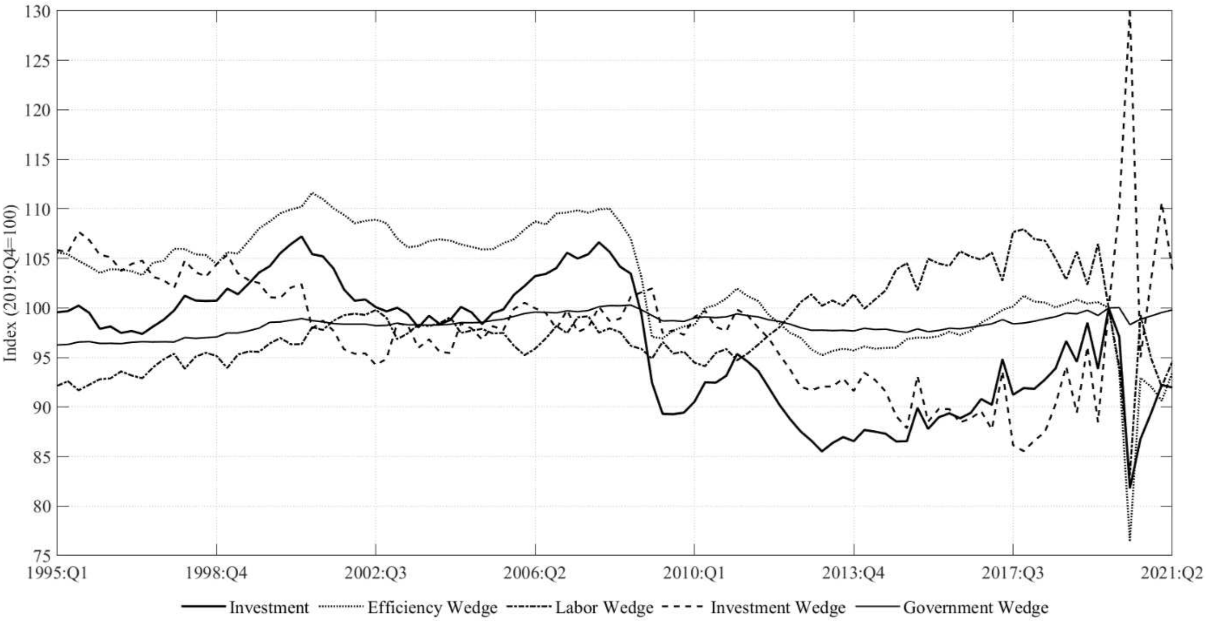


Table 18 – Investment Models' Properties in Relation with Investment and Themselves (Euro Area, 1995:Q1-2021:Q2)[a]

A. Summary Statistics

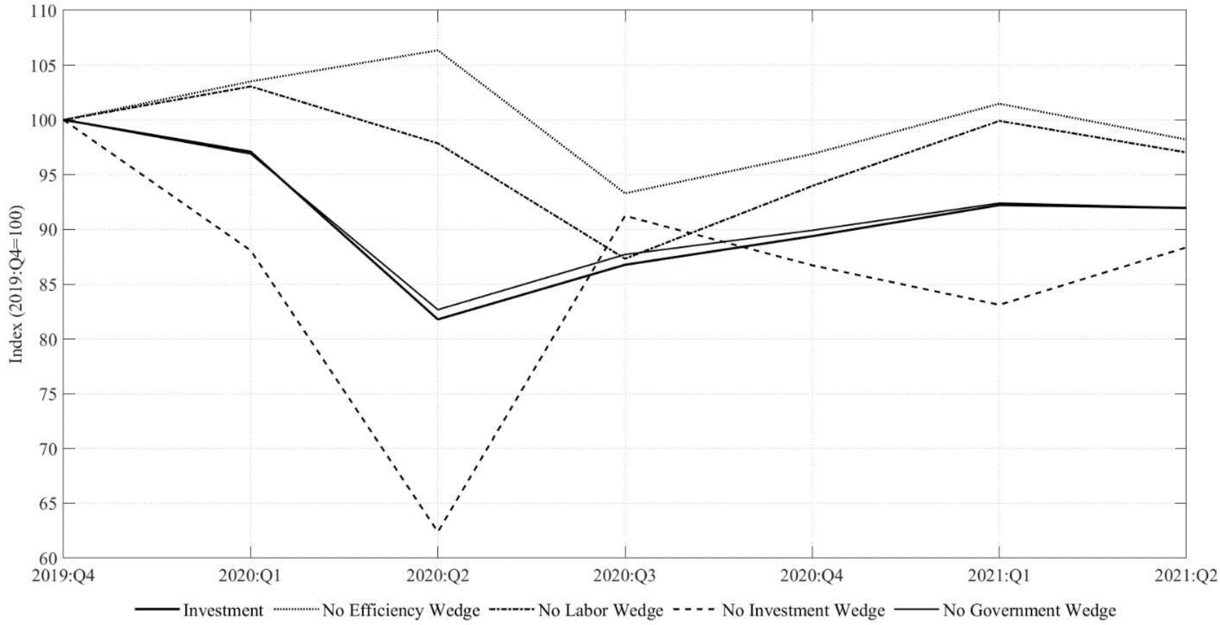
Components	$\frac{\sigma_{w_i}}{\sigma_x}$	Cross Correlations of Investment Models with Investment at Lag $k =$ -2	-1	0	1	2
Efficiency	0.9257	0.7658	0.8112	0.9070	0.8866	0.8342
Labor	0.6812	-0.4060	-0.3976	-0.3248	-0.2848	-0.3142
Investment	1.0316	0.4476	0.4592	0.3652	0.3127	0.3494
Government	0.1621	0.1510	0.1554	0.1561	0.0846	0.0215

B. Cross Correlations

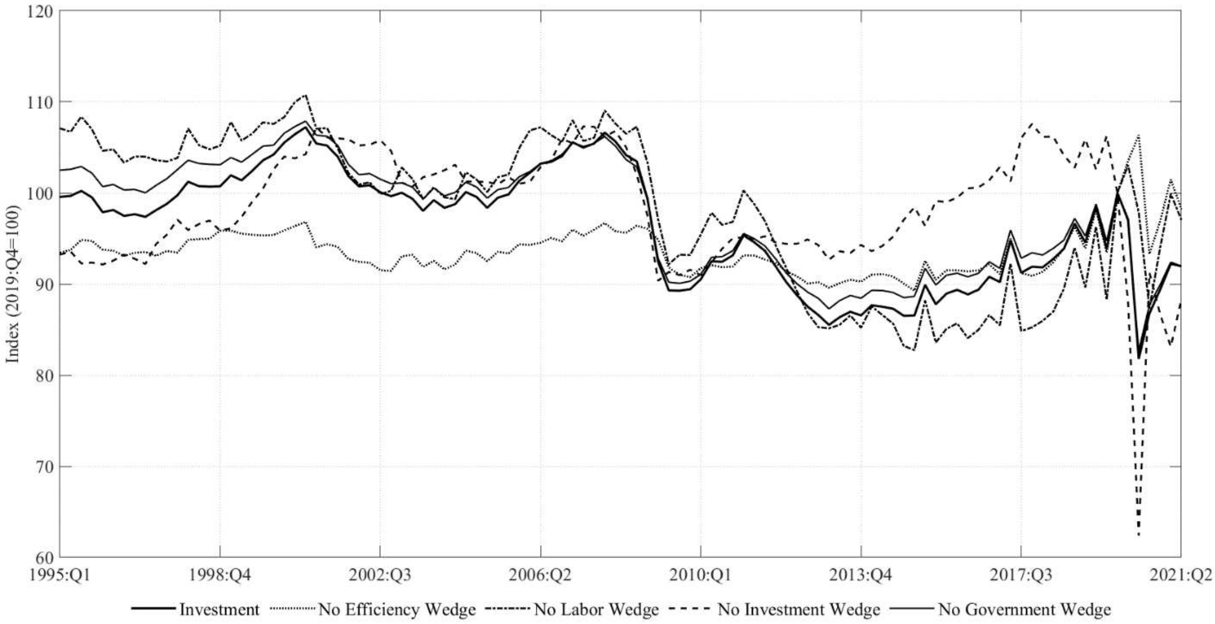
Components (X, Y)	Cross Correlation of Investment Model of Component X with Investment Model of Component Y at Lag $k =$ -2	-1	0	1	2
Efficiency, Labor	-0.2594	-0.1814	-0.0976	-0.2271	-0.2547
Efficiency, Investment	0.2222	0.1374	0.0419	0.2279	0.2598
Efficiency, Government	-0.0740	-0.0388	0.0362	0.0674	0.0785
Labor, Investment	-0.7048	-0.7427	-0.9410	-0.6923	-0.5990
Labor, Government	0.1023	0.1111	0.1746	0.2238	0.2462
Investment, Government	-0.0789	-0.0590	-0.1255	-0.1716	-0.1912

[a] Rounded to the fourth decimal place.

Graph 27 – Detrended Investment and Modeled Detrended Investment With All But One Wedge (Indexed, Euro Area, 2019:Q4-2021:Q2)



Graph 28 – Detrended Investment and Modeled Detrended Investment With All But One Wedge (Indexed, Euro Area, 1995:Q1-2021:Q2)



Graph 29 – Detrended Private Consumption and Modeled Detrended Private Consumption With One Wedge (Indexed, Euro Area, 2019:Q4-2021:Q2)

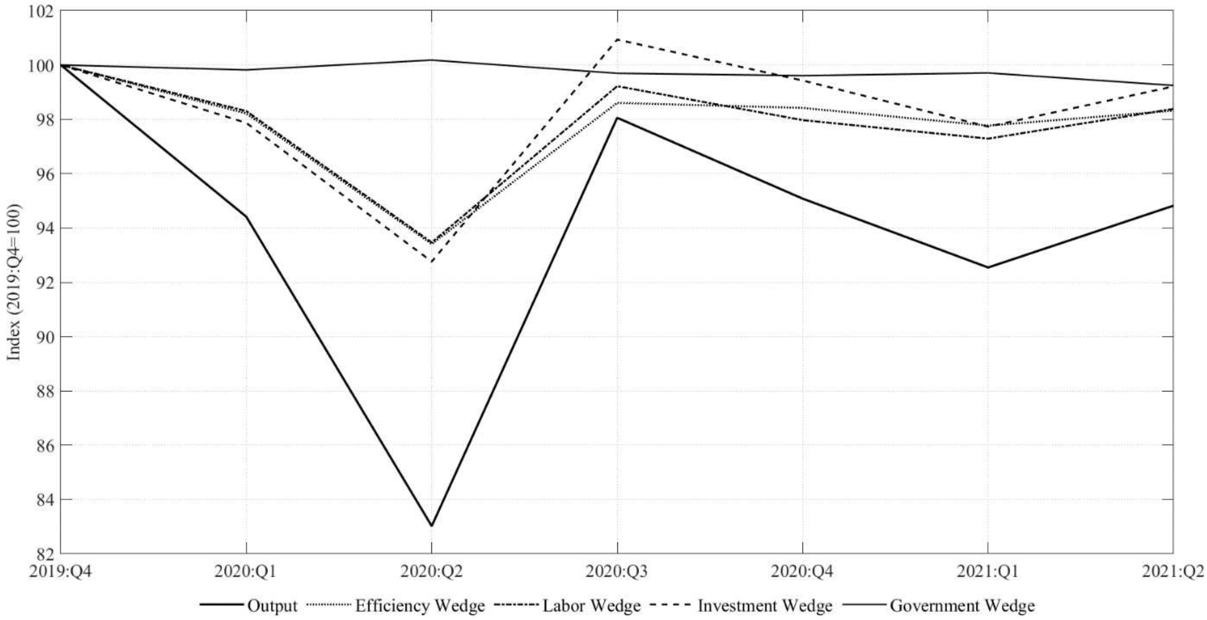


Table 19 – Private Consumption Models' Properties in Relation with Private Consumption and Themselves (Euro Area, 2019:Q4-2021:Q2)[a]

A. Summary Statistics

Components	$\frac{\sigma_{w_i}}{\sigma_c}$	Cross Correlations of Private Consumption Models with Output at Lag $k =$ -2	-1	0	1	2
Efficiency	0.3801	-0.5527	-0.1135	0.9801	-0.37488	-0.4891
Labor	0.3869	-0.4812	-0.2537	0.9943	-0.3685	-0.4907
Investment	0.49342	-0.5497	-0.3762	0.9647	-0.2305	-0.4018
Government	0.0546	0.3900	0.1439	-0.4046	0.3039	-0.2480

B. Cross Correlations

Components (X, Y)	Cross Correlation of Private Consumption Model of Component X with Private Consumption Model of Component Y at Lag $k =$ -2	-1	0	1	2
Efficiency, Labor	-0.5320	-0.7554	-0.7101	-0.7445	-0.7434
Efficiency, Investment	-0.3859	-0.2928	-0.2053	-0.3167	-0.3304
Efficiency, Government	-0.2823	0.6944	0.6921	0.6876	0.6775
Labor, Investment	-0.3411	0.6137	0.7298	0.5334	0.4696
Labor, Government	-0.3247	-0.6224	-0.6495	-0.6415	-0.6480
Investment, Government	-0.2255	-0.1858	-0.2113	-0.1936	-0.2151

[a] Rounded to the fourth decimal place.

Graph 30 – Detrended Private Consumption and Modeled Detrended Private Consumption With One Wedge (Indexed, Euro Area, 1995:Q1-2021:Q2)

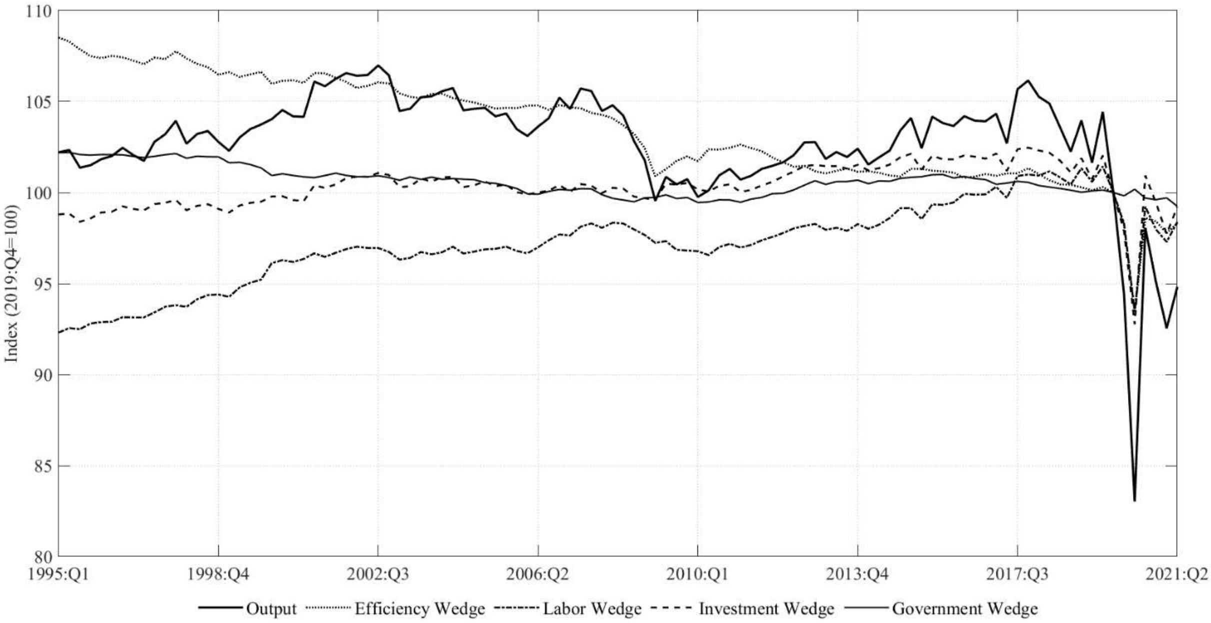


Table 20 – Private Consumption Models' Properties in Relation with Private Consumption and Themselves (Euro Area, 1995:Q1-2021:Q2)[a]

A. Summary Statistics

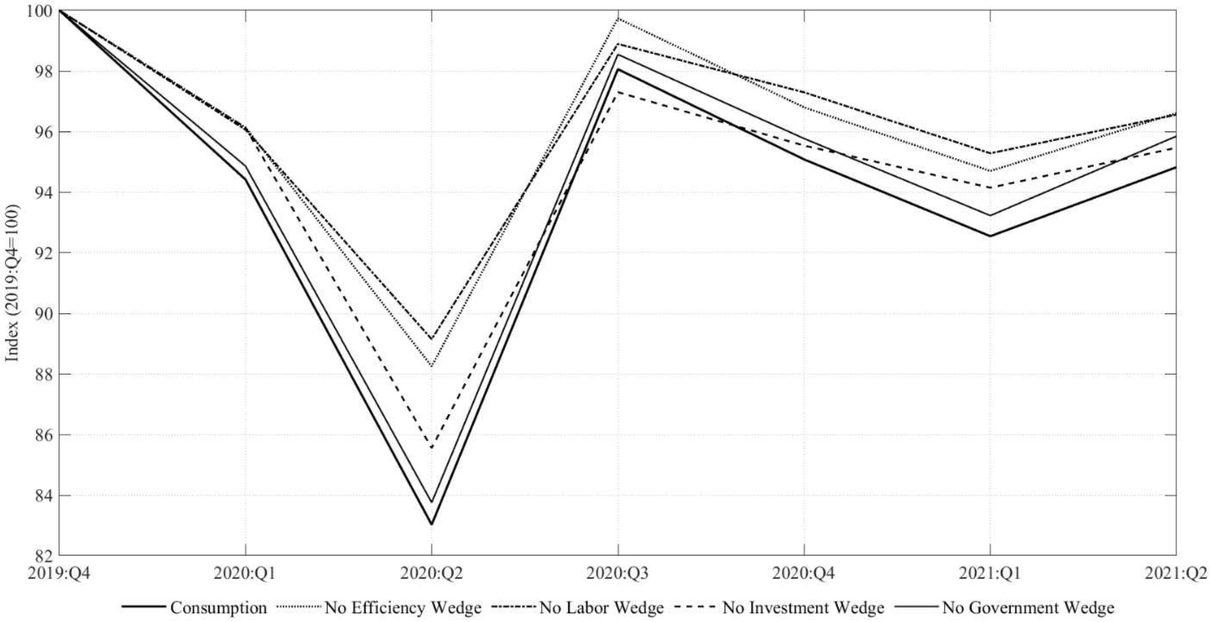
Components	$\frac{\sigma_{w_i}}{\sigma_c}$	Cross Correlations of Private Consumption Models with Output at Lag $k =$ -2	-1	0	1	2
Efficiency	0.9254	0.3939	0.4707	0.5625	0.4797	0.4631
Labor	0.7033	0.0684	0.0657	0.1529	-0.0066	-0.0799
Investment	0.4076	0.2338	0.3291	0.6381	0.3594	0.2503
Government	0.2479	0.2289	0.2608	0.2738	0.2919	0.2817

B. Cross Correlations

Components (X, Y)	Cross Correlation of Private Consumption Model of Component X with Private Consumption Model of Component Y at Lag $k =$ -2	-1	0	1	2
Efficiency, Labor	-0.7883	-0.7555	-0.7102	-0.7445	-0.7434
Efficiency, Investment	-0.3742	-0.2928	-0.2054	-0.3167	-0.3305
Efficiency, Government	0.6883	0.6945	0.6921	0.6876	0.6776
Labor, Investment	0.6248	0.6138	0.7298	0.5335	0.4696
Labor, Government	-0.6136	-0.6225	-0.6496	-0.6416	-0.6480
Investment, Government	-0.2092	-0.1859	-0.2113	-0.1937	-0.2152

[a] Rounded to the fourth decimal place.

Graph 31 – Detrended Private Consumption and Modeled Detrended Private Consumption With All But One Wedge (Indexed, Euro Area, 2019:Q4-2021:Q2)



Graph 32 – Detrended Private Consumption and Modeled Detrended Private Consumption With All But One Wedge (Indexed, Euro Area, 1995:Q1-2021:Q2)

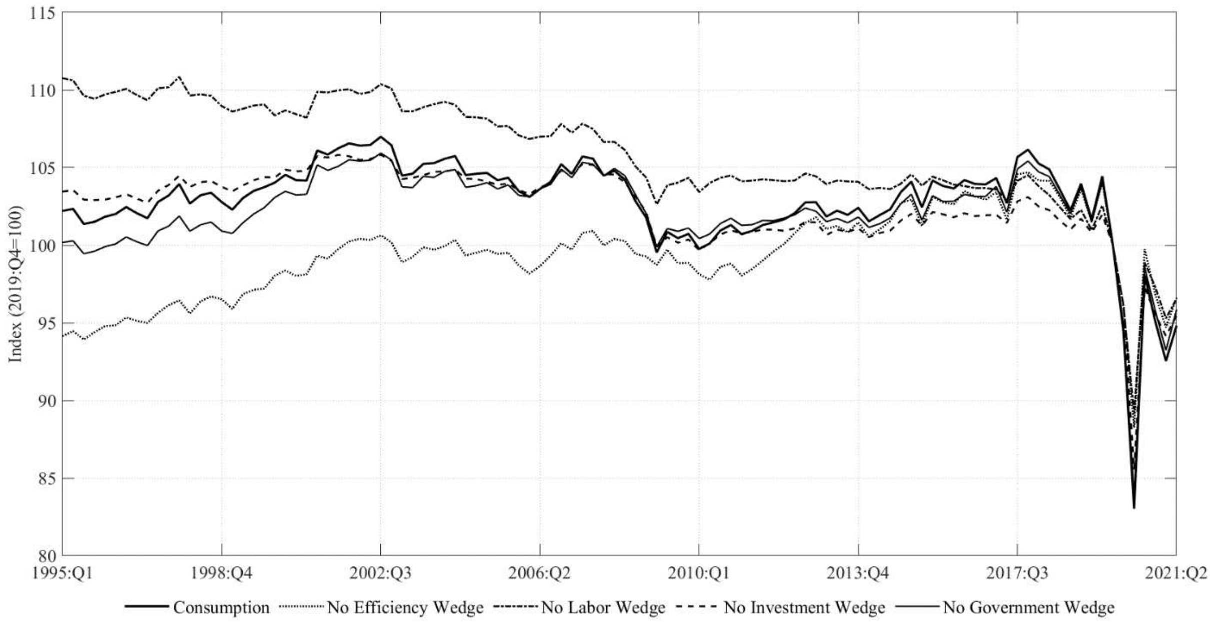


Table 21 - The Contribution of Each Wedge in the Variation of Output (Euro Area, 2019:Q4-2021:Q2)[a] - COMPLETE

θ_e^Y	θ_l^Y	θ_x^Y	θ_g^Y
One Wedge Economies			
69%	24%	2%	4%
All But One Wedge Economies [b]			
99.64%	99.43%	98.43%	2.60%

[a] Rounded to the second decimal place.
[b] For better interpretation, the All But One Wedge Economies present $(1-\theta)$, instead of θ.

Table 22 – The Contribution of Each Wedge in the Variation of Other Economic Variables (Euro Area, 2019:Q4-2021:Q2)[a] - COMPLETE

θ_e^H	θ_l^H	θ_x^H	θ_g^H	θ_e^X	θ_l^X	θ_x^X	θ_g^X	θ_e^C	θ_l^C	θ_x^C	θ_g^C
One Wedge Economies											
36%	50%	4%	11%	62%	27%	2%	9%	29%	36%	50%	4%
All But One Wedge Economies [b]											
94%	99.5%	98%	8%	99.8%	99.5%	99.7%	1%	95%	96%	83%	26%

[a] Rounded to the second decimal place.
[b] For better interpretation, the All But One Wedge Economies present $(1-\theta)$, instead of θ.

Table 23 – The Contribution of Each Wedge in the Variation of Economic Variables (Euro Area, 1995:Q1-2021:Q2)[a]

ϕ_e^Y	ϕ_l^Y	ϕ_x^Y	ϕ_g^Y	ϕ_e^H	ϕ_l^H	ϕ_x^H	ϕ_g^H	ϕ_e^X	ϕ_l^X	ϕ_x^X	ϕ_g^X	ϕ_e^C	ϕ_l^C	ϕ_x^C	ϕ_g^C
One Wedge Economies															
25%	17%	26%	32%	18%	49%	13%	20%	29%	17%	24%	30%	53%	10%	37%	0%
All But One Wedge Economies [b]															
97%	95%	74%	34%	45%	97%	90%	68%	71%	83%	76%	69%	97%	97%	61%	45%

[a] Rounded to the second decimal place.

[b] For better interpretation, the All But One Wedge Economies present $(1-\phi)$, instead of ϕ.

Annex III

Graph 33 – Detrended Output and Wedges (Indexed, United States, 2019:Q4-2021:Q3)

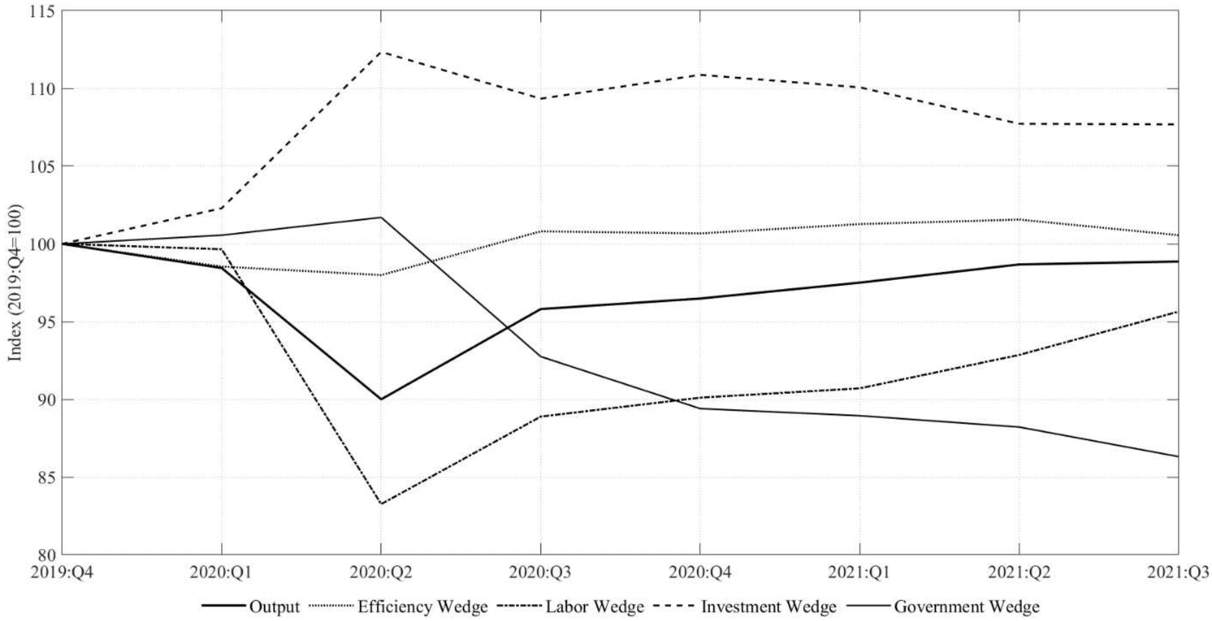


Table 24 – Wedges' Properties in Relation with Output and Themselves (United States, 2019:Q4-2021:Q3)[a]

A. Summary Statistics

Wedges	$\frac{\sigma_{w_i}}{\sigma_y}$	Cross Correlations of Wedges with Output at Lag $k=$ -2	-1	0	1	2
Efficiency	0.4081	-0.4460	-0.4531	0.5369	0.7057	0.2819
Labor	1.8133	-0.2934	0.3982	0.8772	-0.2766	-0.6286
Investment	1.3702	-0.0416	-0.3777	-0.7039	0.2943	0.8144
Government	2.0135	0.5029	0.2382	-0.3578	-0.5847	-0.6697

B. Cross Correlations

Wedges (X, Y)	Cross Correlation of X with Y at Lag $k=$ -2	-1	0	1	2
Efficiency, Labor	-0.5688	-0.8193	0.0679	0.5561	0.4070
Efficiency, Investment	0.7187	0.9156	0.1379	-0.2518	-0.4499
Efficiency, Government	-0.4717	-0.6884	-0.8575	-0.6710	-0.2356
Labor, Investment	0.7799	-0.2196	-0.9248	-0.3241	0.2251
Labor, Government	-0.7507	-0.2706	0.0788	0.6743	0.7199
Investment, Government	0.7785	-0.0639	-0.3986	-0.8015	-0.8710

[a] Rounded to the fourth decimal place.

Graph 34 – Detrended Output and Wedges (Indexed, United States, 1965:Q4-2021:Q3)

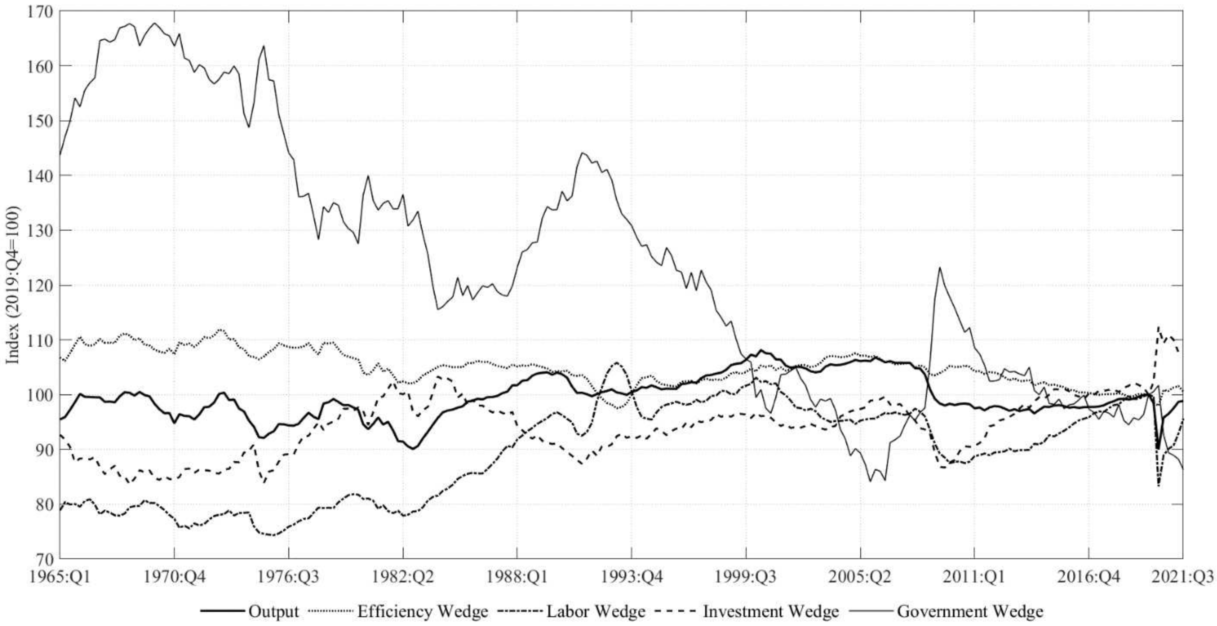


Table 25 – Wedges' Properties in Relation with Output and Themselves (United States, 1965:Q1-2021:Q3)[a]

A. Summary Statistics

Wedges	$\frac{\sigma_{w_i}}{\sigma_y}$	Cross Correlations of Wedges with Output at Lag k =				
		-2	-1	0	1	2
Efficiency	0.8094	-0.0452	-0.0247	0.0036	-0.0048	-0.0224
Labor	2.2481	0.6981	0.7126	0.7210	0.7048	0.6930
Investment	1.4264	-0.0240	-0.0001	0.0109	0.0385	0.0587
Government	6.0501	-0.3931	-0.4104	-0.42360	-0.4321	-0.4355

B. Cross Correlations

Wedges (X, Y)	Cross Correlation of X with Y at Lag k =				
	-2	-1	0	1	2
Efficiency, Labor	-0.6711	-0.6793	-0.6800	-0.6737	-0.6714
Efficiency, Investment	-0.5868	-0.5917	-0.5989	-0.5953	-0.5952
Efficiency, Government	0.5539	0.5562	0.5609	0.5614	0.5686
Labor, Investment	0.4017	0.3890	0.3732	0.3701	0.3597
Labor, Government	-0.6917	-0.6921	-0.6911	-0.6832	-0.6774
Investment, Government	-0.7409	-0.7584	-0.7698	-0.7649	-0.7567

[a] Rounded to the fourth decimal place.

Table 26 – Wedges' Properties in Relation with Other Economic Variables (United States, 2019:Q4-2021:Q3)[a]

A. Hours Worked

Wedges	$\frac{\sigma_{w_i}}{\sigma_h}$	Cross Correlations of Wedges with Output at Lag k = -2	-1	0	1	2
Efficiency	0.3225	-0.5250	-0.7527	0.1652	0.6022	0.3602
Labor	1.4328	-0.4974	0.1951	0.9938	0.0829	-0.6248
Investment	1.0827	0.1366	-0.3137	-0.8887	-0.1177	0.8157
Government	1.5909	0.6610	0.5944	-0.0159	-0.3415	-0.7204

B. Investment

Wedges	$\frac{\sigma_{w_i}}{\sigma_x}$	Cross Correlations of Wedges with Output at Lag k = -2	-1	0	1	2
Efficiency	0.2114	0.0477	0.2261	0.9027	0.7236	0.1970
Labor	0.9393	0.3489	0.4036	0.3880	-0.6019	-0.6983
Investment	0.7098	-0.5625	-0.1704	-0.0925	0.6857	0.8474
Government	1.0430	-0.1269	-0.4377	-0.8558	-0.7840	-0.5880

C. Government Consumption

Wedges	$\frac{\sigma_{w_i}}{\sigma_g}$	Cross Correlations of Wedges with Output at Lag k = -2	-1	0	1	2
Efficiency	0.2027	-0.4717	-0.6884	-0.8575	-0.6710	-0.2356
Labor	0.9006	-0.7507	-0.2706	0.0788	0.6743	0.7199
Investment	0.6805	0.7785	-0.0639	-0.3986	-0.8015	-0.8710

D. Private Consumption

Wedges	$\frac{\sigma_{w_i}}{\sigma_c}$	Cross Correlations of Wedges with Output at Lag k = -2	-1	0	1	2
Efficiency	0.3659	-0.5488	-0.6296	0.3626	0.6707	0.3434
Labor	1.6258	-0.4650	0.3572	0.9534	-0.1204	-0.5794
Investment	1.2285	0.1245	-0.4044	-0.8255	0.1163	0.7862
Government	1.8052	0.6471	0.4298	-0.1839	-0.4893	-0.7196

[a] Rounded to the fourth decimal place.

Table 27 – Wedges' Properties in Relation with Other Economic Variables (United States, 1965:Q1-2021:Q3)[a]

A. Hours Worked

Wedges	$\frac{\sigma_{w_i}}{\sigma_h}$	Cross Correlations of Wedges with Hours Worked at Lag k = -2	-1	0	1	2
Efficiency	0.5723	-0.5800	-0.5851	-0.5792	-0.5741	-0.5738
Labor	1.5896	0.9208	0.9339	0.9442	0.9241	0.9023
Investment	1.0086	0.2743	0.2938	0.3030	0.3210	0.3332
Government	4.2779	-0.4834	-0.4918	-0.50169	-0.5030	-0.5013

B. Investment

Wedges	$\frac{\sigma_{w_i}}{\sigma_x}$	Cross Correlations of Wedges with Investment at Lag k = -2	-1	0	1	2
Efficiency	0.3568	-0.0955	-0.0788	-0.0556	-0.0696	-0.0952
Labor	0.9909	0.5908	0.5934	0.5869	0.5643	0.5442
Investment	0.6287	0.4124	0.4599	0.4912	0.4996	0.4963
Government	2.6668	-0.5630	-0.5891	-0.6074	-0.6059	-0.5946

C. Government Consumption

Wedges	$\frac{\sigma_{w_i}}{\sigma_g}$	Cross Correlations of Wedges with Government Consumption at Lag k = -2	-1	0	1	2
Efficiency	0.1337	0.5539	0.5562	0.5609	0.5614	0.5686
Labor	0.3715	-0.6917	-0.6921	-0.6911	-0.6832	-0.6774
Investment	0.2357	-0.7409	-0.7584	-0.7698	-0.7649	-0.7567

D. Private Consumption

Wedges	$\frac{\sigma_{w_i}}{\sigma_c}$	Cross Correlations of Wedges with Private Consumption at Lag k = -2	-1	0	1	2
Efficiency	0.5270	-0.3727	-0.3653	-0.3558	-0.3566	-0.3639
Labor	1.4636	0.8348	0.8502	0.8646	0.8577	0.8552
Investment	0.9287	0.2218	0.2301	0.2316	0.2521	0.2698
Government	3.9390	-0.7340	-0.7447	-0.7545	-0.7604	-0.7651

[a] Rounded to the fourth decimal place.

Table 28 – Output Models' Properties in Relation with Output and Themselves (United States, 2019:Q4-2021:Q3)[a]

A. Summary Statistics

Components	$\frac{\sigma_{w_i}}{\sigma_y}$	Cross Correlations of Output Models with Output at Lag $k =$ -2	-1	0	1	2
Efficiency	0.4457	-0.4613	-0.4501	0.5282	0.6970	0.3110
Labor	1.1414	-0.3174	0.3407	0.9309	-0.1883	-0.5819
Investment	0.4073	-0.0804	-0.4032	-0.6725	0.3116	0.8272
Government	0.2708	0.5190	0.2065	-0.1831	-0.5401	-0.8076

B. Cross Correlations

Components (X, Y)	Cross Correlation of Output Models of Component X with Output Models of Component Y at Lag $k =$ -2	-1	0	1	2
Efficiency, Labor	-0.5607	-0.7433	0.1834	0.6116	0.4154
Efficiency, Investment	0.7346	0.9258	0.1985	-0.1966	-0.5016
Efficiency, Government	-0.6165	-0.8078	-0.7675	-0.6718	-0.2968
Labor, Investment	0.8091	-0.0697	-0.8612	-0.3869	0.1250
Labor, Government	-0.8595	-0.2720	0.1063	0.5342	0.7104
Investment, Government	0.8307	-0.2430	-0.5843	-0.8033	-0.9005

[a] Rounded to the fourth decimal place.

Graph 35 – Detrended Output and Modeled Detrended Output With One Wedge (Indexed, United States, 1965:Q4-2021:Q3)

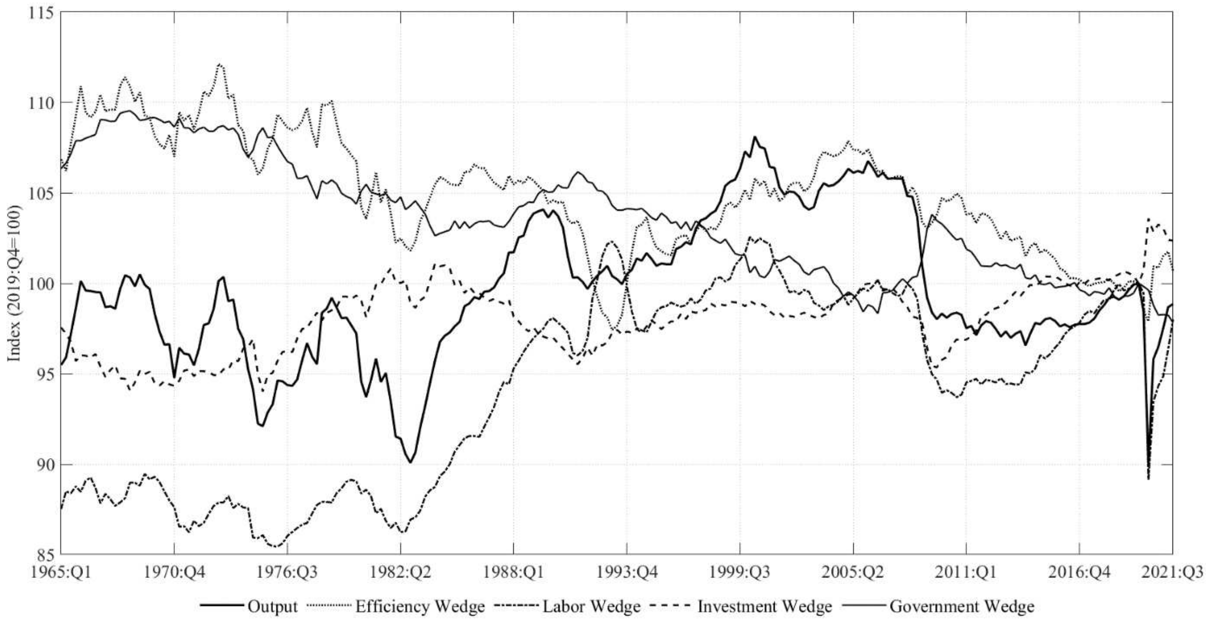


Table 29 – Output Models' Properties in Relation with Output and Themselves (United States, 1965:Q1-2021:Q3)[a]

A. Summary Statistics

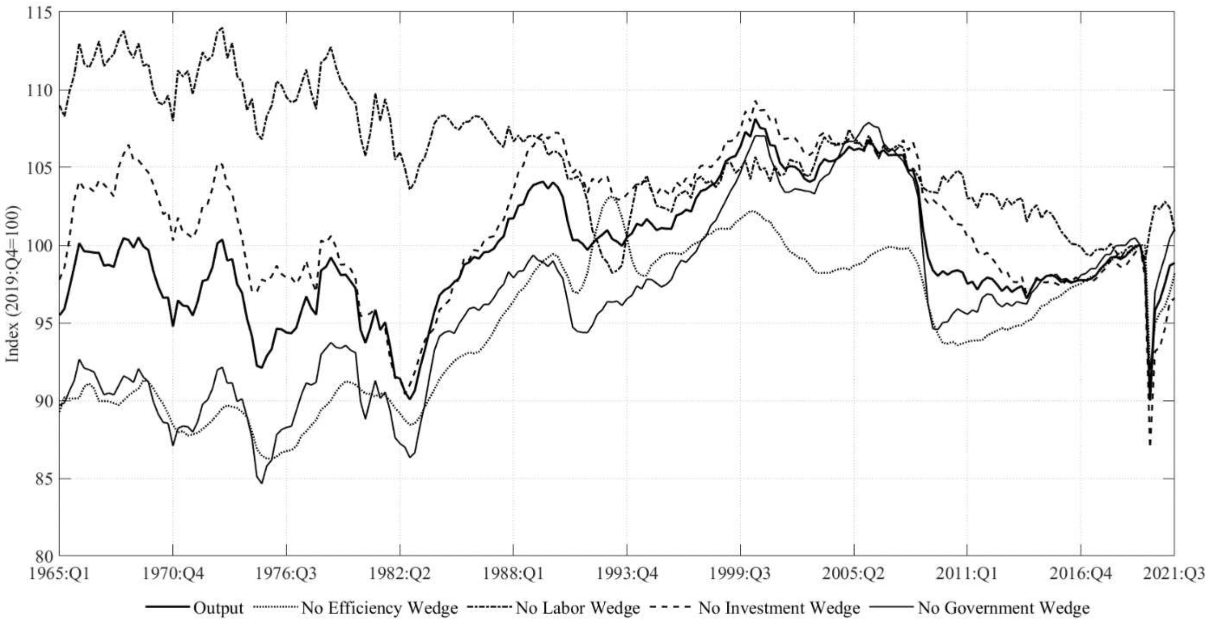
Components	$\frac{\sigma_{w_i}}{\sigma_y}$	Cross Correlations of Output Models with Output at Lag $k =$				
		-2	-1	0	1	2
Efficiency	0.8282	-0.0240	0.0016	0.0342	0.0259	0.0079
Labor	1.3453	0.7489	0.7615	0.7696	0.7506	0.7349
Investment	0.5013	0.0212	0.0465	0.0598	0.0836	0.1013
Government	0.8129	-0.3597	-0.3726	-0.3806	-0.3904	-0.3959

B. Cross Correlations

Components (X, Y)	Cross Correlation of Output Model of Component X with Output Model of Component Y at Lag $k =$				
	-2	-1	0	1	2
Efficiency, Labor	-0.5957	-0.5989	-0.5966	-0.5893	-0.5879
Efficiency, Investment	-0.5382	-0.5403	-0.5435	-0.5422	-0.5457
Efficiency, Government	0.6039	0.6081	0.6152	0.6127	0.6168
Labor, Investment	0.3965	0.3821	0.3640	0.3590	0.3475
Labor, Government	-0.7237	-0.7219	-0.7192	-0.7108	-0.7035
Investment, Government	-0.7921	-0.8092	-0.8205	-0.8135	-0.8031

[a] Rounded to the fourth decimal place.

Graph 36 – Detrended Output and Modeled Detrended Output With All But One Wedge (Indexed, United States, 1965:Q4-2021:Q3)



Graph 37 – Detrended Hours Worked and Modeled Detrended Hours Worked With One Wedge (Indexed, United States, 2019:Q4-2021:Q3)

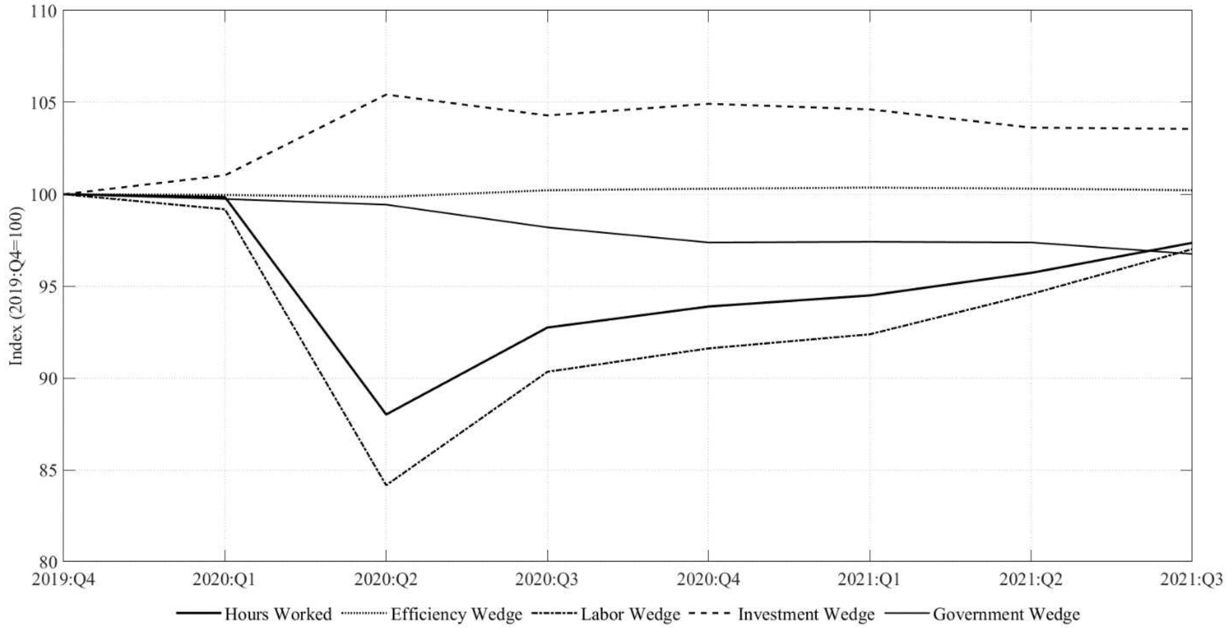


Table 30 – Hours Worked Models' Properties in Relation with Hours Worked and Themselves (United States, 2019:Q4-2021:Q3)[a]

A. Summary Statistics

Components	$\frac{\sigma_{w_i}}{\sigma_h}$	Cross Correlations of Hours Worked Models with Hours Worked at Lag k = -2	-1	0	1	2
Efficiency	0.0476	-0.6813	-0.7165	0.0443	0.3570	0.6440
Labor	1.3173	-0.5131	0.1022	0.9977	0.1485	-0.5761
Investment	0.4869	0.1032	-0.3574	-0.8724	-0.1027	0.8292
Government	0.3193	0.6952	0.5525	0.1425	-0.2263	-0.8466

B. Cross Correlations

Components (X, Y)	Cross Correlation of Hours Worked Model of Component X with Hours Worked Model of Component Y at Lag k = -2	-1	0	1	2
Efficiency, Labor	-0.7025	-0.7127	0.0530	0.3878	0.6741
Efficiency, Investment	0.8019	0.8945	0.3783	0.0546	-0.7545
Efficiency, Government	-0.5569	-0.8197	-0.8704	-0.7628	-0.5360
Labor, Investment	0.8069	-0.0785	-0.8661	-0.3882	0.1325
Labor, Government	-0.8619	-0.2658	0.1151	0.5428	0.7157
Investment, Government	0.8304	-0.2418	-0.5836	-0.8031	-0.9000

[a] Rounded to the fourth decimal place.

Graph 38- Detrended Hours Worked and Modeled Detrended Hours Worked With One Wedge (Indexed, United States, 1965:Q1-2021:Q3)

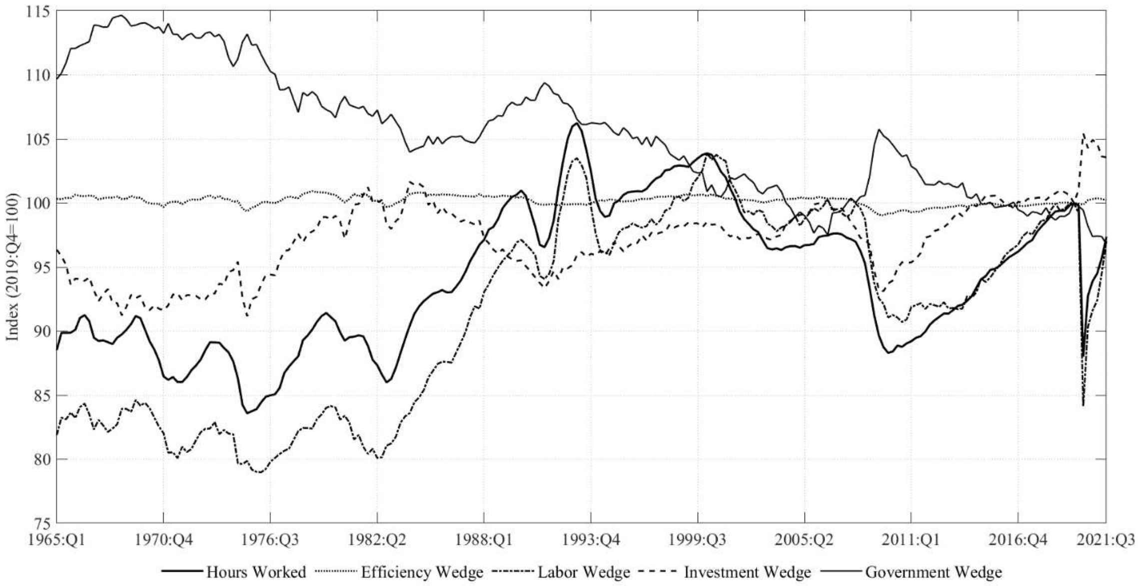


Table 31 – Hours Worked Models' Properties in Relation with Hours Worked and Themselves (United States, 1965:Q1-2021:Q3)[a]

A. Summary Statistics

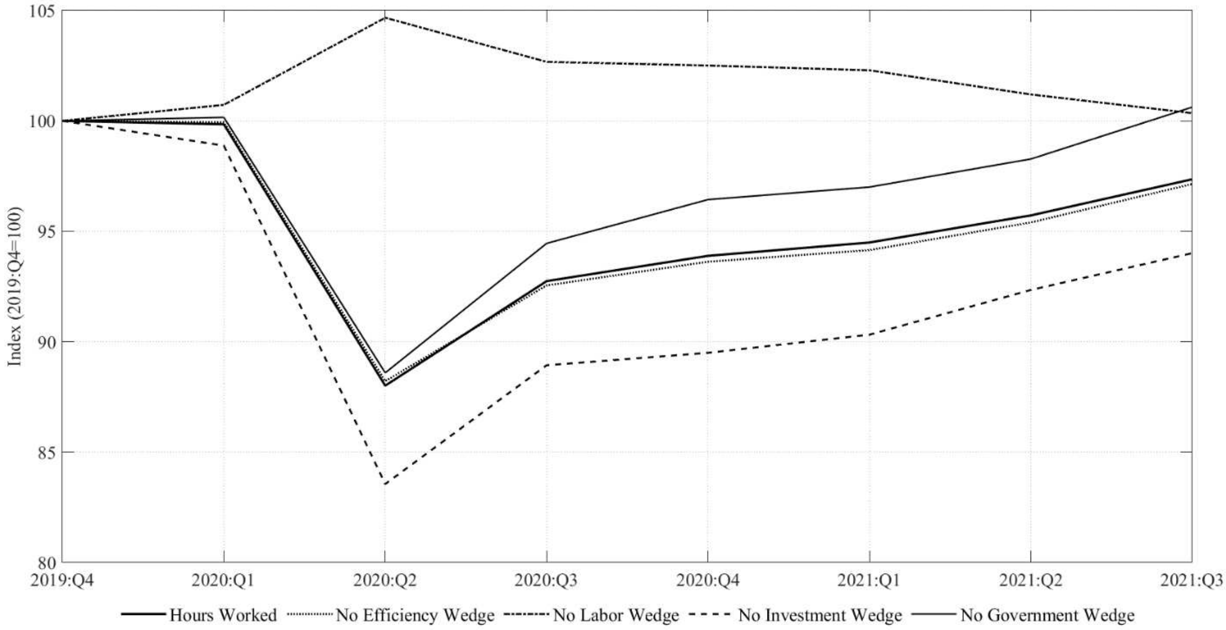
Components	$\frac{\sigma_{w_i}}{\sigma_h}$	Cross Correlations of Hours Worked Models with Hours Worked at Lag $k =$ -2	-1	0	1	2
Efficiency	0.06799	0.1139	0.1509	0.1842	0.1953	0.1913
Labor	1.3803	0.9000	0.9095	0.9187	0.8966	0.8729
Investment	0.5264	0.2905	0.3108	0.3218	0.3378	0.3480
Government	0.8790	-0.50227	-0.5102	-0.5182	-0.5195	-0.5182

B. Cross Correlations

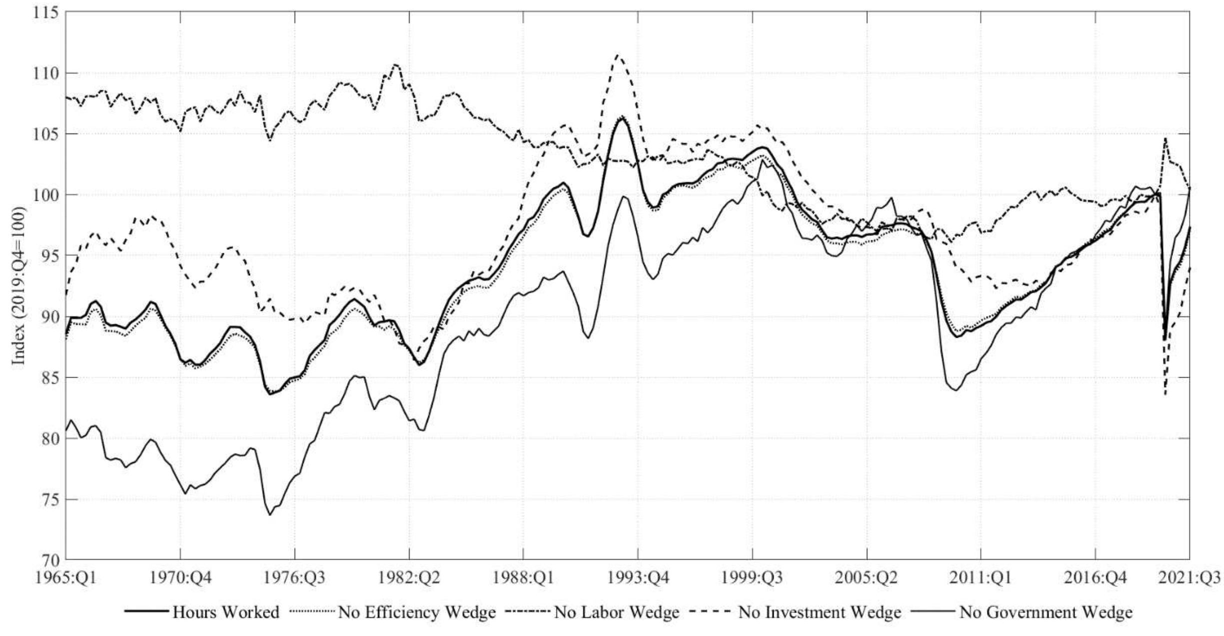
Components (X, Y)	Cross Correlation Hours Worked Model of Component X with Hours Worked Model of Component Y at Lag $k =$ -2	-1	0	1	2
Efficiency, Labor	-0.1499	-0.1261	-0.1059	-0.08383	-0.0726
Efficiency, Investment	0.1610	0.1796	0.1879	0.1539	0.1047
Efficiency, Government	0.1667	0.1577	0.1589	0.1666	0.1851
Labor, Investment	0.3927	0.3783	0.3602	0.3554	0.3441
Labor, Government	-0.7222	-0.7205	-0.7180	-0.7097	-0.7025
Investment, Government	-0.7917	-0.8087	-0.8200	-0.8131	-0.8027

[a] Rounded to the fourth decimal place.

Graph 39 – Detrended Hours Worked and Modeled Detrended Hours Worked With All But One Wedge (Indexed, United States, 2019:Q4-2021:Q3)



Graph 40 - Detrended Hours Worked and Modeled Detrended Hours Worked With All But One Wedge (Indexed, United States, 1965:Q1-2021:Q3)



Graph 41 – Detrended Investment and Modeled Detrended Investment With One Wedge (Indexed, United States, 2019:Q4-2021:Q3)

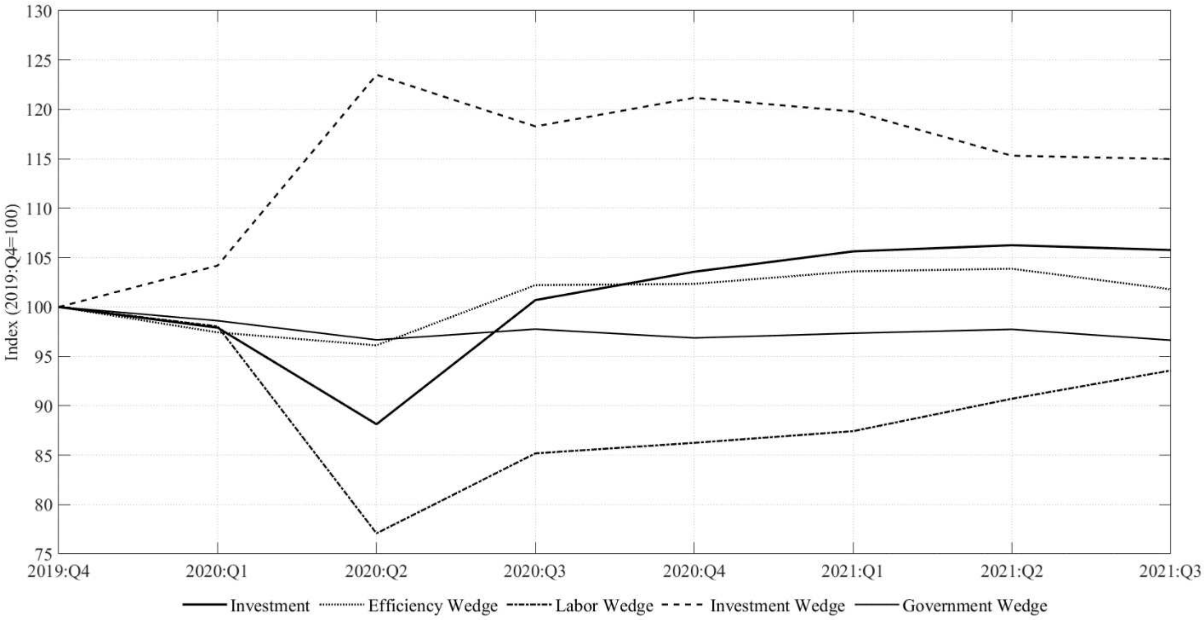


Table 32 – Investment Models' Properties in Relation with Investment and Themselves (United States, 2019:Q4-2021:Q3)[a]

A. Summary Statistics

Components	$\frac{\sigma_{w_i}}{\sigma_x}$	Cross Correlations of Investment Models with Investment at Lag k = -2	-1	0	1	2
Efficiency	0.4710	0.0086	0.2400	0.9079	0.7362	0.2833
Labor	1.2350	0.3598	0.4135	0.4200	-0.5524	-0.7185
Investment	1.3807	-0.5887	-0.1603	-0.0639	0.7044	0.8500
Government	0.1895	0.0970	-0.2302	-0.0119	-0.5402	-0.8987

B. Cross Correlations

Components (X, Y)	Cross Correlation of Investment Model of Component X with Investment Model of Component Y at Lag k = -2	-1	0	1	2
Efficiency, Labor	-0.6383	-0.7894	0.0780	0.5181	0.4925
Efficiency, Investment	0.7421	0.9222	0.2263	-0.1595	-0.5554
Efficiency, Government	-0.8301	-0.8178	-0.1425	-0.1854	-0.0704
Labor, Investment	0.7819	-0.1387	-0.9181	-0.4065	0.2129
Labor, Government	-0.8172	0.3335	0.7321	0.0841	0.0947
Investment, Government	0.5842	-0.6031	-0.8971	-0.2067	0.0010

[a] Rounded to the fourth decimal place.

Graph 42 – Detrended Investment and Modeled Detrended Investment With One Wedge (Indexed, United States, 1965:Q1-2021:Q3)

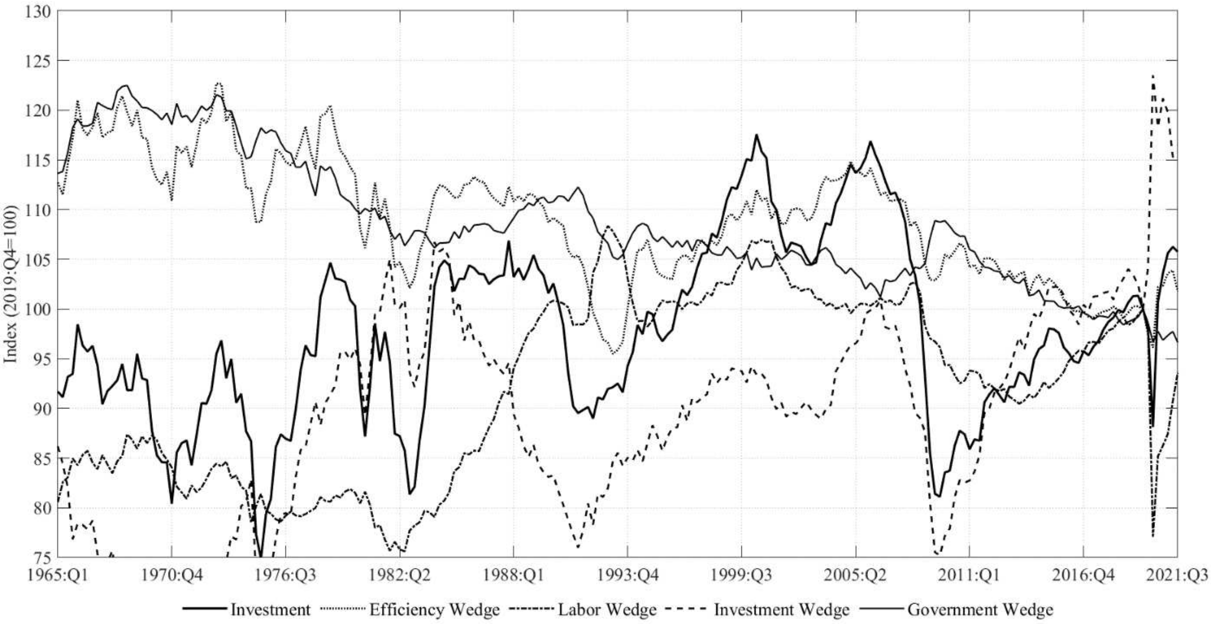


Table 33 – Investment Models' Properties in Relation with Investment and Themselves (United States, 1965:Q1-2021:Q3)[a]

A. Summary Statistics

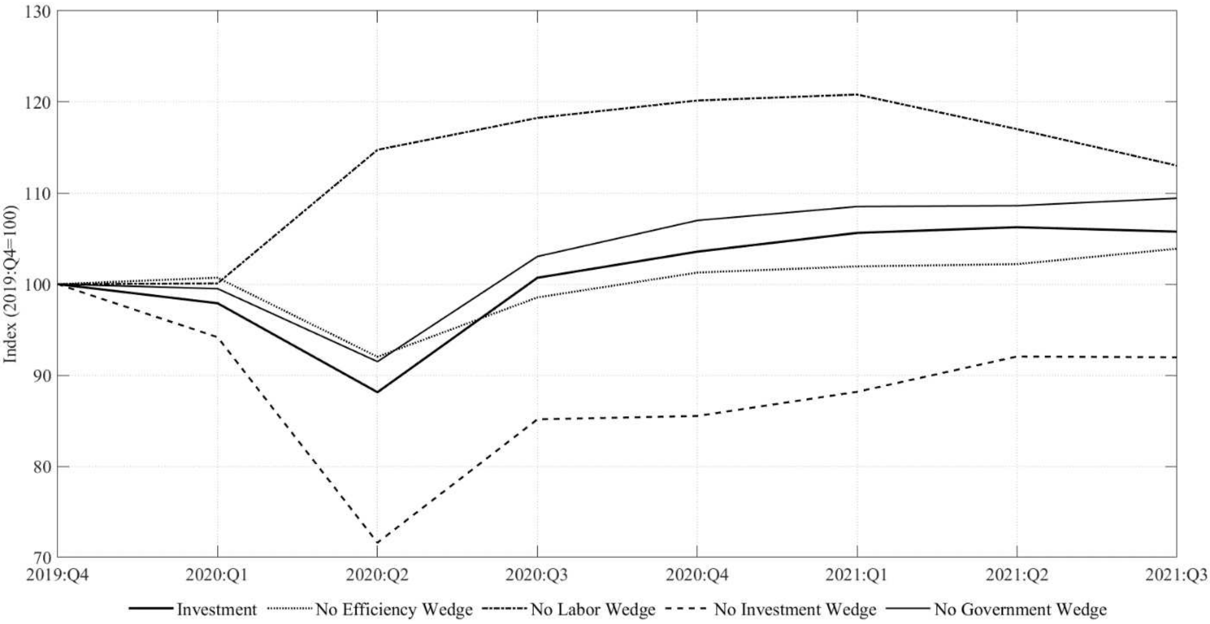
Components	$\frac{\sigma_{w_i}}{\sigma_x}$	Cross Correlations of Investment Models with Investment at Lag k = -2	-1	0	1	2
Efficiency	0.6988	0.0485	0.0830	0.1187	0.0962	0.0595
Labor	1.0203	0.5609	0.5482	0.5304	0.5006	0.4745
Investment	1.2058	0.4353	0.4832	0.5149	0.5210	0.5149
Government	0.7332	-0.4334	-0.4474	-0.4520	-0.4573	-0.4594

B. Cross Correlations

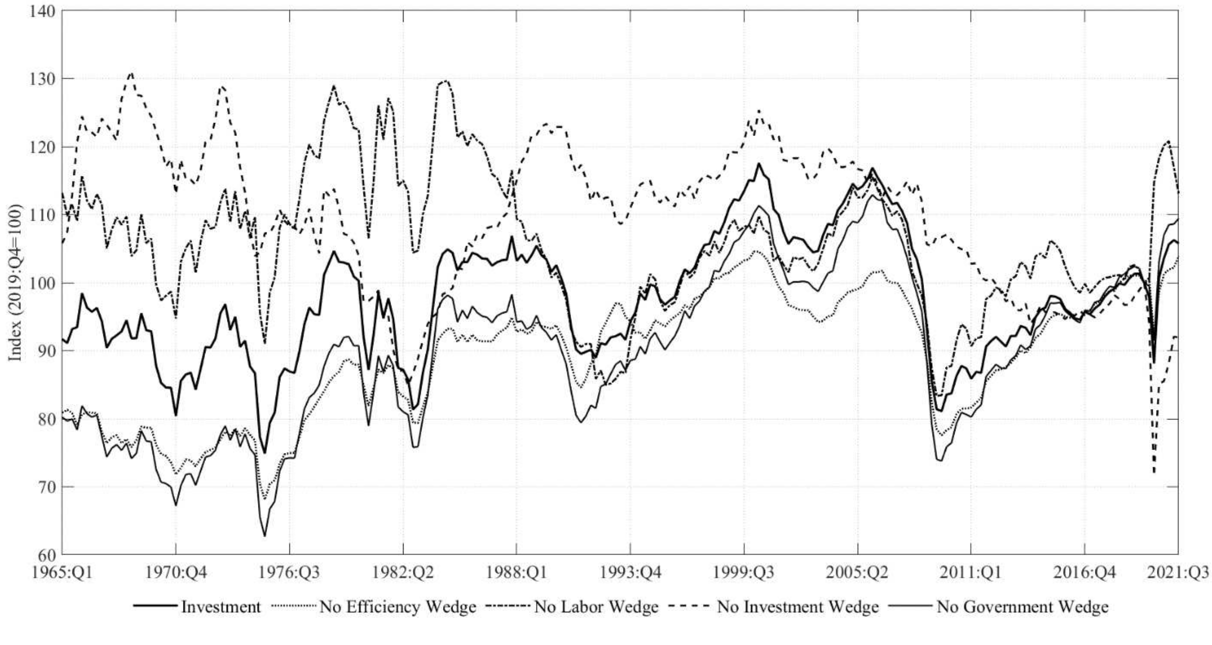
Components (X, Y)	Cross Correlation of Investment Model of Component X with Investment Model of Component Y at Lag k = -2	-1	0	1	2
Efficiency, Labor	-0.4735	-0.4687	-0.4596	-0.4468	-0.4398
Efficiency, Investment	-0.4515	-0.4497	-0.4525	-0.4575	-0.4700
Efficiency, Government	0.7320	0.7425	0.7542	0.7437	0.7387
Labor, Investment	0.1592	0.1358	0.1097	0.1135	0.1115
Labor, Government	-0.5453	-0.5388	-0.5335	-0.5321	-0.5295
Investment, Government	-0.8124	-0.8264	-0.8375	-0.8284	-0.8171

[a] Rounded to the fourth decimal place.

Graph 43 – Detrended Investment and Modeled Detrended Investment With All But One Wedge (Indexed, United States, 2019:Q4-2021:Q3)



Graph 44 - Detrended Investment and Modeled Detrended Investment With All But One Wedge (Indexed, United States, 1965:Q1-2021:Q3)



Graph 45 - Detrended Private Consumption and Modeled Detrended Private Consumption With One Wedge (Indexed, United States, 2019:Q4-2021:Q3)

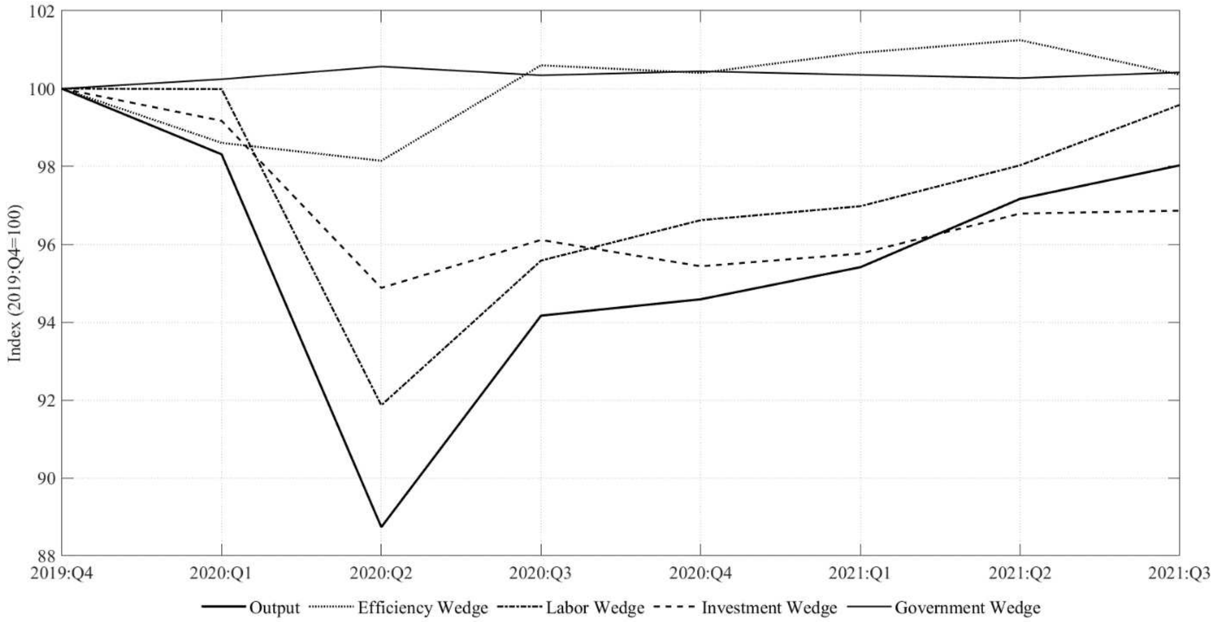


Table 34 – Private Consumption Models' Properties in Relation with Private Consumption and Themselves (United States, 2019:Q4-2021:Q3)[a]

A. Summary Statistics

Components	$\frac{\sigma_{w_i}}{\sigma_c}$	Cross Correlations of Private Consumption Models with Output at Lag $k =$ -2	-1	0	1	2
Efficiency	0.3148	-0.5277	-0.6354	0.3841	0.6888	0.2917
Labor	0.7918	-0.5213	0.2230	0.9854	-0.0184	-0.4206
Investment	0.5193	-0.0944	0.4174	0.8217	-0.1387	-0.7832
Government	0.0484	0.2351	0.0687	-0.8150	-0.2298	0.7454

B. Cross Correlations

Components (X, Y)	Cross Correlation of Private Consumption Model of Component X with Private Consumption Model of Component Y at Lag $k =$ -2	-1	0	1	2
Efficiency, Labor	-0.4412	-0.6689	0.3043	0.7080	0.3176
Efficiency, Investment	-0.6937	-0.9259	-0.1210	0.2785	0.4151
Efficiency, Government	0.7784	0.7036	-0.2204	-0.2808	-0.1171
Labor, Investment	-0.8130	-0.0211	0.8014	0.3099	-0.0110
Labor, Government	0.7459	-0.3453	-0.7303	0.1581	0.1395
Investment, Government	0.4431	-0.6357	-0.8940	0.1392	0.4618

[a] Rounded to the fourth decimal place.

Graph 46 – Detrended Private Consumption and Modeled Detrended Private Consumption With One Wedge (Indexed, United States, 1965:Q1-2021:Q3)

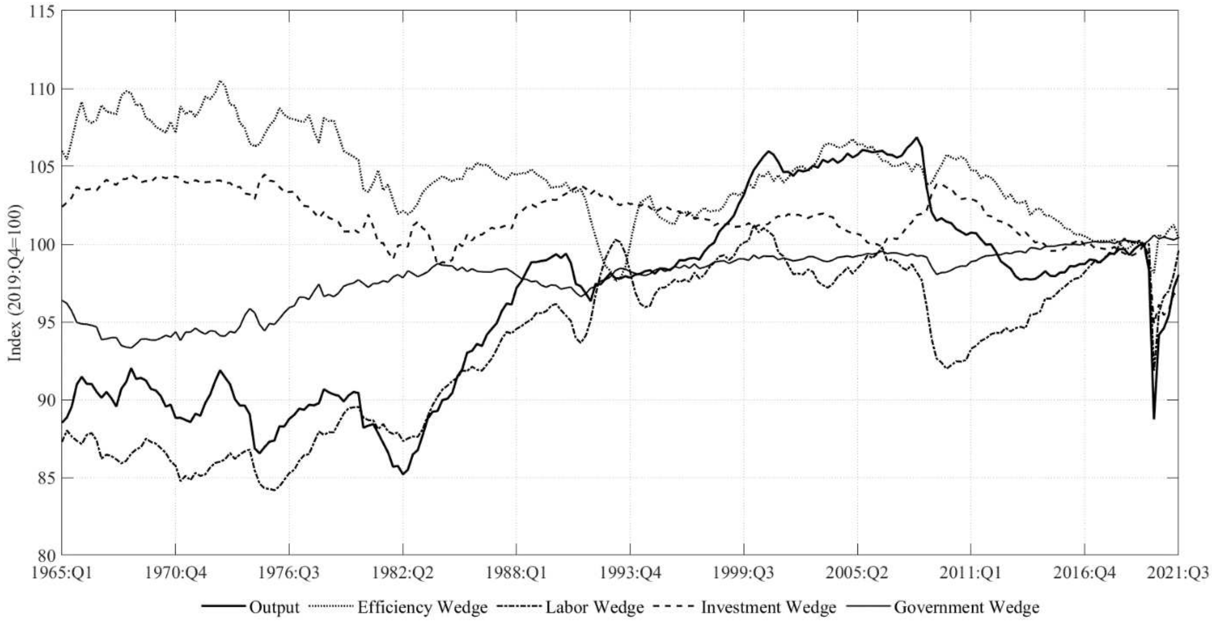


Table 35 – Private Consumption Models' Properties in Relation with Private Consumption and Themselves (United States, 1965:Q1-2021:Q3)[a]

A. Summary Statistics

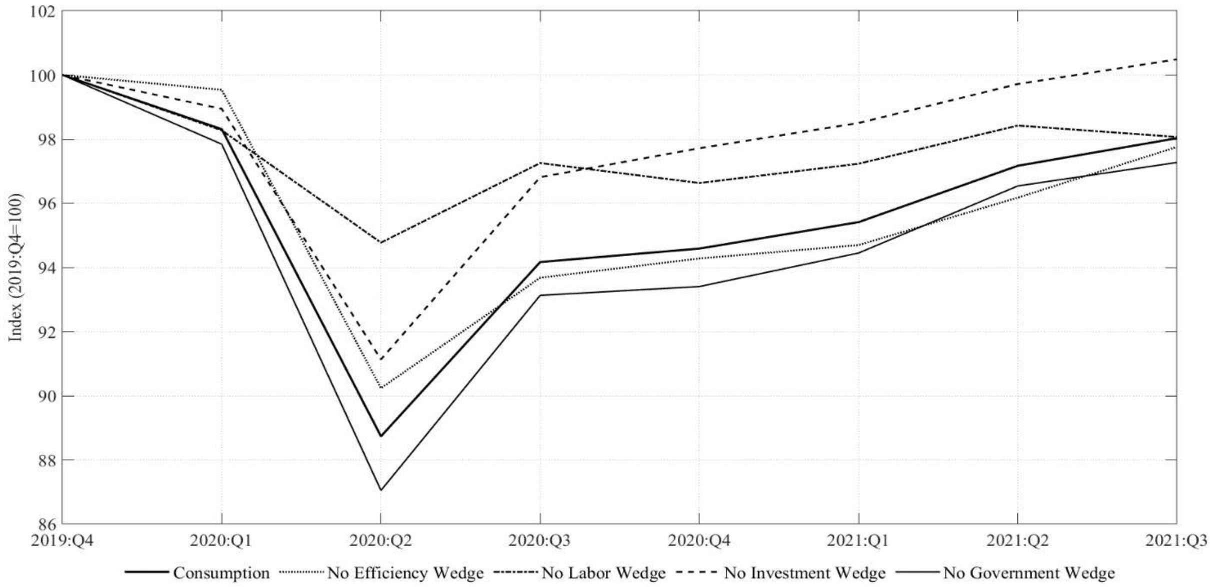
Components	$\frac{\sigma_{w_i}}{\sigma_c}$	Cross Correlations of Private Consumption Models with Output at Lag $k =$ -2	-1	0	1	2
Efficiency	0.4710	-0.3478	-0.3439	-0.3367	-0.3394	-0.3485
Labor	0.8626	0.8509	0.8661	0.8806	0.8775	0.8773
Investment	0.2937	-0.1938	-0.2005	-0.2006	-0.2241	-0.2430
Government	0.3200	0.6480	0.6546	0.6587	0.6650	0.6723

B. Cross Correlations

Components (X, Y)	Cross Correlation of Private Consumption Model of Component X with Private Consumption Model of Component Y at Lag $k =$ -2	-1	0	1	2
Efficiency, Labor	-0.6873	-0.6977	-0.7009	-0.6966	-0.6965
Efficiency, Investment	0.5758	0.5809	0.5916	0.5871	0.5849
Efficiency, Government	-0.7343	-0.7444	-0.7536	-0.7465	-0.7416
Labor, Investment	-0.5011	-0.4909	-0.4755	-0.4687	-0.4541
Labor, Government	0.8271	0.8267	0.8258	0.8182	0.8079
Investment, Government	-0.7571	-0.7685	-0.7769	-0.7688	-0.7598

[a] Rounded to the fourth decimal place.

Graph 47 – Detrended Private Consumption and Modeled Detrended Private Consumption With All But One Wedge (Indexed, United States, 2019:Q4-2021:Q3)



Graph 48 – Detrended Private Consumption and Modeled Detrended Private Consumption With All But One Wedge (Indexed, United States, 1965:Q1-2021:Q3)

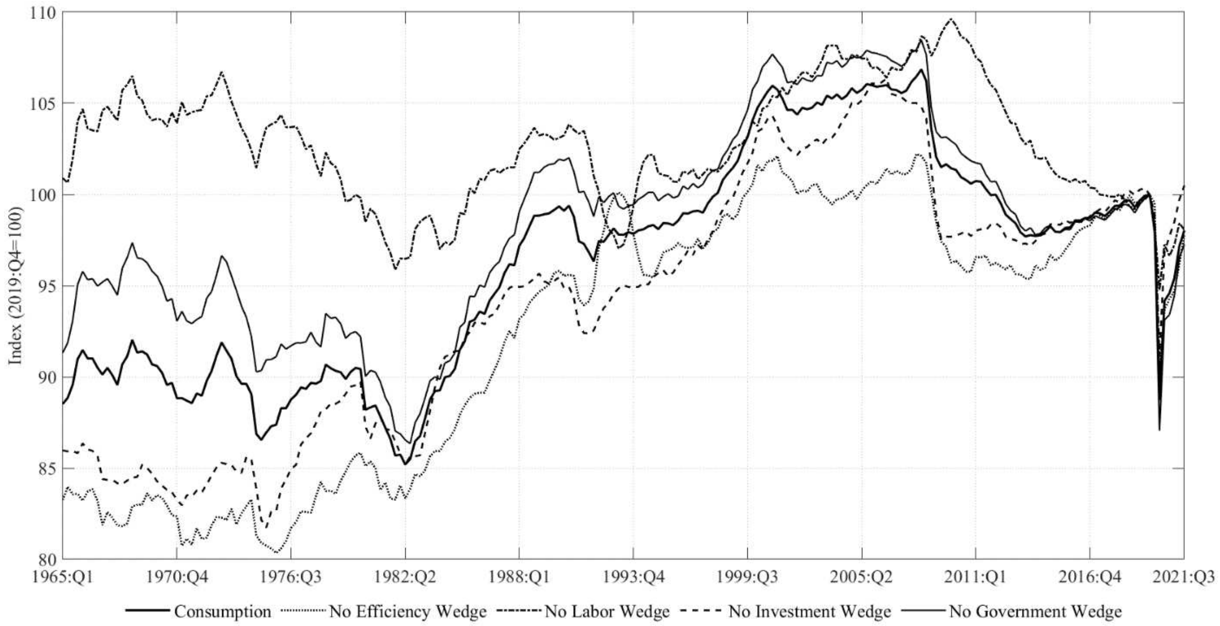


Table 36 – The Contribution of Each Wedge in the Variation of Economic Variables (United States, 2019:Q4-2021:Q3)[a] - COMPLETE

θ_e^H	θ_l^H	θ_x^H	θ_g^H	θ_e^X	θ_l^X	θ_x^X	θ_g^X	θ_e^C	θ_l^C	θ_x^C	θ_g^C
One Wedge Economies											
8%	76%	3%	13%	73%	5%	3%	20%	6%	57%	31%	5%
All But One Wedge Economies [b]											
2%	99.9%	99.6%	98.7%	55%	98.2%	98.1%	49%	50%	95%	94%	62%

[a] Rounded to the second decimal place.
[b] For better interpretation, the All But One Wedge Economies present $(1-\theta)$, instead of θ.

Table 37 – The Contribution of Each Wedge in the Variation of Economic Variables (United States, 1965:Q1-2021:Q3)[a]

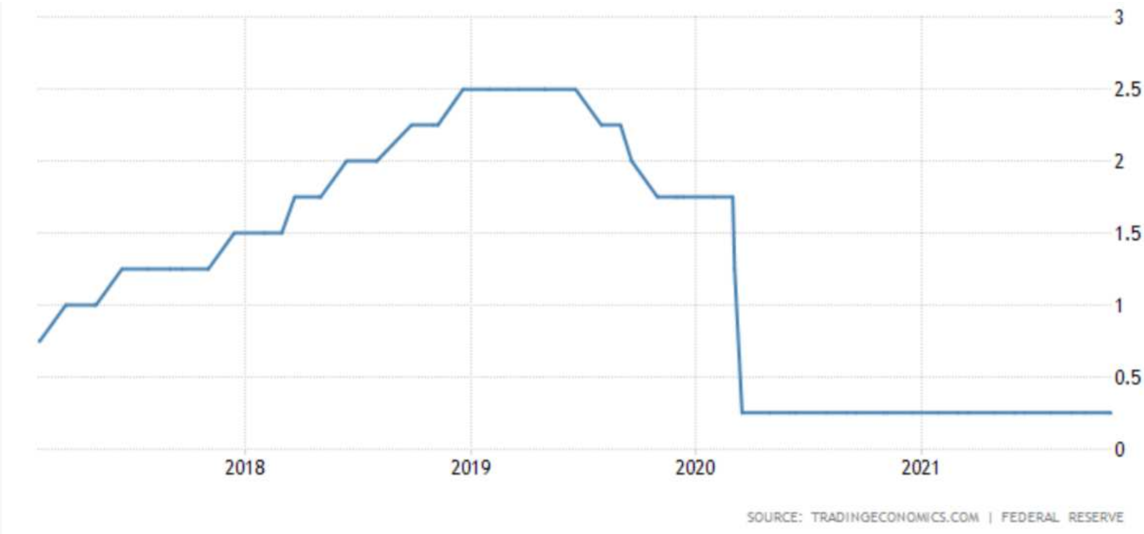
θ_e^Y	θ_l^Y	θ_x^Y	θ_g^Y	θ_e^H	θ_l^H	θ_x^H	θ_g^H	θ_e^X	θ_l^X	θ_x^X	θ_g^X	θ_e^C	θ_l^C	θ_x^C	θ_g^C
One Wedge Economies															
25%	17%	26%	32%	18%	49%	13%	20%	29%	17%	24%	30%	53%	10%	37%	0%
All But One Wedge Economies [b]															
97%	95%	74%	34%	45%	97%	90%	68%	71%	83%	76%	69%	97%	97%	61%	45%

[a] Rounded to the second decimal place.

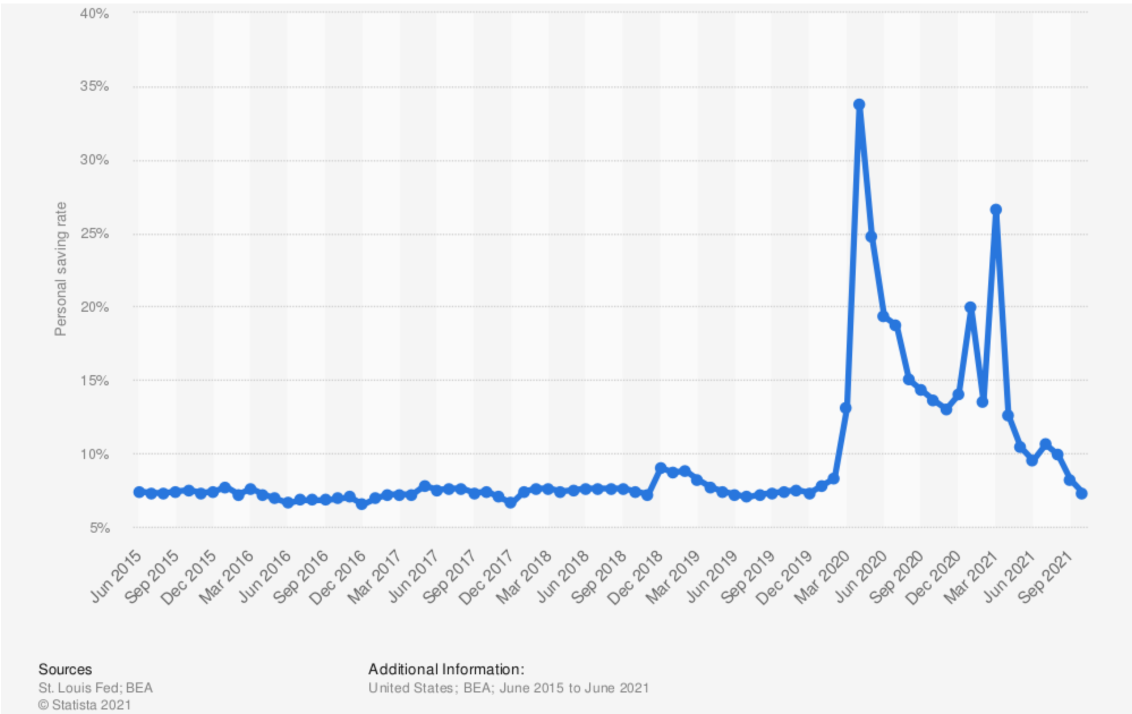
[b] For better interpretation, the All But One Wedge Economies present $(1-\phi)$, instead of ϕ.

Annex IV

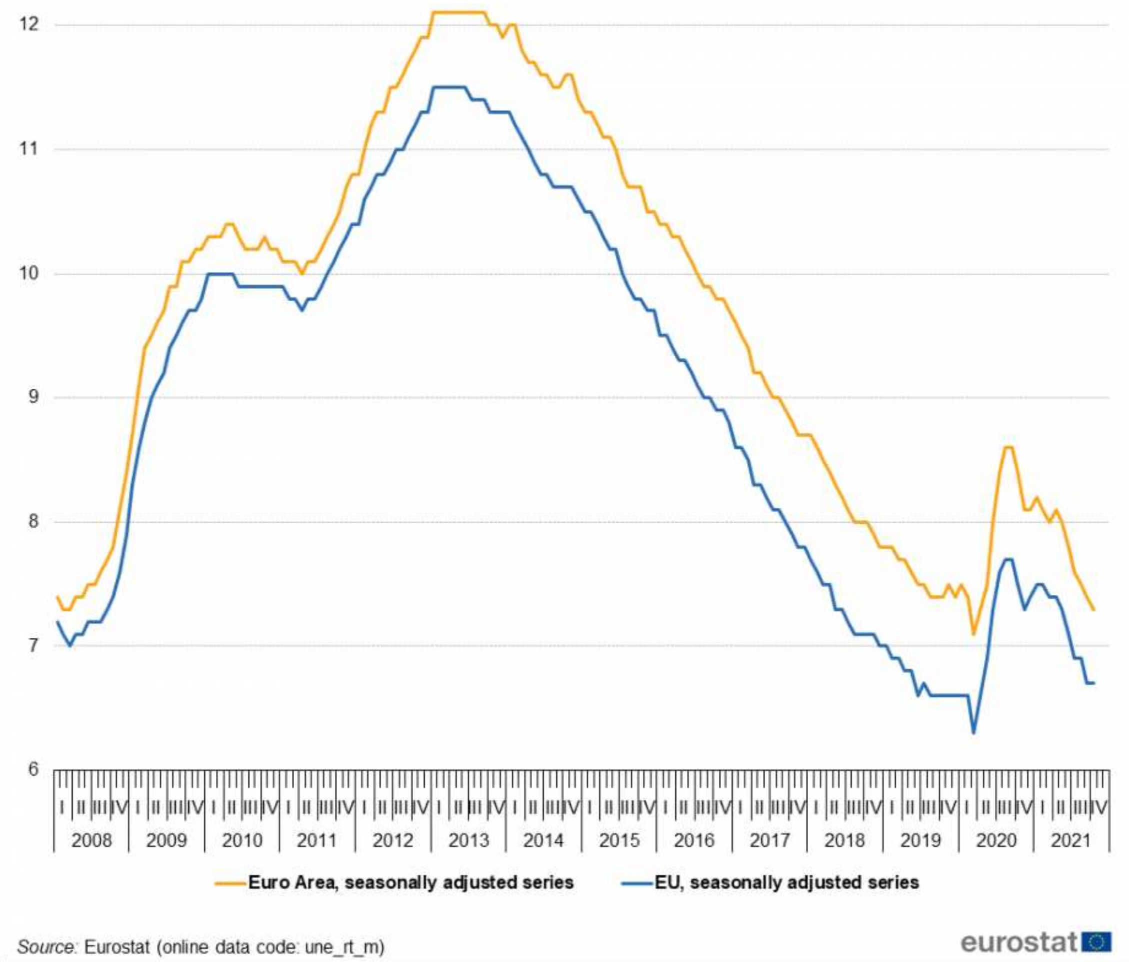
Graph 49 - Federal Funds Rate (United States, January 2017 – December 2021)[a]



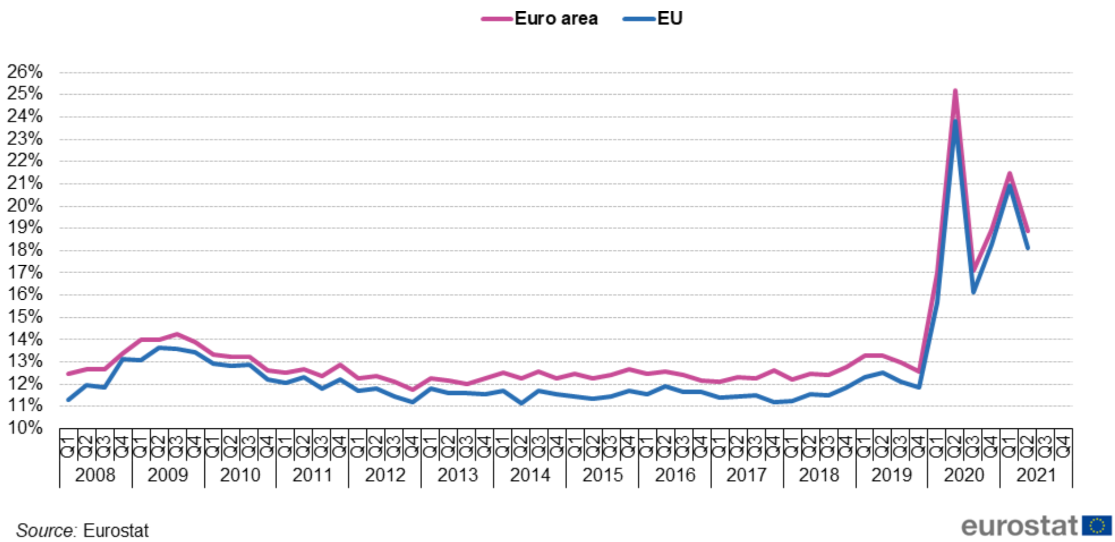
Graph 50 - Personal Savings Rate (United States, June 2015 - June2021)[a]



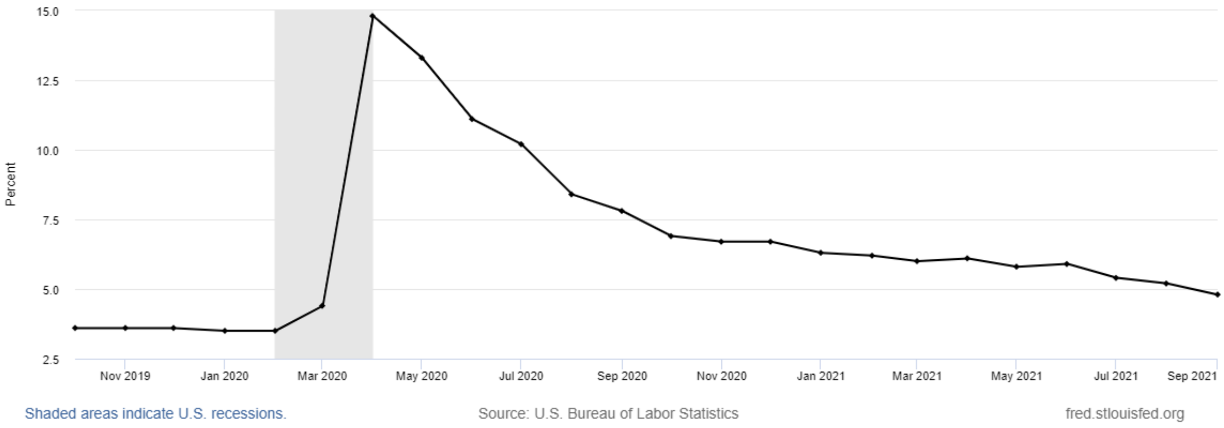
Graph 51 - Unemployment Rate, Seasonally Adjusted (Euro Area, 2008:Q1-2021:Q4)



Graph 52 - Household Gross Savings Rate, Seasonally Adjusted (Euro Area, 2008:Q1-2021:Q2)

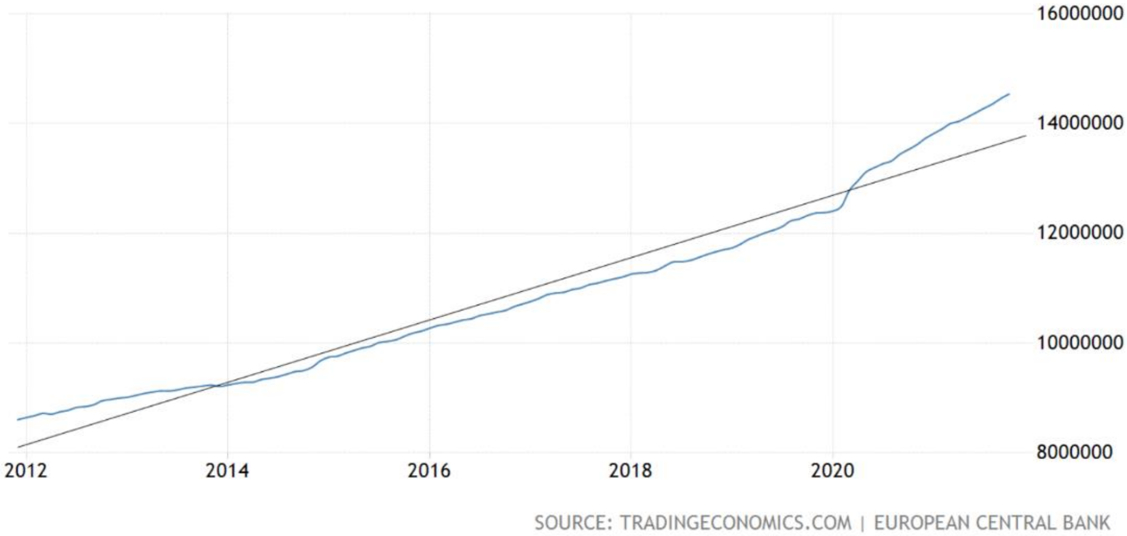


Graph 53 - United States' Unemployment Rate (Seasonally Adjusted, September 2019-September 2021)

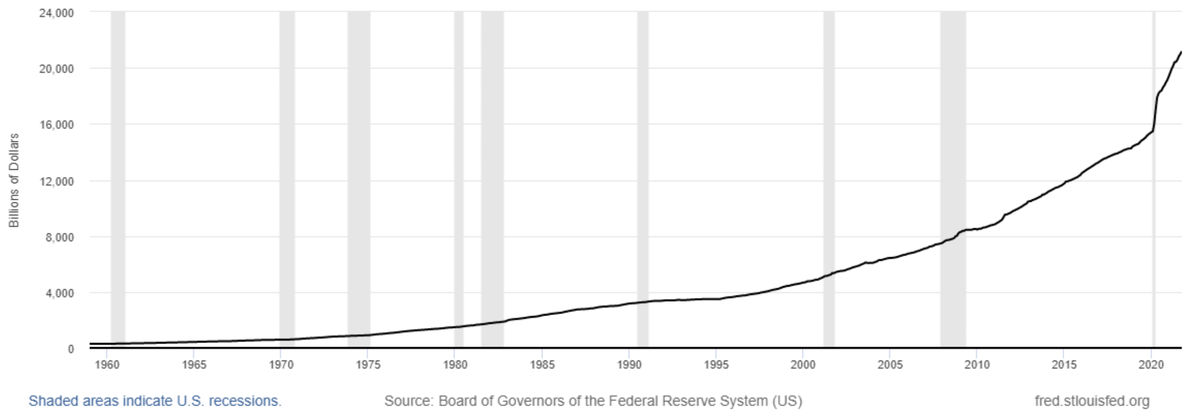


Graph 54 - United States' Unemployment Rate (Seasonally Adjusted, January 1948-November 2021)

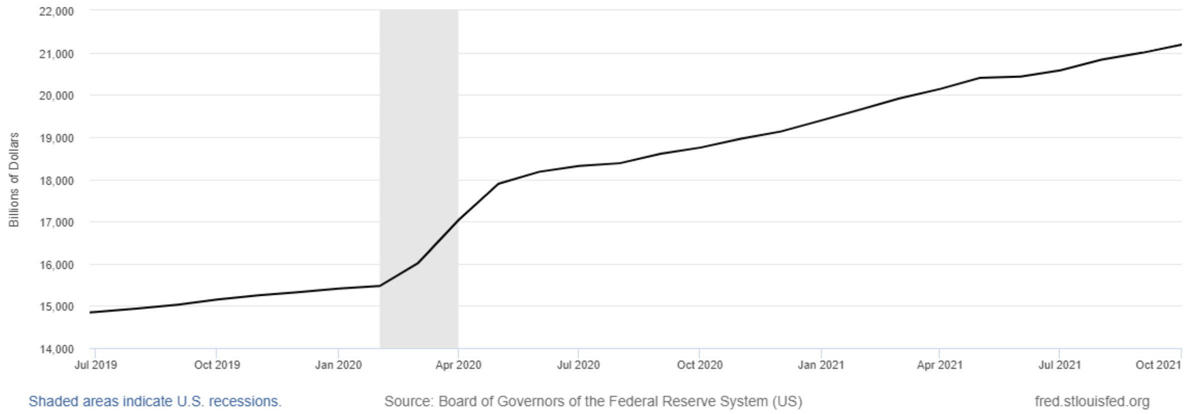
Graph 55 – Euro Area's (January 2012-November 2021)



Graph 56 – United States' M2 (January 1964-November 2021)

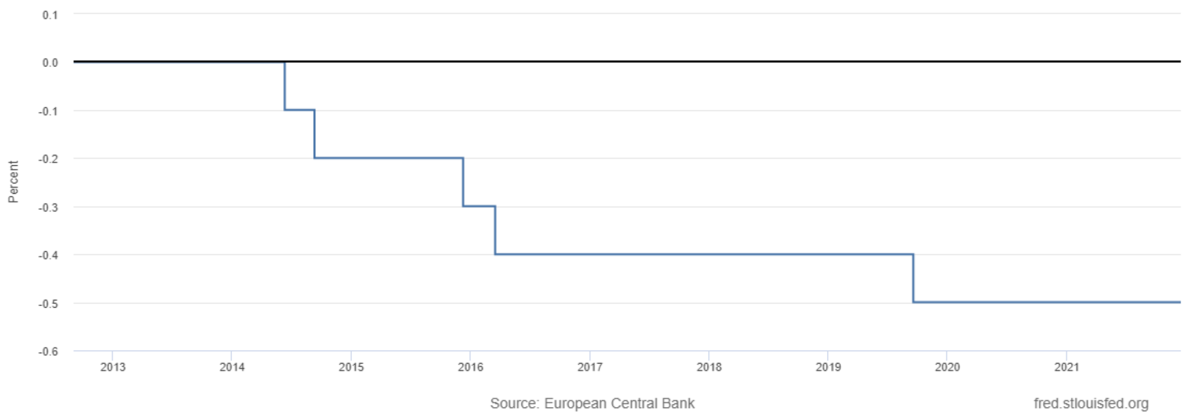


Graph 57 - United States' M2 (July 2019-November 2021



Graph 58 – ECB Interest Rate Decision (January 1999-November 2021)

Graph 59 - European Central Bank Deposit Facility Rate (July 2012-October 2021)



Graph 60 – COVID-related Modifications for U.S. Banks with more than $50 Billion in total Assets (Before and Including 2020:Q2 – After 2020:Q2)

				Loans modified				
				Before June 30, 2020*		On or after June 30, 2020*		
Company (ticker)	City, state/ territory	Total assets ($B)	Total net loans ($B)	As of date	($B)	As of date	($B)	Proportion of net loans (%)
JPMorgan Chase & Co. (JPM)	New York, NY	3,213.12	946.43	NA	NA	06/30/20	45.1	4.8
Bank of America Corp. (BAC)	Charlotte, NC	2,741.69	986.94	04/27/20	43.4	07/23/20	36.2	3.7
Citigroup Inc. (C)**	New York, NY	2,232.72	685.29	NA	NA	06/30/20	26.0	3.8
Wells Fargo & Co. (WFC)	San Francisco, CA	1,968.77	949.92	NA	NA	06/30/20	91.0	9.6
U.S. Bancorp (USB)	Minneapolis, MN	546.65	311.13	04/15/20	5.7	06/30/20	17.2	5.5
Truist Financial Corp. (TFC)	Charlotte, NC	504.34	315.45	04/30/20	37.9	06/30/20	35.2	11.2
PNC Financial Services Group Inc. (PNC)	Pittsburgh, PA	458.98	253.75	04/30/20	9.3	06/30/20	12.9	5.1
Fifth Third Bancorp (FITB)	Cincinnati, OH	202.91	113.27	05/31/20	6.0	06/30/20	6.7	5.9
Citizens Financial Group Inc. (CFG)	Providence, RI	179.87	128.26	04/30/20	4.1	06/30/20	3.5	2.7
KeyCorp (KEY)	Cleveland, OH	171.19	106.46	NA	NA	06/30/20	4.6	4.3
Regions Financial Corp. (RF)	Birmingham, AL	144.07	89.42	05/04/20	5.4	07/31/20	2.1	2.4
M&T Bank Corp. (MTB)	Buffalo, NY	139.54	96.12	04/30/20	16.7	06/30/20	14.0	14.5
First Republic Bank (FRC)	San Francisco, CA	128.30	99.74	04/30/20	3.9	06/30/20	3.9	3.9
Huntington Bancshares Inc. (HBAN)	Columbus, OH	118.43	79.60	04/23/20	5.0	06/30/20	6.8	8.6
SVB Financial Group (SIVB)	Santa Clara, CA	85.73	36.14	04/23/20	2.8	06/30/20	2.9	8.0
Comerica Inc. (CMA)	Dallas, TX	84.40	52.45	05/08/20	3.0	06/30/20	4.5	8.6
Zions Bancorp. NA (ZION)	Salt Lake City, UT	76.45	54.37	04/26/20	1.5	06/30/20	4.6	8.5
Popular Inc. (BPOP)	Hato Rey, PR	62.85	28.22	03/31/20	0.9	06/30/20	8.0	28.3
CIT Group Inc. (CIT)	New York, NY	61.70	36.40	04/24/20	1.6	06/30/20	2.7	7.5
People's United Financial Inc. (PBCT)	Bridgeport, CT	61.51	45.05	05/07/20	6.4	06/30/20	7.2	16.0
Signature Bank (SBNY)	New York, NY	60.35	45.04	05/01/20	8.0	07/31/20	9.2	20.5
New York Community Bancorp Inc. (NYCB)	Westbury, NY	54.21	42.24	04/27/20	4.8	06/30/20	5.9	14.1
Synovus Financial Corp. (SNV)	Columbus, GA	54.12	40.23	05/07/20	5.8	08/04/20	0.7	1.7
TCF Financial Corp. (TCF)	Detroit, MI	50.06	35.61	NA	NA	06/30/20	1.8	5.1
Group median					**5.4**		**6.7**	**6.7**

Data compiled Aug. 11, 2020.
NA = Not available
Analysis limited to public U.S. banks with more than $50 billion in total assets as of June 30, 2020.
* Represents loan forbearances and loan deferrals reported by banks in response to the COVID-19 pandemic and subsequent passing of the CARES Act.
** Figures for Citigroup reflect gross loans.
Loan modification data collected on a best efforts-basis from public filings.
Source: S&P Global Market Intelligence