Hysteresis in *good* times? Autonomous demand shocks' effects on inflation, capital and labor in the US economy (1970–2021)

Lorenzo Di Domenico
Università Cattolica del Sacro Cuore
lorenzo.didomenico@unicatt.it

Santiago José Gahn
Università degli Studi di Bari
santiago.gahn@uniba.it

Davide Romaniello
Università degli Studi Roma Tre
davide.romaniello@uniroma3.it

June 25, 2023

Abstract

Building on the seminal work of Blanchard and Summers (1986) and Ball (1997, 1999, 2014), several authors have developed different arguments on the basis of which a negative shock to aggregate demand could have persistent effects on the level of output, an effect known as *hysteresis*. In some cases, a positive aggregate demand shock could also have persistent effects, as long as GDP is lower than normal. We provide a substantive classification of the literature on *hysteresis*. We also present a model in which *permanent* (and positive) demand shocks have a *permanent* effect on the level of output and transitory effects on inflation. Finally, we analyze empirically autonomous demand shocks' effects on unemployment, capacity utilization, inflation, capital (productive capacity) and labor participation rate in the US economy for the 1970Q1–2021Q4 period. Our results indicate that the US economy is extremely flexible to positive demand shocks even during *good* times, at least during the post Bretton-Woods era.

JEL classification: E22, E23, E24, E31, E32, J21, O41.

Keywords: hysteresis, inflation, autonomous demand, NAIRU, potential output

. . . we have learned a lot, but we still have a lot to learn.

Blanchard, 2006

1. Introduction

Building on the seminal work of Blanchard and Summers (1986) and, notably, Ball (1997, 1999, 2014) several authors have developed different arguments on the basis of which a shock to aggregate demand could have persistent (and permanent[1]) effects on the level of output, an effect known as *hysteresis*. *Hysteresis* effects are controversial in the literature and, naturally, call into question the traditional view that unexpected changes to the growth trend are caused only by supply shocks.[2] In this traditional view, productive capacity (and potential output) is independent from demand shocks. The same occurs for the Non-Accelerating Inflation Rate of Unemployment (NAIRU) which represents the corollary of potential output for the labor market.

At least 3 types of *hysteresis* can be found in the literature. The first one, widespread in the New-Keynesian framework, implies that in the face of a fall in effective output (or increase in unemployment), potential output falls (or the NAIRU increases); in some contributions, even long-run growth is affected (known as '*super hysteresis*'). The second type of *hysteresis* is the *hysteresis* effect during *bad* times: once that a fall in the long-run equilibrium position occurs due to economic crisis, it is recognized that increasing effective output leads to a recovery of potential output in line with its historical pre-crisis trend. In recent years, many papers have included the possibility of *hysteresis* during *bad* times;however, less has been done in relation to the third type, the phenomenon of *hysteresis* during *good* times or 'reverse' *hysteresis*, which involves the analysis of the permanent effects of an aggregate demand expansion and their respective consequences for productive capacity and employment, among other variables, during expansionary phases or *normal* times.

[1]See Cerra et al. (2023) for a discussion of this issue. According to Blanchard (2018, p. 100, emphasis added in *italics*), 'Even in the most standard models, monetary policy is likely to affect potential output for some time. Conversely, in most *hysteresis* models, the effects of monetary policy are likely to be persistent, but not necessarily permanent. The issue is thus about the size and persistence of the effects of monetary policy on potential output, not their existence *nor their permanence*.' In this paper, we analyze permanent shocks. Thus, our definition of *hysteresis* is associated with permanent shocks and the permanent effects of these shocks.

[2]See Røed (1997) for the history of the concept of *hysteresis* and Cerra et al. (2023) for an interesting historical review of the concept in the literature.

The objectives of this paper is threefold. First, we provide a substantive classification of the literature on *hysteresis*. Second, we build a macroeconomic model to study whether demand shocks can have a permanent effect on the level of (effective and potential) output. Finally, we analyze empirically whether these demand effects are permanent (or not) for unemployment, capacity utilization, inflation, capital (productive capacity) and labor force participation. The structure of the paper is as follows: Section 2 describes the discovery and the rediscovery of *hysteresis*. In Section 3, we present our macroeconomic model and in Section 4, our data, methods, identification strategy and results. The last section draws some conclusions.

2. The discovery of *hysteresis*

According to the conventional approach, aggregate demand only matters in the short run while the long run position, both in unemployment and in GDP, is exclusively determined by supply-side forces. This means that aggregate demand has no role in influencing potential GDP (or the NAIRU), given that demand shocks are supposed to be temporary[3] in nature (Cerra et al., 2023). The persistence of a high level of unemployment in Europe in the late '80s, associated with a stable inflation rate, challenged this approach and was the catalyst for the development of models of *hysteresis* (Blanchard and Summers, 1986, 1988; Ball, 1997). After the Great Recession (2008–2009), the concept was rediscovered to explain the reduction of potential GDP (Blanchard et al., 2015; Fatás and Summers, 2018). Hysteresis models deal with the effect of aggregate demand on equilibrium unemployment rate[4] or potential output and, therefore, the long-run effects of demand-side shocks, challenging the exogeneity of NAIRU (Ball and Onken, 2021). This strand of literature has discussed this effect almost exclusively in worsening macroeconomic conditions addressing the persistence of a lower income path (or a high unemployment rate). In this regard, a fall in actual GDP could cause a fall in the potential one and an increase in the actual unemployment rate may cause an increase in the NAIRU.

Although there was a period in which it was ignored or treated as a dubious phenomenon (Ball, 1997), *hysteresis* effects are now acknowledged as a common phenomena, and a large amount of evidence has emerged from empirical analysis (Martin et al., 2015; Cerra et al., 2023) and economic debate (Ball et al., 2017). However, despite the renewed attention, the

[3]In this view, these shocks can be persistent but not permanent. See footnote 2.
[4]See Stanley (2004) for a survey of *hysteresis* in unemployment.

majority of these studies only consider the effects of negative shocks or recessions. In a study covering several Asian countries, Cerra and Saxena (2005), find that the output level is permanently lower after the Asian crisis. In addition, they find that countries revert to the pre-crisis growth rate, but that the level of output remains permanently lower. These findings are supported by Cerra and Saxena (2008) for a sizable dataset of nations. They question whether supply-side policies and economic reforms could bring economies back to pre-crisis output trends. Blanchard (2005) argues that tightening monetary policy will have less of an impact on inflation if hysteresis is at work, by which the author means an increase in the NAIRU that is followed by an increase in the actual unemployment rate. In all advanced economies taken into account, Fatás and Summers (2018) show that fiscal consolidation has a long-term impact on GDP and potential output, and that none of these nations expect GDP to revert to its pre-crisis trajectory. By asserting that fiscal austerity efforts have a negative impact on both actual and potential GDP in the short and long terms, they support the idea of *hysteresis*.

This approach presents a curious asymmetry. If one were to admit that a negative demand shock – induced, for instance, by a restrictive fiscal or monetary policy – can have a persistent negative effect, once hysteresis is at work the inflationary risk of a subsequent expansionary policy would be higher. A clear example can be found in Reifschneider et al. (2015) where, while a recession may cause a persistent rise in unemployment, a fall in labor force participation and in capital accumulation, it is assumed that a subsequent expansion will not have the opposite effects because of increased risks of financial instability or inflation instability.

Most influential research refers to hysteresis only as a long-lasting negative effect of a negative demand shock (Blanchard, 2005; Haltmaier, 2012; Martin et al., 2015; Ball, 2015; Fatás and Summers, 2018; Galí, 2022; Jordà, Singh, and Taylor, 2020; among others). However, there is increased interest in examining the consequences of fiscal policy following a downturn, or what we refer to as hysteresis in *bad* times.

2.1. Hysteresis in bad times

Part of the literature argues that the level of output can revert to the normal pre-recession level after a positive shock to aggregate demand (Stockhammer and Sturn, 2012; Ball et al., 2017). Ball (2009), assuming some degree of reversibility of long-term unemployment, argues that demand expansion could lower the NAIRU without persistent effects on the inflation rate. Ball (2014) finds on a panel of 23 OECD countries that the financial crisis has produced long-term damage and negatively affected the potential output; he also claims that a strong expansion could push potential output back toward its pre-crisis path. Ball (2015) argues that a 'high-pressure economy', which refers to a tight labor market, may cause short-term inflation, but it can also have long-term employment benefits. According to Ball, a significant increase in employment could push the NAIRU down to its pre-recession level. DeLong and Summers (2012), while admitting the positive effect of a fiscal stimulus, limit the validity of this hypothesis to extraordinary recessions in which the zero lower bound constrains monetary policy. The same is true for Tervala and Watson (2022), who find that fiscal stimuli and, in particular, public investments have a positive effect, but only during downturns and only if fiscal policies are timely and temporary.

2.2. Hysteresis in good times?

In this influential literature, one of the exceptions that opens up the possibility of hysteresis in *good* times is Ball (1999).[5] Outside of the New-Keynesian framework, legitimate reasons and solid empirical evidence[6] can be found to support *hysteresis* even in prosperous times, i.e., the possibility that an increase in aggregate demand will have a positive long-lasting impact on GDP and employment without escalating or persistently rising inflation. The size of the capital stock becomes an endogenous variable that responds to the level of autonomous demand. In this view, firms adjust the size of their productive capacity to the level of demand in order to try to maintain a 'normal' degree of capacity utilization over time.[7] Because higher demand is met by increasing capacity utilization and productive capacity as well as employment and the labor force, [8] aggregate supply constraints are generally difficult to find on the capital or labor side. As pointed out in Fazzari (2020), aggregate supply, and so also labor supply, adjust to aggregate demand.[9]

[5] In a previous paper, Ball (1997) tentatively argued in favour of 'reverse' *hysteresis*: 'If tight monetary policy has raised the NAIRU, perhaps loose policy can reduce it'.

[6] It is easy to wonder what happens in the long run with fiscal multipliers. For several authors these are only short-run effects, for others they are not. We can find strong evidence of the persistent effect of demand expansion on income, for example in Blanchard et al. (2017), Giordano et al. (2007), Gechert (2015), Gechert et al. (2019) and Deleidi (2022).

[7] This *normal* degree of utilisation does not necessarily correspond to full employment of the workforce. On the contrary, *involuntary* unemployment is a common feature of capitalist economies also in case of *normal* utilization of capital stock.

[8] For example, by increasing minorities' participation, lowering discouragement, or through migration flows.

[9] As Fazzari (2020, p. 56) argue 'In a "high pressure" economy created by strong demand, low unemployment rates raise the growth rate of the labor force and increase the rate of labor productivity growth. Symmetrically, weak demand leads to high unemployment causing the supply side to stagnate.'

This framework led Girardi et al. (2020) to discover that episodes of significant increases in autonomous demand[10] are linked to a favorable and long-lasting impact on both GDP and capital stock. Additionally, the persistent effect is visible in the labor market, where the participation rate shows persistently higher levels across all specifications. Also, unemployment (and long-term unemployment) is temporarily reduced. Their findings demonstrate that the expansion of demand has no lasting impact on inflation. This is explained in light of a persistent rise in labor productivity and a rise in labor force participation, both of which temper the decline in the unemployment rate. Ball and Onken (2021) find strong evidence of *hysteresis*: a change in u (unemployment rate) causes u_n (NAIRU) to change in the same direction, and therefore has permanent effects. They also find that that decreases in u have larger long-run effects than increases in u. In terms of how an expansion affects inflation, Paternesi Meloni et al. (2022) show that significant drops in long-term unemployment do not result in an increased inflation rate. Recently, Cerra et al. (2023) open up the possibility that hysteresis in *good* times does exist but the authors do not present empirical evidence in this respect.

2.3. Three main explanations of hysteresis

The literature has addressed three main explanations of *hysteresis* effect: the detachment from the labor market of (increased) long-term unemployed workers, the role of labor market institutions in preventing the unemployed workers' reabsorption, and the impact of aggregate demand on capital formation.

The first explanation is the most widespread nowadays. Grounded on the role of long-term unemployment, it postulates that people looking for a job for many months lose employability, are detached from the labor market and so become bad inflation fighters. This means that when their share is considerable, the downward effect of unemployment on real wages is depressed. When a certain level of unemployed workers is no longer associated with a decrease in wage and price inflation rates, the NAIRU will increase (Krueger et al., 2014; Rusticelli, 2015; Blanchard, 2018). The literature invokes different reasons to support the idea that the long-term unemployed have less chance of being re-employed. Some scholars refer to the so-called *stigma effect* to explain the discrimination between applicants by the employers (Blanchard and Diamond, 1994; Kroft et al., 2016) who consider a longer unem-

[10] Girardi et al. (2020) define autonomous demand as the sum of government primary expenditure (government consumption, transfers – excluding interest payments – and capital formation) and exports. In particular, these authors take episodes where autonomous demand increases by more than one standard deviation from the historical average, for a set of 34 OECD countries between 1960 and 2015.

ployment spell as a signal of less desirable individual characteristics, causing a depreciation of human capital, and so they consider long-term unemployed workers *bad apples*. On the other hand, some scholars claim that a longer duration of unemployment is associated with a reduction in the job searching effort, especially when unemployment benefits are notably generous (Bean, 1994; Ljungqvist and Sargent, 1998; Bassanini and Duval, 2006; Krueger and Mueller, 2012). Some works cast doubt on this approach and follow different lines of inquiry. Concerning the *stigma effect*, it should be stronger in a tight labor market than in a slack one (Imbens and Lynch, 2006; Kroft et al., 2013) because employers' screening tends to be easier when the unemployment rate is low. Another aspect is that, to cause an increase in the NAIRU, also if detached from the labor market, the long-term unemployed should not quit the job search and must remain unemployed. On the contrary, if they leave the labor force, the estimated NAIRU will not increase. However, it is possible to appreciate that the inactivity rate responds symmetrically to a strong reduction in the long-term unemployment rate and the irreversibility of long-term unemployment tends to disappear when a correct measure of the phenomenon – e.g. proper lags – is considered. When total unemployment falls, long-term unemployment also falls (Webster, 2005; Paternesi Meloni et al., 2022). Furthermore, to support the presence of *hysteresis* and a higher NAIRU due to a higher long-term unemployment rate, accelerating inflation has to be found after a strong decrease in the long-term unemployment rate. But there is no evidence for the latter (Girardi et al, 2020; Paternesi Meloni et al., 2022). Finally, the thesis that long-term unemployed workers have a weak effect on wages, weaker than short-term ones, has been severely questioned (Speigner, 2014; Killey, 2015).

The first models of hysteresis refer to labor market institutions and wage bargaining systems – namely, insider-outsider models – as the cause of unemployment persistence (Blanchard and Summers, 1986; Lindbeck and Snower, 1984, 1986). Authors who support this view argue that after a negative demand shock, the increased bargaining power of insiders sets wages too high, hindering the reemployment of the outsiders. The persistence would result from the interaction between shocks and institutions that prevent the proper reduction in wages, thereby effecting an increase in unemployment. This approach has had a significant impact on academic research and policy recommendations (OECD, 1994; Bassanini and Duval, 2006; Miyamoto and Suphaphiphat, 2021), but it has not had much empirical support, and its early proponents were hesitant to accept it as a legitimate explanation for hysteresis e.g., Blanchard (2006). Several pieces of research have cast doubt on the role of labor market institutions since they find no link between labor market flexibility and improved employment outcomes (Baker et al., 2005; Howell et al., 2007; Stockhammer, 2011).

Another promising field of research attributes *hysteresis* to the detrimental effects of a protracted decline in aggregate demand on investment and capital accumulation. According to Rowthorn (1995, 1999), reducing unemployment in Europe would need significant capacity-creating investment since the last has the poorest unemployment performance relative to the USA in terms of slower capital accumulation. The influential work of Layard et al. (1991), which ascribes *hysteresis* to the traditional causes founded on labor market institutions or unemployment length, is at odds with this position, as Rowthorn himself notes. Debunking the perfect substitution between capital and labor, Rowthorn (1995) proves that capital scrapping during economic downturns would affect employment and raise the NAIRU. This author contends that when capital stock is decreased, capacity utilization rises and profit margins expand. The struggle over income distribution worsens as a result, and inflation grows unexpectedly. Hence, in order to contain inflation and make one of the two parties accept the associated loss of real income, increased unemployment is necessary. The NAIRU will thus rise as a result. Additionally, after observing a long-lasting impact of recessions on GDP trends in a panel of 40 countries, Haltmaier (2012) mentions the contraction of investment and the ensuing permanently lower level of capital stock as the reason for the decreased potential output and elevated equilibrium unemployment rate. Yet, as long as a model is based on the NAIRU concept, the inflationary risk of a subsequent demand expansion would result in greater accelerated inflation if the initial economic slump, via capital scrapping, produces an increase in the NAIRU (and in potential income).[11] This is not an inevitable consequence, according to certain recent investigations that are supported by compelling theoretical grounds.

2.4. Hysteresis: A Summing Up

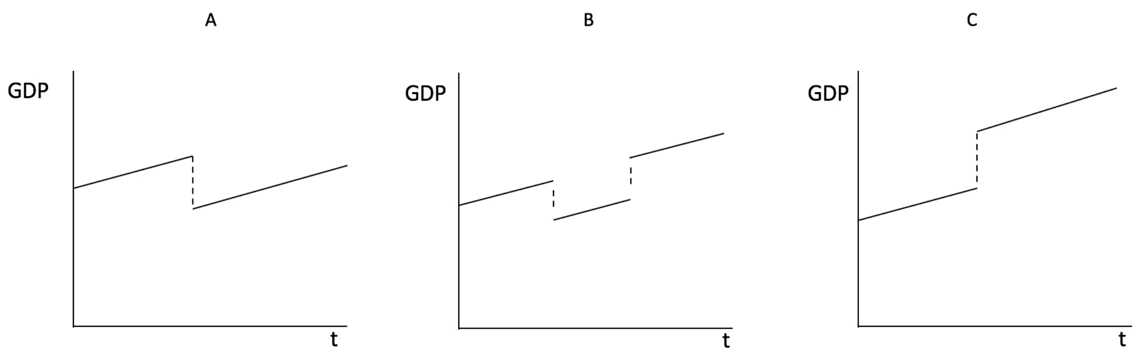
We can conclude that, in literature, *hysteresis* comes in three different forms.[12] The first type (Figure 1A) is the negative effect on potential output of a negative shock to aggregate demand, in other words, an endogenous downward potential output. The second type of *hysteresis* (Figure 1B) allows that, in the face of falls in aggregate demand, increases in aggregate demand – e.g. through higher government spending – can bring output and potential output back to their *natural* (pre negative shock) level. The third and final insight (Figure 1C) is that even during expansionary episodes or *good* times, increases in aggregate demand

[11] As pointed out by Haltmaier (2012, p. 1), 'The lower potential output, the smaller the output gap for a given level of actual output and the sooner inflationary pressures may appear.'

[12] In our taxonomy of *hysteresis* we focus exclusively on level effects.

have the potential to further boost output and potential output.

Fig. 1. Three types of *hysteresis*



Source: Own elaboration.

As we have already said, research has primarily concentrated on the long-lasting effects of recessions. In any event, some contributions, despite being speculative or tentative, raise the question that *hysteresis* during *bad* times may exist – e.g., Ball (2014) and Blanchard (2018). In arranging a summary of the positions taken by various contributions (Table 1), we have taken into account the mechanism that the author(s) emphasizes the most or that is the subject of the empirical study. As we move from left to right in Table 1, we see hysteresis' more pervasive effects. Thus, the articles in Column 2 take for granted the *hystheresis* type indicated in Column 1, and similarly the studies in Column 3 take into account both type of *hysteresis* indicated in Column 1 and Column 2. Since Column 3 presents fewer papers in the literature, in the next section we build a model that accounts for the possibility of *hysteresis* even in regimes of economic expansion or *good* times and then we present empirical evidence that matches our theoretical model.

Table 1: *Hysteresis*: A Summing Up

Hysteresis	**Hysteresis in Bad Times**	**Hysteresis in Good Times**
Blanchard and Summers (1986)	Ball (2009)	Ball (1999)
Blanchard and Summers (1988)	DeLong and Summers (2012)	Girardi et al. (2020)
Ball (1997)	Stockhammer and Sturn (2012)	Ball and Onken (2021)
Blanchard (2005)	Ball (2014)	Paternesi Meloni et al. (2022)
Cerra and Saxena (2005)	Ball (2015)	Cerra et al. (2023)
Cerra and Saxena (2008)	Ball et al. (2017)	
Haltmaier (2012)	Blanchard (2018)	
Blanchard et al. (2015)	Tervala and Watson (2022)	
Martin et al. (2015)		
Reifschneider et al. (2015)		
Fatás and Summers (2018)		
Jordà et al. (2020)		
Galí (2022)		

Source: Own elaboration.

3. A two sector demand-led model with hysteresis

In this section, we present our model based on the classical-Keynesian approach. With this aim, we develop a two-sector model which integrates a conflict augmented Phillips curve. In this framework, inflation is cost-push, driven by incompatible claims over income distribution. These claims depend on the unemployment rate and institutional factors which affect the bargaining power of workers. In particular, we consider a downward nominal wage rigidity according to which workers are more reluctant to accept a decrease in their nominal wages than a decrease in their real wages due to money illusion (Shapiro and Stiglitz, 1984; Fisher, 1989; Daly and Hobijn, 2014). Such a feature entails that the likelihood of having a decrease in nominal wages following a rise in unemployment is extremely low, while the level of unemployment rate generally affects the percentage increase in nominal wages that workers manage to obtain in each bargaining round (for a high level of unemployment this percentage can be zero). In this view, the cost-push inflation is the result of demand pressure which depresses unemployment and raises nominal wages.[13]

Through the model, we show that the rise in inflation following a *permanent* shock in the autonomous component is only a transient phenomenon. This is due to the endogeneity of the

[13]Even though inflation is the result of demand pressure, we consider wage inflation as an instance of cost-push inflation as wages are rising in a situation in which there is no sign of a real scarcity of labor.

labor participation rate to the employment level. To this extent, the labor participation rate represents the adjusting variable bringing unemployment back to its previous – pre-shock – level and extinguishing the inflationary process. A second important feature of the model is the explicit representation of the system of price equations within a production system where the capital good is produced by a different process than the consumption good. This allows us to give a sound basis to the formation of the historical cost of production which is at the root of the inertia that characterizes cost-push inflation.

In our model, firms fix prices by applying a markup over the historical normal cost of production.[14] Besides the labor costs, the normal cost of production depends on the value of the existing productive capacity which, in turn, is composed of several vintage capitals produced in different (past) periods (with different levels of monetary wages). This means that the cost of production in a given period depends only partially on current wages but to a greater extent on the historical cost incurred in purchasing capital goods (and that corresponds to the current value of total amortization). As a consequence, the historical cost causes inertia in the inflation rate as capital costs are partially independent of actual wage inflation: when wages rise, the normal cost of production does not rise proportionally, and the percentage of change is only due to the newly installed capital goods and direct labor costs. The same applies when wages stop rising. Given a permanent change in the level of nominal wages, the level of prices will fully adjust only after a certain lag, that is, when the roll-over on existing capital stock is exhausted and the installed capacity is only composed of capital goods produced at the new-persistent level of nominal wages. In this sense, inflation inertia will also persist also after the labor participation rate has adjusted and the unemployment rate is back to its pre-shock level. The following section presents the main features of the model and results of simulations that highlight these mechanisms.

3.1. Model setup

The baseline model (Serrano, 1995; Freitas and Serrano, 2015) is a demand-led growth model characterized by fully induced investments, an exogenous *normal* degree of capacity utilization and one (or more) autonomous component of demand. The last represents the exogenous injection of purchasing power into the system triggering the interaction between the multiplier and accelerator mechanism which determines the long-run pattern of GDP. In the long run, the growth rate of the economy converges to the growth rate of the autonomous

[14] The historical normal cost of production is the historical cost computed at the normal degree of capacity uitilization.

component of aggregate demand. The realized degree of capacity utilization converges to the *normal* one. In this framework, saving adjusts to investment through both variations in the degree of capacity utilization and the corresponding variations in productive capacity.

In our model, the productive system consists of a consumption good produced by means of labor and fixed capital and a capital good which is produced by means of labor and itself. Public expenditures and exports are the autonomous components of demand; these are expressed in terms of demand for the consumption good. The household sector is composed of N_w workers and N_Π capitalists.

3.1.1. Production

C-Firms fix current production ($y^d_{t,c}$) based on expected demand ($q^e_{t,c}$). In addition, firms consider inventories to address the discrepancies between expected and realized demand. The expectation function and the desired production are defined as follows:

$$q^e_{t,c} = q^e_{t-1,c} + \alpha(q^r_{t-1,c} - q^e_{t-1,c}) \tag{1}$$

$$y^d_{t,c} = max\{0, q^e_{t,c}(1 + \sigma^T) - inv_{t-1,c}\} \tag{2}$$

where σ^T is the desired inventory-to-sales ratio and $inv_{t-1,c}$ is the amount of inventory from the previous period. Labor demand depends on the planned production and the amount of direct labor (l_c):

$$L^d_{t,c} = y^d_{t,c} l_c \tag{3}$$

The production function is a Leontieff one and the feasible production is:

$$y_{t,c} = min\{y^d_{t,c} l_c; \frac{k_t}{v^*_t}\} \tag{4}$$

where v^*_t is the capital-output ratio at full utilization and k_t is the capital stock. C-Firms adjust productive capacity in order to satisfy expected demand at the *normal* degree of capacity utilization:

$$I_{t,c} = max\{0; q^e_{t+1,c}(1 + \sigma^T)v^n_{t,c} - k_{t+1,c}\} \tag{5}$$

where $q^e_{t+1,c}$ is the expected demand in the next period, $v^n_{t,c}$ is the normal capital-output ratio, and $k_{t+1,c}$ is the residual stock of capital if investments were not made. The capital stock in period t is composed of the residuals of capital goods installed in the previous $z+1$ periods (vintage capital goods), with z representing the useful life of the capital good:

$$k_t = \sum_{j=t-z+1}^{t} k_{j,c}^{ins}(\frac{j+z-t}{z}) \tag{6}$$

where $k_{j,c}^{ins}$ is the amount of capital installed in period j and corresponds to the gross investment carried out in $j-1$.

In each period, the capital sector produces the amount of capital goods ordered by C-Firms. K-Firms are a vertically integrated sector which use labor as the only external input. Labor demand is:

$$L_{t,k}^d = y_{t,k}^d l_k \tag{7}$$

where l_k is the value of direct labor in K-Firms and $y_{t,k}^d$ is the desired production.

3.1.2. Price setting

The price of goods is set according to costs of production, and a markup is applied over normal unitary costs. Production costs are determined according to the historical normal cost pricing (Andrews, 1949; Andrews and Brunner, 1975). The unit cost (which takes into account the different ages of the capital goods) is defined at the *normal* degree of capacity utilization and amortization is computed by adopting the full cost methodology.[15] Current amortization is computed over total productive capacity which, in turn, is composed of capital goods installed up to z previous periods. The unit cost of C-Firms depends on labor costs and amortization of the capital good:

$$p_{t,c} = [\bar{w}_t l_c(1+raz) + \frac{\Lambda_{t,c}^r}{\frac{1}{v^n}\sum_{j=t-z+1}^{t} K_j^{ins}(\frac{j+z-t}{z})}](1+\varphi_{t,c}) \tag{8}$$

where $\bar{w}_t$ is the nominal wage, $\varphi_{t,c}$ is the markup, l_c is the reciprocal of labor productivity, r is the interest rate at which the debt was contracted, $\Lambda_{t,c}^r$ is the amortization, a is the multiplicative factor to compute total debt service and the cumulative production over the useful life of the capital good, and z is the useful life of the capital good (which is equal to

[15]The interest rate is applied to all the inputs of production or all the anticipations independently from the actual leverage, that is, we adopt a full cost methodology to compute normal unit costs where the leverage is equal to one.

the payback time of loans).[16] The price of the capital good is:

$$p_{t,k} = \bar{w}_t l_k (1 + \varphi_{t,k}) \tag{9}$$

where l_k is the value of direct labor in K-Firms and $\varphi_{t,k}$ is the markup applied on unit costs of production.

3.1.3. Households

Consumption demand is a function of income:

$$C_t = c_1 YD_t \tag{10}$$

where YD_t is disposable income (net of taxation) and c_1 is the propensity to consume out of income. The labor force is a function of the employment level:

$$F = \beta F_{t-2} + (1 - \beta) F_{t-1} [1 + \alpha E_{t-1}] \tag{11}$$

where β is the parameter for the weighted average and α expresses the sensitivity of labor force to variation in the employment level. The rate of growth of nominal wages depends on the level of the unemployment rate:

$$\bar{w}_t = \bar{w}_{t-1} [1 + \varsigma (1 - U_{t-1})] \tag{12}$$

where ς is a parameter that represents the bargaining power of workers in correspondence with a given level of unemployment (U_{t-1}). The bargaining power of workers depends on labor market regulations.

3.1.4. Government

The real primary expenditure of the public sector is constant, while public debt service is endogenous:

$$G^c_t = G^c_{t-1} (1 + \pi) \tag{13}$$

$$G_t = G^c_t + r_t B_{t-1} \tag{14}$$

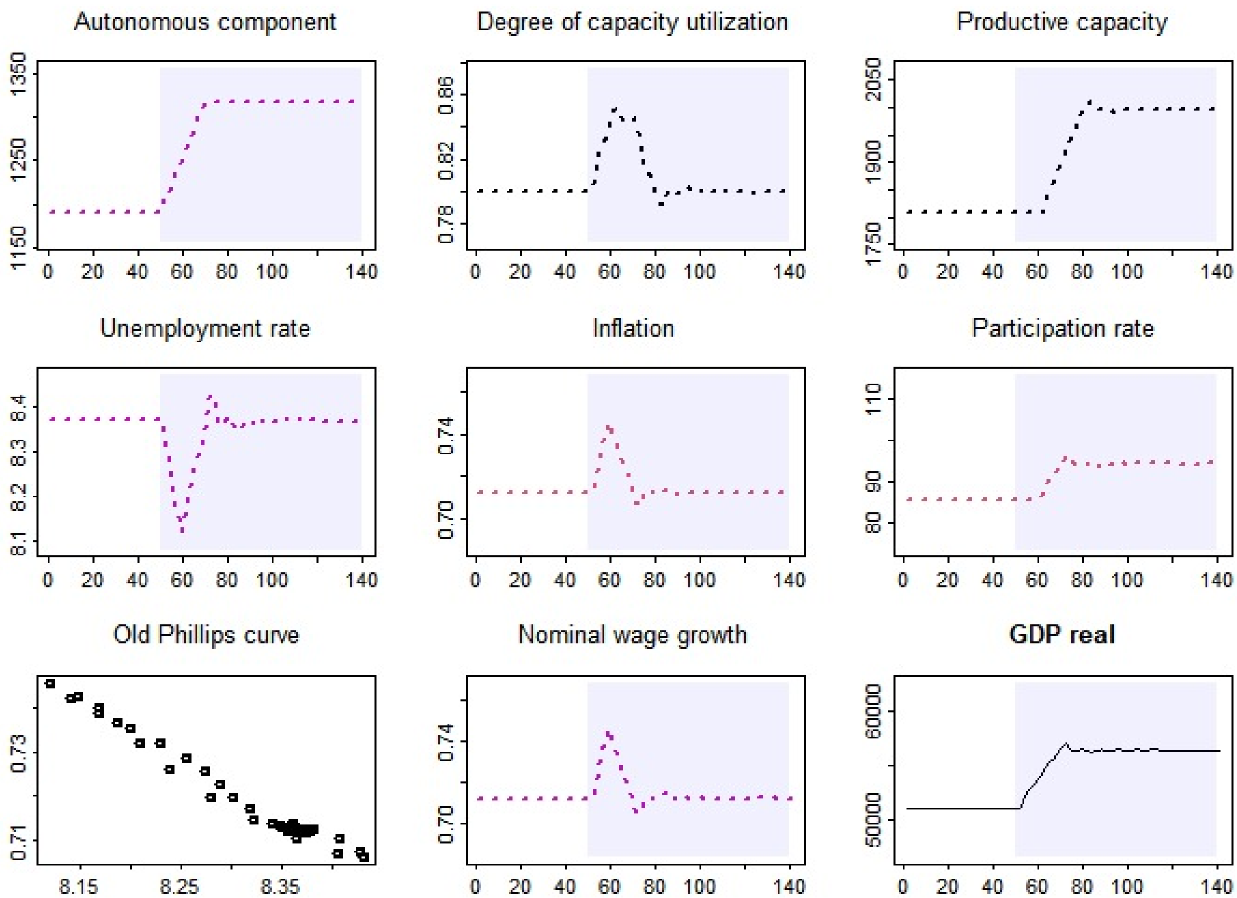
where G^c_t is the primary public expenditure (demand for consumption goods), π is the inflation rate, r_t is the interest rate on public bonds and B_{t-1} is the public debt.

[16] Appendix A explains the derivations in the computation of amortization and profits.

3.2. Simulations

This subsection analyzes the impact of a permanent shock to the level of government expenditures and exports ('Autonomous component') on capacity utilization, productive capacity, unemployment rate, inflation, participation rate, nominal wage growth and GDP, both in the short and in the long run. Figure 2 shows the results of the model simulation.

Fig. 2. The impact of a permanent shock to the 'Autonomous component' on macroeconomic variables



Source: Own elaboration based on simulations.

A permanent expansion of the level of autonomous components generates a permanent rise in the level of GDP and productive capacity. Initially, the increase in aggregate demand is accommodated by an adjustment in the degree of capacity utilization, while in the medium run the increase in investments raises productive capacity – the accelerator effect. Due to the presence of an autonomous component, aggregate demand does not react proportionally to the rise of investments and the degree of capacity utilization reverts to the *normal* one.

Because of the reduction in unemployment following the expansion in autonomous demand (and production), the growth rate of nominal wages rises in the short term. This generates cost-push transient inflation which tends to follow the increase in wage cost while the real wage remains constant. Indeed, firms rigidly translate the increase in nominal wages into a proportional increment in the level of prices, keeping the level of markups unaltered. As a consequence, the functional distribution of income remains unaffected. It is worth noticing that, since current costs are also dependent on the capital goods installed in past periods, actual prices still incorporate the old levels of nominal wages. As a result, inflation is characterized by a certain degree of inertia:[17] initially, the growth rate of inflation is lower than the growth rate of nominal wages.

As the participation rate starts responding to the expansion in labor demand and the level of activity approaches the new stationary level of employment, the unemployment rate slowly goes back to the pre-shock level. Simultaneously, the nominal wage growth slows down and the inflation rate returns to its pre-shock value. The stabilization of the inflation rate is lagged compared to the stabilization of the unemployment rate: when the nominal wage growth decreases, the inflation rate decreases at a slower pace due to the capital cost component. In conclusion, a permanent expansion of the level of aggregate demand generates a long-term increase in productive capacity and GDP, leaving the long-term level of inflation unmodified.

Our model presents the following results: an increase in the level of autonomous demand reduces unemployment and increases capacity utilization temporarily. On the other hand, in the long run, productive capacity and the labor force participation are the adjusting variables. In the next section, we check if these results are compatible with empirical evidence for the case of the United States since the ‘70s - about the time when the dollar standard was born.

[17] The degree of inertia rises as the useful life of the capital good increases or the number of periods required to produce the capital good rises.

4. Empirical evidence

4.1. Data

The econometric analysis carried out in this paper is based on quarterly data provided by the Federal Reserve Bank of St. Louis (`https://fred.stlouisfed.org`). In order to assess the effects of autonomous demand on unemployment, capacity utilization, inflation, capital (productive capacity), and labor rate participation, we run time series regressions for the US economy. We make use of the log of the Autonomous Demand variable (LAD – Government Consumption + Exports); in our view, changes in output-GDP levels are due mainly to aggregate demand shocks – autonomous components shocks (Autonomous Demand, LAD). All time-series are seasonally adjusted and their time span is 1970Q1–2021Q4 (see Table 1).[18] All considered variables are transformed in logarithmic form.

Table 2: Time series data

Autonomous Demand (LAD)	1970Q1-2021Q4
Alternative Autonomous Demand ($LADB$)	1970Q1–2021Q4
Capacity Utilization (LCU)	1970Q1–2021Q4
Consumer Price Index ($LCPI$)	1970Q1–2021Q4
Industrial capacity (LK)	1970Q1–2021Q4
Labor Force Participation Rate ($LLFPR$)	1970Q1–2021Q4
Unemployment Rate (LUR)	1970Q1–2021Q4

Source: own elaboration based on data provided. See Appendix C for details.

4.2. Methods and identification strategy

We use a structural VAR (SVAR) methodology to estimate our model with institutional data, following Blanchard and Perotti (2002). We estimate a reduced-form VAR(p) like the following one:

$$y_t = c + \sum_{i=1}^{p} A_i y_{t-p} + \epsilon_t \tag{15}$$

where y_t is the $kx1$ vector of considered variables – level of Autonomous Demand LAD, capacity utilization (LCU), unemployment rate (LUR), inflation ($D(LCPI)$), productive capacity (LK) and labor force participation ($LLPR$) – c is the constant term, A_i is the kxk matrix of reduced-form coefficients and ϵ_t is a $kx1$ vector composed by the error terms. The lag P of the VAR is calculated using the Akaike Information Criterion (AIC) (see Appendix

[18]We decided to start in 1970, when the dollar standard was already beginning to be imposed.

D). We impose an identification strategy that can be represented as follows in Equation (16):

$$B_0 y_t = c + \sum_{i=1}^{p} B_i y_{t-p} + \omega_t \tag{16}$$

where B_0 represents the matrix of contemporaneous relationships between the k variables in y_t, B_i is the kxk matrix of autoregressive slope coefficients, and ω_t is the vector of serially uncorrelated structural shocks (Kilian and Lütkepohl, 2017). Zero short-run restrictions are imposed on B_0.[19] Impulse response functions (IRFs) are calculated for a period of 20 quarters (5 years). Standard errors are estimated using the Monte Carlo methods (1000 repetitions) and IRFs are reported with a two-standard error bound, namely a 95% confidence interval.

In all considered models, a Cholesky factorization is assumed. Variables able to capture changes in demand levels (*LAD* or *LADB*) are ordered first. The variable chain to measure impulse responses in the 'capital' side is then pre-determined as follows:

$$LAD \rightarrow \text{LCU} \rightarrow \text{D(LCPI)} \rightarrow \text{LK}$$

So our autonomous demand variable is the most exogenous and productive capacity the most endogenous. In the case of the 'labor' side, the exogeneity chain is as follows:

$$LAD \rightarrow \text{LUR} \rightarrow \text{D(LCPI)} \rightarrow \text{LLFPR}$$

In other words, we are assuming that changes in the level of Autonomous Demand (*LAD*) affect capacity utilization, inflation and capital, within the quarter, while exogenous changes in capacity utilization, inflation and capital – whatever their origin – do not influence autonomous demand within the quarter. Autonomous Demand (*LAD*) is then be replaced by another alternative measure of autonomous demand (*LADB*) (Total Government Expenditures + Exports) for a robustness check.

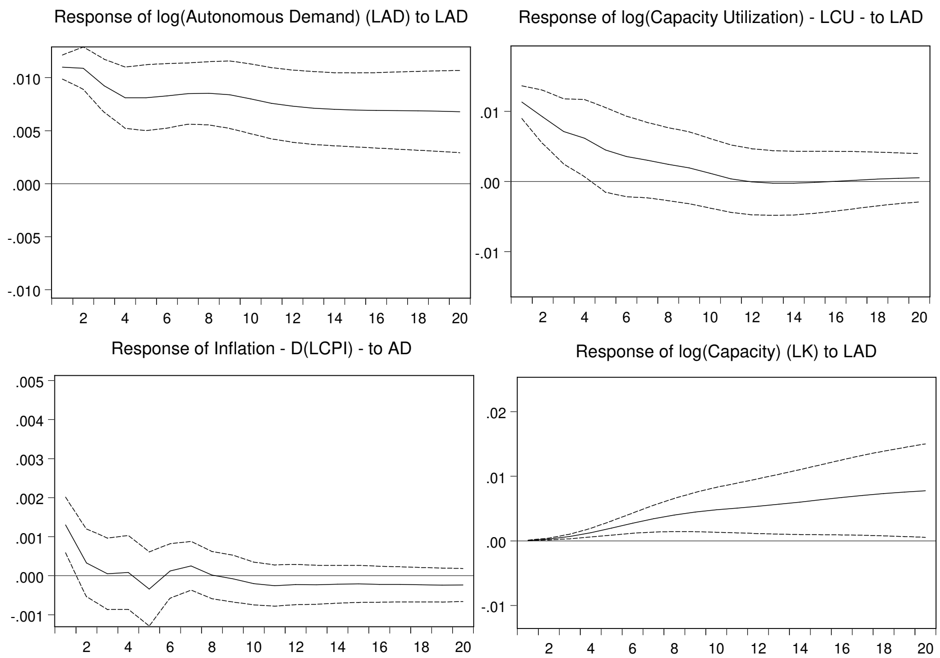
4.3. Results

In this section, we plot the IRFs relative to Autonomus Demand (*LAD*) in Figure 3 and Figure 4. As seen in Figure 3, the shock in the Autonomous Demand level (top left) is highly persistent as it remains significantly positive throughout the whole 20 quarters – in

[19] It should be noticed that we did not introduce linear trends into the equations and regressions performed. Following Nelson and Plosser (1982), there is no reason to introduce linear trends on output, given that it is not necessarily a trend-reverting process, but a unit-root process. The same reasoning might be applied to other variables. A very interesting discussion can be found in Cerra et al. (2023).

our view, this means that it is a permanent shock. The IRFs show that this permanent Autonomous Demand shock has a transitory impact on capacity utilization (LCU) and inflation ($D(CPI)$), which cease to be significant after 6 and 2 quarters, respectively. By contrast, the effect of a permanent Autonomous Demand shock on productive capacity (LK) is relatively more persistent and tends to stay persistently higher for the whole period; it is also permanent.

Fig. 3. Response to Structural VAR Innovations +/- 2 S.E.

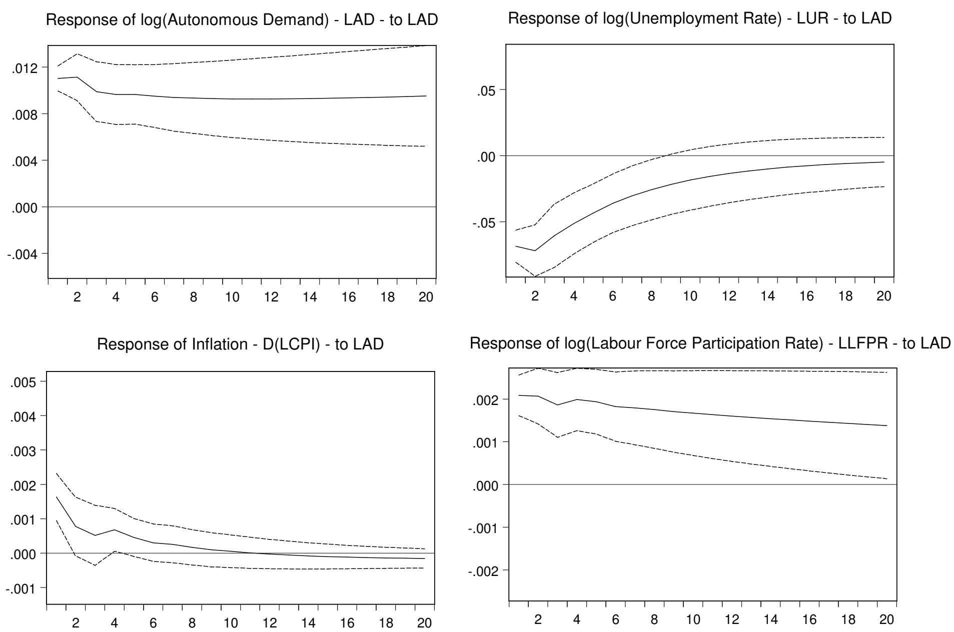


Source: Own elaboration based on data provided in Appendix C.

On the 'labor' side, very similar evidence is shown. According to the IRFs, the unemployment rate (LUR) and inflation rate are temporarily impacted by the autonomous demand (LAD) shock, as seen in Figure 4. In fact, consistently positive IRFs show a relatively larger persistence of the effect of autonomous demand shocks on the labor force participation rate ($LLFPR$), which we interpret to be the adjustment variable allowing the unemployment rate to return to its initial level. The unemployment rate (top right) does, in fact, exhibit a clear tendency to return to its initial value. We argue that this result may be interpreted in light of the rising labor force participation rate ($LLFPR$), which is considered to be positively associated and lagged to the level of employment. Given that the ratio of total unemployed to the labor force determines the unemployment rate, an increase in the population that is actively seeking employment might result in a higher unemployment rate. As shown in Fig.

4, the impact of an autonomous demand shock on labor force participation appears to persist over 20 quarters, longer than the impact of the same shock on the unemployment rate (9–11 quarters). On the other hand, the impact on inflation is relatively mild and transient, and it loses significance after six quarters. Similar results are obtained when Real Government Investment is added to the autonomous demand variable ($LADB$), which in our instance is represented by Total Government Expenditures (Consumption and Investment) + Exports for the same period. This evidence is shown in Appendix D.

Fig. 4. Response to Structural VAR Innovations +/- 2 S.E.



Source: Own elaboration based on data provided in Appendix C.

These results would not be very surprising if we follow the Keynesian principle of effective demand (Keynes, 1936). Entrepreneurs raise the level of capacity utilization, which lowers the unemployment rate, when the level of demand increases (in this instance, directly captured by autonomous demand LAD or $LADB$).[20] A positive price level effects would be expected in an environment where aggregate demand is rising. But in contrast to the more conventional viewpoint, the impact on inflation is only temporary. In the long run, entrepreneurs increase their productive capacity in response to demand shocks. With regard to the labor force, a similar process takes place. The system seems to be so adaptable that,

[20] Actually, they start by increasing the number of hours worked, and if the demand shock persists, they add more employees.

over time, labor supply and demand are balanced, and new labor is added as needed. We plan to look into the possibility that the last is a result of migration or technological factors in future research. Even so, the system is recognized for its resilience to a higher level of demand.

5. Final remarks

The possibility of *hysteresis* calls into question the traditional view that changes in the long-run growth are caused only by supply shocks. According to this traditional view, productive capacity (and potential output) is independent of demand shocks. The same occurs for the NAIRU that represents the corollary of potential output for the labor market. However, persistent high unemployment rates and the persistent damage of recessions in advanced economies have led to a rediscovery of *hysteresis* as a persistent negative effect of temporary downturns. Despite this, it has been largely overlooked that an increase in aggregate demand can have a long-lasting positive effect on GDP and the labor market outcomes.

In 1997, Laurence Ball suggested 'another idea for fighting unemployment: expansion of aggregate demand (. . .) A demand expansion would cause a cyclical fall in unemployment, but would this reverse the hysteresis process, with workers becoming reattached to the labor force? We do not know the answer, because countries have not tried demand expansions to reduce the NAIRU'.

However, few studies have addressed the possibility that an aggregate demand stimulus could reduce the unemployment rate and increase employment without accelerating inflation. In this paper, we seek to fill this gap in the literature in two ways. First, we develop a macroeconomic model that enables us to explain how positive demand shocks can have long-run effects on the economy. Second, we test the effects of demand shocks on the US economy from 1970Q1 to 2021Q4, analyzing the impacts of government consumption plus exports on unemployment, labor participation, the utilization of installed capacity and productive capacity using a SVAR methodology. We also test the impact of a demand shock defined as the sum of government consumption, government investment and exports.

To summarize our findings, we conclude that in the long run aggregate supply is flexible to aggregate demand. Indeed, we find that demand effects have a temporary impact on capacity utilization and unemployment, but they tend to have more persistent or even permanent effects on labor force participation and productive capacity. Notably, our study differs from the majority of influential literature, as we found no evidence of a permanent impact on inflation following an autonomous demand shock. The implications of our findings are particularly significant in the current context of sharp economic crises induced by the COVID-19 epidemic. Specifically, our results suggest that increasing aggregate demand can not only prevent negative damage to the economy but also have lasting positive effects on output, employment, and labor market participation, without resulting in persistently higher inflation rates.

6. References

Andrews, P. W. (1949). A Reconsideration of the Theory of the Individual Business. *Oxford Economic Papers, 1*(1), 54-89.

Andrews, P. W. S., & Brunner, E. (1975). Studies in pricing. Springer.

Baker, D., Glyn, A., Howell, D., Schmitt, J. (2005). Labour Market Institutions and Unemployment: Assessment of the Cross-Country Evidence. In Howell, D. (eds.) Fighting Unemployment. The Limits of Free Market Orthodoxy, Oxford University Press, Oxford.

Ball, L. (1997). Disinflation and the NAIRU. Reducing inflation: Motivation and strategy, 167-185.

Ball, L. M. (1999). Aggregate Demand and Long-Run Unemployment. Brookings Papers on Economic Activity, vol. 1999, no. 2, 189-251.

Ball, L. M. (2009). Hysteresis in unemployment: old and new evidence. National Bureau of Economic Research, No. w14818.

Ball, L. (2014). Long-term damage from the Great Recession in OECD countries. *European Journal of Economics and Economic Policies: Intervention, 11*(2), 149-160.

Ball, L. (2015), Monetary policy for a high-pressure economy, Policy Futures series of the Center on Budget and Policy Priorities, Washington D.C., March 30, `https://www.cbpp.org/research/full-employment/monetary-policy-for-a-high-pressure-economy`.

Ball, L., DeLong, J. B., & Summers, L. H. (2017). Fiscal Policy and Full Employment. Confronting Policy Challenges of the Great Recession: Lessons for Macroeconomic Policy. Kalamazoo, MI: WE Upjohn Institute for Employment Research, 85.

Ball, L. & Onken, J. (2021). Hysteresis in unemployment: evidence from OECD estimates of the natural rate. National Bureau of Economic Research, No. w29343.

Bassanini, A., Duval, R. (2006). Employment Patterns in OECD Countries: Reassessing the Role of Policies and Institutions. OECD Economics Department Working Papers No. 486. OECD Publishing (NJ1).

Bean, C. R. (1994). European unemployment: A survey. *Journal of Economic Literature, 32*(2), 573-619.

Blanchard, O. (2005). Monetary policy and unemployment. Monetary Policy and Unemployment: The US, Euro-Area, and Japan, 9-15.

Blanchard, O. J. (2006). European unemployment: the evolution of facts and ideas. *Economic Policy, 21*(45), 6-59.

Blanchard, O. J. (2018). Should we reject the natural rate hypothesis? Journal of Economic Perspectives, 32(1), 97-120.

Blanchard, O. J., Summers, L. H. (1986). Hysteresis and the European unemployment problem. National Bureau of Economic Research, Macroeconomics Annual, No. 1, 15-78.

Blanchard, O. J., Summers, L. H. (1988). Beyond the Natural Rate Hypothesis. The American Economic Review, 78(2), 182-187.

Blanchard, O. J., Diamond, P. (1994). Ranking, unemployment duration, and wages. *The Review of Economic Studies, 61*(3), 417-434.

Blanchard, O., & Perotti, R. (2002). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. *The Quarterly Journal of Economics, 117*(4), 1329-1368.

Blanchard, O. J., Cerutti, E., Summers, L. H. (2015). Inflation and activity–two explorations and their monetary policy implications. National Bureau of Economic Research, No. w21726.

Blanchard, O., Erceg, C. J., & Lindé, J. (2017). Jump-starting the euro-area recovery: Would a rise in core fiscal spending help the periphery?. NBER macroeconomics annual, 31(1), 103-182.

Cerra, V., and Saxena, S. (2005). Did Ouput Recovery from the Asian Crisis?. *IMF Staff Papers, Vol. 54* (1), pp. 1–23.

Cerra, V., & Saxena, S. C. (2008). Growth dynamics: the myth of economic recovery. *American Economic Review,* 98(1), 439-57.

Cerra, V., Fatás, A., & Saxena, S. C. (2023). Hysteresis and business cycles. *Journal of Economic Literature, 61*(1), 181-225.

Daly, M. C., & Hobijn, B. (2014). Downward nominal wage rigidities bend the Phillips curve. *Journal of Money, Credit and Banking, 46*(S2), 51-93.

DeLong, J. B. and L.H. Summers (2012). Fiscal policy in a depressed economy. Brookings Papers on Economic Activity, Spring 2012, 233-297.

Deleidi, M. (2022). Quantifying multipliers in Italy: does fiscal policy composition matter?. Oxford Economic Papers, 74(2), 359-381.

Fatás, A., & Summers, L. H. (2018). The permanent effects of fiscal consolidations. *Journal of International Economics*, 112, 238-250.

Fazzari, S. M. (2020). Was Keynesian economics ever dead? If so, has it been resurrected?. *Review of Keynesian Economics, 8*(1), 46-60.

Fisher, D. (1989). Money Demand and Monetary Policy. University of Michigan Press.

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

Galí, J. (2022). Insider–outsider labor markets, hysteresis, and monetary policy. *Journal of Money, Credit and Banking, 54*(S1), 53-88.

Gechert, S. (2015). What fiscal policy is most effective? A meta-regression analysis. *Oxford Economic Papers, 67*(3), 553-580.

Gechert, S., Horn, G., Paetz, C. (2019). Long-term Effects of Fiscal Stimulus and Austerity in Europe. *Oxford Bulletin of Economics and Statistics, 81*(3), 647-666.

Giordano, R., Momigliano, S., Neri, S., and Perotti, R. (2007) The effects of fiscal policy in Italy: Evidence from a VAR model, *European Journal of Political Economy, 23*, 707–33.

Girardi, D., Paternesi Meloni, W., Stirati, A. (2020). Reverse hysteresis? Persistent effects of autonomous demand expansions. *Cambridge Journal of Economics, 44*(4), 835-869.

Haltmaier, J. (2012). Do recessions affect potential output? International Finance Discussion Papers, No. 1066.

Howell, D. R., Baker, D., Glyn, A., Schmitt, J. (2007). Are protective labour market institutions at the root of unemployment? A critical review of the evidence. Capitalism and Society, 2, 1-73.

Imbens, G. W., Lynch, L. M. (2006). Re-employment probabilities over the business cycle. *Portuguese Economic Journal, 5*(2), 111-134.

Jordà, Ò., Singh, S. R., & Taylor, A. M. (2020). The long-run effects of monetary policy (No. w26666). National Bureau of Economic Research.

Keynes, J. M. (1936). The General Theory of Employment, Interest, and Money. Mac Millan. Houndsmills, UK.

Kiley, M. T. (2015). An evaluation of the inflationary pressure associated with short-and long-term unemployment. *Economics Letters, 137*, 5-9.

Kilian, L., & Lütkepohl, H. (2017). Structural vector autoregressive analysis. Cambridge University Press.

Kroft, K., Lange, F. & Notowidigdo, M. J. (2013). Duration dependence and labor market conditions: evidence from a field experiment. *Quarterly Journal of Economics, 128*(3), 1123-1167.

Kroft, K., Lange, F., Notowidigdo, M. J. & Katz, L. F. (2016). Long-term unemployment and the Great Recession: the role of composition, duration dependence, and nonparticipation. *Journal of Labor Economics, 34*(S1), S7-S54.

Krueger, A. B. & Mueller, A. I. (2012). Time use, emotional well-being, and unemployment: Evidence from longitudinal data. *American Economic Review, 102*(3), 594-99.

Krueger, A. B., Cramer, J. & Cho, D. (2014). Are the long-term unemployed on the margins of the labor market? Brookings Papers on Economic Activity, 2014(1), 229-299.

Layard, R., Nickell, S. J. & Jackman, R. (1991). Unemployment: macroeconomic performance and the labour market. Oxford University Press on Demand.

Lindbeck, A., & Snower, D. J. (1984). Involuntary Employment as an Insider-Outsider Dilemma. Seminar Paper n.309, Institute for International Economic Studies, University of Stockholm, Sweden.

Lindbeck, A. & Snower, D. J. (1986). Wage setting, unemployment, and insider-outsider relations. The *American Economic Review, 76*(2), 235-239.

Ljungqvist, L., Sargent, T. J. (1998). The European unemployment dilemma. *Journal of Political Economy, 106*(3), 514-550.

Martin, R., Munyan, T., Wilson, B. A. (2015). Potential output and recessions: are we fooling ourselves? FRB International Finance Discussion Paper, 1145.

Miyamoto, H., & Suphaphiphat, N. (2021). Mitigating Long-term Unemployment in Europe. IZA Journal of Labor Policy, 11(1).

Nelson, C. R., & Plosser, C. R. (1982). Trends and random walks in macroeconmic time series: some evidence and implications. *Journal of Monetary Economics, 10*(2), 139-162.

OECD (1994). The OECD Jobs Study, Evidence and Explanations. OECD, Paris.

Paternesi Meloni, W., Romaniello, D., & Stirati, A. (2022). Inflation and the NAIRU: assessing the role of long-term unemployment as a cause of hysteresis. *Economic Modelling, 113*, 105900.

Reifschneider, D., Wascher, W., & Wilcox, D. (2015). Aggregate supply in the United States: recent developments and implications for the conduct of monetary policy. *IMF Economic Review, 63*(1), 71-109.

Rowthorn, R. (1995). Capital formation and unemployment. *Oxford Review of Economic Policy, 11*(1), 26-39.

Rowthorn, R. (1999). Unemployment, wage bargaining and capital-labour substitution. *Cambridge Journal of Economics, 23*(4), 413-425.

Røed, K. (1997). Hysteresis in unemployment. *Journal of Economic Surveys, 11*(4), 389-418.

Rusticelli, E. (2015). Rescuing the Phillips curve: Making use of long-term unemployment in the measurement of the NAIRU. OECD Journal: Economic Studies, 2014(1), 109-127.

Serrano, F. (1995). Long period effective demand and the Sraffian Supermultiplier. Contributions to Political Economy, 14, 67-90. 24

Shapiro, C., & Stiglitz, J. E. (1984). Equilibrium unemployment as a worker discipline device. The American Economic Review, 74(3), 433-444.

Speigner, B. (2014). Long-term unemployment and convexity in the Phillips curve. Bank of England Working Paper No. 519.

Stanley, T. D. (2004). Does unemployment hysteresis falsify the natural rate hypothesis? A meta-regression analysis. *Journal of Economic Surveys, 18*(4), 589-612.

Stockhammer, E. (2011). Wage norms, capital accumulation, and unemployment: a post-Keynesian view. *Oxford Review of Economic Policy, 27*(2), 295-311.

Stockhammer, E., & Sturn, S. (2012). The impact of monetary policy on unemployment hysteresis. *Applied Economics, 44*(21), 2743-2756.

Tervala, J., & Watson, T. (2022). Hysteresis and fiscal stimulus in a recession. *Journal of International Money and Finance, 124*, 102614.

Webster, D. (2005). Long-term unemployment, the invention of 'hysteresis' and the mis-diagnosis of structural unemployment in the UK. *Cambridge Journal of Economics, 29*(6), 975-995.

Appendix A. Amortization of capital stock

We assume a constant absolute deterioration of capital. The amortization ($\Lambda^r_{t,c}$) for computing unit cost includes both the cost of capital and the cost of debt service adopting the full leverage methodology. The amortization for computing profits considers the realized leverageand is defined as follows:

$$\Lambda^r_{t,c} = \frac{1}{az} \sum_{j=t-z+1}^{t} p_{i,indexK} K^{ins}_{j,i} (1 + r_j b l_j)(j + z - t) \tag{17}$$

where r_j and l_j represent, respectively, the interest rate in the period in which the debt was contracted and the leverage realized in purchasing the capital good. $K^{ins}_{j,i}$ is the installed capital in period j from firm i and $p_{i,indexK}$ is its price. $a = \sum_{i=1}^{z} \frac{i}{z}$ and $b = \frac{1}{az} \sum_{i=1}^{z} \frac{i^2+1}{2}$ are the multiplying factors for the calculation, respectively, of normal-cumulated production over the useful life of the capital good and the interest rate accrued on a loan granted in a given period. The amortization to compute unit cost uses the full cost methodology, namely $l_j = 1$. The profits of C-Firms are:

$$Profits_{t,c} = (C_t + G_t + X_t) p_{t,c} + \bar{w} L_{t,c} - \Lambda^r_{t,c} \tag{18}$$

where C_t is the total demand of households, G_t is the real public spending and X_t is exports, $p_{t,c}$ is the price of the consumption good, $\bar{w}$ is the nominal wage, $L_{t,c}$ is employment in C-Firms and $\Lambda^r_{t,c}$ is the amortization with effective leverage. On the other hand, the profits of K-Firms are:

$$Profits_{t,k} = I_t p_{t,k} - \bar{w}_t L_{t,k} \tag{19}$$

where I_t is the production of the capital good, $p_{t,k}$ is the price of the capital good and $L_{t,k}$ is the employment in K-Firms.

Appendix B. Details on data sources

- Autonomous Demand (LAD). Government Consumption plus Exports. Variable in logarithms. Real Government Consumption Expenditures, U.S. Bureau of Economic Analysis, Real Government Consumption Expenditures [A955RX1Q020SBEA], retrieved from FRED, Federal Reserve Bank St. Louis; `https://fred.stlouisfed.org/series/A955RX1Q020SBEA`, October 31, 2022. Plus Exports. U.S. Bureau of Economic Analysis, Real Exports of Goods and Services [EXPGSC1], retrieved from FRED, Federal Reserve Bank of St. Louis; `https://fred.stlouisfed.org/series/EXPGSC1`, October 31, 2022.

- Alternative Autonomous Demand ($LADB$). Real Government Consumption and Gross Investment plus Exports. Variable in logarithms. Real Government Consumption Expenditures and Gross Investment, U.S. Bureau of Economic Analysis, Real Government Consumption Expenditures and Gross Investment [GCEC1], retrieved from FRED, Federal Reserve Bank St. Louis; `https://fred.stlouisfed.org/series/GCEC1`, October 31, 2022. Plus Exports. U.S. Bureau of Economic Analysis, Real Exports of Goods and Services [EXPGSC1], retrieved from FRED, Federal Reserve Bank of St. Louis; `https://fred.stlouisfed.org/series/EXPGSC1`, October 31, 2022.

- Capacity utilization (LCU). Board of Governors of the Federal Reserve System (US), Capacity Utilization: Manufacturing (SIC) [CUMFNS], retrieved from FRED, Federal Reserve Bank of St. Louis; `https://fred.stlouisfed.org/series/CUMFNS`, October 31, 2022.Variable in logarithms.

- Consumer Price Index ($LCPI$). U.S. Bureau of Labor Statistics, Consumer Price Index for All Urban Consumers: All Items in U.S. City Average [CPIAUCSL], retrieved from FRED, Federal Reserve Bank of St. Louis; `https://fred.stlouisfed.org/series/CPIAUCSL`, October 31, 2022.

- Industrial capacity (LK). Board of Governors of the Federal Reserve System (US), Industrial Capacity: Manufacturing (SIC) [CAPB00004SQ], retrieved from FRED, Federal Reserve Bank of St. Louis; `https://fred.stlouisfed.org/series/CAPB00004SQ`, October 31, 2022. Variable in logarithms.

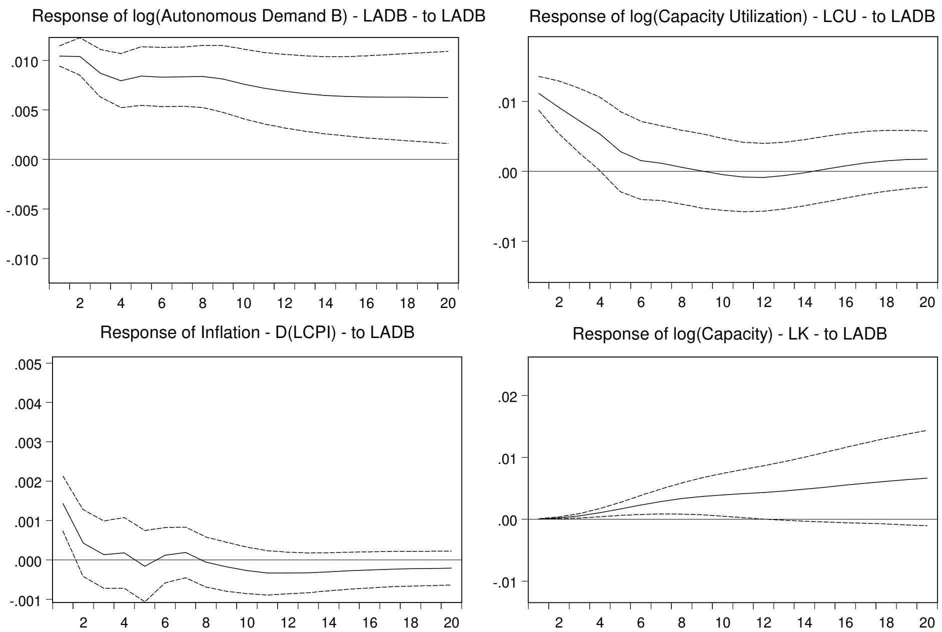
- Labor Force Participation Rate ($LLFPR$). U.S. Bureau of Labor Statistics, Labor Force Participation Rate [CIVPART], retrieved from FRED, Federal Reserve Bank of St. Louis; `https://fred.stlouisfed.org/series/CIVPART`, October 31, 2022.

- Unemployment Rate (LUR). U.S. Bureau of Labor Statistics, Unemployment Rate [UNRATE], retrieved from FRED, Federal Reserve Bank of St. Louis; `https://fred.stlouisfed.org/series/UNRATE`, October 31, 2022. Variable in logarithms.

Appendix C. Alternative Autonomous Demand

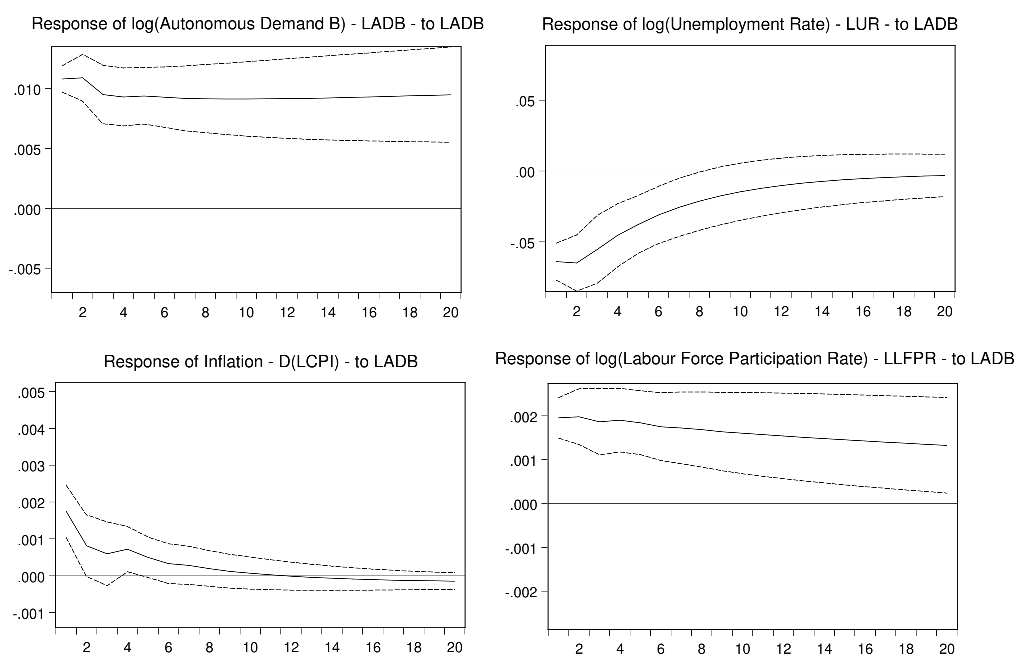
In this case, we also include government investment in the variable for autonomous demand. When we look at the 'capital side' of our model (Figure 5), the shock in Alternative Autonomous Demand (Autonomous Demand B - $LADB$) (top left) is substantially positive and persistent during the whole time, as the IRFs (see Figure 5) show. Similar to the main findings, the autonomous demand's effects on capacity utilization (LCU) and inflation rate ($D(CPI)$), whose IRFs become insignificant after 5 and 3 quarters, respectively, are transitory. On the other hand, it appears that the influence on productive capacity is positive and more persistent, lasting for, at least, 12 quarters.

Fig. 5. Response to Structural VAR Innovations +/- 2 S.E.



Source: Own elaboration based on data provided in Appendix C.

Fig. 6. Response to Structural VAR Innovations +/- 2 S.E.



Source: Own elaboration based on data provided in Appendix C.

When the model on the 'labor side' is implemented, these findings are confirmed. The IRFs for *LADB* (see Figure 6) illustrate that the positive shocks last the entire timespan. After 5 quarters, the effect on inflation seems to have completely disappeared. After 9 quarters, the effect on the unemployment rate typically fades away, but even in this instance, its persistence is comparatively shorter than the labor participation rate, which remains higher throughout the entire period.

Appendix D. Model Selection Criteria

Table 3: Lag selection for Model 1: Autonomous Demand Capital Side

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1168.336	NA	1.16e-10	-11.52808	-11.46257	-11.50157
1	2810.438	3202.912	1.18e-17	-27.62810	-27.30055	-27.49557
2	3097.492	548.5286	8.05e-19	-30.31180	-29.72221	-30.07325
3	3247.019	279.8085	2.15e-19	-31.63385	-30.78222	-31.28928
4	3395.822	272.5602	5.77e-20	-32.94873	-31.83506*	-32.49814*
5	3420.811	44.78244*	5.29e-20*	-33.03774*	-31.66202	-32.48112

Note: *=optimal lag.

Source: own computations based on available data.

Table 4: Lag selection for Model 2: Autonomous Demand Labor Side

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1050.136	NA	3.73e-10	-10.35779	-10.29228	-10.33128
1	2562.844	2950.529	1.37e-16	-25.17667	-24.84912*	-25.04414*
2	2582.493	37.54743	1.32e-16	-25.21280	-24.62321	-24.97425
3	2602.681	37.77649*	1.27e-16*	-25.25426*	-24.40263	-24.90969
4	2615.016	22.59501	1.31e-16	-25.21798	-24.10431	-24.76739
5	2620.125	9.155389	1.47e-16	-25.11015	-23.73443	-24.55353

Note: *=optimal lag.

Source: own computations based on available data.

Table 5: Lag selection for Model 3: Alternative Autonomous Demand Capital Side

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1180.348	NA	1.03e-10	-11.64701	-11.58150	-11.62051
1	2817.142	3192.558	1.10e-17	-27.69447	-27.36692	-27.56195
2	3100.317	541.1177	7.83e-19	-30.33978	-29.75018	-30.10123
3	3249.828	279.7773	2.09e-19	-31.66166	-30.81003	-31.31709
4	3403.244	281.0098	5.36e-20	-33.02222	-31.90855*	-32.57163*
5	3427.457	43.39146*	4.95e-20*	-33.10354*	-31.72782	-32.54692

Note: *=optimal lag.

Source: own computations based on available data.

Table 6: Lag selection for Model 4: Alternative Autonomous Demand Labor Side

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1053.739	NA	3.60e-10	-10.39346	-10.32795	-10.36695
1	2556.638	2931.397	1.45e-16	-25.11523	-24.78768*	-24.98270*
2	2576.259	37.49364	1.40e-16	-25.15108	-24.56149	-24.91253
3	2597.105	39.00946*	1.34e-16*	-25.19906*	-24.34743	-24.85449
4	2609.460	22.62939	1.39e-16	-25.16297	-24.04929	-24.71237
5	2612.821	6.023743	1.58e-16	-25.03783	-23.66212	-24.48122

Note: *=optimal lag.

Source: own computations based on available data.