Ekonomi, Politika & Finans Araştırmaları Dergisi, 2025, 10(1): 1-26
Journal of Research in Economics, Politics & Finance, 2025, 10(1): 1-26
Araştırma Makalesi / Research Article, https://doi.org/10.30784/epfad.1576481

THE DYNAMICS OF OUTPUT GAP HYSTERESIS IN TÜRKİYE

Türkiye'de Çıktı Açığı Histerezisinin Dinamikleri

Koray YILDIRIM[*], Neşe ALGAN[**] & Harun BAL[***]

Keywords:
Output Gap, Hysteresis, Structural Break, Structural VAR

JEL Codes:
E22, E32, E61

Abstract

The aim of this study is to identify the dynamics and hysteresis of the output gap. First, the existence of an output gap in the Turkish economy for the period 2005Q4:2021Q3 is determined using the Hodrick-Prescott and Baxter-King methods, and then the structural break procedure, which is widely used in the literature, is applied to detect hysteresis. The presence of a structural break supports the existence of hysteresis in the output gap. In addition, a structural VAR model is estimated with money supply, capacity utilization rate, and capital productivity variables as components of the output gap. While the empirical evidence points to the role of capacity utilization and productivity variables in explaining hysteresis, capacity utilization shocks are relatively stronger determinants of output gap hysteresis. For future studies, the effect of money supply on capacity utilization and productivity, labor productivity, etc., should be monitored. The novelty of the study is the modeling of hysteresis in a structure that includes demand-side and supply-side components. This innovation allows it to act as a guide for policymaking by taking into account the dynamic conditions appropriate to the nature of hysteresis beyond the static situation, such as the detection of hysteresis in the literature.

Anahtar Kelimeler:
Çıktı Açığı, Histerezis, Yapısal Kırılma, Yapısal VAR

JEL Kodları:
E22, E32, E61

Öz

Bu çalışmanın amacı çıktı açığı histerezis ve dinamiklerinin tespit edilmesidir. İlk olarak Türkiye ekonomisinde çıktı açığının varlığı 2005Q4:2021Q3 dönemi için Hodrick-Prescott ve Baxter-King yöntemleri ile tespit edildikten sonra histerezisin tespiti için literatürde yaygın bir şekilde kullanılan yapısal kırılma prosedürü uygulanmıştır. Yapısal kırılmanın varlığı çıktı açığında histerezisin varlığını desteklemektedir. Ayrıca çıktı açığı bileşenleri olarak para arzı, kapasite kullanım oranı ve sermaye verimliliği değişkenleri ile Yapısal VAR modeli tahmin edilmiştir. Ampirik bulgular histerezisi açıklamada kapasite kullanım oranı ve verimlilik değişkenlerini işaret ederken nispi olarak kapasite kullanım oranı şokları çıktı açığı histerezisinde daha güçlü bir belirleyicidir. Gelecek çalışmalar için para arzının kapasite kullanım oranı ve verimlilik üzerindeki etkisi, işgücü verimliliği izlenmesi gereken noktalar arasındadır. Çalışmanın yeniliği histerezisin talep yanlı ve arz yanlı bileşenlerini içerecek yapıda modellemesidir. Bu yenilik literatürde histerezisin tespiti gibi statik durumun ötesinde histerezisin doğasına uygun dinamik koşulları dikkate alarak politika yapımında rehber görevi üstlenmesine imkan sağlamaktadır.

[*] PhD Cukurova University, FEAS, Department of Economics, Türkiye, korayyildirim80@gmail.com
[**] Prof. Dr. Cukurova University, FEAS, Department of Economics, Türkiye, nalgan@cu.edu.tr
[***] Prof. Dr. Cukurova University, FEAS, Department of Economics, Türkiye, harunbal@cu.edu.tr

Received Date (Makale Geliş Tarihi): 30.10.2024 *Accepted Date (Makale Kabul Tarihi): 02.03.2025*

1. Introduction

The inability of economies to reach their potential growth level has been one of the main structural problems of economic stability since the 1929 crisis. After the permanent structural changes in economies, the business cycle fluctuations settle on a different path, and the economy moves away from its potential and cannot return to its previous level, which is hysteresis behavior. In this process, if the output gap becomes permanent, it may exhibit hysteresis-type behavior. The inefficiency of economic policy, which cannot provide a permanent solution to hysteresis in the output gap, also leads to discussions on the structure of business cycle fluctuations.

The basic explanation of real business cycle theory is that technological shocks are the main dynamic that exogenously drives business cycle fluctuations (Hansen and Wright, 1998). However, empirical studies suggest that the persistent (hysteresis) effects in business cycle fluctuations in the current period are due to shocks in the past period. In the empirical literature, an important criterion for hysteresis is the structure of resistance to the variables that influence business cycle fluctuations. The fundamentals of hysteresis behavior in business cycle fluctuations are based on adjustment time differences in the dynamics that determine output. In terms of the structural state of output, Campbell and Mankiw (1987) argue that the slow movement of output towards the steady state characterizes business cycle fluctuations. In terms of the determinants of output, Lucas (1973) argues that while aggregate demand shocks are temporary in nature, the persistence of structural shocks to real variables is determined by hysteresis. Yellen (2015) argues that the failure of productivity to recover, as a common consequence of structural recessions, becomes a component of the permanent effects on output. The results of studies in the empirical literature are also instructive for understanding the nature of permanent output effects (hysteresis). Kienzler and Schmid (2014) show that hysteresis in real output generally moves in the same direction as the business cycle fluctuations of aggregate demand shocks but exhibits a more persistent structure in supply-side dynamics. Garga and Singh (2021) argue that monetary policy inefficiency, a permanent slowdown in aggregate demand, structural deterioration in employment, and permanent effects on total factor productivity are the factors that deepen the hysteresis as dynamics that prevent output from returning to its previous path after deviating from its path.

The debate on output gap hysteresis focuses on policies that fail to address the output gap. Orphanides et al. (2000), who assessed hysteresis in terms of policy design and effectiveness, pointed out that policies implemented to resolve hysteresis may deepen it. Economic policies implemented by neglecting hysteresis may cause strong hysteresis by becoming the main dynamic of hysteresis, contrary to ensuring economic stability. Mishkin (2017) emphasized that the effectiveness of monetary policy after the crisis should be evaluated through the interaction between the financial system and the real economy. He argues that the policy response function also changes following the structural change in the economy and attributes the failure of the Taylor rule, which is not adapted to dynamic conditions, to this structure. Since it represents structural change, adapting monetary policy to new conditions in the presence of hysteresis will prevent the deepening of hysteresis by increasing the effectiveness of monetary policy. Indeed, the fact that monetary policy becomes ineffective is important evidence of the existence of a hysteresis structure. As a result, it is concluded that the detection of hysteresis effects in the output gap requires an understanding of the nature of the relationship or decoupling (Classical Dichotomy) between nominal (financial) and real (GDP) variables.

The aim of this study is to identify the existence and dynamics of output gap hysteresis and to provide guidance to policymakers. The functioning mechanism of hysteresis is evaluated through the effectiveness of monetary policy on real output and is realized as the economy moves away from its potential through capital stock, employment structure (unemployment hysteresis), and total factor productivity. It is a prominent form of hysteresis behavior in which hysteresis is monetary-based, as shocks in output follow monetary shocks, but real output does not return to its previous path with monetary policy. This structure makes monetary changes a measurement variable in terms of both the dynamics of hysteresis and the inability to resolve hysteresis. Taking into account the behavioral form of the output gap hysteresis and the structure of the Turkish economy, the motivation of the study is directed to constructing the empirical strategy based on these dynamics. In this context, after identifying the hysteresis in the output gap, the effects of money supply, capacity utilization rate, and productivity variables as output gap components on output are taken into account. The lack of such a study in the empirical literature for the Turkish economy indicates that this study will fill an important gap in the literature.

The dynamics of output and output gap hysteresis in the Turkish economy are closely related to the dynamics of important chronic problems. These relations are primarily theoretical in nature. Aydin and Esen (2017) have argued that the policies implemented to achieve full employment cause inflation. From this perspective, the inability of the economy to reach the potential output level due to structural obstacles has revealed the importance of the output gap hysteresis. At the same time, it is noteworthy that the discussions on the middle-income trap in the Turkish economy have links with the output gap. Kargi (2024) argues that the relations between financial processes and output dynamics with globalization have led to the middle-income trap situation in developing countries. As a solution to the middle-income trap of the Turkish economy, technological development and optimization of strategic capital allocation are important dynamics of potential growth. Considering these relationships, providing a comprehensive insight into the output gap hysteresis will be an important guide in policymaking in order for output to reach its potential in the Turkish economy. At the same time, the Turkish economy has been preferred in the model in order to provide important information on chronic inflation and debates on output gap hysteresis findings.

In the case of hysteresis in the output gap, the role of policy is extremely important. This is because the nature of hysteresis is such that policy errors can make policy the source of the problem rather than the solution to hysteresis. First, output gap models increase the margin of error for policymakers in quantitative terms, as they are models for estimating approximate potential (Durand and Fornero, 2024). On the other hand, it contains estimation errors for the determination of which dynamic (supply or demand) causes the output gap and the degree of impact on the output gap. Fatás and Singh (2024) show that in policies implemented for the output gap hysteresis, policies implemented with a lag become a dynamic of hysteresis beyond the dynamics from which the hysteresis originates. In addition, if output is in the form of hysteresis, monetary policy time inconsistencies can transform hysteresis into strong hysteresis.

Traditional structural break tests are widely preferred in the empirical literature to detect hysteresis effects in the output gap. However, the dynamic nature of business cycles makes it very difficult to determine whether these movements are cyclical or due to structural change. In line with this complex structure, holistic empirical strategies that take into account more economic dynamics for hysteresis will produce more effective results. For this reason, in order

to detect the structural change in output, the structural break test was used to find evidence in favor of hysteresis, following a certain tradition. After the identification of hysteresis, it is crucial to analyze the relationship between output and monetary changes, productivity, and capacity utilization rate in order to better understand its nature. Output gap hysteresis is analyzed using the structural VAR method, which is effective in detecting long-run structural changes. The clarification of the weight degrees of the components that are effective in the structural VAR output gap hysteresis will also enable the design of an effective policy mix. In addition to the fact that monetary shocks are theoretically important in determining output, the inability of monetary changes to bring output back to its previous path is also a form of hysteresis behavior. For the supply side, capacity utilization rate and productivity stand out as the dynamics driving hysteresis. Beyond proving hysteresis in the output gap, the findings shed light on many debates, such as the effectiveness/ineffectiveness of monetary policy, the weight of supply and demand dynamics, and the income distribution effects of hysteresis.

The structure of the rest of the study will be as follows: theoretical framework in the second section, literature review in the third section, empirical methodology in the fourth section, empirical findings in the fifth section, and conclusion in the sixth section.

2. Theoretical Framework

The theoretical foundations of hysteresis in economic systems date back a long way, and the empirical literature has an important place in equilibrium debates. Cross (1993) Although not mentioned by name in Alfred Marshall's Principles of Economics, hysteresis is defined as a situation in which a certain movement in production and pricing behavior does not return to its previous level. In the following period, as equilibrium discussions increased, James Tobin stated that hysteresis is nothing different from unemployment that becomes natural unemployment in the long run. Benati and Lubik (2021) argue that the debate on the existence of hysteresis in output and its components is the extent and impact of hysteresis. Indeed, the structural and specific conditions of each economy are unique. Therefore, the effectiveness of hysteresis analyses will increase with comprehensive alternative models. Based on this information, in order to obtain comprehensive and effective findings on the output gap hysteresis in the Turkish economy, the specific conditions of the economy should be taken into account in addition to the theoretical foundations.

Although hysteresis is expressed as the permanent effects of temporary shocks, its forms in economic systems vary in terms of specific conditions. Michl and Oliver (2019) show that there are behavioral forms in which the output gap, defined as the difference between real output and potential output, becomes permanent. In terms of business cycle fluctuations, business cycle fluctuations, which are expressed in many dimensions such as real income, employment, and output, move in a certain systematic (mostly cyclical) way. However, these basic components may exhibit not only a symmetric structure but also an asymmetric structure. The asymmetric structure is based on components that reach equilibrium with a time lag. In this context, the fact that business cycle fluctuations are not defined in a certain systematic way is based on these lagged components (Zarnowitz, 1991). The gap between real output and potential output, which is usually cyclical but whose trend is adjusted to a new path by the permanent effects of shocks, widens and does not return to its previous level. This structure in which the output gap becomes permanent is output gap hysteresis.

The output gap hysteresis is formulated by adding a persistence parameter to the output gap. In the basic definition of the output gap, Y_t is real output and Y_t^* is potential output.

$$Output\ gap\ =\ Yt\ -\ Yt*\qquad(1)$$

The output gap is modeled as hysteresis by adding a persistence parameter and a hysteresis-sensitive output gap form.

$$Lt\ =\ \rho\ Lt-1\ +\ y(\ Yt-1\ -\ Y*t-1\ )\qquad(2)$$

Where y is the hysteresis-sensitive output gap, ρ is the persistence parameter, and Lt is the hysteresis term including persistent effects. By including the hysteresis-free potential output, $\bar{Y}_t^*$, the equation is rearranged to obtain the output gap equation including hysteresis.

$$Yt\ =\ Yt\ -\ (\ \bar{Y}\ +\ Lt\ )\qquad(3)$$

The output gap hysteresis equation implies that the output gap hysteresis is a function of the output gap, output sensitive to persistent effects, and time. Here, the degree of output gap hysteresis is determined by the coefficient of the persistence parameter and the sensitivity of output to persistent effects. The degree of hysteresis determines the path of output in the return of real output to its potential point after the temporary shock. As another form of hysteresis, there are also 'strong hysteresis' conditions in which output persists on the path to which it was adjusted after the shock. Different degrees of output gap hysteresis forms are visualized in Figure 1.

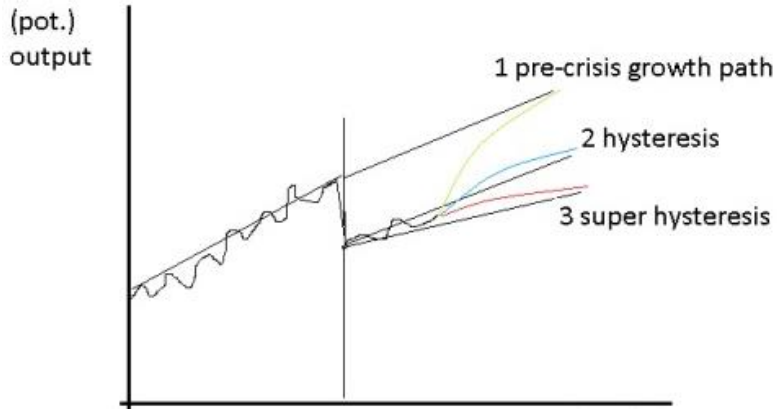

Figure 1. Hysteresis by Resilience Levels

There are different forms of hysteresis in the output gap according to the degree of resilience. As visualized in Figure 1, Van Aarle (2016) defines output path number 1 as the output path that adjusts to its previous path after a temporary shock, output path number 2 as the output path that adjusts to its previous path after a while even if there are permanent effects, and output path number 3 as the strong hysteresis that exhibits persistence in the path it was adjusted after temporary shocks.

Models in which the degree of output gap hysteresis is determined by specific interactions between the structural conditions and dynamics of economies come to the fore. When these relationships are evaluated in terms of theoretical foundations, the importance of monetary policy in aggregate demand shocks is theoretically recognized. As it is known, in Classical

microeconomics, partial equilibrium is formed by the price mechanism, while in Walrasian equilibrium, relative prices are formed by the balance between all markets (Mankiw, 1989). These models do not mention the existence of money in the formation of employment, output, and relative prices. According to the Classical view, markets are shaped in this way by the neutrality of money, while this is rejected in the Keynesian view. Since wages and prices are inelastic in the Keynesian view, the Classical Dichotomy and the neutrality of money disappear. The explanation of the Keynesian view at this point is that when there is an unexpected decrease in the money supply, the temporary decrease in the relative prices of goods encourages producers to reduce the quantity supplied. The real business cycle theory accepts the Classical Dichotomy. However, the fact that fluctuations in real output appear to be related to a nominal variable such as money supply raises doubts about the Classical Dichotomy. On the other hand, the real business cycle theory assumes that the real variable is the cause and the monetary variable is the effect, and the direction of the relationship is accepted as from output to money supply (King and Plosser, 1982). At the same time, as a counter view, the theoretical basis has been formed that demand shocks have a more permanent effect on output (Ball and Onken, 2022). In this debate, the fact that the real business cycle theory takes a view closer to the endogeneity of the money supply provides an exception to the complete disconnect between the financial system and the real economy. Moreover, beyond the disconnect/interaction between the financial system and real dynamics, there are specific factors, such as total factor productivity and its components, and labor market structure and its components, that determine hysteresis.

The existence and direction of the relationship between fixed investment and growth have been widely analyzed, and although no definitive conclusion has been reached, important evidence has been found on the process of this relationship. Blomström et al. (1996), while determining the existence of the effect of fixed investments on growth, also identified the existence of a different mechanism. After increases in fixed investments, growth also accompanies these increases. However, increases in growth mobilize fixed investments before fixed investments mobilize growth. It is observed that this structure is made possible by transferring the increase in per capita income to fixed capital investments along with growth. On the other hand, as studies supporting the effect of fixed investments on growth, Pollard (1964) attributes the start of the Industrial Revolution in England to the fact that there was a lot of capital stock in England at that time, and the existence of this relationship in the historical process is accepted. On the other hand, Fedderke (2004) argues that the functioning of this mechanism also depends on the stability of output. Investments are adversely affected by an increase in output volatility. A decline in investments, on the other hand, leads to a slowdown in output, revealing the existence of a cyclical process that feeds each other in a positive and negative sense. Analyzing this process in terms of hysteresis, the effects of crises last longer as a result of the mutual interaction of deterioration in investments with deterioration in output.

Although the hysteresis structure is historically based on the labor market model (Blanchard and Summers, 1986), the fact that hysteresis effects in employment are closely related to total factor productivity (Fatás and Summers, 2016) provides a comprehensive perspective on the theoretical foundations of hysteresis. Moreover, the relationship between productivity and long-run output makes productivity important in terms of hysteresis. According to Girardi et al. (2020), the traditional approach, which accepts the view that aggregate demand is important only in the short run, recognizes that aggregate demand tends to

adjust to potential output. The functioning of this mechanism is dominated by the view that investments are highly sensitive to interest rates. On the other hand, the Taylor Rule is followed in the interest rate policy that ensures the adjustment between actual and potential output, which is widely used in the current system and expressed as the New Consensus. The effective adjustment of the interest rate policy to the full employment equilibrium level will be possible with the full use of capital, flexibility in labor-capital substitution, and flexible real wages. However, according to the New Keynesian view, the institutional rigidity of real wages makes the effects of economic shocks more permanent. In other words, there is stronger empirical evidence that productivity shocks have a greater impact on the emergence and deepening of the hysteresis structure. Furlanetto et al. (2025), when decomposing the structure of output fluctuations into supply-side and demand-side, make important points about hysteresis effects by re-evaluating empirically the traditional view that sees fluctuations due to demand shocks as temporary. While the transmission mechanism in hysteresis effects takes place through employment and investment, there are uncertain areas regarding output per worker (productivity). The degree to which firms are affected by adverse shocks varies according to their productivity, and in the case of a decline in employment, the increase in productivity with demand that stimulates production may increase the error rate in the measurement of policy responses. The persistence of deterioration in productivity in post-crisis periods and the fact that this situation is mostly caused by demand-side shocks is a form of hysteresis behavior.

Dosi et al. (2018) argue that the insider-outsider model is not the only explanation for the impact of hysteresis on output. Declining investment rates as a result of a decline in aggregate demand due to rigidities in the industrial system, a decline in innovation, a deterioration in the quality of labor, and the market moving away from perfect competition are all determinants of output performance. It is well known that the labor wedge, which is the difference or discrepancy between the marginal rate of substitution (preference for work and leisure) and the marginal product of labor, has increased significantly during recessions, particularly during the Great Depression. Wage and price rigidities are considered to be the main factors in the emergence of this structure. However, other rigidities such as adjustment costs and habit formation in the labor market are also indirect diffusion dynamics. Finally, it is widely accepted that the hysteresis effects in potential GDP deepen the hysteresis by spreading to the supply side through the process starting from the demand shock (Gali et al., 2007; Inaba et al., 2020).

The unique structure of supply-side and demand-side dynamics that cause hysteresis may lead to different dynamics in the hysteresis process. Michl (2018) argues that expectations have an important role in wage bargaining and price determination as mechanisms affected by demand-side policies. Although there is usually persistence in forecast errors arising from worker error and firm error models, it does not indicate a hysteresis structure. However, if expectations are not adjusted according to new conditions after a demand shock and remain constant, it will have permanent effects on output, employment, and real wage levels. On the other hand, the hysteresis process, which is based on a supply shock, is driven by factors such as a decline in capital accumulation, a decrease in labor force qualifications, and a slowdown in the rate of technological diffusion as a result of recessions (Mourougane, 2017). Problems in these dynamics, which cause structural distortions on the supply side, may also exhibit permanence. Indeed, the fact that temporary shocks to supply dynamics have lasting effects on potential output reflects supply-side hysteresis. Therefore, in hysteresis, supply-side dynamics should be evaluated over a longer period than demand-side dynamics.

3. Literature Review

Historically, Hicks attributed the main dynamics of deviations from equilibrium to changes in the interest rate and the value of money. Keynes drew attention to fluctuations in demand in explaining cyclical movements in output. In explaining these cyclical movements, driven by fluctuations in demand and resulting in low growth and high unemployment, Keynes referred to deviations from Classical long-run equilibrium. Burns and Mitchell, on the other hand, characterized these fluctuations in the business cycle as periodic cycles and defined these movements as a necessity of their nature (Cerra et al., 2020).

The phenomenon of hysteresis, which in the empirical literature was expressed as a deviation from the cyclical movements of macroeconomic variables, was also empirically observed in the output gap. The relationship between hysteresis, which is expressed in the persistence of the output gap, and financial crises is widely observed in the empirical literature as well as in the theoretical underpinnings (Redmond and Van Zandweghe, 2016; Romer and Romer, 2017; Blanchard, 2018). Although the view that unemployment, which was a product of the systematic relationship between the financial system and the real economy, was solved by the dynamics of the financial system (money supply, interest rate) was accepted, the view that this process was an equilibrium mechanism has been supported by the experience of resistant output declines in developed economies (Solow, 2000). These long-term effects of financial crises on supply dynamics, starting from the demand structure, were called hysteresis (Ball, 2014). Another situation that increases the importance of hysteresis in terms of business cycle fluctuations is path dependence. Dutt (1997) argues that path dependence manifests itself in the fact that shocks that change the initial conditions in business cycle fluctuations have permanent effects and do not return to the initial conditions with favorable shocks. On the other hand, the deepening of hysteresis in the case of a second negative shock, while the effects of negative shocks persist, increases the importance of timing and historical processes in policymaking.

The structural situation and policy choices of economies are also important for the output gap. The disinflationary policy implemented in the German economy in the 1980s to control inflation made the output gap permanent (Fritsche and Logeay, 2002). The size of the output gap also determines the effectiveness of the policies implemented. A large gap between real and potential output requires a longer period of policy effectiveness. In this process, not neglecting the inflation target will prevent hysteresis in the output gap (Calvert Jump and Levine, 2021). The policy choice for the output gap is also important in terms of hysteresis. Tervala and Watson (2022) find that the most effective policy instrument for the output gap is public investment expenditure.

3.1. Monetary Policy and Hysteresis

Based on Friedman's views, Ball (2009) analyzes the short- and long-run movements of employment, one of the main components of output, for 20 advanced economies and reaches the same conclusions as Friedman. Although the current situation of the developed economies in the 1980s pointed to the validity of the Classical Dichotomy, this structure was not different from hysteresis.

Acharya et al. (2022) argue that the size of shocks is also a determinant of the impact of monetary policy shocks on output, with temporary shocks having permanent effects. The fact

that temporary shocks caused more than one steady-state unemployment in the employment dimension occurs when the labor force loses skills and employment is affected at a level that cannot be recovered spontaneously. Therefore, the reduction in output through employment in a tight monetary policy as a demand-side policy caused a permanent deterioration on the supply side. Bernanke and Mihov (1998) found that the effect of restrictive monetary policy on GDP can last up to 10 years. It can be said that the real economy, which cannot gain the necessary momentum from an expansionary monetary policy, was subject to hysteresis effects. In fact, the results of monetary policy show that hysteresis cannot be assessed only with a supply-side approach but is also related to demand-side policies.

Fontana and Palacio-Vera (2007) argue that the traditional inflation-targeting policy is based on the principle of monetary policy neutrality in the long run and has no effect on output and employment. However, the new consensus is that in the case of hysteresis, output moves independently of aggregate demand and time dynamics and exhibits different trends and equilibrium states, which raises the need for alternative policies to the traditional view in the literature. In this context, a flexible monetary policy that can be adjusted to changing conditions would be the appropriate policy option for hysteresis. Ball (2015) argued that the traditional view that recessions have a short-term impact on output and employment, as experienced in the 2008 crisis, has been challenged. Although recessions cause output and employment to fall, it is accepted that expansionary policy is the appropriate policy in a strong economy to prevent output and employment from returning to their previous path through asymmetric behavior. At this point, an aggressive expansionary monetary policy, which in the case of hysteresis was referred to as a high-pressure economy, would push inflation above expectations. In this case, the cost of returning to the targeted level of inflation would be to raise unemployment above the natural rate. This process will again mobilize the dynamics of hysteresis. Therefore, the view that a gradual expansionary policy is the optimal policy for hysteresis has begun to prevail in the empirical literature.

IMF (2009) Output losses after a recession are not inevitable, but the output gap can be reduced through expansionary monetary and fiscal policies. Following an aggressive expansionary policy after a recession allows output and growth to return to their previous trend more successfully before structural distortions spread through the economy (Ma et al., 2020). Indeed, more aggressive expansionary policies would be appropriate in the case of hysteresis, where the recovery in output has a resilient structure. In conclusion, based on the empirical literature, monetary policy should be conducted according to certain principles in the case of hysteresis. The roadmap for monetary policy in hysteresis is to implement monetary policy in a way that does not cause delays, to implement it aggressively at a level of capacity utilization that does not cause inflation, and to gradually adjust the size of the expansion after the process that causes inflationary effects.

3.2. Capacity Utilisation Rate and Hysteresis

Although the hysteresis literature focuses mainly on absolute changes, such as the persistence of output after a temporary shock or its adjustment to its previous path, income and capital distribution effects are extremely important. In fact, it is the evolution of wage profit and per capita capital that makes income and capital distribution important for output hysteresis. Amadeo (1986) argues that there are two main views that are prominent in sectoral models for

the supply side. The first is the existence of an inverse relationship between wage and profit rates, and the second is the inverse relationship between capital accumulation and the per capita capital ratio. In a high-growth environment with increased capital accumulation, a smaller share of output is allocated to consumption, while if investment is covered by profits, this results in low real wages. The validity of these relationships under the assumption of constant capacity utilization is generally accepted. However, a change in capacity utilization affects all these dynamics and ultimately output. Looking at these dynamics in more detail, Rowthorn (1995) argues that in recessionary periods the NAIRU also rises with the increase in idle capital. This process leads to an increase in profits as capacity utilization rises with the decline in the capital stock. This is due to the fact that production is covered by the increase in existing potential output, as opposed to the participation of labor in the employment of new capital. In fact, it is the rate of capacity utilization that determines these relationships.

Although it is an important determinant of capacity utilization for potential and real output, it has not been given sufficient attention in hysteresis discussions. However, its widespread use in the recent literature is evidence of its importance. Based on the relationship between capacity utilization and business cycle fluctuations, Setterfield and Avritzer (2020) argue that changes in actual capacity utilization are necessary in hysteresis models. Di Domenico et al. (2024) concluded that aggregate supply is influenced by aggregate demand in the long run. More specifically, transitory shocks are found to have a temporary effect on unemployment and capacity utilization, while they have resilient permanent effects on productive capacity and labor force participation. Bassi et al. (2022) find evidence of hysteresis behavior in the capacity utilization rate across sectors in the US economy. However, as the capacity utilization rate at full employment differs for these different sectors, this paves the way for the relative interpretation of hysteresis effects. Bassi (2024) finds evidence of permanent hysteresis in the capacity utilization rate in many EU economies after the 2008 global crisis. Here, capacity utilization adjustments also determine the effectiveness of monetary policy for hysteresis based on inflationary pressures.

3.3. Productivity and Hysteresis

The traditional view that business cycle fluctuations caused by supply and demand shocks move around a certain trend is supported by empirical studies (Tervala, 2021). Therefore, how to model potential output has been questioned more in the literature. In empirical studies, it is among the common results that demand shocks cause hysteresis in output starting from total factor productivity. Other studies in this direction are Adler et al. (2017) and Anzoategui et al. (2019). In the New Keynesian view, recessions cause a short-term decline in consumption, while in the case of hysteresis, consumption falls permanently, leading to further welfare losses. Therefore, the social cost of hysteresis becomes important in terms of restoring demand to its previous level. Blanchard and Summers (1986) empirically proved that the time trend of many economic variables with hysteresis structure is non-stationary. In the European unemployment hysteresis, along with unemployment, total factor productivity also exhibited a hysteresis behavior by not returning to the mean. On the other hand, the fact that productivity shocks have the same effect as positive supply shocks makes productivity an important dynamic in measuring hysteresis effects and determining effective policy.

Blanchard et al. (2015), who tested the persistent effects of recessions in 23 countries over the last 50 years, found the presence of hysteresis in the vast majority of them. The impact of recessions on output mainly spreads through the employment and total factor productivity (TFP) channels, causing deviations in output. Jordà et al. (2020) empirically prove that monetary shocks cause hysteresis in output and total factor productivity. Engler and Tervala (2018) show that the recession in the euro area caused a 4% and 0.9% deviation in output and TFP, respectively. Anzoategui et al. (2019) found that the recession in the US economy reduced productivity by 5%, emphasizing that TFP is the most important dynamic in hysteresis. In terms of the relationship between hysteresis and capacity utilization rate, Köberl (2011) argues that the non-inflationary capacity utilization rate (NAIRCU), which is defined as the capacity utilization of a firm without price adjustment pressure, is effective in measuring the performance of the economy. NAIRU is used as an effective measure of labor costs and the output gap. Although most empirical studies find that it has a constant trend, Bassi (2019) observes that NAIRCU has a time-varying trend. Deviations in GDP can create permanent shocks in total factor productivity if chronically underutilized capacity moves with inflation. If NAIRU remains below full capacity output, demand-side expansionary policies will not create inflationary pressures until full capacity. The fact that temporary demand shocks have permanent effects, in other words, hysteresis effects, results in a spillover to the supply side through the total factor productivity channel. As a matter of fact, adjusting demand-side expansionary policies in recessionary periods in a way not to trigger inflationary acceleration will provide stability in economic activity without deepening hysteresis effects. Approaching hysteresis from the perspective of technological development, Li et al. (2015) argue that technological progress is considered the most important trigger in economic development. Since technological progress is a slow-moving process due to its nature, it is important in terms of hysteresis that there is no time inconsistency in the policies implemented by the governments. Total factor productivity, which reacts with a delay to policies implemented with a delay, will cause distortions in the supply structure. At this point, policies implemented on time by encouraging the innovative production system and improving the adaptation to the innovative production system will be the optimum policy option.

Summers (2014) argues that the future potential of the economy depends on current conditions. Moreover, the hysteresis situation in which economic recovery does not lead to an improvement in total factor productivity is followed by a reduction in capital investment and labor input. After the 2008 World Crisis, labor and capital decreased more than total factor productivity decreased, which better explains why potential output in the US fell to around 5%. Since interest rates have reached lower limits, limiting the room for maneuvering in monetary policy, healthy growth policies have become the more reasonable option for the solution to the recession.

Standard unit root tests (Brunello, 1990; Mitchell, 1993) have been used for hysteresis, which was first examined in unemployment dynamics in economic systems. The presence of a unit root implying a structural break may be misleading in some cases. Structural shocks such as oil shocks, which can be effective on a global scale, cause structural changes in macroeconomic variables. In standard unit root tests, estimation is made without taking into account the endogeneity of structural breaks. In order to compensate for this limitation of standard unit root tests, the Zivot-Andrews test was developed in which structural breaks are endogenous. However, even if structural breaks are endogenous, there are specific conditions for output gap

hysteresis. Tests with endogenous structural breaks based on the standard unit root test have some limitations due to the specific conditions of the Turkish economy. For the Turkish economy, the presence of a unit root or unit root with a structural break in output implies a trend change. This trend change in output is interpreted as the persistence of structural shocks in the economy. The fact that output interacts with all macroeconomic variables increases the likelihood that structural changes will spread gradually to the whole economy in the long run beyond the increase in costs on the supply side. For this reason, the Leybourne et al. (1998) smooth transition structural break test developed for gradual transitions instead of sharp structural breaks will produce effective results for the output gap hysteresis in the Turkish economy.

The hysteresis literature in the Turkish economy has focused on unemployment. Akcan (2019) finds that there is hysteresis in youth and general unemployment rates in the Turkish economy, which is supported by the findings obtained from standard and structural break unit root tests. Tekin (2018) states that in the Turkish economy, the long-run effects of unemployment shocks lead to an increased unemployment path, validating the concept of unemployment hysteresis. Additionally, Ozturk (2020) finds that hysteresis behavior is evident not only in unemployment rates but also in the labor force participation rate in the Turkish economy. These results obtained on the basis of unemployment indicate a permanent deterioration in the dynamics of the employment structure. Since unemployment and employment are components of output, it proves that output in the Turkish economy may have a permanent trend deviation. Therefore, the output gap hysteresis should be comprehensively analyzed for the Turkish economy. Accordingly, the motivation of this study includes the determination of the output gap hysteresis in the Turkish economy as well as the determination of the dynamics and the extent of the hysteresis. Output gap hysteresis is a topic that has not been analyzed in the empirical literature for the Turkish economy. While the study contributes to the literature in this respect, it follows a comprehensive path in terms of the variables used (monetary change, capacity utilization, productivity) and the empirical strategy (smooth transition structural break, SVAR model). In this context, the study provides a new perspective for policymakers by extending the limited empirical contributions on output gap hysteresis in the literature.

4. Data and Methodology

The empirical method of the study is designed to determine the dynamics of the output gap hysteresis and to provide suggestions for policymaking. The variables to be used in the study are defined as gross domestic product (GDP), money supply (M3), capacity utilization rate (CUR), and capital productivity (PRODUCTIVITY), and time series are constructed with the data obtained from the CBRT (CBRT/EVDS) system for 2005Q4:2021Q3 (t=64). The defined time series are visualized in Figure 2.

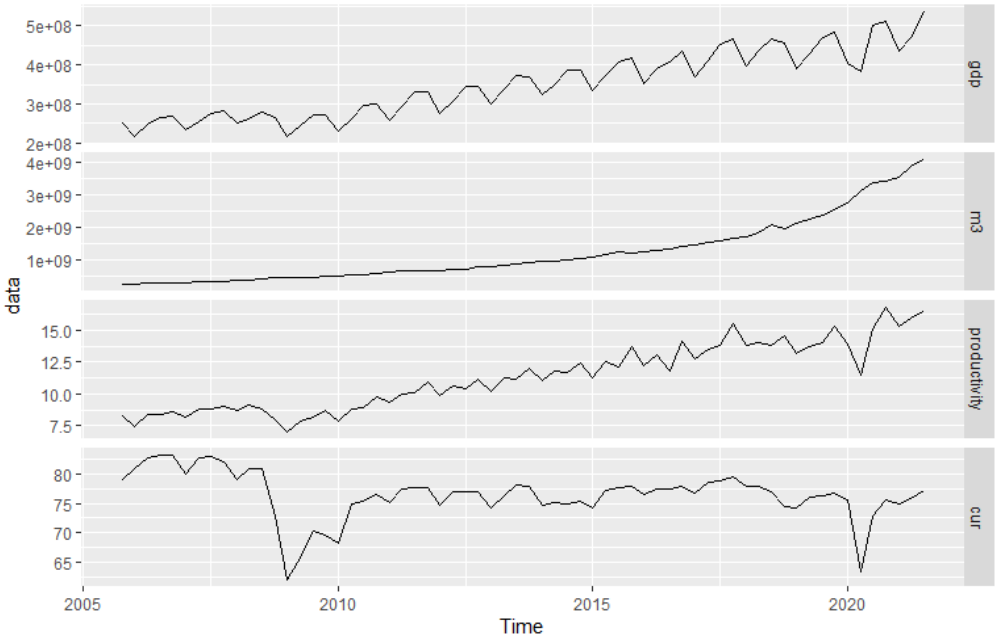

Figure 2. Developments in Variables

In order to evaluate the output gap hysteresis, the output gap in the Turkish economy will be determined by the Hodrick-Prescott (HP) and Baxter-King (BK) methods. The persistence of the trend change in output after a temporary shock or the level of resistance to output components (money supply, capacity utilization rate, productivity) in case output returns to its previous path requires specific analyses to understand the nature of hysteresis. Accordingly, the smooth transition structural break test will be applied to detect permanent trend changes in output, and the structural VAR method will be applied to measure the response of output to its components. For the structural VAR method, the model specification conditions are met as a result of the data processing processes suggested by the logarithmic transformation, Kruskal Wallis seasonality test, and stationarity (Augmented Dickey-Fuller, Phillips-Perron) tests.

4.1. Hodrick-Prescott and Baxter-King Method Output Gap Estimates

The Hodrick-Prescott (HP) filter is widely used in the estimation of the output gap (Hodrick and Prescott, 1997). The estimation method of the HP filter is estimated by minimizing the variance of GDP based on the values of the two main components of GDP: trend and cyclical movement. The HP filter method is based on estimating the output gap from the difference between the actual GDP and the predicted GDP by weighting the linearised GDP series with the help of a logarithm with trend growth. Another frequency filter method is the Baxter-King (BK) filter method. The BK filter has an important advantage over the HP filter. The strength of the BK filter is that it provides a symmetric estimation of real data by taking weighted averages of GDP data and reducing data loss (Iacobucci and Noullez, 2005). On the other hand, the BK filter method has a disadvantage. In the moving average technique, the same number of initial and final observation data are needed for the observation to be estimated.

Therefore, a certain number of observations from the beginning and end of the series are lost (Oomes and Dynnikova, 2006).

4.2. Smooth Transitions Structural Break Test

It is a structural break test developed by Leybourne et al. (1998), which also takes into account non-linearity. The strength of the smooth transition structural break test is that it can detect structural breaks in nonlinear time series while measuring soft breaks instead of hard breaks. The smooth transition structural break test is estimated with the help of the logistic smooth transition function defined as St instead of hard and sudden breaks modeled with the help of a dummy variable in other structural break tests. The logistic smooth transition function is presented below.

$$St\ (\gamma, \tau)\ =\ [\,1\ +\ exp\ \{-\lambda\ (t\ -\ \tau\ T)\}] - 1 \tag{4}$$

Since it tests a nonlinear structure in the estimation phase, the nonlinear ECM method is used, and error terms are obtained. The models from which the error terms are obtained have three different structures. Model A takes into account the smooth transition break in the level, Model B takes into account the smooth transition break in the trend, and Model C takes into account the smooth transition break in both level and trend. The estimation equations obtained for Model A, Model B, and Model C are given below.

$$yt\ =\ \alpha 1\ +\ \alpha 2\ St\ (\lambda, \tau)\ +\ \nu t \tag{5}$$

$$yt\ =\ \alpha 1\ +\ \beta 1t\ +\ \alpha 2\ St\ (\lambda, \tau)\ +\ \nu t \tag{6}$$

$$yt\ =\ \alpha 1\ +\ \beta 1t\ +\ \alpha 2\ St\ (\lambda, \tau) + \beta 2t\ St\ (\lambda, \tau)\ +\ \nu t \tag{7}$$

Structural break in level is detected by Model A, structural break in trend is detected by Model B, and structural break in level and trend is detected by Model C. The interpretation of the estimation results is made with the help of hypothesis tests. While the hypothesis H0: $\delta=0$ accepts the existence of a unit root with a structural break, the alternative hypothesis H1: $\delta < 0$ is interpreted as stationary with a structural break.

4.3. Structural VAR Model

Due to the dynamic structure of vector autoregressive-based models, it is difficult to detect long-run relationships. In standard VAR models, this problem leads to the deterioration of long-run relationships with the increase in the number of variables as well as the decrease in the efficiency of estimation. The structural VAR (SVAR) model, which was developed to overcome this deficiency of vector autoregressive models, can make effective forecasts even in models with a large number of variables by eliminating the restriction in matrix form. The superiority of structural VAR-based models stems from the reduced form achieved with the restriction in matrix form (Dungey and Pagan, 2000). While all variables affect each other throughout the time series in the standard VAR model, only independent variables have an effect on the dependent variable in the restricted form estimation. Kilian (2013) also argues that with the historical decomposition function, the extent to which the share of independent variables in the structural change in the dependent variable is realized can be effectively determined. Therefore, the effectiveness of the structural VAR technique in measuring the

hysteresis in the output gap determined the empirical method of the study. While defining the structural VAR model, Amisano and Giannini's (2012) and Zivot's (2000) studies are taken as references.

Considering the variable and data scale of the study, a four-variable structural VAR form is defined. Equation (8) shows the estimation equation obtained from the matrix form.

$$Byt = \square 0 + \Gamma 1yt - 1 + \varepsilon t \quad (8)$$

The restricted form of the vector autoregressive structural VAR is obtained by multiplying equation (8) by B^{-1} and solving Yt in terms of Y_{t-1} and ε_t. In this way, the matrix form is obtained by restricting Y_t (9), and different forms is obtained.

$$yt = B - 1 \square 0 + B - 1 \Gamma 1yt - 1 + B - 1 \varepsilon t \quad (9)$$

As seen in Equation 6, matrix B is obtained from the reduced form. The structural VAR form with four variables is visualized in equation (10).

$$A(1) - 1B = \begin{bmatrix} 1 & 0 & 0 & 0 \\ * & 1 & 0 & 0 \\ * & * & 1 & 0 \\ * & * & * & 1 \end{bmatrix} \quad (10)$$

5. Empirical Findings

In line with the empirical strategy of the study, firstly, output gap estimation is analyzed with the help of the HP filter and BK filter. The output gap estimation results of the HP filter and BK filter are presented in Figure 3.

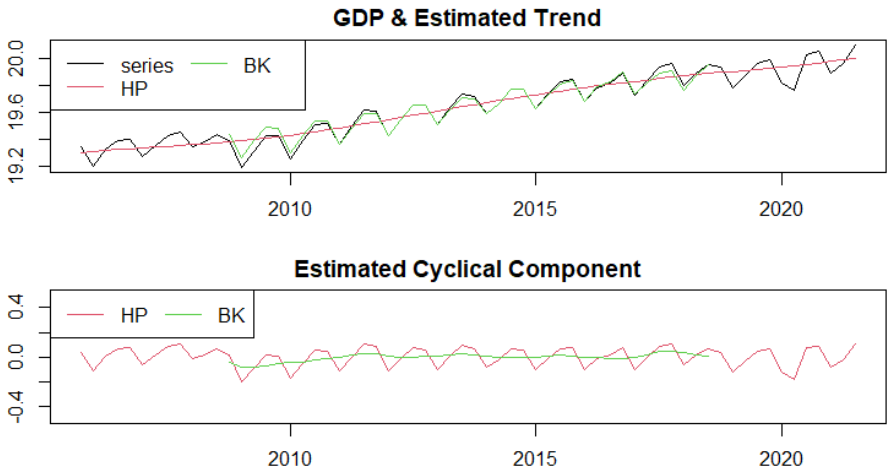

Figure 3. Output Gap Estimation Result Of HP Filter And BK Filter

HP and BK filter results indicate the existence of an output gap. Due to the 2008 World Crisis, output deviated from its trend, and its effect continues throughout the time series. This situation proves the existence of hysteresis effects in the output gap. Another method to detect hysteresis is the smooth transition structural break test. Cremaschini and Maruotti (2023) argue that due to the structural nature of output, trend changes are endogenous to gradual changes when they do not involve a sharp change. Moreover, the strength of the smooth transition

structural break test, which is estimated by internalizing the structural break in hysteresis models, emerges at this point. Smooth transition structural break test results are presented in Table 1.

Table 1. Smooth Transition Structural Break Results

Model	Observation Range	t statistics	Critical Value %1	Result
Model A	50<T<100	-3.26***	-5.09	Smooth break
Model B	50<T<100	-2.55***	-5.77	Smooth break
Model C	50<T<100	-3.40***	-6.13	Smooth break

Note: Leybourne et al. (1998) critical values. ***, ** and * represent 1%, 5% and 10% level respectively. Model A Smooth transition in level ($S2\alpha$), Model B Smooth transition in trend ($S\alpha(\beta)$), Model C Smooth transition in level and trend ($S\alpha\beta$)

Smooth transition structural break estimation results support the existence of a structural break for GDP. Model C, which includes structural breaks in the level and trend, is the more efficient model in terms of hysteresis. Model C results indicate the existence of hysteresis in the output gap.

The interaction between the output gap and the components of the output gap allows not only for determining the existence of hysteresis but also for assessing the degree of influence of these determinants (money supply, capacity utilization rate, productivity) on the hysteresis in output gap hysteresis. These relationships are evaluated by the structural VAR method. In this sense, structural VAR model outputs are an important guide for policy makers.

The matrix form used in the structural VAR model estimation and the coefficients of the variables obtained as a result of the estimation are presented in equation (11).

$$\begin{bmatrix} \text{GDP} \\ \text{PRODUCTIVITY} \\ \text{CUR} \\ \text{M3} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ -1.218636 & 1 & 0 & 0 \\ 0.042380 & -0.592309 & 1 & 0 \\ -0.089520 & 0.312658 & -0.255454 & 1 \end{bmatrix} * \begin{bmatrix} \varepsilon\text{GDP} \\ \varepsilon\text{M3} \\ \varepsilon\text{CUR} \\ \varepsilon\text{PRODUCTIVITY} \end{bmatrix} \quad (11)$$

Since the structural VAR (SVAR) model has an autoregressive structure, the coefficients cannot be interpreted. Therefore, impulse-response function analysis, structural decomposition, and historical decomposition function will be used to explain the structure of output gap hysteresis.

Impulse response analysis (Figure 4) is used to determine the extent to which one unit standard deviation shocks in the independent variable affect the dependent variable. In terms of the response of output to explanatory variables, capacity utilization rate shocks have a positive effect on output, while productivity shocks have a negative effect on output. Money supply shocks do not have a statistically significant effect on output.

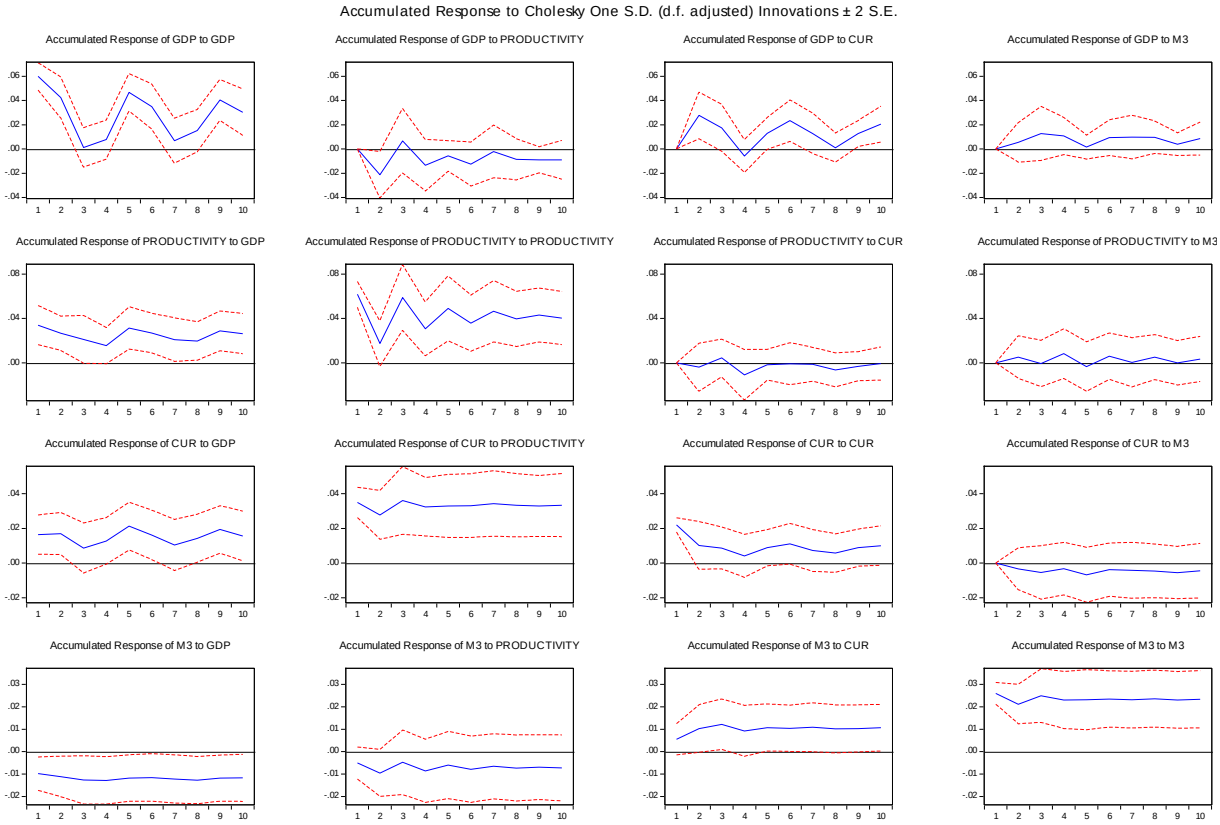

Figure 4. Impulse Response Analysis

Structural variance decomposition measures the explanatory power of independent variables for the dependent variable. According to the variance decomposition results (Table 2), the capacity utilization rate and productivity explain the output at the highest rates of 17.27% and 14.23%, respectively. The money supply does not have a significant effect at the rate of 2.14%.

Table 2. Structural Variance Decomposition (GDP)

Period	Standard Error	GDP	Productivity	CUR	M3
1	0.059975	100.0000	0.000000	0.000000	0.000000
2	0.071788	75.72026	8.830622	14.87700	0.572116
3	0.088296	71.83666	15.91796	11.17686	1.068520
4	0.093753	64.19280	18.76284	16.04914	0.995223
5	0.103902	66.29120	15.83809	16.27997	1.590747
6	0.105598	65.41324	15.74274	16.76035	2.083672
7	0.110267	66.45318	15.33621	16.29795	1.912660
8	0.111385	65.67443	15.37420	17.07685	1.874515
9	0.114945	66.49460	14.43763	17.05478	2.012998
10	0.115749	66.33747	14.23789	17.27682	2.147822

VAR-based models are frequently used to analyze structural changes in time series models. However, when the time series exhibits non-linear behavior, the effective analysis technique may also change. Historical decomposition becomes effective in nonlinear models due to structural breaks along the time series. Historical decomposition is used to identify the

contribution of shocks in independent variables throughout the time series to the structural change in the dependent variable (Wong, 2017). The historical decomposition function will give more effective results on which variable shocks are responsible for the structural change in output, which exhibits non-linear behavior due to hysteresis effects. The historical decomposition function enables the identification of the common effect of all shocks in past periods for a given time point. According to the results of the historical decomposition function, capacity utilization rate and productivity shocks have the highest cumulative effect on the structural change in output, while money supply shocks do not have a significant effect.

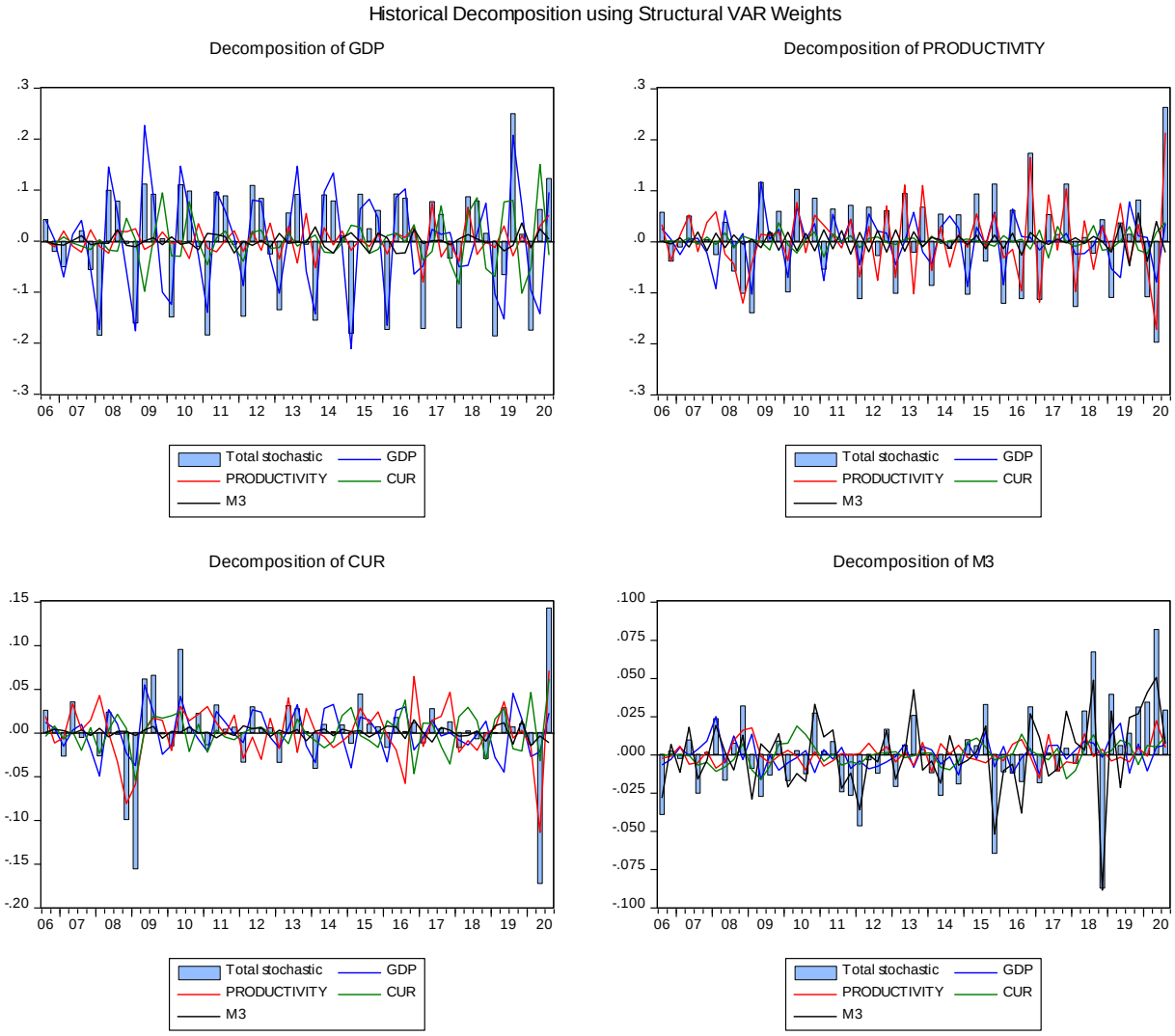

Figure 5. Historical Decomposition

The hysteresis in the output gap may be highly effective in the fact that the dynamics that cause hysteresis also undergo structural changes, as output undergoes structural changes and does not return to its previous path. Therefore, the persistence of the breaks in the capacity utilization rate and productivity in the Turkish economy explains the hysteresis in the output gap to a great extent. This can be observed in the course of capacity utilization rate and productivity in Figure 1. Due to the 2008 World Crisis, productivity experienced a significant

break, and its effect lasted for a long time. However, productivity, which returned to its old path in the long run, had an effect on the output gap hysteresis, but it was temporary. Similarly, in support of our findings, Clavijo-Cortes (2022) concluded that when productivity shocks are accompanied by output shocks, permanent effects on output deepen. On the other hand, the break in the capacity utilization rate, on the other hand, exhibits a more resilient structure and does not return to its previous path throughout the time series and even falls permanently after the trend deviations in 2008 and 2018. In this context, the capacity utilization rate stands out as the strongest dynamic in explaining the strong hysteresis in the output gap. The importance of the capacity utilization rate for the output gap hysteresis is its relationship with monetary policy. Parigi and Siviero (2001) show that changes in the capacity utilization rate in response to monetary policy adjustments also adjust inflationary pressures. The capacity utilization rate that can be adjusted in this way can expand the room for maneuvering of central banks in policies implemented for output growth. This process also provides central banks with a favorable position to set policy boundaries in the fight against inflation. On the other hand, empirical studies show that monetary expansion that is not reflected in output also points to hysteresis. Borio and Hofmann (2017) argue that the demand expansionary policies implemented in the US, the Euro area, and the UK after the 2008 World Crisis were insufficient to return the output that deviated from its trend to its former path. In this context, the effect of monetary easing on output in the Turkish economy remains limited (inability to return output to its previous path) and supports the empirical findings in terms of hysteresis.

As is known, the effects of the 2008 World Crisis were more severe and permanent than expected (Stiglitz, 2018). In the case of secular stagnation, which is defined as the persistence of the effects of the crisis by acquiring a resilient structure, the massive redistribution of income and wealth from lower-income groups to higher-income groups results in a weakening of aggregate demand. As can be seen in Figure 1, the fact that the increase in money supply does not lead to a change in output despite a significant acceleration is evidence of the weakening aggregate demand due to the redistribution of income and wealth to upper-income groups in secular stagnation.

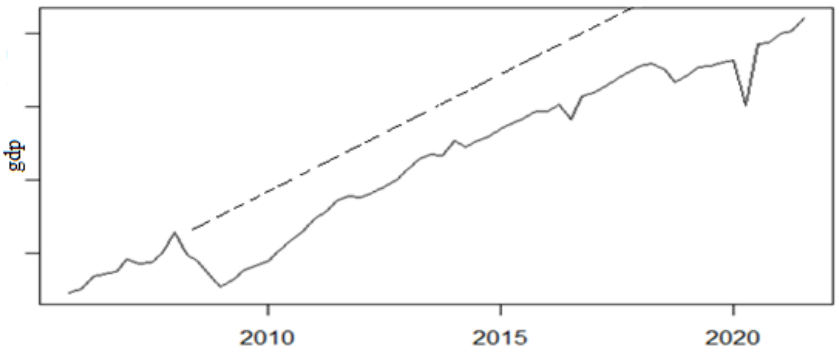

Figure 6. Turkish Economy Output Path

Figure 6 shows the path of Turkish economic output after the 2008 World Crisis. The dashed line represents the expected output path without the impact of the 2008 World Crisis. The fact that output did not return to its previous path after the crisis can be interpreted as secular stagnation. The fact that output does not return to its previous path despite the monetary

policy developments by exhibiting a resilient structure points to strong hysteresis as defined in the empirical literature. This structure of output in the Turkish economy is in line with the findings in the empirical literature (Ball, 2014; Lavoie, 2018; Eo and Morley, 2022), and it is concluded that the strong hysteresis structure is valid in output.

6. Conclusion

The difference between potential output and actual output, which is defined as the output gap, and its hysteresis form (becoming permanent) is a dynamic that determines economic stability on policy effectiveness. In addition, output gap hysteresis and its solution proposals are the guide to healthy growth in terms of explaining the inflationary pressures that have become a chronic problem in the Turkish economy and suggesting policies. The empirical literature analyzes the relationship between output and dynamics such as money supply, productivity, and capacity utilization rate in order to identify hysteresis in the output gap. In the case of hysteresis in the output gap, the movement in output ceases to be cyclical and adapts to a different path in the form of structural change. At this point, monetary policy developments are insufficient to return output to its previous path. On the other hand, since productivity and capacity utilization rates do not return to their previous levels and are the main dynamics of the structural change in output, they can provide important information in output gap hysteresis. Taking these variables into account, the output gap hysteresis of the Turkish economy for the 2005Q4:2021Q3 period is analyzed through money supply, capacity utilization rate, and productivity variables. The empirical setup of the study aims to identify the output gap with the Hodrick-Prescott and Baxter-King methods. In order to detect the persistence of output deviation from its trend, in other words, hysteresis, the smooth transition structural break test is used to detect hysteresis in output, while the structural VAR method aims to provide important information to policymakers for output gap hysteresis through the interaction/response of output to its components.

In the first stage, the Hodrick-Prescott and Baxter-King methods are used to determine the existence of an output gap. According to the smooth transition structural break test, the detection of a structural break in output proves the existence of hysteresis. The structural VAR model estimated with output, money supply, capacity utilization rate, and productivity variables yielded satisfactory results for the existence of output gap hysteresis. In terms of money supply, the fact that money supply does not have a significant effect on output indicates hysteresis behavior on theoretical grounds. The fact that the long-run change in the level of money supply is insufficient to return output to its previous path is another important finding that proves the existence of hysteresis. In the hysteresis dimension, this situation is among the results commonly found in the empirical literature. Productivity and capacity utilization rate variables are important determinants of output gap hysteresis. According to the structural decomposition and historical decomposition function, capacity utilization rate and productivity are the two main variables in terms of hysteresis. While the permanent adjustment of the capacity utilization rate to a lower path after shocks explains the basis of the strong hysteresis in the output gap, the fact that shocks to productivity are compensated in the long run and adjusted to the old path reveals the importance of output in the hysteresis structure. As a matter of fact, taking into account capacity utilization rate and productivity changes in order of importance as determinants of output in policymaking will increase policy effectiveness.

The study contributes to the empirical literature in several aspects. The study first analyzes the output gap hysteresis for the Turkish economy. Its contribution to the hysteresis literature is that, in addition to identifying the output gap, it uses the smooth transition structural break test, which is more appropriate to the nature of business cycle fluctuations, and analyzes the output gap hysteresis through its interaction/response with output components (money supply, capacity utilization rate, productivity). The empirical strategy designed in this way has enabled the identification of hysteresis and its dynamics, leading to important key findings for policymaking. Another important contribution of the study is that it provides information on which dynamics should be emphasized in policymaking in terms of hysteresis and to what extent. In this context, based on the empirical findings, it is extremely important in terms of hysteresis that the money supply should not be tightened more than necessary in a way to slow down output in money supply changes, and that the money supply should be adjusted quickly in expansionary policies so as not to cause inflationary pressures. Because actual output that does not move towards its potential with expansionary policies will cause inflation. Here, the central bank's room for maneuver in policy implementation is determined by the flexibility of the capacity utilization rate. Moreover, calculating the marginal change effect of monetary policy on the capacity utilization rate at different levels will increase the effectiveness of demand-side expansionary policy. Increasing productivity is another important dynamic in eliminating the hysteresis behavior in the output gap. Increasing productivity is also associated with an increase in the capacity utilization rate, which underlines the importance of productivity. More specifically, increasing new products and services and more flexible working models in terms of the labor market will increase the capacity utilization rate. Since the Turkish economy is open to foreign markets, domestic and foreign demand developments are determinant for the capacity utilization rate. More specifically, if expenditure-shifting policies are not adjusted effectively during exchange rate fluctuations, the appreciated local currency will shift demand to foreign markets, thus preventing the incentive to increase production capacity.

Although the study uses output, money supply, capacity utilization rate, and productivity variables in the output gap hysteresis, it has some limitations. In terms of productivity, labor productivity is neglected in the empirical model by taking capital productivity into account. While employment and investments decrease permanently in recessions driven by demand shocks that are effective in the long term, while output per worker is not significantly affected (Furlanetto et al., 2025), in Turkey, as a developing economy, employment shows sharper changes and more production factors are included in production during the expansion period. For this reason, the productivity of the labor force specifically participating in production in the Turkish economy will also determine total factor productivity. In future studies, monitoring labor productivity at different employment levels will increase policy effectiveness.

Declaration of Research and Publication Ethics
This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement
The authors declare that they have contributed equally to the article.

Declaration of Researcher's Conflict of Interest
There is no potential conflicts of interest in this study.

References

Acharya, S., Bengui, J., Dogra, K. and Wee, S.L. (2022). Slow recoveries and unemployment traps: Monetary policy in a time of hysteresis. *The Economic Journal*, 132(646), 2007-2047. https://doi.org/10.1093/ej/ueac016

Adler, G., Duval, M.R.A., Furceri, D., Çelik, S.K., Koloskova, K. and Poplawski-Ribeiro, M. (2017). *Gone with the headwinds: Global productivity* (IMF Discussion Note No. SDN/17/04). Retrieved from https://hacerperu.pe/wp-content/uploads/2023/05/Adler-et-al-2017.pdf

Akcan, A.T. (2019). Türkiye'de gençlerin işsizlik histerisi. *Kastamonu Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 21(1), 31-47. Retrieved from https://dergipark.org.tr/en/pub/iibfdkastamonu/

Amadeo, E.J. (1986). Notes on capacity utilisation, distribution and accumulation. *Contributions to Political Economy*, 5(1), 83-94. https://doi.org/10.1093/oxfordjournals.cpe.a035705

Amisano, G. and Giannini, C. (2012). *Topics in structural VAR econometrics*. Berlin: Springer.

Anzoategui, D., Comin, D., Gertler, M. and Martinez, J. (2019). Endogenous technology adoption and R&D as sources of business cycle persistence. *American Economic Journal: Macroeconomics*, 11(3), 67-110. Retrieved from https://www.aeaweb.org/

Aydin, C. and Esen, Ö. (2017). Inflationary threshold effects on the relationship between unemployment and economic growth: Evidence from Turkey. *International Journal of Economic Perspectives*, 11(2), 88-97. Retrieved from https://ijeponline.org/

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. https://doi.org/10.4337/ejeep.2014.02.02

Ball, L. (2015). *Monetary policy for a high-pressure economy*. Retrieved from https://www.cbpp.org/sites/default/files/atoms/files/3_30_15fe_ball.pdf

Ball, L. and Onken, J. (2022). Hysteresis in unemployment: Evidence from OECD estimates of the natural rate. *International Finance*, 25(3), 268-284. https://doi.org/10.1111/infi.12424

Ball, L.M. (2009). *Hysteresis in unemployment: Old and new evidence* (NBER Working Paper No. w14818). Retrieved from https://www.nber.org/system/files/working_papers/w14818/w14818.pdf

Bassi, F. (2019). *Capacity Utilization and the NAIRCU-Evidences of Hysteresis in EU countries* (CEPN Working Papers No. 2019-09). Retrieved from https://econpapers.repec.org/paper/upnwpaper/2019-09.htm

Bassi, F. (2024). Excess capacity and hysteresis in EU Countries. A structural approach. *Structural Change and Economic Dynamics*, 71, 116-134. https://doi.org/10.1016/j.strueco.2024.07.002

Bassi, F., Bauermann, T., Lang, D. and Setterfield, M. (2022). Is capacity utilization variable in the long run? An agent-based sectoral approach to modeling hysteresis in the normal rate of capacity utilization. *Structural Change and Economic Dynamics*, 63, 196-212. https://doi.org/10.1016/j.strueco.2022.09.005

Benati, L. and Lubik, T.A. (2021). *Searching for hysteresis* (Bern University Discussion Papers No. 21-07). Retrieved from https://hdl.handle.net/10419/242858

Bernanke, B.S. and Mihov, I. (1998). *The liquidity effect and long-run neutrality* (NBER Working Paper Series No. 6608.) Retrieved from https://www.nber.org/system/files/working_papers/w6608/w6608.pdf

Blanchard, O. (2018). Should we reject the natural rate hypothesis? *Journal of Economic Perspectives*, 32(1), 97-120. doi:10.1257/jep.32.1.97

Blanchard, O., Cerutti, E. and Summers, L. (2015). *Inflation and activity–two explorations and their monetary policy implications* (NBER Working Paper No. w21726). Retrieved from https://www.nber.org/system/files/working_papers/w21726/w21726.pdf

Blanchard, O.J. and Summers, L.H. (1986). Hysteresis and the European unemployment problem. *NBER Macroeconomics Annual*, 1, 15-78. Retrieved from https://www.journals.uchicago.edu/

Blomström, M., Lipsey, R.E. and Zejan, M. (1996). Is fixed investment the key to economic growth? *The Quarterly Journal of Economics*, 111(1), 269-276. https://doi.org/10.2307/2946665

Borio, C.E. and Hofmann, B. (2017). *Is monetary policy less effective when interest rates are persistently low?* (BIS Working Paper No. 628). Retrieved from https://ssrn.com/abstract=2957961

Brunello, G. (1990). Hysteresis and "the Japanese unemployment problem": A preliminary investigation. *Oxford Economic Papers*, 42(3), 483-500. https://doi.org/10.1093/oxfordjournals.oep.a041959

Campbell, J.Y. and Mankiw, N.G. (1987). Are output fluctuations transitory? *The Quarterly Journal of Economics*, 102(4), 857-880. https://doi.org/10.2307/1884285

Cerra, M.V., Fatás, A. and Saxena, M.S.C. (2020). Hysteresis and business cycles. *Journal of Economic Literature,* 61(1), 181-225. doi:10.1257/jel.20211584

Clavijo-Cortes, P. (2022). Output hysteresis in the US: New evidence from a time-varying Verdoorn's law. *Journal of Economic Studies,* 49(1), 185-197. https://doi.org/10.1108/JES-06-2020-0263

Cremaschini, A. and Maruotti, A. (2023). A finite mixture analysis of structural breaks in the G-7 gross domestic product series. *Research in Economics,* 77(1), 76-90. 10.1016/j.rie.2023.01.001

Cross, R. (1993). On the foundations of hysteresis in economic systems. *Economics & Philosophy*, 9(1), 53-74. https://doi.org/10.1017/S0266267100005113

Di Domenico, L., Gahn, S.J. and Romaniello, D. (2024). *Testing the waters of positive hysteresis: The effects of autonomous demand shocks on ınflation, accumulation, and labor in the US economy* (CSWP Working Papers No. CSWP64). Retrieved from http://www.centrosraffa.org/centrosraffaworkingpapersSEARCH.aspx

Dosi, G., Pereira, M.C., Roventini, A. and Virgillito, M.E. (2018). Causes and consequences of hysteresis: Aggregate demand, productivity, and employment. *Industrial and Corporate Change*, 27(6), 1015-1044. https://doi.org/10.1093/icc/dty010

Dungey, M. and Pagan, A. (2000). A structural VAR model of the Australian economy. *Economic Record*, 76(235), 321-342. https://doi.org/10.1111/j.1475-4932.2000.tb00030.x

Durand, L. and Fornero, J.A. (2024). Estimating the output gap in times of COVID-19. *Latin American Journal of Central Banking*, 5(4), 100129. https://doi.org/10.1016/j.latcb.2024.100129

Dutt, A.K. (1997). Dependence and hysteresis in post Keynesian models. *Markets, Unemployment, and Economic Policy*, 2, 238. https://doi.org/10.4324/9780203848456

Engler, P. and Tervala, J. (2018). Hysteresis and fiscal policy. *Journal of Economic Dynamics and Control*, 93, 39-53. https://doi.org/10.1016/j.jedc.2018.02.002

Eo, Y. and Morley, J. (2022). Why has the US economy stagnated since the Great Recession? *Review of Economics and Statistics*, 104(2), 246-258. https://doi.org/10.1162/rest_a_00957

Fatás, A. and Singh, S.R. (2024). Supply or demand? Policy makers' confusion in the presence of hysteresis. *European Economic Review*, 161, 104617. https://doi.org/10.1016/j.euroecorev.2023.104617

Fatás, A. and Summers, L.H. (2016). The permanent effects of fiscal consolidations. *Journal of International Economics*, 112, 238-250. https://doi.org/10.1016/j.jinteco.2017.11.007

Fedderke, J. (2004). Investment in fixed capital stock: Testing for the impact of sectoral and systemic uncertainty. *Oxford Bulletin of Economics and Statistics*, 66(2), 165-187. https://doi.org/10.1046/j.0305-9049.2003.00078.x

Fontana, G. and Palacio- Vera, A. (2007). Are long- run price stability and short- run output stabilization all that monetary policy can aim for? *Metroeconomica*, 58(2), 269-298. https://doi.org/10.1111/j.1467-999X.2007.00268.x

Fritsche, U. and Logeay, C. (2002). *Structural unemployment and the output gap in Germany: Evidence from an SVAR analysis within a hysteresis framework* (DIW Discussion Papers No. 312). Retrieved from https://www.econstor.eu/handle/10419/18047

Furlanetto, F., Lepetit, A., Robstad, Ø., Rubio-Ramírez, J. and Ulvedal, P. (2025). Estimating hysteresis effects. *American Economic Journal: Macroeconomics*, 17(1), 35-70. Retrieved from https://www.aeaweb.org/

Gali, J., Gertler, M. and Lopez-Salido, J.D. (2007). Markups, gaps, and the welfare costs of business fluctuations. *The Review of Economics and Statistics*, 89(1), 44-59. https://doi.org/10.1162/rest.89.1.44

Garga, V. and Singh, S.R. (2021). Output hysteresis and optimal monetary policy. *Journal of Monetary Economics*, 117, 871-886. https://doi.org/10.1016/j.jmoneco.2020.06.005

Girardi, D., Paternesi Meloni, W. and Stirati, A. (2020). Reverse hysteresis? Persistent effects of autonomous demand expansions. *Cambridge Journal of Economics*, 44(4), 835-869. https://doi.org/10.1093/cje/beaa009

Hansen, G.D. and Wright, R. (1998). The labor market in real business cycle theory. In J.E. Hartley, K.D. Hoover and K.D. Salyer (Eds.), *Real business cycles: A reader* (pp. 168-178). London: Routledge.

Hodrick, R.J. and Prescott, E.C. (1997). Postwar US business cycles: An empirical investigation. *Journal of Money, credit, and Banking*, 29(1), 1-16. https://doi.org/10.2307/2953682

Iacobucci, A. and Noullez, A. (2005). A frequency selective filter for short-length time series. *Computational Economics*, 25(1), 75-102. https://doi.org/10.1007/s10614-005-6276-7

IMF. (2009). *"What's the damage? medium-term output dynamics after financial crises.* Retrieved from https://www.bookstore.imf.org/books/financial-crises-causes-consequences-and-policy-responses

Inaba, M., Nutahara, K. and Shirai, D. (2020). *What drives fluctuations of labor wedge and business cycles? Evidence from Japan* (RISS Discussion Paper Series No. 89). Retrieved from https://www.kansai-u.ac.jp/riss/output/paper/pdf/RISS_DP_No89.pdf

Jordà, Ò., Singh, S.R. and Taylor, A.M. (2020). *The long-run effects of monetary policy* (NBER Working Paper No. w26666). Retrieved from https://www.nber.org/system/files/working_papers/w26666/w26666.pdf

Jump, R.C. and Levine, P. (2021). *Hysteresis in the New Keynesian three equation model* (University of Surrey Discussion Papers in Economics No. 0821). Retrieved from https://www.surrey.ac.uk/sites/default/files/2021-09/DP08-21.pdf

Kargi, B. (2024). Evidence of Turkey falling into the middle ıncome trap. *The Pakistan Development Review*, 63(3), 383-398. Retrieved from https://thepdr.pk/

Kienzler, D. and Schmid, K.D. (2014). Hysteresis in potential output and monetary policy. *Scottish Journal of Political Economy*, 61(4), 371-396. https://doi.org/10.1111/sjpe.12050

Kilian, L. (2013). *Structural vector autoregressions* (CEPR Discussion Paper No. DP8515). Retrieved from https://ssrn.com/abstract=1908563

King, R.G. and Plosser, C.I. (1982). *The behavior of money, credit, and prices in a real business cycle* (NBER Working Paper No. 853). Retrieved from https://www.nber.org/system/files/working_papers/w0853/w0853.pdf

Köberl, E.M. and Lein, S.M. (2011). The NIRCU and the Phillips curve: An approach based on micro data. *Canadian Journal of Economics/Revue Canadienne D'économique*, 44(2), 673-694. https://doi.org/10.1111/j.1540-5982.2011.01649.x

Lavoie, M. (2018). Rethinking macroeconomic theory before the next crisis. *Review of Keynesian Economics*, 6(1), 1-21. https://doi.org/10.4337/roke.2018.01.01

Leybourne, S., Newbold, P. and Vougas, D. (1998). Unit roots and smooth transitions. *Journal of Time Series Analysis*, 19(1), 83-97. https://doi.org/10.1111/1467-9892.00078

Li, J., Zhang, J., Gong, L. and Miao, P. (2015). Research on the total factor productivity and decomposition of Chinese coastal marine economy: Based on DEA-Malmquist index. *Journal of Coastal Research*, 73(10073), 283-289. https://doi.org/10.2112/SI73-050.1

Lucas, R.E. (1973). Some international evidence on output-inflation tradeoffs. *The American Economic Review*, 63(3), 326-334. Retrieved from https://www.jstor.org/

Ma, C., Rogers, J.H. and Zhou, S. (2020). *Modern pandemics: Recession and recovery* (SSRN Paper No. 3565646). http://dx.doi.org/10.2139/ssrn.3565646

Mankiw, N.G. (1989). Real business cycles: A new Keynesian perspective. *Journal of Economic Perspectives*, 3(3), 79-90. https://doi.org/10.1007/978-1-349-24002-9_18

Michl, T.R. (2018). Hysteresis in a three-equation model. *Eastern Economic Journal*, 44(2), 305-322. https://doi.org/10.1057/s41302-016-0083-9

Michl, T.R. and Oliver, K.M. (2019). Combating hysteresis with output targeting. *Review of Keynesian Economics*, 7(1), 6-27. https://doi.org/10.4337/roke.2019.01.02

Mishkin, F.S. (2017). Rethinking monetary policy after the crisis. *Journal of International Money and Finance*, 73, 252-274. https://doi.org/10.1016/j.jimonfin.2017.02.007

Mitchell, W.F. (1993). Testing for unit roots and persistence in OECD unemployment rates. *Applied Economics*, 25(12), 1489-1501. https://doi.org/10.1080/00036849300000153

Mourougane, A. (2017). Crisis, potential output and hysteresis. *International Economics*, 149, 1-14. https://doi.org/10.1016/j.inteco.2016.07.001

Oomes, N. and Dynnikova, O. (2006). *The utilization-adjusted output gap: Is the Russian economy overheating?* (IMF Working Paper No. 06/68). Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=898729

Orphanides, A., Porter, R.D., Reifschneider, D., Tetlow, R. and Finan, F. (2000). Errors in the measurement of the output gap and the design of monetary policy. *Journal of Economics and Business*, 52(1-2), 117-141. https://doi.org/10.1016/S0148-6195(99)00031-4

Ozturk, M. (2020). Validity of the unemployment hysteresis hypothesis in Turkey: Multidimensional and asymmetrical approach. *OPUS International Journal of Society Researches*, 15(1), 4882-4910. https://doi.org/10.26466/opus.725553

Parigi, G. and Siviero, S. (2001). An investment-function-based measure of capacity utilisation: Potential output and utilised capacity in the Bank of Italy's quarterly model. *Economic Modelling*, 18(4), 525-550. https://doi.org/10.1016/S0264-9993(00)00051-1

Pollard, S. (1964). Fixed capital in the industrial revolution in Britain. *The Journal of Economic History*, 24(3), 299-314. https://doi.org/10.1017/S0022050700060861

Redmond, M. and Van Zandweghe, W. (2016). The lasting damage from the financial crisis to US productivity. *Economic Review*, 101(1), 39-64. Retrieved from https://www.kansascityfed.org/

Romer, C.D. and Romer, D.H. (2017). New evidence on the aftermath of financial crises in advanced countries. *American Economic Review*, 107(10), 3072-3118. doi:10.1257/aer.20150320

Rowthorn, R. (1995). Capital formation and unemployment. *Oxford Review of Economic Policy*, 11(1), 26-39. https://doi.org/10.1093/oxrep/11.1.26

Setterfield, M. and Avritzer, J.D. (2020). Hysteresis in the normal rate of capacity utilization: A behavioral explanation. *Metroeconomica*, 71(4), 898-919. https://doi.org/10.1111/meca.12307

Solow, R. (2000). *Unemployment in the United States and in Europe-A contrast and the reasons* (CESifo Working Paper No. 231). Retrieved from https://www.econstor.eu/bitstream/10419/75622/1/cesifo_wp231.pdf

Stiglitz, J. (2018). The myth of secular stagnation. *Project Syndicate*, 28, 1-3. Retrieved from https://www.economics.utoronto.ca/

Summers, L.H. (2014). US economic prospects: Secular stagnation, hysteresis, and the zero lower bound. *Business Economics*, 49(2), 65-73. https://doi.org/10.1007/978-1-137-57251-6_38

Tekin, İ. (2018). Unemployment hysteresis in Turkey: Stationarity tests with Fourier functions. *İzmir Journal of Economics*, 33(1), 97-127. https://doi.org/10.24988/deuiibf.2018331685

Tervala, J. (2021). Hysteresis and the welfare costs of recessions. *Economic Modelling*, 95, 136-144. https://doi.org/10.1016/j.econmod.2020.12.012

Tervala, J. and Watson, T. (2022). Hysteresis and fiscal stimulus in a recession. *Journal of International Money and Finance*, 124, 102614. https://doi.org/10.1016/j.jimonfin.2022.102614

Van Aarle, B. (2016). Secular stagnation: Insights from a New Keynesian model with hysteresis effects. In G.D. Bartolomeo and E. Saltari (Eds.), *Theoretical foundations of macroeconomic policy: Growth, productivity and public finance.* London: Routledge.

Wong, B. (2017). *Historical decompositions for nonlinear vector autoregression models* (CAMA Working Papers No. 62/2017). Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3057759

Yellen, J.L. (2015). *The outlook for the economy: A speech at the Providence Chamber of Commerce, Providence, Rhode Island.* Retrieved from https://ideas.repec.org/p/fip/fedgsq/851.html

Zarnowitz, V. (1991). *What is a business cycle?* (NBER Working Paper Series No. 3863). Retrieved from https://www.nber.org/system/files/working_papers/w3863/w3863.pdf

Zivot, E. (2000). *Notes on structural VAR modeling.* Retrieved from https://www.eco.uc3m.es/~jgonzalo/teaching/timeseriesma/zivotvarnotes-reading.pdf

Zivot, E. and Andrews, D.W.K. (2002). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of Business & Economic Statistics*, 20(1), 25-44. https://doi.org/10.1198/073500102753410372