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Chronic Excess Capacity and Unemployment Hysteresis in EU Countries. A Structural Approach.

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Abstract: We develop a structural method for identifying the unobservable rate of capacity utilization in 14 EU countries, by simultaneously estimating the coefficients of a production function, an investment function, a labor productivity function and an unemployment function. Our results provide evidence of chronic underutilization of productive capacity and hysteresis in unemployment, especially after the 2008' financial crisis. We show that our series of the rate of capacity utilization are significant predictors of capacity accumulation, productivity growth and unemployment rates. Moreover, they predict inflation as efficiently as the DG ECFIN series of capacity utilization and output gaps.

Keywords: Capacity utilization, Potential GDP, Output gap, Hysteresis

JEL codes: C51, E22, E32

1. Introduction

Potential output and the *output gap* are two theoretical concepts representing the core of modern economic policy theory in standard textbooks (Taylor, 2000). Moreover, most international institutions, including the International Monetary Fund (IMF), the Organization for Economic Co-operation and Development (OECD) and the European Commission (EC), rely extensively on these concepts to build theoretical and empirical models for forecasts and policy recommendations (De Masi, 1997; Havik et al, 2014; Chalaux & Guillemette, 2019).

Potential output and the output gap are theoretical and unobservable concepts that reflect the full capacity output of firms and the degree of utilization of the productive capacity in place. Following the *engineering* approach, the productive capacity of a firm consists of the full-utilization of the productive capital stock in place, which implies running machines 24 hours a day and 365 days a year (Perry, 1973; Shapiro, 1989). By taking into account technological constraints and necessary shutdown periods due to regular maintenance, full capacity output, or *engineer-rated capacity* (Eichner, 1976; Lavoie, 2014), corresponds to a *normal* rate of utilization of the productive capacity in place. Hence, the output gap is the gap between the actual rate of capacity utilization – which is the ratio of current output to the productive capacity – and the *normal* rate of capacity utilization, relative to this latter. Following the *economic* approach, full capacity output is defined as the *desired* or *optimal* level of output of a cost-minimizing firm, which is generally lower than the *engineering* normal output. In this approach, the output gap is defined as the gap between the current rate of capacity utilization and the economically optimal rate of utilization, relative to this latter (Winston, 1974; Nelson, 1989).

Most methods for estimating potential output and the output gap assume that real output fluctuates around full-capacity output. This allows identifying full-capacity output following three alternative strategies (Cerra & Saxena, 2000; Ladiray et al, 2003): 1) Business surveys that investigate the fluctuations of the rate of capacity utilization around the *normal* rate; 2) Statistical methods that extrapolate the unobservable potential output out of the observed real output; 3) Structural methods that identify potential output out of estimated theoretical models.

In this paper, we develop a structural method for estimating the rate of capacity utilization in 14 EU countries, without assuming that output fluctuates around full-capacity output, in order to verify *ex post* whether the excess capacity observed in most industries (Crotty, 2002; Haugh et al, 2010; de Carvalho et al, 2015) is merely a sectoral self-adjusting pattern, or an aggregate persistent outcome. Partially inspired by the production function methodology (Havik et al, 2014), we identify the parameters of a production function by simultaneously estimating the coefficients of an aggregate theoretical model that relates the rate of capacity utilization to a set of macroeconomic variables, namely the rate of capacity accumulation, the rate of growth of labor productivity and the rate of unemployment. We show that our method allows detecting persistent underutilization of capacity that standard methods neglect by construction. We also show that our method is internally and externally consistent. Namely, our series of the rate of capacity utilization explain significantly the internal variables – capacity accumulation, productivity growth and the unemployment rate. Moreover, they explain the rate of inflation as efficiently as official estimates provided by the European Commission.

The structure of the paper is as follows. In section 2, we retrace the literature on structural and non-structural methods for estimating capacity output, capacity utilization and the output gap. In section 3, we present our original method. In section 4, we illustrate the results and test both internal and external consistency. In section 5, we briefly discuss the theory and the policy implications of chronic excess capacity. In section 6, we conclude.

2. Capacity utilization and full capacity output

We identify three macro classes of methods for estimating full capacity output and the output gap: business surveys, *statistical* or *non-structural* methods, and *structural* or *economic* methods (Cerra & Saxena, 2000; Ladiray et al, 2003).

2.1 Business surveys

The Federal Reserve Board and the Directorate General for Economic and Financial Affairs (DG ECFIN) of the European Commission (EC) provide regular estimates of the rate of capacity utilization in the US and the EU Member states, respectively, by means of business surveys. The business surveys (BS) methodology consists of sending questionnaires to firms' managers in order to obtain qualitative and quantitative measures of a large variety of indicators, including firms' productive capacity and capacity utilization (Perry, 1973; Shapiro, 1989; OECD, 2003). In order to reconcile the engineering definition of capacity utilization with an economic approach, questionnaires suggest managers to refer to what they consider a *normal* business activity, and to define their current level of activity in reference to this normal benchmark, either in percentage (X% of normal capacity) or in qualitative (below normal, normal or above normal) terms.

Although largely diffused, this methodology has important drawbacks. What managers consider a normal production at the time they answer the survey does not necessarily correspond to what they considered normal in the past, or what they would consider normal in the future. Most managers explicitly refer to an average of past observed business activity to define what they consider as a normal business activity (Ragan, 1976; OECD, 2003; Brierley et al, 2006). Hence, managers' self-assessed and time-dependent normal production cannot be a consistent indicator or proxy for an aggregate measure of productive capacity that is supposed to be a stable attractor. Furthermore, because persistent periods of reported *abnormal* utilization are supposed to reflect over- or under-optimism of respondents, the series are either de-trended or adjusted in order to remove artificially any emerging pattern of chronic underutilization of productive capacity (Shapiro, 1989; OECD, 2003; Nikiforos, 2016). Consequently, the rate of capacity utilization fluctuates around an artificial stationary trend and reveals cyclical biases and *lost-and-found effects*: the artificial anti-cyclicality of capacity utilization generates an artificial and unrealistic pro-cyclicality of productive capacity, which as quickly as it disappears during downswings it re-appears during recoveries (Perry, 1973; Shapiro, 1989).

2.2 Statistical or non-structural methods

Statistical or non-structural methods consist of estimating full-capacity output by means of de-trending techniques aiming at identifying the unobserved trend and cyclical components out of an observed time-series. These models are not exactly a-theoretical, as they assume that actual output systematically gravitates around – or anyway tends to – full-capacity output because of endogenous mechanisms that rule out persistent under or overutilization of productive capacity. Nevertheless, they do not explicitly mobilize any business cycle or growth model to identify these unobserved components, but they refer to stylized statistical patterns of aggregate time series – namely, co-variance and non-stationarity – as a guidance to identify unobservable components out of observable time series. To say it with Sargent & Sims (1977), the aim is "modelling without pretending to have too much a priori economic theory". In the end, full-capacity output is a more or less sophisticated statistical trend of observed output. We identify four classes of statistical models.

The output-capital ratio

This method consists of extrapolating a trend and cyclical component out of the observed output-capital ratio, whereby the trend component is supposed to capture Solow-neutral technical progress and the cyclical component is supposed to capture the rate of capacity utilization. A basic application of this model implies assuming that Solow-neutral technical progress is a linear time process, by simply regressing the output-capital ratio on time and taking the residuals as the cyclical component (Santeusanio & Storti, 2002). A slightly more complex application consists of assuming that Solow-neutral technical progress is a function of the capital stock in place plus a stochastic component. In this case, the log of the output-capital ratio is regressed on both time and the log of capital stock. Hence, the rate of capacity utilization is equal to the stochastic component of this linear process net of the stochastic component of Solow-neutral technical progress (Shaikh & Moudud, 2004). A third solution consists of simply de-trending the output-capital ratio through a standard Hodrick-Prescott filter and taking the gap between the observed value and the filtered series as the rate of utilization (Franke, 2017).

The Wharton method

The Wharton method, or peak-to-peak method, starts from the assumption that output always converges to full-capacity output, and that historical peaks of actual output reflect periods of full-utilization of capacity (Perry, 1973; Klein & Long, 1973; Shapiro, 1989). The method consists of interpolating linearly the historical peaks of observed GDP such that the emerging *kinked* series represent the full-capacity output series. The rate of capacity utilization, or output gap, is the difference between full capacity output and actual output relative to the former.

The linear de-trending or filtering methods

These methods consist of de-trending output time series by assuming that potential output follows a deterministic linear trend, thus simply regressing observed output on time, or by assuming that it follows a time-varying trend, thus filtering the series through a standard Hodrick-Prescott filter (Ladiray et al, 2003). Therefore, the output gap is a stochastic zero-mean variable that takes both positive and negative values. With respect to methods based on the output-capital ratio, there is no assumed relationship between output and capital stock. In other words, the only information that these methods require is limited to the set of statistical properties of the series of actual GDP.

The Beveridge-Nelson decomposition and univariate unobservable components

A fourth class of statistical models consists of identifying the unobserved trend and cyclical components out of observable output series, by assuming a pre-determined auto-correlation or correlation structure between trend and cycle (Cerra & Saxena, 2000). The Nelson-Beveridge decomposition method implies assuming that the unobserved permanent and temporary components of output follow two dependent, auto-regressive moving average (ARMA) processes, such that real output can be decomposed into a deterministic trend, a stochastic trend and a cyclical component. Univariate unobservable components methods follow the same approach, although the deterministic trend disappears and the remaining stochastic trend and cyclical components follow two independent stochastic processes.

The main advantage of statistical methods is their simplicity, as the set of information required is extremely parsimonious. The extreme simplicity, however, comes at the cost of their theoretical consistency and explanatory power, as they do not process any theoretical information for estimating potential output. Namely, although they are extremely sensitive to the smoothing parameters of the filtered series or to the specific hypothesis about the statistical properties of the unobservable components, there is no theoretical guidance behind the choice of these parameters or the choice of the stochastic process. Moreover, and this is especially true for the Wharton method and the HP filters, they are highly sensitive to end-sample observations, such that recent periods that were initially identified as periods of underutilization might easily turn into periods of full or over-utilization of capacity as new observations add up to the observed GDP series (Cerra & Saxena, 2000). Conversely, periods of full capacity utilization might quickly turn to into periods of weak recovery, or *weak peaks* (Klein & Long, 1973).

2.3 Economic or structural methods

Economic methods – as opposed to statistical methods – consist of identifying full capacity output by setting and estimating, through more or less complex econometric techniques, a structural theoretical model. Hence, full capacity output is a theoretical concept clearly defined by the structure of macroeconomic causalities implied in the theoretical model, rather than a simple statistical trend. To put it differently, these methods do not simply extrapolate an unobserved statistical trend out of an observed time-series, but they rather estimate a theoretical unobserved correlation structure among observed and unobserved variables. With respect to statistical models, which all define full capacity output as a *statistical trend*, economic models provide different definitions – hence, different estimates – of potential output according to the specific theoretical model used. We identify five classes of economic or structural models.

The Okun's model

By introducing and defining the concept of *Potential Gross National Product*, or potential GNP, as the level of GNP consistent with full employment, Arthur Okun developed the first prototype of structural method (Okun, 1962). After assuming a linear relationship between the output gap and the rate of unemployment, he regressed this latter (U_t) on the percentage gap between Gross National Product (GNP_t) and its time trend, in order to estimate the coefficients of this linear relationship. Then, after approximating the estimated full-employment rate (α_0) to 4%, he identified the output gap out of the gap between the rate of unemployment and 4%:

$$\begin{cases} U_t = \alpha_0 + \alpha_1 (\frac{GNP^{trend}}{GNP} - 1) + \varepsilon_t \\ \frac{GNP^p}{GNP} - 1 = 0{,}032(U_t - 4) \end{cases} \quad (1)$$

Recent updates of Okun (1962) account for time-varying potential GNP and full employment, or for structural breaks in the linear relationship (Ball et al, 2017; Fontanari et al, 2019).

The Non-accelerating inflation rate of unemployment (NAIRU) or utilization (NAIRCU)

Franco Modigliani and Lucas Papademos, who first introduced and defined the concept of Non-Inflationary Rate of Unemployment (NIRU), suggested a linear and stable relationship between unemployment and inflation, such that there exists a unique rate of unemployment, the NIRU, implying stable inflation (Modigliani & Papademos, 1975). By opposing Okun's hypothesis that potential output is the level of output consistent with an exogenously defined minimum rate of unemployment, they suggested to think of potential output as the level of output consistent with the NIRU. Since then, a large literature tried to fine-tune the relationship between unemployment and inflation in order to identify the most significant Non-accelerating inflation rate of unemployment (NAIRU) (Gordon, 1997). An alternative but complementary approach consists of replacing the rate of unemployment with the rate of capacity utilization, in order to identify a Steady-inflation or Non-accelerating inflation rate of capacity utilization (SIRCU/NAIRCU) (McElhattan, 1978, 1984; Nahuis, 2003). Both approaches are econometrically equivalent. Namely, they both consist of identifying the rate of unemployment or capacity utilization consistent with steady inflation (U^*), by regressing changes of the rate of inflation ($\Delta\pi_t$) on past values ($\sum_{j=1}^{n}\zeta_j\Delta\pi_{t-j}$), on supply-side variables ($\sum_{i=1}^{m}\gamma_i Z_{i,t}$), such as changes in oil price or unit labor costs inflation, and on the observed rate of unemployment or utilization (U_t). In these models, the rate of capacity utilization comes from business surveys.

$$\begin{cases} \Delta\pi_t = \alpha_0 + \beta U_t + \sum_{i=1}^{m}\gamma_i Z_{i,t} + \sum_{j=1}^{n}\zeta_j\Delta\pi_{t-i} + \varepsilon_t \\ U^* = -\frac{\alpha_0}{\beta} \end{cases} \quad (2)$$

The minimum costs, normal rate of capacity utilization

Based on the neoclassical theory of costs and production (Klein, 1960; Hickman, 1964), full capacity output is the level of output that corresponds to the minimum point in the Short-run average total cost curve (SRATC) or, alternatively, to the point of tangency of the SRATC with the Long-run average total cost curve (LRATC) (Berndt & Hesse, 1986; Nelson, 1989). This method requires defining a variable costs function (*VC*) that is concave in capital (K) and output (Q), such that there exists an optimal level of output (Q^n) that minimizes the SRATC and an optimal level of capital (K^n) such that the derivative of the SRATC with respect to the capital stock is equal to the price of capital (*r*). This last condition implies that the firm has no incentive to add up a marginal unit of capital beyond the optimal level of capital, because the reduction in costs due to economies of scale is lower than the price of the marginal unit of capital invested. In Q^n and K^n, the SRATC and the LRATC are tangent.

$$\begin{cases} SRATC = \frac{VC}{Q^n} + \frac{r*K^n}{Q^n} \\ \frac{\partial SRATC}{\partial Q^n} = 0 \\ \frac{\partial SRATC}{\partial K^n} = r \end{cases} \quad (3)$$

The Structural vector auto-regressive (SVAR) models

A fourth class of models consists of identifying potential output and the output gap out of a Vector auto-regressive (VAR) model (Blanchard & Quah, 1989; Clarida & Gali, 1994; Cerra & Saxena, 2000; Dergiades & Tsoulfidis, 2007). Based on the new Keynesian theoretical framework, the simplest version of this method consists of a three equations model represented in a VAR form, whereby the three endogenous variables are the variation of the rate of growth of output (Δy_t), the variation of the real exchange rate (Δr_t) and the inflation rate (π_t). We can thus represent the three variables as a function of the residuals (u^y, u^r, u^p), with $\mathrm{A(L)} = (\mathrm{I} - A_1 L^1 - A_2 L^2 - \cdots - A_p L^p)$. I is the identity matrix and L the lag operator:

$$\begin{vmatrix} \Delta y_t \\ \Delta r_t \\ \pi_t \end{vmatrix} = A(L)^{-1} \begin{vmatrix} u^y \\ u^r \\ u^p \end{vmatrix} = R(L) \begin{vmatrix} u^y \\ u^r \\ u^p \end{vmatrix} = I \begin{vmatrix} u^y \\ u^r \\ u^p \end{vmatrix}_t + R(1) \begin{vmatrix} u^y \\ u^r \\ u^p \end{vmatrix}_{t-1} + R(2) \begin{vmatrix} u^y \\ u^r \\ u^p \end{vmatrix}_{t-2} + \cdots \tag{4}$$

By assuming that these unexplained residuals depend, respectively, on unobservable supply shocks (ε^y), unobservable real exchange rate shocks (ε^r) and unobservable inflation shocks (ε^p), orthogonal by assumption, and assuming a linear and stable relationship between the reduced form residuals and the structural shocks, we obtain the *structural* model:

$$\begin{vmatrix} u^y \\ u^r \\ u^p \end{vmatrix}_t = S \begin{vmatrix} \varepsilon^y \\ \varepsilon^r \\ \varepsilon^p \end{vmatrix}_t = \begin{vmatrix} S_{11} & S_{12} & S_{13} \\ S_{21} & S_{22} & S_{23} \\ S_{31} & S_{32} & S_{33} \end{vmatrix} \begin{vmatrix} \varepsilon^y \\ \varepsilon^r \\ \varepsilon^p \end{vmatrix}_t \tag{5}$$

Three restrictions are necessary to identify the coefficients of S. The standard approach consists of imposing that structural shocks to inflation and the real exchange rate ($\varepsilon^p, \varepsilon^r$) do not affect output directly, and that nominal inflationary shocks do not even affect the real exchange rate, thus coefficients S_{12}, S_{13} and S_{23} are set to zero (Clarida & Gali, 1994). After defining potential output as the supply-side component of observed output, the sequence of potential output changes is thus directly derived from the series of the structural supply shocks:

$$\Delta y_t{}^S = S_{11}\varepsilon^y + R_{11}(1)S_{11}\varepsilon^y{}_{t-1} + R_{11}(2)S_{11}\varepsilon^y{}_{t-2} + \cdots \tag{6}$$

The Production function methodology (PFM)

The Production function methodology (PFM), which is the reference methodology for international institutions including the International Monetary Fund (IMF), the Organization for Economic Co-operation and Development (OECD) and the European Commission (EC), is an efficient synthesis of business surveys, non-structural and structural approaches. The PFM of the European Commission (Havik et al, 2014) consists of estimating a Cobb-Douglas production function using aggregate series of the capital stock (*K*), aggregate series of the level of employment (L) and the residual total factor productivity (*TFP*). The TFP, on its hand, is decomposed into a structural trend ($E_L{}^\alpha E_K{}^{1-\alpha}$), which captures factors' technological efficiency, and a cyclical component ($u_L{}^\alpha u_K{}^{1-\alpha}$), which captures cyclical fluctuations in factors' degree of utilization, using a Kalman filter.

$$\begin{cases} Y = TFP * L^{\alpha} K^{1-\alpha} \\ TFP = (E_L u_L)^{\alpha} (E_K u_K)^{1-\alpha} \end{cases} \quad (7)$$

Potential output is thus defined as the level of output consistent with full utilization of capital ($u_K = 1$), full utilization of labor ($u_L = 1$), potential labor ($L = L_p$), which is the level of employment corresponding to the NAIRU, and the structural trend of total factor productivity:

$$Y^P = \left(E_L{}^{\alpha} E_K{}^{1-\alpha}\right) L_p{}^{\alpha} K^{1-\alpha} \quad (8)$$

Although structural methods are far more complex with respect to statistical methods, as they require processing a larger information that goes beyond the statistical properties of the observed output series, they nonetheless provide a measure of full-capacity output that allows a direct economic interpretation. The PFM, in particular, provides empirical estimates of potential output that are fully consistent with the new-Keynesian growth theory, based on factors substitutability and total factor productivity, and with the new-Keynesian labor market theory, based on the concept of NAIRU and the expectations-augmented Phillips curve. The NAIRU or NAIRCU measures of capacity output provide a direct information about the relationship between demand and inflation, which might be useful to monetary authorities targeting inflation stability. The Okun's law, on the other hand, provides a useful information between output growth and unemployment, which might be useful to monetary and budgetary authorities targeting full employment. Hence, so long as estimating potential output serves to provide monetary and fiscal authorities with information about the productive capacity or the inflation barrier of a country, it might be preferable to provide a measure of potential output consistent with a robust theoretical model rather than simply de-trending output or referring to surveyed measures of *normal* capacity. Furthermore, with respect to statistical methods, structural methods turn out to be less sensitive with respect to latest information and new observations, thus providing more stable predictions (Cerra & Saxena, 2000).

The most sensitive issue with structural methods is the choice of the theoretical model. Models that identify potential output out of a single relationship between output and unemployment (Okun, 1962; Ball, et al, 2017; Fontanari et al, 2019), capacity utilization and inflation (McElhattan, 1978, 1984; Nahuis, 2003), capacity utilization and variable costs (Berndt & Hesse, 1986; Nelson, 1989) or output and investments (Parigi & Siviero, 2001), are highly sensitive to the specification and the stability of the assumed relationship. The SVAR approach is highly sensitive to the assumption that structural shocks are uncorrelated and perfectly identifiable as purely supply or purely demand shocks, while it is practically impossible to identify real shocks that conform to these assumptions (Cerra & Saxena, 2000). Both the SVAR and the production function approaches assume that demand shocks are neutral in the long term, such that output residuals reflect *ontologically* exogenous supply shocks, ruling out *hysteresis effects* (Blanchard & Summers, 1986; Ball, 2009, 2014; Jump & Stockhammer, 2019).

The assumption of demand neutrality, which implies that output naturally gravitates around an exogenous full capacity output, is common to business surveys, statistical models and most structural models. Nevertheless, when we abstract for this assumption, we do find evidence of persistent underutilization of capacity (Berndt & Hesse, 1986; Fontanari et al, 2019). The method that we propose in the next section addresses explicitly this issue. Because statistical models cannot, by construction, account for persistent underutilization of productive capacity, we propose a structural method for estimating the rate of capacity utilization that does not assume that real output gravitates around full capacity output. The aim is to verify *ex post* if this assumption is reasonable enough, or if we should consider chronic underutilization of productive capacity as an endogenous and aggregate outcome.

3. Estimating the rate of capacity utilization in EU countries

3.1 The methodology

Our methodology finds inspiration from the structural approaches presented in the previous section. To estimate the rate of capacity utilization, we identify the parameters of a production function by simultaneously estimating, through standard econometric techniques, the coefficients of a theoretical model that we assume *true* and correctly specified. The estimation procedure follows the method of the *simulated minimum distance* (SMD), which is typically used for calibrating computational models (Grazzini & Richiardi, 2015). As a first step, we give arbitrary values to the parameters of a fixed coefficients production function (namely, the capacity-to-capital ratio and the depreciation rate) in order to obtain the initial series of the rate of capacity utilization and capacity accumulation (section 3.2). As a second step, we plug these series into our system of linear equations (an investment function, a labor productivity function and an unemployment function) and estimate the coefficients through standard OLS estimators (section 3.3). As a third and last step, we define and compute an objective function based on the R^2 and the t-values of the OLS estimators. Then, we let an optimizing algorithm changing the initial parameters of the production function (step 1), re-estimating the coefficients of the theoretical model (step 2) and re-computing the objective function (step 3) to find the parameters that maximize the objective function (section 3.4).

3.2 Defining productive capacity and capacity utilization

We define the rate of capacity utilization as the ratio of current output Y to the productive capacity in place Y^p, such that $0 \leq u \leq 1$.

$$u = \frac{Y}{Y^p} \quad (9)$$

We also define the productive capacity Y^p as the level of output consistent with a full utilization of the capital stock in place, and make the "heroic assumption" (Domar, 1946) that the productive capacity generated by an additional unit of capital goods invested is constant over time. This implies that changes in the productive capacity reflect changes in the capital stock:

$$\frac{\Delta Y^p}{Y^p} = \frac{\Delta K}{K} \quad (10)$$

Hence, the ratio of the productive capacity to the capital stock, v, is fixed:

$$\frac{Y^p}{K} = v \quad (11)$$

To estimate the unobserved productive capacity, which is a function of the unobserved capital stock, we use the Perpetual Inventory Method (PIM) (OECD, 2009). The PIM consists of computing the current stock of capital by adding past investment to past capital stock, net of capital depreciation. We follow the standard assumption of geometric capital depreciation and assume that in every period a fixed proportion δ of the past capital stock K_{t-1} is scrapped:

$$Dep_t = \delta K_{t-1} \quad (12)$$

We thus derive capital accumulation as a function of the observed investment rate *I/Y*, the two unknown parameters v and δ, and the past rate of capacity utilization u_{t-1}:

$$\widehat{K}_t = \frac{\Delta K_t}{K_{t-1}} = \frac{I_{t-1} - \delta K_{t-1}}{K_{t-1}} = \frac{I_{t-1}}{K_{t-1}} - \delta = \left(\frac{I_{t-1}}{Y_{t-1}} \frac{Y_{t-1}}{Y^p{}_{t-1}} \frac{Y^p{}_{t-1}}{K_{t-1}}\right) - \delta = \left(\frac{I_{t-1}}{Y_{t-1}} u_{t-1} v\right) - \delta \quad (13)$$

Then, by applying a logarithmic transformation of equation (9), and plugging equation (13) into equation (10), we derive the rate of change of the rate of capacity utilization:

$$\hat{u}_t = \frac{\Delta u_t}{u_{t-1}} = \frac{\Delta Y_t}{Y_{t-1}} - \frac{\Delta Y^p{}_t}{Y^p{}_{t-1}} = \frac{\Delta Y_t}{Y_{t-1}} - \frac{\Delta K_t}{K_{t-1}} = \frac{\Delta Y_t}{Y_{t-1}} - \left(\frac{I_{t-1}}{Y_{t-1}} u_{t-1} v\right) + \delta \quad (14)$$

Which implies that:

$$u_t = u_{t-1}(1 + \hat{u}_t) \tag{15}$$

By setting for simplicity u_0=1, the rate of capacity utilization comes down to a function of the observed real GDP growth rate ($\Delta Y_t / Y_{t-1}$), the observed investment rate (I_{t-1}/Y_{t-1}) and two unknown parameters that we need to estimate: the ratio of the productive capacity to the productive capital stock (v) and the depreciation rate (δ).

3.3 The theoretical model

To estimate the unknown parameters of the production function, v and δ, we set a simplified system of OLS equations that captures the theoretically (and empirically) acknowledged correlations between capacity utilization, capital accumulation, labor productivity and unemployment. The first equation aims at capturing the theoretically and empirically acknowledged interaction between output growth and labor productivity growth, also called *Kaldor-Verdoorn law* (Kaldor, 1966; McCombie & De Ridder, 1984; Verdoorn, 2002; Castiglione, 2011; Millemaci & Ofria, 2014). However, following Stockhammer & Onaran (2004), we split output growth into the capacity accumulation and the capacity utilization components, which we estimate separately. The intuition is that capital accumulation explains labor productivity growth through the introduction of new vintages of capital goods, which embed a more efficient technology, while the rate of capacity utilization explains labor productivity growth by capturing economies of scale. If we also account for *learning by doing* (Arrow, 1962), we formalize labor productivity growth as a linear function of current and past capacity utilization, current and past capacity accumulation and past labor productivity growth:

$$\hat{A}_t = \frac{\dot{A}}{A} = \alpha_1 + \alpha_2 \hat{A}_{t-1} + \alpha_3 \hat{K}_t + \alpha_4 u_t + \alpha_5 \hat{K}_{t-1} + \alpha_6 u_{t-1} + \varepsilon_t \tag{16}$$

The second equation aims at capturing the theoretically and empirically acknowledged relationship between output growth and unemployment, also called *Okun's Law* (Okun, 1962; Santacreu, 2016; Ball et al, 2017; Fontanari et al, 2019). Again, following Stockhammer & Onaran (2004), we consider capacity accumulation and capacity utilization separately, in order to isolate their specific effects on unemployment. The intuition is that changes in the capital stock might require additional employees to work at additional machines so long as labor and capital are at least partially complementary, while changes in the rate of utilization might lead at first to changes in the working time before varying the number of employees. Therefore, the effect on unemployment might be different in the two circumstances. In order to capture plausible *hysteresis effects*, we formalize current unemployment as a function of current and past capacity utilization, current and past capital accumulation and past unemployment:

$$U_t = \beta_1 + \beta_2 U_{t-1} + \beta_3 \widehat{K}_t + \beta_4 u_t + \beta_5 \widehat{K}_{t-1} + \beta_6 u_{t-1} + \mu_t \qquad (17)$$

The third equation aims at capturing the theoretically and empirically acknowledged relationship between output growth and investments, according to the accelerator principle (Hickman, 1957; Smyth, 1964; IMF, 2015; Kopp, 2018), which we normalize for the capital stock in order to obtain a classical accumulation function that relates capacity accumulation to capacity utilization (Rowthorn, 1981; Dutt, 1984). The rationale is that positive or negative changes in the rate of capacity utilization push firms to accumulate capacity faster or slower in order to, respectively, expand capacity constraints or scrap idle capacity. Hence, by accounting for persistency effects, we formalize the current rate of capital accumulation as a function of the past and current rate of capacity utilization and the past rate of capital accumulation:

$$g^K{}_{t+1} = \frac{I_t}{K_t} = \gamma_1 + \gamma_2 \frac{I_{t-1}}{K_{t-1}} + \gamma_3 u_t + \gamma_4 u_{t-1} + \Phi_t \qquad (18)$$

The endogenous variable of equation (18) is unobservable, and this might lead to estimation biases. To avoid this, we transform the left hand side into the observable investment rate $(I/Y)_t$ by multiplying both the left and the right hand sides of equation (18) for the capital output ratio (K_t/Y_t), which – combining equations (11) and (9) – is equal to $(vu_t)^{-1}$. After simple algebra (see appendix A2), we obtain the normalized OLS equation:

$$\frac{I_t}{Y_t} = \gamma'_1 + \gamma'_2 \left(\frac{I_{t-1}}{Y_{t-1}} \frac{u_{t-1}}{u_t}\right) + \gamma'_3 u_t{}^{-1} + \gamma'_4 \frac{u_{t-1}}{u_t} + \Phi'_t \qquad (18’)$$

Our baseline theoretical model is thus composed of the three equations (16), (17) and (18), whereby equation (18) is transformed into (18’) before estimation. Nevertheless, to test the sensitivity of the method with respect to the theoretical model, we also consider alternative specifications by adding to our simplest, baseline model additional variables. Table 1 reports the four theoretical models that we explored.

[Table 1]

The first model is thus the simplest, baseline model composed of equations (16) to (18). In the second model, we add real wage growth as a further explanatory variable of labor productivity growth, in order to capture the Webb effect (Webb, 1914). The Webb effect suggests that higher real wages positively affect labor productivity because of a higher incentive for firms to select workers that are more productive and a higher incentive for workers to increase the quality of their work. This is consistent with the more recent literature on efficiency wages (Shapiro & Stiglitz, 1984), which underlines the positive effects of higher real wages on workers labor effort and productivity. We also add real unit labor costs (the wage share) in the unemployment equation, in order to capture the negative effect – which is standard in new-Keynesian NAIRU models – of higher real wages on firms hiring decisions, after accounting for labor productivity (Stockhammer & Onaran, 2004). Furthermore, we add the profit share in the investment equation to capture the positive effect of higher profits out of income on investment decisions (Badhuri & Marglin, 1990). In the third model, we start from model 2 but change the labor productivity function, by substituting the real wage growth with the organization effect and the Ricardo effect (Sylos Labini, 1983; 1995). The organization effect assumes that firms target a constant mark-up. Hence, an increase in real unit labor costs will induce firms to adopt a more efficient labor organization, in order to increase labor productivity and re-establish the targeted mark-up. The Ricardo effect assumes that labor productivity growth depends on the cost of labor relative to the cost of capital goods. If wages run faster than capital goods prices, such that labor becomes more expensive relative to capital, firms will invest in labor saving techniques that increase labor productivity. If, on the other hand, capital goods prices run faster than nominal wages, such that labor becomes cheaper relative to capital, firms invest less in labor saving techniques by slowing down labor productivity growth. In the fourth and last model, we start from model 3 and add the real interest rate in the investment function, in order to account for the negative effect of a higher interest rate on firms' investment decisions (Keynes, 1936). As we show in Appendix A4, however, changing the theoretical specification of the model does not have any relevant effect on the parameters of the production function and the dynamics of the rate of capacity utilization. We interpret this result as an evidence of the correct specification of our baseline model, which already provides consistent estimates of the rate of capacity utilization. We thus refer to the baseline model to estimate capacity utilization.

3.4 The objective function and the estimation procedure

The last step of the estimation procedure consists of identifying the *true* parameters of the production function using the non-linear Generalized Reduced Gradient (GRG) algorithm (Lasdon et al, 1974). The method is straightforward. We first give arbitrary values to the production function's parameters v and δ in order to obtain initial time-series of the rate of capacity utilization and the rate of capital accumulation (section 3.2). We then plug these initial series into the system of three equations to estimate the linear OLS coefficients (section 3.3). Finally, we define an objective function that aims at capturing the statistical significance of the theoretical model and use the GRG algorithm to find the vector (v^*, δ^*) that maximizes the objective function. We define our objective function as an increasing function of the three R^2 and the sixteen t-statistics of the OLS estimators of (16), (17) and (18'):

$$Q(v, \delta) = \alpha \sum_{i=1}^{3} (R^2(\mathrm{v}, \delta)_i * 100) + (1 - \alpha) \sum_{j=1}^{16} t(\mathrm{v}, \delta)_j \quad (19)$$

Hence, the GRG algorithm finds the vector $(v^*, \delta^*) = \text{argmax } Q(v, \delta)$. Since $Q(v, \delta)$ is a non-linear function of v and δ, we set different initial values (v_0, δ_0) in order to explore all local *maxima* and retain the one with the highest value of the objective function among those who have an economic meaning[1]. We also explore the sensitivity of the objective function by testing different values of α, ranging from 0 to 1. We find that the estimated parameters are relatively stable when $\alpha \leq 0.5$, while they tend to change significantly when the R^2 becomes the main or unique maximizing argument of the objective function ($\alpha \geq 0.5$). Nevertheless, for some values of α we could not find meaningful estimates of v and δ. For this reason, we set $\alpha = 0.5$ for all countries except in those few where we could not find meaningful estimates. In these cases, we set the value of α closer to 0.5. See appendix A3 for further details.

4. Results

4.1 Chronic excess capacity in EU

We apply the methodology described in section 3 to 14 EU countries. As shown in figure 1, in most countries our series broadly co-evolve with the DG ECFIN's series of capacity utilization (*DG CU*) and output gaps (*DG OG*), which are obtained respectively through business surveys and through the Production function methodology, although our series display a larger volatility. Moreover, our series show that the rate of capacity utilization does not gravitate around a unique and stable long-run trend but rather around a multiplicity of medium-run trends, capturing patterns of persistent underutilization of productive capacity. If we focus on the decade following the 2008' financial crisis, we can clearly distinguish different trends.

[Figure 1]

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[1] Some local maxima imply a vector (v^*, δ^*) with abnormal values, such as a depreciation rate equal to 0 or larger than 1. To avoid as much as possible an arbitrary selection of "economically meaningful" results, we accept depreciation rates from 1% to 40% and capacity-to-capital ratios from 0,1 to 2.

The Northern countries (Belgium, Denmark, Finland, Sweden and the UK) display significantly lower and stable rates of capacity utilization, showing no clear convergence towards the pre-crisis rates. The same applies for the Mediterranean countries, particularly Spain and Greece, which still face lower rates of capacity utilization although they seem to converge slowly to the pre-crisis rate, while Italy and Portugal are rapidly converging toward historically high rates of capacity utilization after a long and sustained period of excess capacity. This rapid convergence towards historical peaks, however, follows a massive destruction of idle capacity rather than a demand recovery (Romano, 2016). Austria, France, Germany, Ireland and the Netherlands, on the other hand, do not seem to record permanent drops in the rate of capacity utilization, despite remarkably large fluctuations in France, Ireland and Netherlands.

Note that these differences between our series and the DG ECFIN series reflect our choice not to impose any prior stability constraint. If we de-trend our series using a Hodrick-Prescott filter (λ=6.25), we find that the correlation between our filtered series (*F.CU*) and the DG ECFIN's series of capacity utilization (*DG.CU*) and output gaps (*DG.OG*) improves significantly with respect to the correlation between our original series (*CU*) and the DG ECFIN series. This suggests that our series and the DG ECFIN series capture the same short-run business cycle properties of capacity utilization, despite the different medium- to long-run trends (Table 2).

[Table 2]

To confirm the existence of structural differences in long run trends between our series and the European Commission series, we perform unit roots and structural breaks tests (Table 3).

[Table 3]

In most series of the rate of capacity utilization and output gap produced by the European Commission, the Augmented Dickey-Fuller (ADF) test rejects the null hypothesis of a unit root, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test does not reject the null hypothesis of stationarity. The Bai-Perron test detects few structural breaks in some countries. As far as concerns our series of the rate of capacity utilization, the ADF and the KPSS tests allow, respectively, not to reject the null hypothesis of a unit root and to reject the null hypothesis of stationarity in most countries. Moreover, the Bai-Perron test detects several endogenous breaks in all series, suggesting that the rate of capacity utilization is not stationary around an *absorbing* long run trend, but it rather fluctuates around multiple *statistical* medium run trends[2].

[2] Refer to Grazzini & Richiardi (2015) for a definition of *absorbing* and *statistical* equilibrium.

4.2 Capital accumulation, labor productivity and unemployment in EU

We now turn to the estimated coefficients of equations (16) to (18) to analyze whether our estimated series of the rate of capacity utilization can explain the rate of growth of labor productivity, the rate of capital accumulation and the rate of unemployment, as we assumed in our theoretical model. Table 4.1 shows that labor productivity growth correlates positively with the current rate of capacity utilization ($\alpha_4 > 0$), but negatively with the past rate of capacity utilization ($\alpha_6 < 0$), and the negative correlation is stronger than the positive correlation ($|\alpha_6| > |\alpha_4|$). This suggests that the rate of growth of labor productivity is positively correlated with changes (Δu_t) and negatively correlated with past levels (u_{t-1}) of capacity utilization Hence, an increase in the rate of utilization exerts at first a positive effect on labor productivity, because firms partially accommodate the higher demand by extending the working schedule rather than hiring new employees. Nevertheless, the larger utilization of capacity reduces average costs by allowing economies of scale, thereby reducing the pressure for firms to seek for faster productivity gains. We also find an overall positive correlation with past and current rates of accumulation except in few countries, where the correlation with the current rate of accumulation is negative. This negative correlation might depend on the inherent difficulty to adapt new technologies to existing production techniques, such that the positive effect is more likely to involve past rather than current investments (Sylos Labini, 1983; 1995). Finally, we do not find persistency effects, as α_2 is not statistically different from zero or is anyway low.

[Table 4.1 goes here]

As far as concerns the unemployment function (17), Table 4.2 shows that the rate of unemployment correlates negatively with the current rate of capacity utilization ($\beta_4 < 0$) and positively with the past rate of capacity utilization ($\beta_6 < 0$), suggesting an overall negative correlation with changes in the rate of utilization (Δu_t). Nevertheless, we do not find a common and significant increasing or decreasing effect ($|\beta_6|$ is not systematically larger or smaller than $|\beta_4|$). Moreover, despite the effect of past accumulation on current unemployment is often non-significant, the effect of the current rate of capacity accumulation is always negative and significant (β_3 significantly lower than zero), by confirming our initial hypothesis that labor and capital inputs are at least partially complementary. Finally, and most interestingly, we find a large and significant persistent effect of past unemployment rates (β_2 very close to 1 in most countries). These results suggest that temporary shocks to the rate of utilization might have permanent effects to the rate of unemployment, thus confirming the *hysteresis hypothesis.*

[Table 4.2 goes here]

We now turn to the investment function. The series of the rate of capacity utilization derived from business surveys are typically poor predictor of the surveyed rate of capacity accumulation (Perry, 1973; Shapiro, 1989). As shown in Table 4.3, our estimated series of the rate of capacity utilization are instead strong and significant predictors of capacity accumulation rates. Namely, we find a positive and significant effect of the current rate of capacity utilization ($\gamma_3 > 0$) and a negative and significant effect of the past rate of capacity utilization ($\gamma_4 < 0$), with the positive current effect stronger than the negative lagged effect ($|\gamma_3| > |\gamma_4|$). This suggests that the rate of accumulation correlates positively with both changes (Δu_t) and current levels (u_t) of capacity utilization. Moreover, we also find a large and significant persistent effect of past accumulation on current accumulation, with γ_2 very close to, or larger than 1. These results suggest that an increase in the rate of utilization exerts a large, positive and persistent effect on the rate of capacity accumulation, and that a plausible source of *hysteresis* in unemployment might be therefore the strong persistence of investment decisions (Dixit, 1989; 1992).

[Table 4.3 goes here]

4.3 Inflation and capacity utilization in EU

Section 4.2 investigated the *internal* consistency of the model by analyzing the correlation structure among our *in sample* variables, according to equations (16) to (18). In this section we investigate the *external* consistency of the model by testing the explanatory power of the rate of utilization with respect to the *out sample* rate of inflation, which we did not consider in our theoretical model. To do that, we estimate a generic Phillips curve that relates the rate of inflation to the rate of capacity utilization and to a set of exogenous, supply variables:

$$\pi_t = \alpha_0 + \zeta_0 \pi_{t-1} + \sum_{z=0}^{1} \beta_z Z_{t-z} + \sum_{j=0}^{1} \gamma_j W_{j,t-j} + \sum_{i=0}^{1} \delta_i u_{t-i} + \varepsilon_t \tag{20}$$

Note that equation (20) is very similar to equation (2). Nevertheless, because we do not aim to identify the *non-accelerating inflation rate of capacity utilization*, we do not impose $\zeta_0 = 1$ but we rather let the model estimating the value of ζ_0. Therefore, instead of referring to the rate of change of the rate of inflation ($\Delta\pi_t$), we follow Dergiades & Tsoulfidis (2007) and consider the rate of inflation π_t as the endogenous variable by controlling for the past rate of inflation as an additional explanatory variable. As far as concerns the supply variables, we consider oil price inflation (Z_{t-j}) and unit labor costs inflation (W_{t-i}) as suggested by McElhattan (1978) and Nahuis (2003). We thus estimate equation (20) using, alternatively, our series of the rate of capacity utilization, the DG ECFIN series of the rate of capacity utilization and the DG ECFIN's output gaps as proxies for the demand variable u_{t-i}, and show the results in tables 4.1 to 5.2.

[Tables 5.1 and 5.2 go here]

As shown in tables 5.1 and 5.2, in terms of adjusted R^2 and p-values of the rate of capacity utilization at different lags, our estimated series of the rate of capacity utilization outperform the DG ECFIN surveyed series in Austria, Denmark and Ireland. The DG ECFIN estimates outperform our series in France and Sweden, although in France the estimated coefficients are not significantly different from zero in both models. In Belgium, the DG ECFIN series show a higher R^2 although the effect of the current rate of capacity utilization is not significantly different from zero, while our series can capture a significant relationship despite a slightly lower R^2. In the other countries, the two models are not significantly different. We do the same comparative econometric analysis using the DG ECFIN series of the output gap obtained through the standard Production function methodology (Havik et al, 2014). As shown in tables 6.1 and 6.2, either in terms of the adjusted R^2 or in terms of the p-value of the coefficients, the performance of the two models is not significantly different except in Germany, where the DG ECFIN estimates of the output gap outperform our series. Furthermore, contrarily to expectations, in Belgium, Denmark, Finland and Ireland our series perform even better although we did not fit any Phillips curve to estimate our series. The difference between the two models is, anyway, almost negligible. This result is definitely unexpected: the DG ECFIN computes potential output by explicitly fitting a Phillips curve that relates the rate of unemployment to the rate of inflation. Hence, we should have expected that the DG ECFIN series of the output gap would predict inflation more efficiently than our series of capacity utilization.

[Tables 6.1 and 6.2 go here]

5. Theory and policy implications of chronic excess capacity

Our results show that the rate of capacity utilization, far from gravitating around a constant *normal* trend, fluctuates around endogenous medium run trends, such that excess capacity appears as a chronic and structural feature, rather than a temporary deviation from *normal* capacity output. A plausible explanation, dating back to Joan Robinson, relies on the idea that firms' *desired* rate of capacity utilization is a historical convention[3]:

[3] Robinson (1956) *The accumulation of capital*, cited in Lavoie (1996)

“(…) experience gradually modifies the views of entrepreneurs about what level of profit is obtainable, or what the average utilization of plant is likely to be over its life-time, and so react upon subjective-normal prices for the future”.

This implies that firms might get accustomed with *lower-than-normal* rates of utilization, without necessarily entailing a costly adjustment process, especially if deviations from the *normal* rate are within a tolerable range (Dutt, 1990, 2010; Setterfield, 2019). For instance, investment or de-investment decisions imply *sunk* costs that firms cannot recover *ex post*. Hence, departures from the *desired* rate of capacity utilization might not necessarily induce a change in the capital stock if entrepreneurs believe that these departures are only temporary, and that the cost of underutilizing capacity is lower than the expected cost of scrapping idle capacity (Dixit, 1989; 1992), or that capacity is anyway indivisible (Nikiforos, 2016).

Entrepreneurs might also wish to keep investing and increasing capacity despite the low rate of utilization, because of conflicting goals with stakeholders. Because managers aim to expand the firm to maximize their power, they keep investing as long as they have enough internal liquidity at disposals, in order to avoid costly conflicts with workers or other economic, social and psychological costs implied by downsizing (Jensen, 1993; Schoenberger, 1994; Hein et al, 2012). In this case, entrepreneurs might wish to react to falling profits through other costs, or through prices. Business surveys refer that most accountants rely upon measures of *budgeted* or *normal* capacity to compute their overheads costs, and because budgeted and normal capacity depend on past production levels, this implies, in periods of negative cycles, pumping up prices to preserve profit margins rather than cutting prices to boost demand (Brierley et al, 2006).

Accumulating idle capacity might also represent a best response in presence of strategic interactions among firms. If entrepreneurs who face excess capacity believe that the whole sector is facing excess capacity, they might prefer to wait for competitors to move first, in order not to bear an *inventory risk* (Petach & Tavani, 2019) or a lack of capacity when the most fragile competitors will have to give in and cede their demand to incumbents. As reported by Jensen (1993, p. 847), when asking to entrepreneurs who face excess capacity why they keep investing instead of downsizing, answers usually sound like “we want to have a chair when the music stops". Excess capacity is thus the consequence of a global *struggle for survival* (Crotty, 2002).

If chronic underutilization of capacity is an endogenous pattern of capitalist economies, economic models should not take full capacity as a *center of gravity*. Properly identifying the endogenous nature of capacity utilization has relevant policy implications. Suppose that a temporary demand shock leads to a persistent underutilization of aggregate capacity. Official estimates of potential GDP, however, rule it out by construction, such that the persistent deviation of GDP from its medium-run trend is assumed to reflect exogenous productivity shocks, thus supply-side shocks. If the monetary policy targets inflation stability, as soon as the demand shock turns *artificially* into a supply shock, they will fear inflationary pressures and rise interest rates. Moreover, if the fiscal policy is institutionally constrained by debt-to-income ratios relating public deficits or debts to potential GDP, this would also lead to fiscal consolidation as soon as the *cyclical* deficit-to-income ratio is artificially turned into *structural*. Consequently, a temporary demand shock would lead to a policy-induced recession and a structural increase in unemployment, because of the underestimation of potential GDP by monetary and fiscal authorities (Schettkat & Sun, 2009).

If, on the other hand, the persistent negative deviation of GDP from its previous trend were properly associated to excess capacity, monetary authorities would record a negative output gap and lower the interest rate to avoid disinflation. Fiscal authorities, on the other hand, would implement countercyclical fiscal policies without having subsequently to engage on harsh fiscal consolidation plans, since the consequent increase in public debt would be classified as *cyclical*, not structural. This would thus help to recover pre-crisis output and employment levels without paying the useless social and economic costs of structural reforms and fiscal consolidation plans, which raise structural unemployment and lower potential growth (Botta & Tippet, 2020).

The large unutilized capacity that we observe in many EU countries, especially after 2008, suggests that demand policies have still ample margins of maneuver, and justifies the growing demand for countercyclical fiscal policies to complement conventional and unconventional monetary policies (Blanchard, 2019; Rachel & Summers, 2019; Blanchard & Summers, 2020).

6. Conclusion and discussion

Potential output is an unobservable variable that reflects the full utilization of the capacity in place. Because the gap between real output and potential output is a core variable for policy makers, providing reliable estimates of the rate of capacity utilization and the *output gap* is crucial. Most methods for estimating potential output assume that the rate of capacity utilization gravitates around a fixed, full-capacity rate, ruling out persistent underutilization of capacity.

In this paper, we develop a structural method for estimating the rate of capacity utilization in 14 EU countries, without assuming nor rejecting that this is stable around a fixed *normal* rate. Our method consists of identifying the parameters of a production function by simultaneously estimating the coefficients of a theoretical model that relates the rate of capacity utilization to the rate of capacity accumulation, the rate of unemployment and the rate of growth of labor productivity, consistently with previous theoretical and empirical contributions. We show that our series of the rate of capacity utilization co-evolve with the DG ECFIN's series of capacity utilization and output gaps, although they exhibit a larger volatility and capture patterns of chronic underutilization of productive capacity that the DG ECFIN's series rule out by construction. Namely, unit root and structural break tests show that our series of the rate of capacity utilization do not gravitate around a unique long run trend but they rather fluctuate around multiple medium run trends. To validate our method, we investigate both internal and external consistency. We first analyze the correlation structure that emerges between capacity utilization and the other *in sample* variables, namely the rate of capacity accumulation, the rate of growth of labor productivity and the rate of unemployment. We show that the signs of the coefficients are statistically significant and robust, in line with theoretical predictions, and provide significant evidence of hysteresis in unemployment, suggesting that temporary shocks to the rate of utilization produce permanent effects to the rate of unemployment in most EU countries. We also estimate a standard Phillips curve and show that our series help to explain inflation rates as efficiently as the DG ECFIN series of capacity utilization and output gaps.

Disentangling supply shocks *to* the potential path and persistent deviations *from* the potential path is therefore crucial for policy guidance. If real output can persistently deviate from full capacity output after a large negative shock, monetary and fiscal policies can contribute to restore higher rates of growth without resorting to structural labor market reforms and fiscal consolidation plans, thereby avoiding hysteresis effects on unemployment. Bassi (2019), for instance, based on time series produced by the method presented in section 3, provides evidence of hysteresis in the *non-accelerating inflation rate of capacity utilization (NAIRCU)*, suggesting that temporary demand shocks can imply a permanent change in the rate of utilization without implying a permanent acceleration or deceleration of inflation. Bassi (2020), based on the same data on capacity utilization, provides evidence of hysteresis also in the *normal* rate of capacity utilization, suggesting that temporary demand shocks lead to permanent changes in the rate of utilization without implying a permanent acceleration or deceleration of capacity accumulation. Our method might improve, however, by accounting for structural breaks in the estimation procedure, or by making some parameters endogenous. We might also adapt the theoretical specification to account for countries heterogeneity, instead of referring to a one-fits-all model. Therefore, we leave this for future research.

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References

Arrow K. (1962) The Economic Implications of Learning by Doing, *The Review of Economic Studies*, Vol. 29, No. 3, pp. 155-173.

Bhaduri A., Marglin S. (1990) Unemployment and the Real Wage: the Economic Basis for Contesting Political Ideologies, *Cambridge Journal of Economics*, Vol. 14, No. 4, pp. 375-393.

Ball L. (2009) Hysteresis in Unemployment: Old and New Evidence, NBER Working Paper No. 14818, pp. 1-35.

Ball L. (2014) Long Term Damage from the Great Recession in OECD Countries, *European Journal of Economics and Economic Policies: intervention*, Vol. 11, No. 2, pp 149-160.

Ball L., Leigh D., Loungani P. (2017) Okun's Law: Fit at 50?, *Journal of Money, Credit and Banking*, Vol. 49, No. 7, pp. 1413-1441.

Bassi F. (2019) Capacity Utilization and the NAIRCU- Evidences of Hysteresis in EU Countries, CEPN Working Paper No. 9, pp. 1-32.

Bassi F. (2020) Growth Without Full Capacity Utilization and Full Capacity Utilization Without Growth, CEPN Working Paper No. 2, pp. 1-21

Berndt E. R., Hesse D. H. (1986) Measuring and Assessing Capacity Utilization in the Manufacturing Sectors of nine OECD Countries, *European Economic Review*, Vol. 30, No. 5, pp. 961-989.

Blanchard O. J. (2019) Public Debt: Fiscal and Welfare Costs in a Time of Low Interest Rates, Peterson Institute for International Economics Policy Brief No. 2, pp. 1-5.

Blanchard O. J., Summers L. H. (1986) Hysteresis and the European Unemployment Problem, *NBER Macroeconomics Annual*, Vol. 1, pp.15-89.

Blanchard O. J., Summers L. (2020) Automatic Stabilizers in a Low Rate Environment, Peterson Institute for International Economics Policy Brief No. 2, pp. 1-11.

Blanchard O. J., Quah D. (1989) The dynamic effect of aggregate demand and supply disturbances, *American Economic Review*, Vol. 79, No. 4, pp. 655-673.

Botta A., Tippet B. (2020) Secular Stagnation and Core-Periphery Uneven Development in Post-Crisis Eurozone, Post-Keynesian Economics Society Working Paper No. 2002, pp. 1-24.

Brierley J. A., Cowton C. J., Drury C. (2006) Reasons for Adopting Different Capacity Levels in the Denominator of Overhead Rates: A Research Note, *Journal of Applied Management Accounting Research*, Vol. 4, No. 2, pp. 53-62.

Castiglione C. (2011) Verdoorn-Kaldor's Law: an empirical analysis with time series data in the United States, *Advances in Management & Applied Economics*, Vol. 1, No. 3, pp. 135-151.

Cerra V., Saxena S. C. (2000) Alternative Methods of Estimating Potential Output and the Output Gap: An Application to Sweden, IMF Working Paper No. 59, pp. 1-33.

Chalaux T., Guillemette Y. (2019) The OECD Potential Output Estimation Methodology, OECD Economic Department Working Paper No 1563, pp. 1-28.

Clarida R., Gali J. (1994) Sources of Real Exchange Rate Fluctuations: How Important Are Nominal Shocks? Carnegie-Rochester Conference Series on Public Policy, Vol. 41, No. 1, pp. 1-56.

Crotty J. (2002) Why There is Chronic Excess Capacity, *Challenge*, Vol. 45, No. 6, pp 21-44.

De Carvalho A., Sekiguchi N., Silva F. (2015) Excess Capacity in the Global Steel Industry and the Implications of New Investment Projects, OECD Technology and Industry Policy Paper No. 18, pp. 1-38.

De Masi P. R. (1997) IMF Estimates of Potential Output: Theory and Practice, IMF Working Paper No. 177, pp. 1-14.

Dergiades T., Tsoulfidis L. (2007) A New Method for the Estimation of Capacity Utilization: Theory and Empirical Evidence from 14 EU Countries, *Bulletin in Economic Research*, Vol. 59, No. 4, pp. 361-381.

Dixit A. (1989) Entry and Exit Decisions Under Uncertainty, *The Journal of Political Economy*, Vol. 97, No. 3, pp. 620-638.

Dixit A. (1992) Investment and Hysteresis, *Journal of Economic Perspectives*, Vol. 6, No. 1, pp. 107-132.

Domar E. D. (1946) Capital Expansion, Rate of Growth, and Employment, *Econometrica*, Vol. 14, No. 2, pp. 137-147.

Dutt A. K. (1984) Stagnation, Income Distribution, and Monopoly Power, *Cambridge Journal of Economics*, Vol. 8, No. 1, pp. 25-40.

Dutt A. K. (1990) *Growth, Distribution and Uneven Development*, Cambridge: Cambridge University Press.

Dutt A. K. (2010) Equilibrium, Stability and Path Dependence in Post Keynesian Models of Economic Growth, In Birolo A., Foley D., Kurz H.D., Schefold B. and Steedman I. (Eds) Production, Distribution and Trade: Alternative Perspectives. Essays in Honour of Sergio Parrinello, London: Routledge.

Eichner A. S. (1976) *The Megacorp and Oligopoly: Micro Foundations of Macro Dynamics*, Cambridge: Cambridge University Press.

Fontanari C., Palumbo A., Salvatori C. (2020) Potential Output in Theory and Practice: A Revision and Updates of Okun's Original Method, *Structural Change and Economic Dynamics*, Vol. 54, pp. 247-266.

Franke R. (2017) What Output-Capital Ratio to Adopt for Macroeconomic Calibrations?, *International Review of Applied Economics*, Vol. 31, No. 2, pp. 208-224.

Gordon R. (1997) The Time-Varying NAIRU and its Implications for Economic Policy, *Journal of Economic Perspectives*, Vol. 11, No. 1, pp 11-32.

Gorzig B. (2007) Depreciation in EU Member States: Empirical and Methodological Differences, EU Klems Working Paper No. 17, pp. 1-27.

Grazzini J., Richiardi M. (2015) Estimation of ergodic agent-based models by simulated minimum distance, *Journal of Economic Dynamics and Control*, Vol. 51, No. C, pp. 148-165.

Haugh D., Mourougane A., Chatal O. (2010) The Automobile Industry In and Beyond the Crisis, OECD Economics Department Working Paper No. 745, pp. 1-36.

Havik K., Mc Morrow K., Orlandi F., Planas C., Raciborski R. Roger W., Rossi A., Thum-Thysen A., Vandermeulen V. (2014) The Production Function Methodology for Calculating Potential Growth Rates & Output Gaps, ECFIN Economic Papers No. 535, pp. 1-112

Hein E., Lavoie M., Van Treeck T. (2012) Harrodian Instability and the “Normal Rate” of Capacity Utilization in Kaleckian Models of Distribution and Growth – A Survey, *Metroeconomica*, Vol. 63, No. 1, pp. 139-169.

Hickman B. G. (1957) Capacity, Capacity Utilization, and the Acceleration Principle, NBER Chapters, in: Problems of Capital Formation: Concepts, Measurement, and Controlling Factors, pp. 419-468.

Hickman B. G. (1964) On a New Method of Capacity Estimation, *Journal of the American Statistical Association*, Vol. 59, No. 306, pp. 529-549.

IMF (2015) *World Economic Outlook: Uneven Growth—Short- and Long-Term Factors*, Washington.

Jensen M. C. (1993) The Modern Industrial Revolution, Exit, and the Failure of Internal Control Systems, *The Journal of Finance*, Vol. 48, No. 3, pp. 831-880.

Jump R. C., Stockhammer E. (2019) Reconsidering the Natural Rate Hypothesis, FMM Working Paper No. 45, pp. 1-28

Kaldor N. (1966) *Causes of the Slow Economic Growth of the United Kingdom*, London: Cambridge University Press.

Keynes J. M. (1936) *The General Theory of Employment, Interest and Money*, London: Palgrave/Macmillan.

Klein L. R. (1960) Some Theoretical Issues in the Measurement of Capacity, *Econometrica*, Vol. 28, No. 2, pp. 272-286.

Klein L. R., Long V. (1973) Capacity Utilization: Concept, Measurement, and Recent Estimates, *Brooking Papers on Economic Activity*, Vol. 4, No. 3, pp. 743-764.

Kopp E. (2018) Determinants of US Business Investment, IMF Working Paper No. 18/139, pp. 1-31.

Ladiray D., Mazzi G. L., Sartori F. (2003) Statistical Methods for Potential Output Estimation and Cycle Extraction, European Commission Working Papers and Studies, pp. 1-65.

Lasdon L. S., Fox R. L., Ratner M. W. (1974) Nonlinear Optimization Using the Generalized Reduced Gradient Method, *Revue française d'automatique, informatique, recherche opérationnelle*, Vol. 8, No. 3, pp. 73-103.

Lavoie M. (1996) Traverse, Hysteresis, and Normal Rates of Capacity Utilization in Kaleckian Models of Growth and Distribution, *Review of Radical Political Economics*, Vol. 28, No. 4, pp. 113-147.

Lavoie M. (2014) *Post-Keynesian Economics: New Foundations*, Cheltenham, UK: Edward Elgar Publishing.

McCombie J. S. L., De Ridder, J. R. (1984) "The Verdoorn Law Controversy": Some New Empirical Evidence Using U.S. State Data, *Oxford Economic Papers*, Vol. 36, No. 2, pp. 268-284.

McElhattan R. (1978) Estimating a Stable-Inflation Capacity-Utilization Rate, *Economic Review*, Federal Reserve Bank of San Francisco, Fall 1978, pp. 20-30.

McElhattan R. (1984) Inflation and Capacity, *FRBSF Economic Letter*, Federal Reserve Bank of San Francisco, April 1984, pp. 1-4.

Millemaci E., Ofria F. (2014) Kaldor-Verdoorn's Law and Increasing Returns to Scale: A Comparison Across Developed Countries, *Journal of Economic Studies*, Vol. 41, No. 1, pp. 140-162.

Modigliani F., Papademos L. (1975) Targets for Monetary Policy in the Coming Year, *Brookings Papers on Economic Activity*, Vol. 6, No. 1, pp 141-163.

Nahuis N. J. (2003) An Alternative Demand Indicator: The Non Accelerating Inflation Rate of Capacity Utilization, *Applied Economics*, Vol. 35, No. 11, pp. 1339-1344.

Nelson R. A. (1989) On the Measurement of Capacity Utilization, *The Journal of Industrial Economics*, Vol. 37, No. 3, pp 273-286.

Nikiforos M. (2016) On The "Utilisation Controversy": A Theoretical and Empirical Discussion of the Kaleckian Model of Growth and Distribution, *Cambridge Journal of Economics*, Vol. 40, No. 2, pp. 437-467.

OECD (2003) *Business Tendency Surveys: a Handbook*, Paris: OECD publishing.

OECD (2009) *Measuring Capital - OECD Manual 2009*, Second ed., Paris: OECD Publishing.

Okun A. M. (1962) Potential GNP: Its Measurement and Significance, *Proceedings of the Business and Economics Section of the American Statistical Association*, Washington, DC: American Statistical Association, pp. 98-104.

Parigi G., Siviero S. (2001) An Investment-Function-Based Measure of Capacity Utilization. Potential Output and Utilised Capacity in the Bank of Italy's Quarterly Model, *Economic Modelling*, Vol. 18, No. 4, pp. 525-550.

Perry G. L. (1973) Capacity in Manufacturing, *Brookings Papers on Economic Activity,* No. 1, pp. 701-742.

Petach L., Tavani D. (2019) No One Is Alone: Strategic Complementarities, Capacity Utilization, Growth, and Distribution, *Structural Change and Economic Dynamics*, Vol. 50, No. C, pp. 203-215.

Rachel L., Summers L. (2019) On Secular Stagnation in the Industrialized World, *Brooking Papers on Economic Activity*, Spring 2019, pp. 1-54

Ragan J. F. (1976) Measuring Capacity Utilization in Manufacturing, *FRBNY Quarterly Review*, Winter 1976, pp. 13-20.

Romano L. (2016) Puntare Sulla Manifattura Per Far Ripartire la Crescita, Nota del Centro Studi di Confindustria No. 4, pp 1-7.

Rowthorn R. E. (1981) Demand, real wages and economic growth, *Thames Papers in Political Economy*, Autumn 1981, pp. 1–39.

Santacreu A. M. (2016) Employment and Capacity Utilization Over the Business Cycle, *Economic Synopses*, Federal Reserve Bank of Saint Louis, No. 19, pp. 1-2.

Santeusanio A., Storti G. (2002) *Statistica Economica,* Fisciano: Edizioni C.U.S.L.

Sargent T. J., Sims C. A. (1977) Business Cycle Modeling Without Pretending to Have Too Much A Priori Economic Theory, Federal Reserve Bank of Minneapolis, Working Paper No. 55, pp 1-89.

Schettkat R., Sun R. (2009) Monetary Policy and European Unemployment, *Oxford Review of Economic Policy*, Vol. 25, No. 1, pp. 94-108.

Schoenberger E. (1994) Corporate Strategy and Corporate Strateists: Power, Identity and Knowledge Within the Firm, Environment and Planning, Vol. 26, No. 3, pp. 435-451.

Setterfield M. (2019) Long-Run Variation in Capacity Utilization in the Presence of a Fixed Normal Rate, *Cambridge Journal of Economics*, Vol. 43, No. 2, pp. 443-463.

Shaikh A. M., Moudud J. K. (2004) Measuring Capacity Utilization in OECD Countries: A Cointegration Method, Levy Economic Institute Working Paper No 387, pp. 1-19.

Shapiro M. D. (1989) Assessing the Federal Reserve's Measures of Capacity and Utilization, *Brookings Papers on Economic Activity*, No. 1, pp. 181-241.

Shapiro C., Stiglitz J. (1984) Equilibrium Unemployment as a Worker Discipline Device, *American Economic Review*, Vol. 74, No. 3, pp. 433-444.

Smyth D. (1964) Empirical Evidence on the Accelerator Principle, *The Review of Economic Studies*, Vol. 31, No. 3, pp. 185-202.

Stockhammer E., Onaran O. (2004) Accumulation, Distribution and Employment: A Structural VAR Approach to a Kaleckian Macro Model, *Structural Change and Economic Dynamics*, Vol. 15, No. 4, pp. 421-447.

Sylos Labini P. (1983) Factors affecting changes in productivity, *Journal of Post Keynesian Economics*, Vol. 6, No. 2, pp. 161-179.

Sylos Labini P. (1995) Why the interpretation of the Cobb-Douglas production function must be radically changed, *Structural Change and Economic Dynamics*, Vol. 6, No. 4, pp. 485-504.

Taylor J. B. (2000) Teaching Modern Macroeconomics at the Principles Level, *American Economic Review*, Vol. 90, No. 2, pp. 90-94.

Verdoorn P. J. (2002) Factors that Determine the Growth of Labor Productivity, in McCombie J., Pugno M., Soro B. (eds) *Productivity Growth and Economic Performance. Essays on Verdoorn's Law*, UK: Palgrave Macmillan.

Webb S. (1914) The Economic Theory of Legal Minimum Wage, *Journal of Political Economy*, Vol. 20, No. 10, pp. 973-998.

Winston G. C. (1974) The Theory of Capital Utilization and Idleness, *Journal of Economic Literature*, Vol. 12, No. 2, pp. 1301-1320.

Figure 1: Capacity utilization and the output gap

Note: the series *Utilization rate* and *DG CU* are normalized to 1 and plotted on the left scale, while the series *DG OG* are plotted on the right scale.

Table 1: Alternative theoretical specifications

Equations	Variables	M1	M2	M3	M4
	Constant	α_1	α_1	α_1	α_1
	Labor productivity growth (t-1)	α_2	α_2	α_2	α_2
	Utilization rate (t)	α_3	α_3	α_3	α_3
	Utilization rate (t-1)	α_4	α_4	α_4	α_4
	Accumulation rate (t)	α_5	α_5	α_5	α_5
Labor productivity growth (t)	Accumulation rate (t-1)	α_6	α_6	α_6	α_6
	Real wage growth (t)		α_7		
	Real wage growth (t-1)		α_8		
	Real unit labor cost growth (t)			α_7	α_7
	Real unit labor cost growth (t-1)			α_8	α_8
	Ricardo effect* (t)			α_9	α_9
	Ricardo effect* (t-1)			α_{10}	α_{10}
	Constant	β_1	β_1	β_1	β_1
	Unemployment rate (-1)	β_2	β_2	β_2	β_2
	Utilization rate (t)	β_3	β_3	β_3	β_3
Unemployment rate (t)	Utilization rate (t-1)	β_4	β_4	β_4	β_4
	Accumulation rate (t)	β_5	β_5	β_5	β_5
	Accumulation rate (t-1)	β_6	β_6	β_6	β_6
	Real unit labor cost (t)		β_7	β_7	β_7
	Real unit labor cost (t-1)		β_8	β_8	β_8
	Constant	γ_1	γ_1	γ_1	γ_1
	Accumulation rate (t)	γ_2	γ_2	γ_2	γ_2
	Utilization rate (t)	γ_3	γ_3	γ_3	γ_3
	Utilization rate (t-1)	γ_4	γ_4	γ_4	γ_4
Accumulation rate (t+1)	Profit share (t)		γ_5	γ_5	γ_5
	Profit share (t-1)		γ_6	γ_6	γ_6
	Real interest rate (t)				γ_7
	Real interest rate (t-1)				γ_8

* The Ricardo effect is the difference between the rate of growth of the nominal wage and capital goods inflation.

Table 2: Correlation indices

	ρ(*CU*, *DG.CU*)	ρ(*F.CU*, *DG.CU*)	ρ(*CU*, *DG.OG*)	ρ(*F.CU*, *DG.OG*)
Austria	0,43	0,62	0,50	0,82
Belgium	0,10	0,62	0,46	0,69
Denmark	0,56	0,74	0,27	0,77
Finland	0,24	0,55	0,68	0,89
France	0,65	0,66	0,06	0,41
Germany	0,42	0,73	-0,14	0,69
Greece	0,66	0,35	0,67	0,51
Ireland	0,49	0,24	0,59	0,57
Italy	0,62	0,66	0,51	0,64
Netherlands	0,54	0,43	-0,05	0,2
Portugal	0,17	0,3	0,43	0,78
Spain	0,60	0,58	0,41	0,65
Sweden	0,76	0,78	0,31	0,67
UK	0,17	0,48	0,27	0,87

Correlation indices between our original (*CU*) and filtered (*F.CU*) series of the rate of capacity utilization, the DG ECFIN series of capacity utilization (*DG.CU*) and the DG ECFIN series of the output gaps (*DG.OG*).

Table 3: Unit roots and structural breaks

	ADF			KPSS			BP		
	CU	*DG.CU*	*DG.OG*	*CU*	*DG.CU*	*DG.OG*	*CU*	*DG.CU*	*DG.OG*
Austria	-5,15 ***	-3,06**	-4,21***	0,39*	0,28	0,21	1	0	0
Belgium	-2,34	-3,47**	-3,95***	0,23	0,15	0,29	3	0	1
Denmark	-2,35	-3.10**	-3.07**	0.27	0.23	0.17	3	1	1
Finland	-3,16 **	-2.73*	-5.11***	0.36*	0.54**	0.10	4	1	0
France	-2,62 *	-2.95*	-2.86*	0.21	0.14	0.07	2	0	0
Germany	-2,10	-3.96***	-5.63***	0.72**	0.14	0.16	3	0	0
Greece	-2,29	-1.48	-2.30	0.32	0.48**	0.25	3	1	2
Ireland	-2,22	-4.14***	-3.45**	0.66**	0.15	0.18	4	0	0
Italy	-2,62 *	-3.57**	-3.65***	0.22	0.12	0.13	2	0	2
Netherlands	-2,22	-2.54	-4.26***	0.26	0.21	0.34	4	2	1
Portugal	-1,68	-2.39	-5.64***	0.18	0.21	0.10	2	2	0
Spain	-2,61 *	-2.31	-3.25**	0.49**	0.22	0.10	3	2	2
Sweden	-2,80 *	-2.89*	-4.73***	0.39*	0.31	0.05	4	1	0
UK	-2,28	-3.59**	-5.01***	0.81***	0.09	0.18	3	0	1

Note: the Augmented Dickey-Fuller (ADF) test tests the null hypothesis of a unit root, while the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test tests the null hypothesis of stationarity. The Bai-Perron (BP) test identifies the presence of breaks in the time series. Legend: * <0.1, **<0.05, ***<0.01.

Table 4.1: Estimated coefficients of the labor productivity function (equation 16)

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain	Sweden	UK
α_1	0.20***	0.02	0.02	0.11***	0.04	-0.01	0.09**	0.09***	0.06***	0.22***	0.06*	0.07**	0.03	0.10***
	(0.00)	(0.41)	(0.55)	(0.00)	(0.10)	(0.84)	(0.01)	(0.00)	(0.02)	(0.00)	(0.08)	(0.02)	(0.34)	(0.00)
α_2	0.02	0.21**	-0.02	0.05	0.20**	0.09	0.02	0.04	0.03	-0.33***	0.30***	0.53***	0.09	0.05
	(0.87)	(0.02)	(0.86)	(0.57)	(0.03)	(0.24)	(0.85)	(0.69)	(0.72)	(0.00)	(0.02)	(0.00)	(0.42)	(0.63)
α_3	1.26***	0.29	-1.00	-0.81**	0.47***	-0.03	0.73*	0.50***	0.73***	1.06***	0.44*	-0.89	0.11	-2.40***
	(0.00)	(0.11)	(0.11)	(0.03)	(0.00)	(0.87)	(0.05)	(0.01)	(0.00)	(0.00)	(0.05)	(0.17)	(0.49)	(0.01)
α_4	0.66***	0.60***	0.51***	0.49***	0.66***	0.77***	0.58***	0.40***	0.75***	0.99***	0.42***	0.11	0.54***	0.63***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.11)	(0.00)	(0.00)
α_5	-0.14	0.39***	1.54***	1.74***	0.22***	0.21	0.16	0.32	0.21	-0.25***	0.22	1.34*	0.32***	3.45***
	(0.62)	(0.01)	(0.01)	(0.00)	(0.01)	(0.28)	(0.57)	(0.15)	(0.11)	(0.00)	(0.22)	(0.05)	(0.02)	(0.00)
α_6	-0.82***	-0.62***	-0.52***	-0.58***	-0.70***	-0.76***	-0.65***	-0.45***	-0.80***	-1.20***	-0.45***	-0.15**	-0.56***	-0.72***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)
R^2	0.75	0.72	0.55	0.82	0.88	0.95	0.76	0.69	0.90	0.74	0.71	0.65	0.63	0.76
$Adj. R^2$	0.73	0.68	0.50	0.80	0.87	0.93	0.74	0.65	0.89	0.71	0.67	0.60	0.59	0.74
DW	2.15	1.73	2.15	1.63	1.51	2.80	1.28	1.30	1.48	2.19	2.06	1.93	1.43	1.48
BPG	0.39	0.63	0.76	0.29	0.61	0.74	0.07	0.47	0.17	0.10	0.82	0.05	0.96	0.10
W	0.54	0.97	0.89	0.23	0.62	0.31	0.26	0.03	0.12	0.00	0.35	0.03	0.93	0.00
JB	0.00	0.00	0.93	0.32	0.01	0.86	0.00	0.38	0.35	0.00	0.75	0.62	0.62	0.84

Note: p-values in parenthesis. Legend: *p<0.1, **p<0.05, ***p<0.01, DW: Durbin-Watson statistics, BPG: Breusch-Pagan-Godfrey test (p-value), W: White test (p-value), JB: Jarque-Bera test (p-value).

Table 4.2: Estimated coefficients of the unemployment function (equation 17)

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain	Sweden	UK
β_1	1.58	1.36	-0.21	8.05***	-1.61	3.56*	2.01	3.46***	-2.53	0.18	3.79**	-0.70	3.25**	5.87***
	(0.31)	(0.42)	(0.87)	(0.00)	(0.32)	(0.10)	(0.25)	(0.00)	(0.25)	(0.96)	(0.02)	(0.75)	(0.05)	(0.00)
β_2	0.93***	0.81***	0.83***	1.08***	0.79***	0.91***	0.95***	0.98***	0.69***	0.71***	0.91***	0.84***	0.99***	0.96***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_3	-15.2*	-60.8***	-163***	-50.2**	-42.8***	-58.9***	-42.4***	-37.9***	-43.5***	-33.9***	-24.8***	-195***	-44.8***	-176***
	(0.05)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)
β_4	-10.0***	-22.6***	-24.1***	-20.9***	-19.2***	-14.0***	-16.3***	-6.19***	-5.50*	-20.4***	-7.53***	-33.4***	-24.0***	-19.7***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_5	5.02	27.4***	84.8***	100***	7.98*	-9.50	20.5	45.5***	10.4	-0.96	20.1***	84.1	15.4***	155***
	(0.37)	(0.00)	(0.00)	(0.00)	(0.07)	(0.48)	(0.15)	(0.00)	(0.14)	(0.82)	(0.00)	(0.14)	(0.01)	(0.00)
β_6	9.26***	23.4***	26.1***	13.0***	23.1***	11.9**	15.6***	4.33*	10.2***	22.6***	5.89*	36.7***	21.7***	15.2***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.06)	(0.01)	(0.00)	(0.07)	(0.00)	(0.00)	(0.00)
R^2	0.97	0.96	0.94	0.97	0.99	0.97	0.97	0.96	0.95	0.91	0.95	0.98	0.96	0.95
$Adj. R^2$	0.96	0.95	0.93	0.97	0.99	0.96	0.97	0.95	0.94	0.90	0.94	0.97	0.96	0.95
DW	2.11	1.38	2.08	1.68	1.61	1.12	0.99	1.96	1.33	1.39	1.26	1.52	1.28	1.25
BPG	0.54	0.71	0.84	0.01	0.06	0.62	0.00	0.87	0.22	0.00	0.49	0.84	0.37	0.46
W	0.96	0.52	0.076	0.00	0.14	0.80	0.00	0.06	0.15	0.00	0.33	0.46	0.14	0.06
JB	0.10	0.15	1.00	0.00	0.50	0.47	0.00	0.00	0.76	0.01	0.71	0.00	0.12	0.51

Note: p-values in parenthesis. Legend: *p<0.1, **p<0.05, ***p<0.01, DW: Durbin-Watson statistics, BPG: Breusch-Pagan-Godfrey test (p-value), W: White test (p-value), JB: Jarque-Bera test (p-value).

Table 4.3: Estimated coefficients of the investment function (Equation 18)

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain	Sweden	UK
γ_1	-0.06***	-0.06***	-0.01	-0.02***	-0.10***	-0.06**	-0.03***	-0.04**	-0.06***	-0.13***	-0.02	-0.01***	-0.07***	0.00
	(0.00)	(0.00)	(0.17)	(0.01)	(0.00)	(0.04)	(0.01)	(0.03)	(0.00)	(0.00)	(0.22)	(0.00)	(0.00)	(0.86)
γ_2	0.95***	1.11***	1.17***	0.98***	1.19***	0.64***	1.00***	0.74***	1.10***	1.33***	1.12***	0.99***	1.26***	0.90***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
γ_3	0.25***	0.37***	0.13***	0.13***	0.62***	0.24***	0.24***	0.13***	0.35***	1.00***	0.26***	0.09***	0.51***	0.07***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
γ_4	-0.21***	-0.31***	-0.13***	-0.12***	-0.53***	-0.19***	-0.22***	-0.10**	-0.31***	-0.89***	-0.25***	-0.08***	-0.45***	-0.07***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R^2	0.88	0.84	0.93	0.93	0.93	0.74	0.95	0.74	0.93	0.67	0.92	0.98	0.87	0.88
$A.R^2$	0.87	0.84	0.93	0.93	0.92	0.71	0.95	0.72	0.93	0.65	0.91	0.98	0.86	0.87
DW	2.05	1.61	1.80	1.58	1.01	1.40	2.00	2.07	1.4	2.43	2.18	1.03	1.63	1.84
BPG	0.40	0.31	0.89	0.25	0.37	0.69	0.20	0.02	0.70	0.55	0.49	0.07	0.52	0.00
W	0.55	0.65	0.29	0.59	0.30	0.63	0.48	0.05	0.01	0.45	0.76	0.39	0.58	0.00
JB	0.68	0.00	0.50	0.80	0.45	0.63	0.43	0.00	0.00	0.00	0.4	0.56	0.94	0.49

Note: p-values in parenthesis. Legend: *p<0.1, **p<0.05, ***p<0.01, DW: Durbin-Watson statistics, BPG: Breusch-Pagan-Godfrey test (p-value), W: White test (p-value), JB: Jarque-Bera test (p-value).

Table 5.1: Estimated coefficients of the Phillips curve (equation 20)

	Austria		Belgium		Denmark		Finland		France		Germany		Greece	
	CU	*DG.CU*	*CU*	*DG.CU*	*CU*	*DG.CU*	*CU*	*DG.CU*	*CU*	*DG.CU*	*CU*	*DG.CU*	*CU*	*DG.CU*
α_0	-0,214	0,009	0,030	0,061	-0,001	0,007	-0,017	-0,032	-0,005	-0,025	-0,038	-0,128*	0,038	0,036
	(0,182)	(0,945)	(0,207)	(0,230)	(0,946)	(0,895)	(0,626)	(0,615)	(0,885)	(0,578)	(0,280)	(0,079)	(0,300)	(0,679)
ζ_0	0,409	0,181	-0,229	-0,043	0,542***	0,550***	0,564**	0,472*	0,488**	0,614***	0,691***	0,681***	0,546***	0,581***
	(0,206)	(0,645)	(0,244)	(0,810)	(0,003)	(0,002)	(0,047)	(0,082)	(0,013)	(0,004)	(0,001)	(0,000)	(0,000)	(0,000)
β_0	0,014**	0,017**	0,016***	0,017***	0,011*	0,013***	0,018*	0,018*	0,018***	0,017***	0,011**	0,009	0,010	0,007
	(0,041)	(0,044)	(0,005)	(0,003)	(0,051)	(0,042)	(0,069)	(0,076)	(0,006)	(0,003)	(0,043)	(0,114)	(0,525)	(0,647)
β_1	0,009	0,010	0,003	0,003	-0,001	-0,004	0,001	0,007	-0,001	-0,004	0,007	0,009	0,011	0,008
	(0,186)	(0,284)	(0,620)	(0,635)	(0,881)	(0,575)	(0,887)	(0,424)	(0,826)	(0,423)	(0,197)	(0,142)	(0,493)	(0,624)
γ_0	-0,171	0,026	0,590***	0,456***	0,216*	0,177	0,197	0,254	0,217	0,190	0,092	-0,003	0,112	0,108
	(0,497)	(0,904)	(0,000)	(0,000)	(0,100)	(0,229)	(0,203)	(0,132)	(0,485)	(0,351)	(0,587)	(0,978)	(0,244)	(0,286)
γ_1	0,073	-0,002	-0,019	-0,119	0,141*	0,064	0,008	-0,084	0,038	0,001	0,033	0,184	0,301***	0,290***
	(0,553)	(0,991)	(0,826)	(0,172)	(0,092)	(0,478)	(0,933)	(0,425)	(0,800)	(0,994)	(0,648)	(0,125)	(0,004)	(0,006)
δ_0	0,172*	0,000	0,176*	0,001	0,178*	0,001	0,189*	0,002*	0,088	0,001	0,206*	0,001*	-0,028	0,000
	(0,063)	(0,905)	(0,059)	(0,201)	(0,065)	(0,102)	(0,054)	(0,078)	(0,513)	(0,155)	(0,094)	(0,061)	(0,704)	(0,968)
δ_1	0,004	0,000	-0,190*	-0,001**	-0,175*	-0,001	-0,175*	-0,001*	-0,081	-0,001	-0,173	0,000	-0,001	0,000
	(0,978)	(0,925)	(0,067)	(0,027)	(0,097)	(0,238)	(0,080)	(0,088)	(0,496)	(0,380)	(0,154)	(0,661)	(0,989)	(0,806)
R^2	0,630	0,458	0,689	0,706	0,693	0,661	0,560	0,552	0,602	0,637	0,714	0,724	0,944	0,942
$Adj.R^2$	0,430	0,166	0,598	0,621	0,595	0,553	0,368	0,356	0,448	0,496	0,596	0,611	0,929	0,927
DW	1,909	1,901	1,946	2,204	1,954	1,943	1,445	1,555	2,099	2,212	1,610	1,760	1,840	1,828
BPG	0,909	0,730	0,793	0,992	0,002	0,618	0,227	0,208	0,245	0,170	0,416	0,018	0,059	0,241
W	/	/	/	/	/	/	/	/	/	/	/	/	/	/
JB	0,354	0,770	0,286	0,507	0,854	0,801	0,944	0,905	0,221	0,609	0,427	0,447	0,036	0,023

Note: p-values in parenthesis. Legend: *p<0.1, **p<0.05, ***p<0.01, DW: Durbin-Watson statistics, BPG: Breusch-Pagan-Godfrey test (p-value), W: White test (p-value), JB: Jarque-Bera test (p-value).

Table 5.2: Estimated coefficients of the Phillips curve (equation 20)

	Ireland		Italy		Netherlands		Portugal		Spain		Sweden		UK	
	CU	*DG.CU*	*CU*	*DG.CU*	*CU*	*DG.CU*	*CU*	*DG.CU*	*CU*	*DG.CU*	*CU*	*DG.CU*	*CU*	*DG.CU*
α_0	0,00	-0,135	-0,024	-0,084	-0,015	-0,026	-0,073	0,014	0,016	0,044	-0,027	-0,154	0,142**	-0,136**
	(0,872)	(0,143)	(0,395)	(0,130)	(0,697)	(0,643)	(0,164)	(0,870)	(0,631)	(0,503)	(0,634)	(0,133)	(0,046)	(0,038)
ζ_0	0,284	0,382	0,666***	0,728***	0,607***	0,619***	0,784***	0,705***	0,703***	0,570***	0,178	0,393	0,300**	0,525***
	(0,199)	(0,116)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,001)	(0,000)	(0,004)	(0,627)	(0,202)	(0,052)	(0,000)
β_0	0,031**	0,023*	0,017**	0,013*	0,010	0,007	0,024**	0,020*	0,030***	0,026***	0,013	-0,001	0,019**	0,013*
	(0,011)	(0,087)	(0,018)	(0,099)	(0,139)	(0,273)	(0,037)	(0,099)	(0,003)	(0,002)	(0,262)	(0,946)	(0,025)	(0,093)
β_1	0,005	-0,003	0,001	-0,002	0,015**	0,017***	0,010	0,009	-0,008	-0,005	-0,007	-0,006	0,003	-0,001
	(0,656)	(0,835)	(0,901)	(0,736)	(0,022)	(0,008)	(0,369)	(0,487)	(0,364)	(0,611)	(0,593)	(0,584)	(0,685)	(0,936)
γ_0	0,273***	0,155*	0,177	0,135	0,144	0,238*	-0,014	0,136	0,105	0,275*	0,180	0,273*	0,217**	0,124
	(0,006)	(0,079)	(0,102)	(0,210)	(0,314)	(0,087)	(0,920)	(0,348)	(0,417)	(0,084)	(0,395)	(0,088)	(0,013)	(0,179)
γ_1	-0,061	-0,045	0,024	0,015	-0,028	-0,058	0,018	0,076	0,046	-0,008	0,033	0,053	0,106	0,123
	(0,400)	(0,584)	(0,788)	(0,867)	(0,805)	(0,536)	(0,883)	(0,521)	(0,729)	(0,943)	(0,776)	(0,624)	(0,261)	(0,188)
δ_0	0,077**	0,001	0,079	0,001	0,035	0,002	0,080	0,002	0,077	0,001	0,043	0,003*	-0,125	0,001
	(0,011)	(0,577)	(0,234)	(0,134)	(0,635)	(0,109)	(0,159)	(0,182)	(0,102)	(0,124)	(0,794)	(0,078)	(0,208)	(0,182)
δ_1	-0,073**	0,001	-0,058	0,000	-0,017	-0,002	-0,035	-0,002	-0,084	-0,002*	-0,015	-0,001	0,010	0,001
	(0,016)	(0,190)	(0,381)	(0,921)	(0,786)	(0,196)	(0,617)	(0,182)	(0,109)	(0,086)	(0,923)	(0,486)	(0,900)	(0,487)
R^2	0,623	0,557	0,962	0,964	0,710	0,732	0,905	0,895	0,828	0,833	0,311	0,473	0,878	0,882
$Adj.R^2$	0,513	0,428	0,953	0,955	0,640	0,667	0,875	0,861	0,773	0,780	-0,059	0,189	0,848	0,853
DW	1,891	1,931	2,035	2,004	2,131	2,117	1,485	1,312	1,917	1,781	1,946	2,283	1,749	1,794
BPG	0,027	0,215	0,749	0,595	0,148	0,268	0,994	0,509	0,394	0,240	0,196	0,312	0,246	0,770
W	/	/	0,916	0,546	0,960	0,442	/	/	/	/	/	0,000	0,350	0,547
JB	0,731	0,345	0,398	0,391	0,638	0,578	0,417	0,366	0,753	0,917	0,722	0,502	0,993	0,643

Note: p-values in parenthesis. Legend: *p<0.1, **p<0.05, ***p<0.01, DW: Durbin-Watson statistics, BPG: Breusch-Pagan-Godfrey test (p-value), W: White test (p-value), JB: Jarque-Bera test (p-value).

Table 6.1: Estimated coefficients of the Phillips curve (equation 20)

	Austria		Belgium		Denmark		Finland		France		Germany		Greece	
	CU	*DG.OG*	*CU*	*DG.OG*	*CU*	*DG.OG*	*CU*	*DG.OG*	*CU*	*DG.OG*	*CU*	*DG.OG*	*CU*	*DG.OG*
α_0	-0,003	0,007**	0,029	0,002	0,010	0,001	0,034	0,001	-0,020	0,000	-0,038	0,004*	0,029	0,009
	(0,934)	(0,011)	(0,228)	(0,346)	(0,670)	(0,770)	(0,208)	(0,806)	(0,553)	(0,946)	(0,280)	(0,075)	(0,465)	(0,220)
ζ_0	0,491***	0,468***	0,559***	0,643***	0,643***	0,610***	0,500***	0,492***	0,623***	0,652***	0,691***	0,587***	0,532***	0,572***
	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,001)	(0,000)	(0,000)	(0,000)
β_0	0,015***	0,013***	0,021***	0,021***	0,022***	0,021***	0,022***	0,022***	0,024***	0,022***	0,011**	0,010**	0,037**	0,035**
	(0,001)	(0,004)	(0,000)	(0,000)	(0,001)	(0,001)	(0,002)	(0,002)	(0,000)	(0,000)	(0,043)	(0,030)	(0,021)	(0,030)
β_1	0,006	0,005	0,004	0,001	-0,010	-0,011	0,004	0,004	-0,011**	-0,009**	0,007	0,008*	-0,019	-0,021
	(0,217)	(0,262)	(0,491)	(0,804)	(0,145)	(0,127)	(0,535)	(0,611)	(0,022)	(0,035)	(0,197)	(0,083)	(0,172)	(0,126)
γ_0	0,278***	0,255**	0,405***	0,397***	0,319***	0,402***	0,366***	0,402***	0,427***	0,441***	0,092	-0,066	0,338***	0,315***
	(0,000)	(0,011)	(0,000)	(0,000)	(0,001)	(0,005)	(0,000)	(0,000)	(0,000)	(0,000)	(0,587)	(0,496)	(0,001)	(0,003)
γ_1	0,034	0,048	-0,136	-0,164*	-0,043	-0,048	0,044	0,032	-0,085	-0,112	0,033	0,140**	0,055	0,024
	(0,616)	(0,488)	(0,104)	(0,060)	(0,627)	(0,577)	(0,562)	(0,684)	(0,324)	(0,123)	(0,648)	(0,029)	(0,629)	(0,827)
δ_0	0,161**	0,004***	0,138**	0,002	0,071	0,001	0,118**	0,002	0,119*	0,003***	0,206*	0,003***	-0,043	0,000
	(0,011)	(0,004)	(0,034)	(0,164)	(0,332)	(0,457)	(0,027)	(0,102)	(0,082)	(0,005)	(0,094)	(0,005)	(0,652)	(0,860)
δ_1	-0,155***	-0,002	-0,162**	-0,002*	-0,076	-0,002	-0,144***	-0,003***	-0,100*	-0,004***	-0,173	0,000	0,026	0,001
	(0,006)	(0,297)	(0,014)	(0,097)	(0,272)	(0,275)	(0,005)	(0,009)	(0,100)	(0,003)	(0,154)	(0,985)	(0,783)	(0,711)
R^2	0,850	0,855	0,906	0,899	0,901	0,901	0,925	0,922	0,967	0,971	0,714	0,813	0,888	0,890
$Adj.R^2$	0,826	0,831	0,892	0,883	0,886	0,885	0,914	0,910	0,961	0,967	0,596	0,737	0,870	0,873
DW	1,933	1,897	1,747	1,761	2,285	2,301	2,129	2,060	1,682	1,735	1,610	1,537	1,765	1,713
BPG	0,092	0,169	0,169	0,295	0,155	0,051	0,127	0,314	0,004	0,119	0,416	0,641	0,747	0,531
W	0,095	0,299	0,119	0,218	0,711	0,317	0,000	0,000	0,003	0,435	/	/	0,591	0,045
JB	0,611	0,019	0,167	0,159	0,000	0,012	0,000	0,017	0,354	0,553	0,427	0,630	0,000	0,000

Note: p-values in parenthesis. Legend: *p<0.1, **p<0.05, ***p<0.01, DW: Durbin-Watson statistics, BPG: Breusch-Pagan-Godfrey test (p-value), W: White test (p-value), JB: Jarque-Bera test (p-value).

Table 6.2: Estimated coefficients of the Phillips curve (equation 20)

	Ireland		Italy		Netherlands		Portugal		Spain		Sweden		UK	
	CU	*DG.OG*	*CU*	*DG.OG*	*CU*	*DG.OG*	*CU*	*DG.OG*	*CU*	*DG.OG*	*CU*	*DG.OG*	*CU*	*DG.OG*
α_0	0,005	0,005	-0,040	0,000	0,005	0,006**	-0,014	0,002	-0,008	0,000	0,007	0,001	0,105**	0,000
	(0,779)	(0,256)	(0,218)	(0,897)	(0,888)	(0,046)	(0,744)	(0,796)	(0,731)	(0,910)	(0,867)	(0,747)	(0,043)	(0,922)
ζ_0	0,591***	0,604***	0,414***	0,517***	0,424***	0,491***	0,735***	0,764***	0,500***	0,343**	0,536***	0,612***	0,351***	0,361***
	(0,000)	(0,000)	(0,001)	(0,000)	(0,005)	(0,000)	(0,000)	(0,000)	(0,000)	(0,021)	(0,000)	(0,000)	(0,001)	(0,001)
β_0	0,038***	0,028***	0,027***	0,024***	0,009*	0,008	0,049***	0,046***	0,015*	0,019**	0,016*	0,014	0,021**	0,019**
	(0,000)	(0,007)	(0,000)	(0,002)	(0,087)	(0,135)	(0,004)	(0,007)	(0,078)	(0,021)	(0,097)	(0,144)	(0,011)	(0,018)
β_1	0,019**	0,014	-0,001	-0,003	0,007	0,010*	-0,024	-0,026	-0,001	0,003	-0,001	-0,001	0,008	-0,001
	(0,046)	(0,133)	(0,877)	(0,708)	(0,168)	(0,064)	(0,188)	(0,138)	(0,886)	(0,712)	(0,926)	(0,947)	(0,407)	(0,939)
γ_0	0,294***	0,297***	0,504***	0,493***	0,372***	0,326***	0,095	0,069	0,506***	0,592***	0,341***	0,279**	0,400***	0,527***
	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,483)	(0,648)	(0,000)	(0,000)	(0,005)	(0,028)	(0,000)	(0,000)
γ_1	-0,013	-0,005	0,011	-0,061	-0,020	-0,004	0,134	0,154	-0,064	0,001	0,047	0,048	0,084	0,072
	(0,870)	(0,949)	(0,902)	(0,478)	(0,838)	(0,964)	(0,207)	(0,162)	(0,632)	(0,991)	(0,670)	(0,648)	(0,275)	(0,338)
δ_0	0,094***	0,004**	0,235***	0,004***	0,085	0,002	0,063	0,002	0,004	-0,001	0,112	0,003**	0,027	0,002
	(0,005)	(0,012)	(0,001)	(0,007)	(0,207)	(0,130)	(0,417)	(0,436)	(0,949)	(0,766)	(0,204)	(0,049)	(0,805)	(0,171)
δ_1	-0,096***	-0,004**	-0,203***	-0,005***	-0,083	-0,002	-0,053	-0,001	0,002	-0,002	-0,118	-0,002	-0,115	-0,005**
	(0,002)	(0,016)	(0,002)	(0,002)	(0,167)	(0,204)	(0,444)	(0,797)	(0,979)	(0,421)	(0,157)	(0,292)	(0,262)	(0,020)
R^2	0,915	0,911	0,959	0,959	0,857	0,859	0,861	0,862	0,917	0,923	0,817	0,824	0,928	0,929
$Adj.R^2$	0,901	0,897	0,952	0,952	0,835	0,837	0,839	0,840	0,904	0,911	0,788	0,797	0,917	0,917
DW	1,730	1,766	2,163	2,274	2,141	2,149	2,057	2,120	1,619	1,551	2,253	2,384	2,556	2,718
BPG	0,241	0,063	0,698	0,444	0,370	0,504	0,003	0,006	0,057	0,220	0,244	0,542	0,004	0,001
W	0,005	0,010	0,293	0,015	0,407	0,904	0,000	0,000	0,000	0,383	0,430	0,034	0,001	0,002
JB	0,618	0,072	0,969	0,534	0,762	0,966	0,577	0,275	0,092	0,088	0,410	0,009	0,222	0,088

Note: p-values in parenthesis. Legend: *p<0.1, **p<0.05, ***p<0.01, DW: Durbin-Watson statistics, BPG: Breusch-Pagan-Godfrey test (p-value), W: White test (p-value), JB: Jarque-Bera test (p-value).

Appendix A1 – Description and source of statistical variables

Table A1: Description and sources of statistical variables

Label	Variable	Description	Database
Y	GDP	Gross domestic product at 2010 prices (OVGD)	AMECO
E	Employment	Civilian employment, persons (national) (NECN)	AMECO
A	Labor productivity	GDP / Employment	AMECO
I	Investment	Gross fixed capital formation at 2010 prices: total economy (OIGT)	AMECO
U	Unemployment rate	Unemployment rate: total : Member States: definition EUROSTAT (ZUTN)	AMECO
CGP	Cons. Goods price	Price deflator gross domestic product (PVGD)	AMECO
NW	Nominal wage	Nominal compensation per employee: total economy (HWCDW)	AMECO
RW	Real wage	Nominal wage / GDP deflator	AMECO
$RULC$	Real unit labor cost	Adj. wage share: total economy: percentage GDP current prices (ALCD0)	AMECO
PS	Profit share	100 – Real unit labor cost	AMECO
RIR	Real interest rate	Real long-term interest rates, deflator GDP (ILRV)	AMECO
CGP	Capital goods price	Price deflator gross fixed capital formation: total economy (PIGT)	AMECO
W	Unit labor costs	Nominal unit labor costs : total economy (PLCD)	AMECO
p^{CPI}	Prices	National consumer price index (All-items) (ZCPIN)	AMECO
Z	Oil Price	Spot Crude Oil Price: West Texas Intermediate (WTI) (WTISPLC)	FRED
$DG.OG$	Output gap	Gap between actual and potential GDP, % of potential GDP (AVGDGP)	AMECO
$DG.CU$	Capacity utilization	Current level of capacity utilization (%)	DG ECFIN

Appendix A2 – The investment function

We consider an investment function that relates the rate of accumulation to the rate of utilization and the past rate of capacity accumulation:

$$g^K{}_{t+1} = \frac{I_t}{K_t} = \gamma_1 + \gamma_2 \frac{I_{t-1}}{K_{t-1}} + \gamma_3 u_t + \gamma_4 u_{t-1} + \Phi_t \qquad (18)$$

In our application, the estimated rate of capacity accumulation is unobserved and identified according to equation (13), which is a direct function of the estimated parameters (v^*, δ^*):

$$\widehat{K}_t = \frac{\Delta K_t}{K_{t-1}} = \frac{I_{t-1} - \delta K_{t-1}}{K_{t-1}} = \frac{I_{t-1}}{K_{t-1}} - \delta = \left(\frac{I_{t-1}}{Y_{t-1}} \frac{Y_{t-1}}{Y^p{}_{t-1}} \frac{Y^p{}_{t-1}}{K_{t-1}}\right) - \delta = \left(\frac{I_{t-1}}{Y_{t-1}} u_{t-1} v^*\right) - \delta^* \qquad (13)$$

When we identify the unknown parameters v and δ by maximizing the R^2 and the t-values of equation (18), the GRG algorithm provides the optimal vector $(v^*, \delta^*) \rightarrow (0, C)$. Indeed, if $v^* = 0$ and $\delta^* = C$, the rate of capacity accumulation, according to equation (13), is a vector of constants, and the estimated investment function (18) comes down to the identity:

$$\frac{I_t}{K_t} = \gamma_2 \frac{I_{t-1}}{K_{t-1}}$$

With $\gamma_1 = \gamma_3 = \gamma_4 = 0$, $\gamma_2 = 1$, $R^2 = 1$ and the t-value associated to γ_2 close to infinity.

To avoid this, we rewrite equation (18) such that the left hand side is the observed investment rate (I_t/Y_t), by multiplying the left and the right hand sides for the capital output ratio (K_t/Y_t), which – combining (11) and (9) – is equal to $(vu_t)^{-1}$. We thus estimate the OLS equation:

$$\frac{I_t}{Y_t} = \left(\gamma_1 + \gamma_2 \frac{I_{t-1}}{K_t-1} + \gamma_3 u_t + \gamma_4 u_{t-1} + \Phi_t\right)(vu_t)^{-1} =$$

$$\frac{\gamma_1}{v} {u_t}^{-1} + \frac{\gamma_2}{v} {u_t}^{-1} \frac{I_{t-1}}{K_t-1} + \frac{\gamma_3}{v} + \frac{\gamma_4}{v} \frac{u_{t-1}}{u_t} + \frac{1}{v} \frac{\Phi_t}{u_t} =$$

$$\frac{\gamma_1}{v} {u_t}^{-1} + \frac{\gamma_2}{v} \left(\frac{1}{u_t} \frac{I_{t-1}}{K_{t-1}} \frac{\overbrace{Y_{t-1}}^{=1}}{Y_{t-1}} \right) + \frac{\gamma_3}{v} + \frac{\gamma_4}{v} \frac{u_{t-1}}{u_t} + \frac{1}{v} \frac{\Phi_t}{u_t} =$$

$$\frac{\gamma_1}{v} {u_t}^{-1} + \gamma_2 \left(\frac{1}{u_t} \frac{I_{t-1}}{Y_{t-1}} \overbrace{\frac{Y_{t-1}}{vK_{t-1}}}^{=u_{t-1}} \right) + \frac{\gamma_3}{v} + \frac{\gamma_4}{v} \frac{u_{t-1}}{u_t} + \frac{1}{v} \frac{\Phi_t}{u_t} =$$

$$\frac{\gamma_1}{v} {u_t}^{-1} + \gamma_2 \left(\frac{I_{t-1}}{Y_{t-1}} \frac{u_{t-1}}{u_t} \right) + \frac{\gamma_3}{v} + \frac{\gamma_4}{v} \frac{u_{t-1}}{u_t} + \frac{1}{v} \frac{\Phi_t}{u_t}$$

Hence:

$$\frac{I_t}{Y_t} = \gamma'_1 + \gamma'_2 \left(\frac{I_{t-1}}{Y_{t-1}} \frac{u_{t-1}}{u_t} \right) + \gamma'_3 {u_t}^{-1} + \gamma'_4 \frac{u_{t-1}}{u_t} + \Phi'_t \qquad (18')$$

With $\gamma'_1 = \frac{\gamma_3}{v}$, $\gamma'_2 = \gamma_2$, $\gamma'_3 = \frac{\gamma_1}{v}$, $\gamma'_4 = \frac{\gamma_4}{v}$ and $\Phi'_t = \frac{1}{v} \frac{\Phi_t}{u_t}$

If we assume that (18) is well specified, such that Φ_t and u_t are independent, $cov(\Phi_t, u_t) = 0$ and $E(\Phi_t) = 0$, thus $cov(\Phi_t, {u_t}^{-1}) = 0$ and $E(\Phi'_t) = v^{-1} E(\Phi_t) E({u_t}^{-1}) = 0$. Hence, the OLS estimators of equation (18') are also robust and well identified.

Appendix A3- Sensitivity to alternative specifications of the objective function

We test different specifications of the objective function, with $\alpha = (0, 0.25, 0.5, 0.75, 1)$, and find a clear correlation with the two estimated parameters v^* and δ^*, although some countries do not have any meaningful vector (v^*, δ^*) for some values of α (figures A3.1 and A3.2). Moreover, the correlation between the ratio of these two, v^*/δ^*, and α is always positive and relatively stable for $\alpha \leq 0.5$, while it tend to explode for values higher than 0.5 (Figure A3.3).

This reflects the strong trade-off between the R^2 and the t-statistics around the optimal vector (v^*, δ^*): small deviations from this optimal point that imply small improvements in the R^2 imply large losses in the t-statistics. Hence, as soon as the R^2 becomes the main or unique maximizing argument and α approaches to 1, the estimated values (v^*, δ^*) change in the direction of an improvement in the R^2 in spite of the significant drop in the t-statistics. Hence, a low value of α stabilizes the solution (v^*, δ^*) by penalizing those vectors (v, δ) that imply small improvements in the R^2 at the cost of large losses in the t-statistics. Because $\alpha \leq 0.5$ seems the most appropriate choice, we retain $\alpha = 0.5$ for all countries except Denmark, France, Germany and the Netherlands, which have no meaningful vector (v^*, δ^*) with $\alpha = 0.5$. In these countries, we set the value of α closest to 0.5 among those providing meaningful estimates. Namely, we set $\alpha = 0.25$ for Denmark, $\alpha = 0$ for France, $\alpha = 1$ for Germany and $\alpha = 0.75$ for the Netherlands.

Figure A3.1: The capacity-to-capital-ratio for each specification of the objective function in 14 EU countries

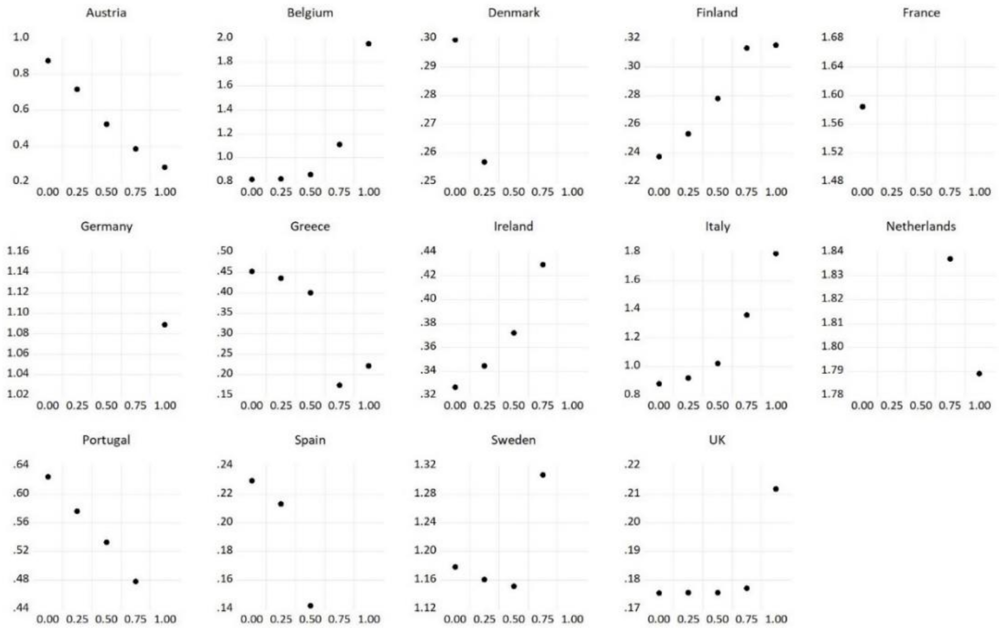


Figure A3.2: The depreciation rate for each specification of the objective function in 14 EU countries

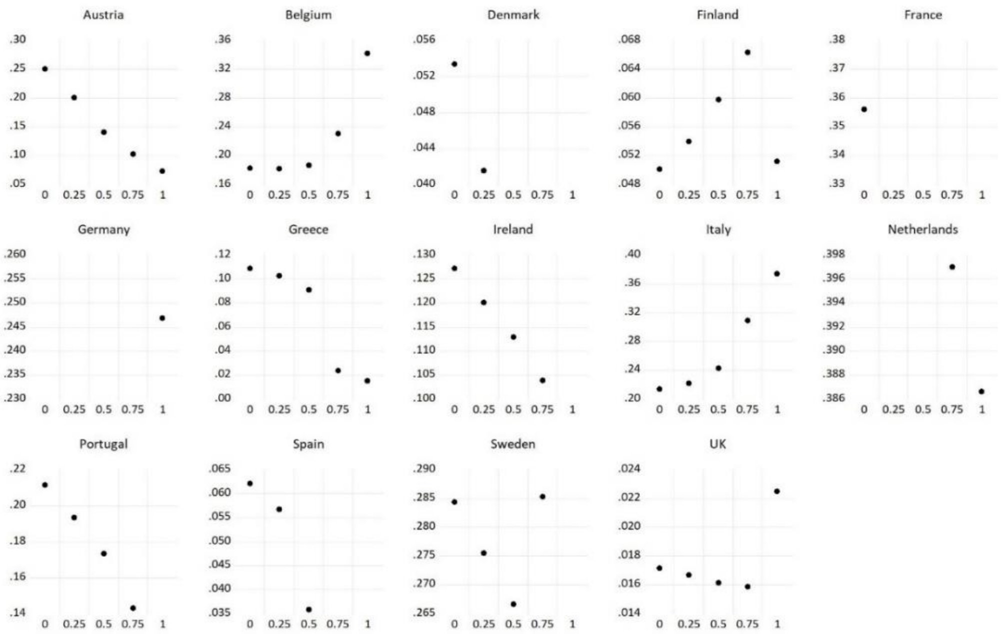


Figure A3.3: The ratio of the capacity-to-capital ratio to the depreciation rate for each specification of the objective function in 14 EU countries

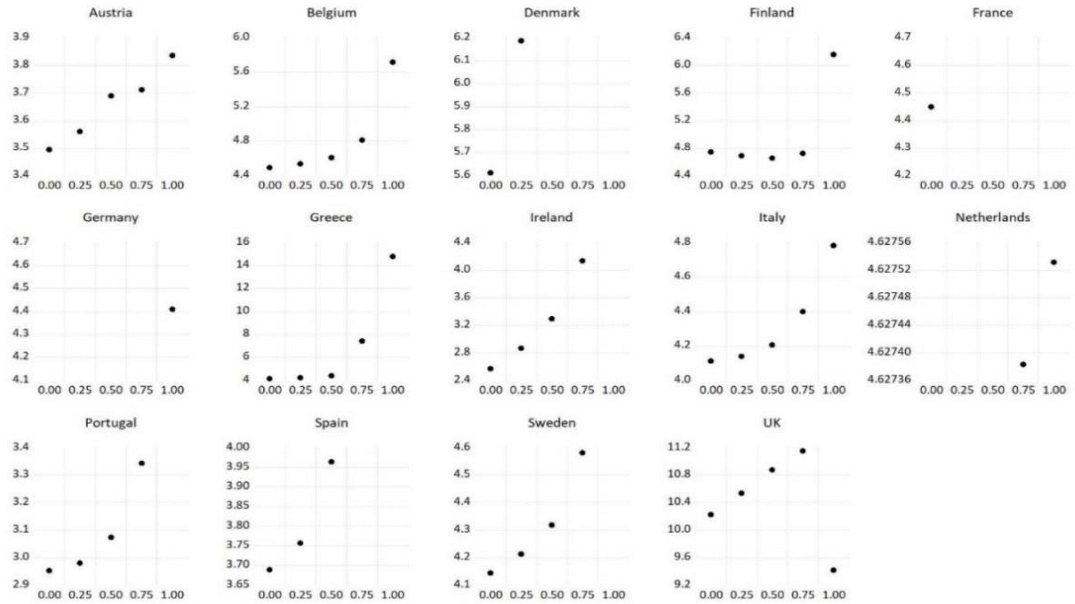
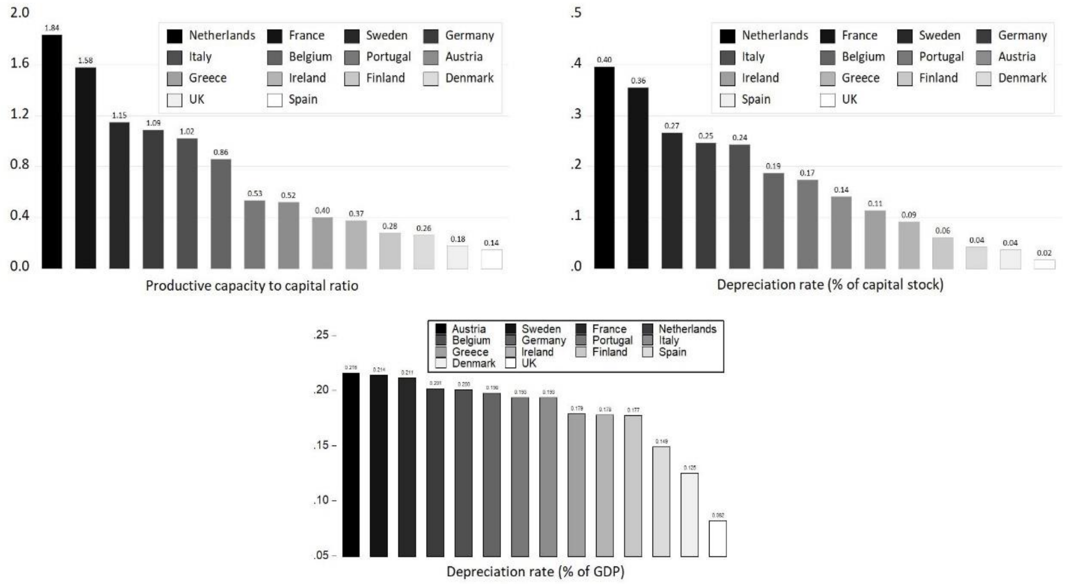


Figure A3.4 shows the estimated parameters of the production function v and δ with the selected value of α. Depreciation rates (% of capital stock) range between 2% in UK to 40% in Netherlands (top-right), while capacity-to-capital ratios (top-left) range between 0.14 in Spain to 1.84 in the Netherlands. The positive correlation between the two parameters suggests that a faster depreciation compensates the higher productivity of the capital stock. Moreover, the choice of setting $u_0 = 1$ might also explain the large volatility of these two ratios. Indeed, if we compute the average depreciation rate as % of GDP (bottom-center), this volatility falls substantially: the average depreciation rate ranges between 8.2% in UK and 21.6% in Austria, a range of variation that is consistent with alternative estimates for the EU (Gorzig, 2007).

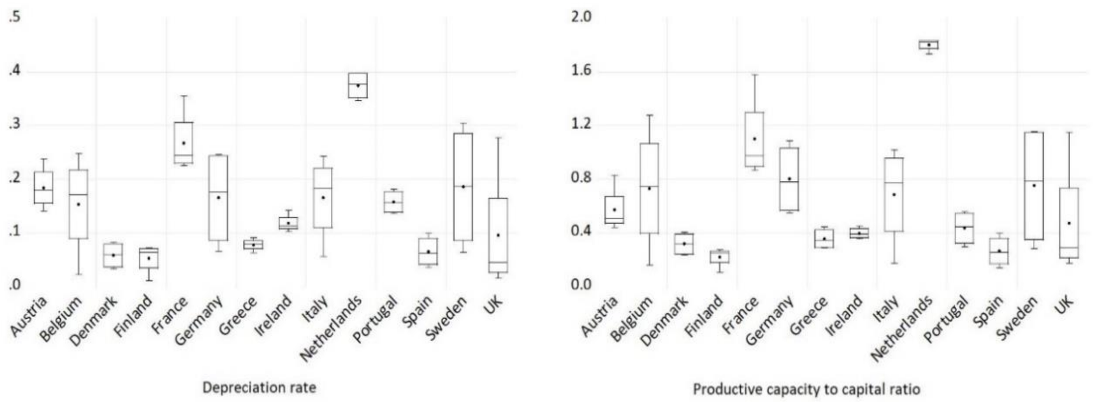
Figure A3.4: Depreciation rates (% of capital stock and % of GDP) and the capacity-to-capital ratio in 14 EU countries



Appendix A.4: alternative theoretical specifications

While the specification of the objective function might affect the estimated parameters beyond a certain value of α, as shown in appendix A.3, the specification of the theoretical model seems to have a limited impact. In most countries, there are no significant differences in (v^*, δ^*) when the theoretical specification changes: in most countries, the boxplot of the estimated values (v^*, δ^*) in the four theoretical models shows that estimates are concentrated on a relatively tight variation range (Figure A4.1)

Figure A4.1: Boxplot of the depreciation rates and the capacity-to-capital ratios



A graphical inspection of the time-series of the rate of capacity utilization for each theoretical specification confirms this result: as shown in figure A4.2, in most countries there are no significant differences in the dynamics of the rate of capacity utilization across the four theoretical specifications: the series appear to converge towards a common evolution trend within few years and co-evolve parallel each other. The only significant exception is Germany, which has significantly different initial trends. The smaller number of observations available for Germany – we used 1992, instead on 1965, as initial date – can explain this larger variation across models.

Because of the relatively small differences across the four models, we retain for simplicity the simplest model, model one, as benchmark. In future research, we might investigate more deeply the issue of which theoretical specification best suits each country's estimate of capacity utilization, with a closer inspection of the macroeconomic correlations that emerge with the other explanatory variables. At this point, however, we prefer to stick to a simple and one-fits-all model that is more easily interpretable, as the signs and magnitudes of correlations between explained and explanatory variables are comparable across countries and theoretically acknowledged. On the other hand, sign and magnitude of correlations in more complex theoretical specifications can be highly heterogeneous across countries and controversial from a theoretical standpoint. Namely, the effect of the profit share on investment decisions, or the effect of the wage share on the unemployment rate, are highly volatile across countries, as they are either positive or negative, or not significantly different from 0. This heterogeneity across countries is clearly an interesting finding that deserves a specific investigation, but it goes beyond the scope of this paper.

Figure A4.2: The rate of capacity utilization in the four theoretical specifications

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