Inflation, Capacity Utilization and Endogenous Growth

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Abstract

The paper contributes new theory and econometric panel data estimation of output growth for twenty-one countries for annual data averaging almost four decades. Using the returns to human and physical capital that determine economic growth in the model, we specify the baseline econometric model with variables that most directly affect these returns. The inflation rate and the physical capital capacity utilization rate robustly result as the two main significant variables with opposite signs as expected from theory across a set of advanced panel econometric models using Mean Group and Common Correlated Effects. The theory-guided specification of the econometric model advances shows the importance of the return to capital in explaining economic growth. Using tax smoothing principles to interpret results implies that inflation surges detrimentally affect growth policies, so that more crisis financing of public debt by the private sector remains preferable but risks a tradeoff of lower capital utilization.

JEL Classification: C23, E31, E52, O16, O42

Keywords: Inflation, economic growth, common correlated effects, panel error correction model, capacity utilization, income taxes.

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1 Introduction

Economic growth remains a prominent policy goal internationally yet a lack of consensus remains for what causes it, how to model it, and how to estimate it. Solow (1956) exogenous growth and Lucas (1988) endogenous growth through human capital accumulation have stimulated estimating growth with variables measuring the inputs of these production functions. However, these Neoclassical theories also show that growth depends directly on the returns to capital rather than the inputs to the production functions, making for a gap in how estimation of growth is formulated.[1]

Addressing this gap, we set out an endogenous growth model showing what variables most directly affect the returns to physical and human capital that determine economic growth, in particular the utilization rates and taxes affecting these returns. From this, theory and panel data testing procedures for common correlated effects with cointegration, we formulate a baseline econometric model with four variables. This approach contributes robust new evidence using advanced panel econometric methodology through mean group (MG), common correlated effects (CCE), and panel error correction model (ECM) with CCE (CS - ARDL) estimations. For robustness, we also estimate the model with Two-Way Fixed Effects (TWFE) and pooled estimators. Results provide significance and signs as predicted in theory for all variables to varying degrees. Significantly robust across all specifications, the inflation rate negatively affects and the physical capital capacity utilization rate positively affects growth.

Inflation in our model causes a Tobin (1965) effect in general equilibrium with endogenous growth that induces goods to leisure substitution, less working time, a higher wage to rental rate input price ratio, and physical capital deepening across sectors. In response to inflation surges in our model, the capacity utilization rate rises to partially offset the decline in the return to physical capital and so lessen the decrease in the growth rate. Given that CCE methods eliminate unobserved common trends identified through testing, which may include international real business cycle trends, we interpret the results on the importance of inflation and the capacity utilization rate as reflecting such a Tobin (1965) mechanism. Alongside inflation, finding the importance of a positive capacity utilization rate effect on growth is novel and emphasized by finding it in both dynamics and cointegrating vector of the panel ECM, as well as in all of the alternative estimation methods.[2]

Policy trade-offs suggest a trade-off between financing expenditure induced debt through the central bank versus private capital markets. The inflation tax harms growth. Our theoretical model implies that an increase in the capacity utilization rate can offset some of the inflation induced lower growth, which our empirical results may reflect. But the capacity utilization may fall if real interest rates rise in private markets should they take on the burden from the central bank in buying debt. Given traditional tax smoothing arguments of Lucas and Stokey (1983) that include the inflation tax alongside fiscal income tax rates, the policy dictum is to keep these tax rates smooth while instead borrowing in private capital markets for crisis-era expenditure, with the jumps in debt paid off through future steady rates of monetary and fiscal taxation. Such policy differs from the commonplace policy today of relying on the inflation tax to finance sudden increases in government debt through central bank purchase of the debt. The paper's results suggest weighing the distortion

[1] Gillman (2021) describes how Lucas (1988) generalizes Solow (1956) Solow (1956) by augmenting labor with an endogenously growing human capital stock and with a constant productivity factor, rather than augmenting labor with an exogenously rising productivity factor.

[2] See Gillman and Nakov (2003), Gillman and Kejak (2011) for this type of Tobin (1965) effect, Csabafi et al. (2019) and Benk et al. (2024) for real business cycle trends with the latter featuring a variable capacity utilization rate.

of the inflation tax that decreases growth against the distortion of a higher real interest rate in private markets that may lower the capacity utilization rate and thereby decrease growth.

Section 2 overviews the literature on the theory and estimation of real output growth. Section 3 presents an endogenous growth model; Section 4 lists data sources for our unbalanced panel consisting of 21 covering Europe and the US, with annual data through 2022 that averages almost four decades; and Section 5 provides testing for cross-sectional dependence, panel unit roots, cointegration and Granger causality, from which we specify our baseline econometric model. Section 6 presents the econometric results, Section 7 robustness evidence, and Section 8 discussion of results. Section 9 concludes.

2 Related Literature

Solow (1956), Denison (1962a), Uzawa (1965), and Lucas (1988) production functions form the basis to estimate growth as in Mankiw et al. (1992), but Hall and Jones (1997) express scepticism with this approach in favor of using general equilibrium concepts for what determines economic growth. Pedroni (1993), Durlauf and Quah (1998) and Restuccia and Rogerson (2017) advocate such a broader approach to growth by using equilibrium conditions.[3] Gillman and Kejak (2005) extend a Lucas (1988) endogenous growth model's stationary equilibrium to show the negative effect on growth from the inflation tax. Jones (2005) favors labor-augmenting technology for explaining growth; Jones (2023) considers knowledge driving growth; Lucas (2009a,b), Lucas and Moll (2014), Lucas (2015), Buera and Lucas (2018), and Caicedo et al. (2019) emphasize diffusion of knowledge; and Lucas (2018) uses a human capital quantity vs. quality trade-off to explain historical growth facts. Benk et al. (2024) emphasize a variable capital utilization rate as in Greenwood et al. (1988) that comprehensively explains real business cycle (RBC) facts through the return to human and physical capital, while augmenting Total Factor Productivity (TFP) through Lucas (1988) human capital. McGrattan and Prescott (2009) and McGrattan (2020) alternatively use intangible capital to augment TFP to explain RBC facts, whereas Huo et al. (2023) proposes an empirical capacity-utilization-adjusted Total Factor Productivity (TFP) that better matches growth cycle turning points.[4] Kaus et al. (2024) find that including intangible capital investment as factors of production tightens the TFP distribution, with firms at the top of the intangible capital investment distribution having a high elasiticity of such investment and a more variable capacity utilization rate of intangible physical capital.

[3] Hall and Jones (1997): "The underlying differences in infrastructure and government policies that influence long-run economic performance show up in levels, not growth rates...To explain differences in levels of long-run economic success across countries, one is forced to focus on more basic determinants." Durlauf and Quah (1998) finds that "the new literature...eschews understanding growth exclusively in terms of factor inputs...It freely uses all kinds of auxiliary explanatory factors, no longer making the production function residual a primary part of the analysis (p. 2)." Pedroni (1993) states: "Rather than attempting to estimate the structure of aggregate production function directly, or some transformation thereof, this paper instead works indirectly from the first order efficiency conditions implied by the different growth models (p. 1-2)." Restuccia and Rogerson (2017) emphasize distortions affecting marginal products, total factor productivity (TFP) and growth: "The literature has identified changes in misallocation as an important component of low-frequency movements in productivity (p. 161)."

[4] Romer (1990) uses research and development (R&D) for endogenous growth; Jones (1995a,b) finds a lack of support for R&D-induced growth; Ulku (2007) finds empirical support for R&D helping growth. Angeletos et al. (2020) identify empirically an endogenous TFP shock that has little effect on macroeconomic variables, whereas Gillman and Pagan (2024) show with the same identification scheme except with exogenous TFP that TFP shocks have a major impact on the economy.

Using a Kaleckian approach with productivity,[5] Nishi (2020) and Nishi and Stockhammer (2020) provide an alternate resurgence in interest in capacity utilization, in the former using variable physical capital investment demand, and in the latter with labor variation when below output capacity. Holm et al. (2024) interpret a greater degree of diminishing returns as more variable labor capacity utilization that with Rotemberg (1982) pricing makes a New Keynesian Phillips curve steeper so as to explain hysterisis from crisis recessions; Reiter and Wende (2024) find greater price pass through with generalized Rotemberg (1982) pricing. Woo (2020) provides evidence of variable physical capital capacity utilization to news shocks; Gahn and Gonzalez (2022) finds a lack of correlation between physical capital capacity utilization and growth; Gahn (2023) reviews related theory on endogenous capacity utilization; Gahn (2024) uses the output to capital ratio to study trends in capacity utilization; de Oliveira (2023) finds evidence with a survey measure of capacity utilization of cyclical variation; Benk et al. (2024) use the Federal Reserve Board measure of the physical capital utilization rate using maximum sustainable output.[6]

Finn (1996) includes Greenwood et al. (1988) variable physical capital capacity utilization in a monetary rational expectations RBC economy that uses the unitary consumption velocity of Lucas (1980). Benk et al. (2024) use endogenous Lucas (1988) productivity and growth along with the same capacity utilization function of Finn (1996) to explain a broad array of business cycle facts. We extend Finn (1996) by adding Lucas (1988) endogenous growth as in Gillman and Kejak (2014) and Benk et al. (2024), and by making money demand endogenous with variable consumption velocity as in Benk et al. (2005, 2008, 2010) and Gillman (2020). With an our endogenous money demand extension of the cash-in-advance exchange technology of Berentsen et al. (2011), as in their New Monetarist approach we present theory and evidence of a long run upward sloping Phillips curve. While this differs from the New Keynesian literature, overlap exists with both de Oliveira (2023) and our theory and evidence using a varying physical capital capacity utilization rate over time. Similarly, extensions of the Tobin (1965) effect come from such different perspectives: Lavoie and Godley (2001-2002) in a (Kalecki 1939, Kalecki(1939))-Kaldor (1957) model, Gillman and Nakov (2003) and Gillman and Kejak (2011) in a monetary RBC extension of Lucas (1988) endogenous growth, and Mattesini and Nosal (2016), Altermatt and Wipf (2024), and Cui et al. (2025) in New

[5] Productivity driving growth remains the confluence among the alternative Kalecki (1935, 1939) growth theories that Dutt (2012) reviews, the Kaldor (1957) Keynesian models of growth, and the above Neoclassical theory that extends Solow (1956) and Lucas (1988). Instead of exogenous growth theory, Kaldor (1957) argues that the output growth rate depends on the growth rate of the capital stock, while Kaldor and Mirrlees (1962) add that labor productivity embodied in capital also drives growth. Kurz and Salvadori (2005) investigate historial work by Sraffa (1960) in accounting for capital usage. Parigi and Siviero (2001) compare measures of capacity utilization with a focus on potential output. Business cycles end up playing a key role in bringing capacity utilization into explanation of key facts, despite being developed from differing strategies. Kalecki (1935) presents a theory of real business cycles based on Keynes (1930) in which the value of output equals consumption plus investment (Gillman 2002), with different production technologies for each. Barbieri Goes and Deleida (2022) derive multiplier effects of spending as in Keynes (1930, 1936) but without capacity utilization rate effects. Kaldor (1955 - 1956) and Kuznets (1955) review theories of growth and income inequality, while Kaldor (1972) argues that equilibrium value theory (Hicks 1946) in the full optimization sense is irrelevant. In contrast, Lucas (1972, 1996) provides the "rational expectations" Phillips curve theory without a permanent trade-off and Atkinson and Lucas (1992) demonstrate ever increasing income inequality in a rational expectations model.

[6] "The Federal Reserve Board constructs estimates of capacity and capacity utilization for industries in manufacturing, mining, and electric and gas utilities. For a given industry, the capacity utilization rate is equal to an output index (seasonally adjusted) divided by a capacity index. The Federal Reserve Board's capacity indexes attempt to capture the concept of sustainable maximum output – the greatest level of output a plant can maintain within the framework of a realistic work schedule, after factoring in normal downtime and assuming sufficient availability of inputs to operate the capital in place." (Board of Governors of the Federal Reserve System (US), Capacity Utilization: Total Index [TCU], retrieved from FRED, Federal Reserve Bank of St. Louis).

Monetarist models; unlike previous work, in our model extension with capacity utilization inflation induces substitution towards a higher physical capital capacity utilization rate.

To model money demand and the inflation tax without money in the utility function as in Pedroni (1993) and Lucas (2000), Prescott (1987), Gillman (1993), and Benk et al. (2005, 2008, 2010) instead use a Baumol (1952)-Tobin (1965) margin of optimally setting the marginal cost of money to the marginal cost of resource costly exchange credit that avoids the inflation tax through earning short term interest. Using an RBC approach, Benk et al. (2010), Gillman and Kejak (2014), and Gillman (2020) decentralize the bank sector with production of exchange credit as in the microeconomic banking literature. This give the effective inflation tax a basis built on a production-based technology consistent both with RBC multi-sectoral production sector microfoundations, known as the production approach to financial intermediation (Degryse et al. 2009). Empirically, although for example D'Arcy et al. (2024) estimates economic growth without inflation, Kormendi and Meguire (1985), Barro (2001), Gillman et al. (2004), Chudik and Pesaran (2015) and Chudik et al. (2017) provide evidence that inflation significantly decreases growth. Basu et al. (2012) model an RBC match to the data of a low frequency negative correlation between inflation and output growth. Related to this, Chudik et al. (2023) estimate a robust negative effect of inflation on consumption that decreases working time.

By including income taxes as a variable in estimating growth while heretofore unknown to us, we follow Stokey and Rebelo (1995) who show how these taxes decrease the returns to capital and endogenous growth, as well as Myles (2000) who states that "Endogenous growth theory provides models that can assess the effects of taxation upon economic growth (p. 164)." Others such as McGrattan et al. (1997) and Ohanian et al. (2008) employ taxes for studying fiscal policy in RBC models; and Restuccia and Rogerson (2017) use income tax rates in a panel estimation of capital misallocation couched in an economic growth context.[7] Instead focusing on the debt to GDP ratio, Chudik et al. (2013) and Chudik et al. (2017) estimate growth while also including the inflation rate.

Methodologically, Hall and Jones (1997) notes that "The trend in the empirical growth literature has been to slice up 30 years of cross-section data into a panel data set of decade or five-year growth rates." Lee et al. (1997, 1998) considers cross-section estimates to be biased, finds the growth convergence literature violates assumptions, and prefers a focus on growth fundamentals.[8] Pedroni (1993) critiques estimates using the output production function as being econometrically implausible; Eberhardt and Teal (2010, 2011) extend that argument. Pesaran and Smith (1995) advance two-way fixed effects using mean group estimators with unobserved heterogeneity, independent country intercepts and slopes, and any frequency of data, which we employ. Pesaran (2006, 2007), Coakley et al. (2006)), and Pesaran and Yamagata (2008) allow for panel unobserved heterogeneity and common correlated effects (CCE), which Eberhardt and Teal (2011) survey and which we also employ. Chudik and Pesaran (2015) develop panel error correction estimation with CCE, as does Ditzen (2016, 2018, 2021), whom we follow using his codes, without biased estimators as

[7] Restuccia and Rogerson (2017): "in the context of the standard neoclassical growth model, a proportional tax on income will distort household decisions regarding consumption and labor supply, and hence may be described as causing misallocation along these margins (p. 152)."

[8] Lee et al. (1997): "the hypothesis of growth homogeneity (which is a necessary condition for convergence across countries) is rejected irrespective of whether the output series are assumed to possess a unit root or not ...it appears that the convergence literature has paid undue attention to these dynamics, and may have misdirected attention from the more fundamental issue of the determination and diffusion of technological growth (p. 323)." Lee et al. (1998): "To the extent that these intercepts are correlated with the regressors (as the theory in fact predicts they will be), the conventional cross-section estimates used by Barro and Mankiw, Romer, and Weil will be biased (p. 319)."

Chen and Zhang (2025) describe. Preliminary to estimation, data testing methods that we use include Ahn and Horenstein (2013), Onatski (2010), and Gagliardini et al. (2019) for unobserved common factors, Kao (1999), Pedroni (1999, 2004) and Westerlund (2005) for panel cointegration, and Dumitrescu et al. (2012), Lu et al. (2017) and Juodis et al. (2021b) for Granger causality testing with panel cointegration. Regarding the sample size, Harding et al. (2020) show appropriate CCE estimation with a small N sample and sufficiently large time series. While their remains no definite answer as to what is a sufficiently large N and T, our number of N=21 countries and an average of T=37 time periods compares for example to Özmen and Yaşar (2016) with N=29 and T=15, Chang et al. (2018) with N=31 and T=25, Chudik et al. (2017) with N=40 and T=45, De Vos and Westerlund (2019) with N=25 and T=25 (among others in a simulation), Mauro et al. (2023) with N=20 and T=31, Camarero et al. (2023) with N=15 and T=50, and Chudik et al. (2023) with N= 17 and T = 147.

3 Endogenous Growth Monetary Model

Starting with Gillman and Kejak (2014) that includes both inflation and income taxes to finance government expenditure in a Lucas (1988) endogenous growth economy, we extend this with variable physical capital capacity utilization as in Benk et al. (2024). The representative agent owns the exchange credit intermediary supplying inflation tax avoidance through an endogenously upward sloping marginal cost of exchange credit. This pays dividends to the household equal to the amount of inflation tax avoided. The agent rents human-capital augmented labor and physical capital to the three sectors that produce goods, human capital investment, and exchange credit.

With $\alpha \in R_{++}$ and $\beta \in (0,1)$ the discount factor for utility, each period t the household has log utility U_t over consumption goods c_t and leisure time x_t :

$$U_t = \ln c_t + \alpha \ln x_t,$$

that is discounted over the infinite horizon as subject to constraints.

Let l_{Gt} denote goods production time, l_{Ht} education production time, and l_{Qt} exchange credit production time, with the remainder of time taken as leisure x_t. This makes the allocation of time constraint:

$$1 - x_t = l_{Gt} + l_{Ht} + l_{Qt} \equiv l_t. \tag{1}$$

Human capital h_t augments l_t in all production activity but not leisure (Stokey and Rebelo 1995), making l_t the utilization rate of the human capital stock.

Let s_{Gt}, s_{Ht} and s_{Qt} denote the share of physical capital k_t used in each sector:

$$1 = s_{Gt} + s_{Ht} + s_{Qt}. \tag{2}$$

The household chooses physical capital investment i_t, and a common utilization rate u_t of physical capital k_t across sectors. While the utilization rates empirically may differ across sector, there is an aggregate procyclical real business cycle movement of the utilization rate and sectoral utilization rates tend to move together with the aggregate rate. Therefore the use of a single utilization rate is an abstraction of the symmetric treatment of capital that has been used in the literature with multi-sectoral models (Greenwood et al. 1993) and is exactly as specified in Benk et al. (2024).

The depreciation rate $\delta(u_t)$ of k_t is a function of u_t as in Greenwood et al. (1988) and Benk et al. (2024):

$$
\begin{aligned}
i_t &= k_{t+1} - k_t \left[1 - \delta(u_t)\right], \qquad (3)\\
\delta(u_t) &= \frac{\delta_K}{\psi} u_t^{\psi}; \quad \psi \geq 1, \;\; \delta_K \in \mathbb{R}_{++}. \qquad (4)
\end{aligned}
$$

Given that $\psi > 1$, the depreciation rate rises at an increasing rate with the utilization rate, in that $\delta'(u_t) > 0$ and $\delta''(u_t) > 0$.

Income from effective working time across sectors, of $l_{Gt}h_t$, $l_{Ht}h_t$, and $l_{Qt}h_t$, and from renting physical capital of $s_{Gt}u_tk_t$, $s_{Ht}u_tk_t$, and $s_{Qt}u_tk_t$, yield the effective wages and rents. The household faces a common tax rate τ on both human and physical capital income. With the raw labor wage rate denoted by w_t and the rental rate on physical capital by r_t, the agent earns after tax τ income of $(1-\tau)(w_tl_th_t + r_tu_tk_t)$. The agent deposits this income net of physical capital investment automatically into the intermediary, which in turn credits it with deposits d_t that can be withdrawn to buy goods c_t. With a competitive equilibrium deposit return (yield) denoted by R_t^d, the agent also receives dividends from owning the bank of $R_t^d d_t$ as well as a real government transfer of Γ_t.

The household buys goods c_t, education from human capital investment i_{Ht} with a real price denoted by p_{Ht} and outlay of $p_{Ht}i_{Ht}$, and exchange credit q_t at a real price denoted by p_{Qt} and outlay of $p_{Qt}q_t$. Denote the money stock by M_t, nominal government bonds by B_t, the nominal price of goods by P_t, the inflation rate by $1 + \pi_{t+1} \equiv \frac{P_{t+1}}{P_t}$, real money by $m_t \equiv \frac{M_t}{P_t}$, real bonds by $b_t \equiv \frac{B_t}{P_t}$, and the nominal bond interest rate by R_t. The agent's investment in real money holdings and real bond holdings is $m_{t+1}(1+\pi_{t+1}) - m_t + b_{t+1}(1+\pi_{t+1}) - b_t(1+R_t)$. This gives a budget constraint of

$$
\begin{aligned}
0 \;\leq\; & (1-\tau)(w_tl_th_t + r_tu_tk_t) + R_t^d d_t + \Gamma_t - c_t - k_{t+1} + k_t\left[1 - \delta_k(u)\right] - p_{Ht}i_{Ht} - p_{Qt}q_t\\
- \;& m_{t+1}(1+\pi_{t+1}) + m_t - b_{t+1}(1+\pi_{t+1}) + b_t(1+R_t). \qquad (5)
\end{aligned}
$$

The consumer also faces an exchange technology that combines the use of money with the production technology of using exchange credit to buy goods, such that the exchange means need to be at least as large as consumption purchases:

$$
m_t + q_t \geq c_t. \qquad (6)
$$

The money and exchange credit come from deposits at the bank, with money withdrawn in advance of trading and credit paid off at the end of the period. Income deposited of $(1-\tau)(w_tl_th_t + r_tu_tk_t) - i_t = c_t$ must be at least as great as deposits d_t withdrawn to buy goods:

$$
c_t \geq d_t. \qquad (7)
$$

Given $\delta_H \in [0,1]$, the household's last constraint is that investment in human capital i_{Ht} follows a standard capital accumulation equation:

$$
i_{Ht} = h_{t+1} - h_t(1 - \delta_H), \qquad (8)
$$

noting that i_{Ht} is a production function including both human and physical capital inputs as specified below. The household optimization problem and equilibrium conditions are given in Appendix A.

The government budget constraint is that

$$\Gamma_t = \tau(w_t l_t h_t + r_t u_t k_t) + m_{t+1}\left(1+\pi_{t+1}\right) - m_t + b_{t+1}\left(1+\pi_{t+1}\right) - b_t\left(1+R_t\right),$$

where the net bonds held in equilibrium by the representative agent are zero and the constant money supply growth rate, denoted by σ is defined by

$$M_{t+1} = M_t(1+\sigma). \tag{9}$$

Government spending is paid for through income taxes and money supply creation. With stochastic shocks added in extension, government debt can be held optimally to finance surges in spending as set out in Lucas and Stokey (1983).

The representative agent's three competitive industry profit maximization problems are as follows, with profit denoted by Π_G, Π_H, and Π_Q for goods, human capital investment, and bank credit, respectively. The goods and human capital investment sectors have zero profit as Cobb-Douglas sectors, whereas the exchange credit sector has zero profit after paying out the producer surplus as dividends.

With $A_G \in R_{++}$ and $\phi \in [0,1]$, goods production is given by

$$y_t = A_G\left(l_{Gt}h_t\right)^{\phi}\left(s_{Gt}u_t k_t\right)^{1-\phi}; \tag{10}$$

profit maximization of Π_{Gt} is

$$\underset{l_{Gt},s_{Gt}}{Max}\,\Pi_{Gt} = A_G(l_{Gt}h_t)^{\phi}(s_{Gt}u_t k_t)^{1-\phi} - w_t l_{Gt}h_t - r_t s_{Gt}u_t k_t.$$

This gives equilibrium conditions of

$$w_t = \phi A_G\left(\frac{l_{Gt}h_t}{s_{Gt}u_t k_t}\right)^{\phi-1}; \tag{11}$$

$$r_t = (1-\phi)A_G\left(\frac{l_{Gt}h_t}{s_{Gt}u_t k_t}\right)^{\phi}. \tag{12}$$

With $A_H \in R_{++}$ and $\varepsilon \in [0,1]$, production of human capital investment is given by

$$i_{Ht} = A_H(l_{Ht}h_t)^{\varepsilon}(s_{Ht}u_t k_t)^{1-\varepsilon}; \tag{13}$$

profit maximization is

$$\underset{l_{Ht},s_{Ht}}{Max}\,\Pi_{Ht} = p_{Ht}A_H(l_{Ht}h_t)^{\varepsilon}(s_{Ht}u_t k_t)^{1-\varepsilon} - w_t l_{Ht}h_t - r_t s_{Ht}u_t k_t.$$

The equilibrium conditions result as

$$w_t = p_{Ht}\varepsilon A_H\left(\frac{l_{Ht}h_t}{s_{Ht}u_t k_t}\right)^{\varepsilon-1}; \tag{14}$$

$$r_t = p_{Ht}(1-\varepsilon)A_H\left(\frac{l_{Ht}h_t}{s_{Ht}u_tk_t}\right)^{\varepsilon}. \tag{15}$$

The production of exchange credit involves, in addition to human and physical capital inputs, the amount of income deposits that the agent puts in the financial intermediary as a third factor of production as first used in Clark (1984). The normalization of the quantity of real credit q_t by the amount of income deposits d_t, gives the amount of credit provided per unit of deposits in equilibrium, or q_t/d_t, which implies an "upward-sloping" credit supply that results from q_t/d_t having returns to scale less than one. In particular, with $A_Q \in R_{++}$ and $\gamma \equiv \gamma_1 + \gamma_2 < 1$, the intermediary exchange credit production function is

$$q_t = A_Q\left(l_{Qt}h_t\right)^{\gamma_1}\left(s_{Qt}u_tk_t\right)^{\gamma_2}\left(d_t\right)^{1-\gamma_1-\gamma_2}. \tag{16}$$

This means that

$$\frac{q_t}{d_t} = A_Q\left(\frac{l_{Qt}h_t}{d_t}\right)^{\gamma_1}\left(\frac{s_{Qt}u_tk_t}{d_t}\right)^{\gamma_2},$$

and given $\gamma_1 + \gamma_2 < 1$ there exists an endogenously upward sloping marginal cost curve and unique equilibrium between money and exchange credit (Gillman 2020).The profit maximization problem is to maximize profit Π_{Qt} of revenue of $p_{Qt}q_t$ minus the costs of production by choosing inputs of labor l_{Qt}, the share of capital s_{Qt}, and the deposits d_t subject to the production function as follows.

$$\underset{l_{Qt},s_{Qt},d_t}{Max}\,\Pi_{Qt} = p_{Qt}A_Q\left(l_{Qt}h_t\right)^{\gamma_1}\left(s_{Qt}u_tk_t\right)^{\gamma_2}\left(d_t\right)^{1-\gamma_1-\gamma_2} - w_tl_{Qt}h_t - r_ts_{Qt}u_tk_t - R_t^dd_t,$$

with equilibrium conditions of

$$w_t = p_{Qt}\gamma_1A_Q\left(\frac{l_{Qt}h_t}{d_t}\right)^{\gamma_1-1}\left(\frac{s_{Qt}u_tk_t}{d_t}\right)^{\gamma_2}; \tag{17}$$

$$r_t = p_{Qt}\gamma_2A_Q\left(\frac{l_{Qt}h_t}{d_t}\right)^{\gamma_1}\left(\frac{s_{Qt}u_tk_t}{d_t}\right)^{\gamma_2-1}; \tag{18}$$

$$R_t^d = p_{Qt}\left(1-\gamma_1-\gamma_2\right)A_Q\left(\frac{l_{Qt}h_t}{d_t}\right)^{\gamma_1}\left(\frac{s_{Qt}u_tk_t}{d_t}\right)^{\gamma_2}. \tag{19}$$

From the household problem equilibrium conditions, it results in dynamic equilibrium and along the balanced growth path (without time subscripts) that

$$p_Q = R. \tag{20}$$

The price per unit of exchange credit p_Q equals the government bond rate R. Then it follows in equilibrium from equations (6), (7), (16), (19), and (20) that $R^d = R\left(1-\gamma\right)\frac{q_t}{c_t}$. After some algebra, the effective optimal inflation tax per unit of goods is the interest differential $R - R^d$ (the "user cost" of exchange) that is in turn a weighted average of the cost of using money $R_t\frac{m_t}{c_t}$ and the cost of using credit $R_t\gamma\frac{q_t}{c_t}$:

$$R - R^d = R_t\frac{m_t}{c_t} + R_t\gamma\frac{q_t}{c_t}. \tag{21}$$

Because $\gamma R_t < R_t$, the household uses an optimal amount of both money and exchange credit.

3.1 Balanced Growth Path Equilibrium

Along the balanced growth equilibrium (BGP) of the economy, note that the variables that grow have the time notation applied as c_t, y_t, k_t, h_t, i_t, i_{Ht}, m_t, and q_t, while stationary variables have the time notation dropped. And for ease of expression, denote the marginal product of human capital from equation (14) as r_H :

$$r_H \equiv \frac{w}{p_H} = \varepsilon A_H \left(\frac{s_H u k_t}{l_H h_t} \right)^{1-\varepsilon}. \tag{22}$$

The BGP growth rate, denoted by g, results endogenously from the marginal returns to each physical and human capital, in two separate balanced BGP intertemporal equations for the growth rate. Starting with the better-known physical capital condition, $1+g$ equals 1 plus the marginal product of capital r factored by the utilization rate of physical capital u, which is the "effective marginal product" ru, as factored by $(1-\tau)$ (to be net of taxes) and net of depreciation $\delta(u)$, all divided by 1 plus the rate of time preference ρ (with $\beta \equiv \frac{1}{1+\rho}$) :

$$1+g = \frac{1+[ru(1-\tau)-\delta(u)]}{1+\rho}; \tag{23}$$

so that the growth rate by this margin is $g = \frac{ru(1-\tau)-\delta(u)-\rho}{1+\rho}$.

From the human capital intertemporal condition, g in parallel also depends on the discounted marginal product of human capital r_H as factored by its own utilization rate, which is the percent of time productively employed across industries l. This makes $r_H l$ the "effective marginal product" (parallel to $r \cdot u$ for physical capital), which is factored by $(1-\tau)$ and net of depreciation δ_H :

$$1+g = \frac{1+[r_H l(1-\tau)-\delta_H]}{1+\rho}, \tag{24}$$

where $g = \frac{r_H l(1-\tau)-\delta_H-\rho}{1+\rho}$. Therefore the "effective marginal products" that include the utilization rates of capital, net of taxes and depreciation, are equal and determine economic growth:

$$ru(1-\tau)-\delta(u) = r_H l(1-\tau)-\delta_H. \tag{25}$$

The inflation rate and capacity utilization rate alter the BGP equilibrium through the returns to capital. An increase in the BGP money supply growth rate σ increases the nominal interest rate R, increases the shadow cost of exchange and so the shadow cost of consumption, induces substitution from goods c_t to leisure x, decreases l, and so decreases the BGP return to human capital, and the BGP growth rate g. To moderate the degree to which the growth rate g declines, the agent increases r_H as a result of the Tobin (1965) effect in general equilibrium (Gillman and Nakov 2003, Gillman and Kejak 2011). When l goes down, it follows that w/r goes up and substitution occurs from human to physical capital inputs in production across sectors, which causes physical capital deepening as $\frac{s_G u k_t}{l_G h_t}$ and $\frac{s_H u k_t}{l_H h_t}$ increase. With r falling as $\frac{s_G u k_t}{l_G h_t}$ rises, the agent increases the physical capital utilization rate u to optimally moderate the decline in $ru(1-\tau)-\delta(u)$, which equals the decline in $r_H l(1-\tau)-\delta_H$ as g falls. Therefore u also rises as part of the Tobin (1965) effect, a new feature of this extended model.

More formally, the inflation effect occurs through the marginal rate of substitution between leisure and goods (MRS). From the equilibrium conditions of the Appendix A, this margin can be alternatively expressed as equating the ratio of the marginal utilities of leisure to goods consumption to the ratio of the shadow price of consumption relative to the shadow price of leisure:

$$\frac{x}{\alpha c_t} = \frac{1+R-R^d}{wh_t\,(1-\tau)} = \frac{1+R\frac{m_t}{c_t}+\gamma R\frac{q_t}{c_t}}{wh_t\,(1-\tau)}. \tag{26}$$

The shadow price of goods to leisure is $\frac{1+R-R^d}{wh_t(1-\tau)}$, in which $R-R^d$ is the optimal effective inflation tax that the household pays. In comparison, in an economy without an exchange cost the MRS is $\frac{1}{wh_t(1-\tau)}$ and in a cash-only economy in which $\frac{m_t}{c_t}=1$, the MRS is $\frac{1+R}{wh_t(1-\tau)}$. Thus $R-R^d<R$ shows the advantage to the household in using exchange credit (even though it is socially wasteful to spend resources avoiding the government's inflation tax).

An increase in the money supply growth rate σ directly increases the interest rate R. From equation (6), along the *BGP*, it holds that $m+q=c$; let $a_t \equiv \frac{m_t}{c_t} = 1-\frac{q_t}{c_t}$, which is stationary over time ($a_t = a_{t+1} = ...$). Then it is true from equation (6) that for the nominal money, $M_t = a_t P_t c_t$. Consider the change over time in nominal money, $\frac{M_{t+1}}{M_t}$, which by the government constraint (9) is $1+\sigma$. Since $\pi = \frac{P_{t+1}}{P_t}$ and along the *BGP* it results that $\frac{c_{t+1}}{c_t}=1+g$, then $1+\sigma = \frac{M_{t+1}}{M_t} = \frac{a_{t+1}P_{t+1}}{a_t P_t}\frac{c_{t+1}}{c_t} = (\,1+\pi)\,(1+g)$. The model's Fisher equation of interest rates is $1+R = (\,1+\pi)\,\{1+[ru\,(1-\tau)-\delta_k\,(u)]\}$. By the growth equation (23), it is true that $\{1+[ru\,(1-\tau)-\delta_k\,(u)]\} = (1+g)\,(1+\rho)$. Therefore $1+R = (\,1+\pi)\,(1+g)\,(1+\rho)$. Since we know that $1+\sigma = (\,1+\pi)\,(1+g)$, it follows that $1+R = (1+\sigma)\,(1+\rho)$.

The increase in the money supply growth rate σ causes R to increase and triggers substitution from money to credit. This lessens the increase in $R-R^d = R\frac{m_t}{c_t}+\gamma R\frac{q_t}{c_t}$ but $R-R^d$ still rises and causes goods to leisure substitution and working time l to fall. As σ and R rise, so does the inflation rate π by the Fisher equation but by slightly less than the increase in R because the growth rate g falls.

This is the endogenous growth rationale for why we find so many empirical results of inflation negatively affecting growth. The more direct influence is from the money supply growth rate, with the problem that this is measured through many different monetary aggregates across countries with ambiguity as to what constitutes the monetary aggregate corresponding to the theoretic models. In contrast, the inflation rate is measured relatively precisely across countries with data widely available and commonly used in econometric panel applications to economic growth.

Two other features to mention include possible effects on growth from the income tax rate and the physical capital investment rate. An increase in the income tax rate τ directly decreases growth by equations (23) and (24). For the physical capital investment along the *BGP*, it holds that $i_t = k_{t+1} - k_t\,[1-\delta\,(\,u_t)] = k_t\,(1+g) - k_t\,[1-\delta\,(\,u_t)] = k_t\,[g+\delta\,(u_t)]$. Clearly then an increase in $\frac{i_t}{y_t} = \frac{k_t}{y_t}\,[g+\delta\,(u)]$ can coincide with the growth rate g increases, depending on how k_t/y_t changes at the same time. While both i_t/y_t and k_t/y_t are stationary on the *BGP*, the capital stock tends to change more smoothly than the investment rate i_t/y_t so that i_t/y_t may be a significant factor related to economic growth. However, we also know that $g = \frac{ru(1-\tau)-\delta(u)-\rho}{1+\rho}$, so that $\frac{i_t}{y_t} = \frac{k_t}{y_t}\left(\frac{ru(1-\tau)-\rho[1+\delta(u)]}{1+\rho}\right)$. This means that the investment rate change occurs simultaneously with changes in the marginal product of capital r and the capacity utilization rate u. As u could be said from equation (23) to more directly affect growth than i_t/y_t, if both i_t/y_t and the utilization rate u are included in the empirical estimation along with the tax rates, then i_t/y_t may be dominated by u and emerge as a subsidiary factor. This may run counter to conventional wisdom on the importance of i_t/y_t that dates back to the production approach to estimating growth.

Finally, the returns to capital, r and r_H, are generally not available as data series that could be used in econometrically estimating what determines economic growth g. These marginal products of capital depend upon the input ratio of physical to human capital used in each sector, $\frac{s_G u k_t}{l_G h_t}$ and $\frac{s_H u k_t}{l_H h_t}$, which remain difficult to measure. [9] This remains true even given availability of international data for human capital and physical capital stocks since k_t/h_t alone does not determine r and r_H but rather only in combination with the ratio of factor shares $\frac{s_G}{l_G}$ and $\frac{s_H}{l_H}$. There is no direct link from k_t and h_t to the BGP growth rate g, keeping in mind also that an increase in $\frac{s_G u k_t}{l_G h_t}$ and $\frac{s_H u k_t}{l_H h_t}$ causes r to fall but also causes r_H to rise, moving them in opposite directions.

3.2 Empirical Conjectures from the Model

Given the above description of the BGP equilibrium, the endogenous growth model leads to a set of conjectures for what empirical results may find.

Conjecture 1 *An increase in the physical capital utilization rate u increases economic growth g.*

Conjecture 2 *An increase in the human capital utilization rate l increases economic growth g.*

Conjecture 3 *An increase in the income tax rate τ decreases economic growth g.*

Conjecture 4 *An increase in the inflation rate π decreases economic growth g.*

Conjecture 5 *The investment rate i_t/y_t increases economic growth g less directly than the capacity utilization rate of physical capital u; as a result it may be dominated by including u in the econometric model.*

4 Data Description

Table 4 in Appendix B lists the countries and data series used in the econometric analysis. In total, $N = 21$ countries, with the US and Western Europe as sixteen of these countries with annual data from 1974 to 2022, except Portugal, and the remaining five Eastern European countries with data ranging starting in the 1990s. The average time period is $T = 37$. The first five data series below source from the World Development Indicators, the next two income tax series from the OECD, and the capacity utilization rate from FRED. The per capita real GDP growth rate (g_y) divides the level of real GDP by the population. The investment share (i/y) is calculated from the change in fixed capital formation relative to GDP. The effective tax (τ) is the OECD sum of the average corporate and personal income tax revenue share of GDP. All series enter the econometric model in net terms as a fraction less than one.

1. Real Gross Domestic Product (World Bank, World Development Indicators; Units: Constant 2015 Dollars, Frequency: Annual);
2. Real Gross Fixed Capital Formation (World Bank, World Development Indicators; Units: Constant 2015 Dollars, Frequency: Annual);
3. Inflation (CPI) (World Bank, World Development Indicators; Units: Percent per Annum, Frequency: Annual);

[9] See Gillman and Nakov (2003) for one such application.

4. Employment Rate (National Estimates retrieved from World Bank, World Development Indicators; Units: Percent of Population, Frequency: Annual);
5. Population (World Bank, World Development Indicators; Units: Millions of People, Frequency: Annual);
6. Corporate Income Tax Relative to GDP (Source: OECD; Units: Percent of GDP; Frequency: Annual);
7. Individual Income Tax Relative to GDP (Source: OECD; Units: Percent of GDP; Frequency: Annual);
8. Capacity Utilization Rate (Source: FRED; Units: Rate of Capacity Utilization).

5 Econometric Methodology

We specify the initial model to be estimated as an unbalanced panel, using the set of variables most directly affecting the return to capital of the theoretical model. The countries are indexed by $i = 1, ..., 21$. The annual time period begins at $t = 1974$ for fifteen of the countries and in the 1990s for the remaining six, ending in 2022. All in fractions, the growth rate of real GDP per capita (g_y) depends upon the inflation rate (π), capacity utilization rate (u), income tax rate (τ), gross fixed capital formation as a share of GDP (i/y), and the employment rate (l). This gives our initial functional form:

$$g_{y,it} = f\left[\pi_{it}, u_{it}, i/y_{it}, \tau_{it}, l_{it}\right]. \tag{27}$$

The following empirical model follows as

$$g_{y,it} = \alpha_i + \beta_1 \pi_{it} + \beta_2 u_{it} + \beta_3 \left(i/y\right)_{it} + \beta_4 \tau_{it} + \beta_5 l_{it} + \epsilon_{it}, \tag{28}$$

where α_i are country-specific effects, $\beta_1 - \beta_5$ the coefficients and ϵ_{it} the error term. Every variable uses data entered as a fraction, so that the coefficients are comparable and each indicates the change in the GDP growth rate from the change in each variable.

We then estimate this using the panel advances with Mean Group (MG) estimation, MG with Common Correlated Effects (CCE) and the panel error correction model with CCE. This shows how correlated effects across countries can affect results, and within a cointegration framework allows identification of the dynamics as well as the cointegrating relations. For this approach, a series of tests are useful.

5.1 Cross Sectional Dependence Test

Pesaran and Smith (1995) and Pesaran et al. (2001) suggest allowing for heterogeneous slopes for each country, although this can yield biased estimates if cross sectional dependence is present due to autocorrelated error terms. Misidentification of cross-sectional dependence can also lead to spurious results caused by common shocks and spatial spillovers. Pesaran (2006) and Chudik and Pesaran (2015) address testing for weak cross-sectional dependence, which we follow using the CD test of Pesaran (2015, 2021) as in Ditzen (2018). The baseline CD test statistic in Pesaran (2021) is $CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho_{ij}} \right)$, where $\hat{\rho_{ij}}$ are the pair-wise correlation coefficients estimated from OLS residuals of individual specific regressions of observations i and state j, where $j \neq i$. The null H_0 is that there exists zero or weak cross sectional dependence; the alternative H_1 is strong cross sectional dependence. Rejection of the null hypothesis suggests evidence of the presence of cross-sectional independence. Results of this test in Appendix B Table 5 indicate rejection of the null of weak cross sectional dependence in favor of the presence of a strong one, for all variables.

To identify the appropriate estimator given the presence of strong cross sectional dependence, one needs to test if there are heterogenous slopes in cross sections. We implement the Blomquist and Westerlund (2013) test for slope heterogeneity with the null being that the slope coefficients are homogeneous. Appendix Table 6 reports the Δ test statistic of this model and the corresponding $p-$values that indicate rejection of the null and the existence of slope heterogeneity.

Using the methods of Ahn and Horenstein (2013), Onatski (2010), and Gagliardini et al. (2019), Appendix B Table 7 presents results on the existence of common factors that need to be taken into account in the CCE methodology with panel cointegration, since these factors can obscure the existence of a cointegrating relation. With the full model including the employment rate, a conflict arises between alternative test statistics as to whether there are two common factors or zero. Dropping the employment rate, results consistently find two common factors.

5.2 Panel Unit Root Test

Given that common factors can affect stationarity, we treat their existence using the Pesaran (2007) Cross-sectionally Augmented Dickey Fuller (CADF) test and the Cross-sectionally Augmented version of that Im et al. (2003) test (CIPS). These operate under the null hypothesis of a unit root being present, allow for heterogeneous slopes and cross-sectional dependence, eliminate cross-sectional dependence by augmenting the cross-sectional averages of lagged levels and first-differenced data into individual ADF regressions, and implicitly absorb unobserved common factors (Pesaran 2007). Appendix B Table 8 reports the CADF test results that indicate a mix of unit root and stationary processes.

5.3 Cointegration Test

Cointegration among per capital output growth and explanatory variables indicates a type of long-run relation. If results find that a linear combination of $I(1)$ variables is integrated of order zero, then this implies a cointegrating relation in which variables move together in this long-run (Pesaran et al. 2001, Westerlund 2007), which may be augmented by stationary processes as well. We test for cointegration using the Kao (1999), Pedroni (1999, 2004) and Westerlund (2005) tests. Kao (1999) tests with the null of no cointegration between variables and the alternative hypothesis of cointegration; Pedroni (2004) similarly uses a null of no cointegration but including a panel specific autoregressive (AR) term and panel specific time trends; Westerlund (2005) tests with the null of cointegration.

The Kao (1999) test identifies if spurious regression may result when using variables not fully cointegrated, a key litmus test. Appendix B Table 9 presents the cointegration test results. In the top half of the table with all five variables, the tests reject cointegration by the Kao (1999) test in four of the five cases. However, by eliminating the employment variable, the bottom half finds cointegration by all measures.

Inclusion of the employment rate variable indicates a lack of cointegration by the Kao (1999) test and inconsistent results for the number of common factors. In addition, estimation results when including the employment rate indicate what appear to be spurious regression results. Taken together these test results lead us to define our baseline model without the employment rate, instead including for the baseline: the growth rate g plus the four variables of the investment rate i/y, the inflation rate π, the income tax rate τ, and the capacity utilization rate u.

5.4 Granger Causality Tests

Appendix B Table 10 reports the Cross-Sectional Heteroskedasticity-Robust Variance Estimation test of Juodis et al. (2021b) for the baseline model's four dependent variables jointly Granger causing economic growth. The Wald statistic indicating acceptance of joint Granger causality for both cases of the data set ending in 2022 and in 2019.

We next investigate whether individual variables are significant in Granger causing economic growth. Online Appendix B Table 11 reports in the first column the result that the investment rate, inflation and capacity utilization each are individually significant for the full sample. For data ending in both 2022 and in 2019, Alternative I eliminates the income tax rate from the model; Alternative II further eliminates the investment rate from the model. The investment rate along with inflation and capacity utilization significantly Granger cause growth for the full period, whereas with the data ending in 2019 the investment rate loses individual significance.

6 Estimation Results

For the baseline model, we now present the main empirical results. These are the MG, CCE, and panel ECM with CCE (CS-ARDL) estimations of the baseline model, both for data ending in 2022 and in 2019.[10] Table 1 presents these results with and without a trend for both the MG and the CCE estimators, along with the test for the existence of a trend. The Mean Group estimator assumes independent effects within each country rather than allowing for Common Correlated Effects. The table shows that inflation is not significant in the MG estimations for the full period through 2022, but is significant in all of the CCE cases. The right-hand side of the table shows the results for data through 2019, with the inflation rate negatively significant for both MG and CCE results. The trend is insignificant for the CCE results in both sets of results, while the trend is significant for the MG results in both cases. For the 2019 results, with the trend the MG inflation coefficient is -0.25; for the CCE results without the trend the coefficient is about half that magnitude at -0.13 for both sets of results. The capacity utilization rate is positively significant in all cases, at around 0.6 for MG results and about half that at 0.3 for CCE results. The investment rate and income tax rates are insignificant in all cases. An additional qualification is to test post-estimation for strong cross-sectional dependence (Rupert and Sustek 2019). This finds strong cross-sectional dependence for the case of the MG with a trend estimator, which is the case in which inflation is insignificant, as well as for the cases of trends in both MG and CCE estimators for the estimation with data through 2019.

Table 2 presents the results for the panel ECM with CCE (CS-ARDL). Both inflation and capacity utilization find significance in both dynamics and the cointegrating vector, along with the investment rate in the dynamics for the full data period (at a 10% level), but not for the

[10] Note that the Stata xtdcce2 command by Ditzen (2018, 2021) estimates even if some cross-sectional units have missing observations for certain time periods, but also can impute observations using test statistics as in Chudik and Pesaran (2015), which we follow. For example, the UK leaving the EU in 2020 leaves the last 2 years for the capacity utilization rate UK data to be interpolated by the algorithm in this command.

data ending in 2019, making the result less robust. The negative coefficients on inflation have magnitudes around 0.24 in dynamics and cointegration vector for data through 2022, but higher ones of 0.26 and 0.34, respectively, for data through 2019, a modest difference. The positive significant coefficient for the capacity utilization rate is higher for the full sample, near 0.4 in both dynamics and cointegrating vector, and lower for data to 2019, near to 0.24 and 0.29 respectively. The latter result are significantly lower than for the MG cases but compare closely to the CCE results of Table 1. Table 2 also shows the pooled ECM CCE results, in which results are similar for the data up through 2019, but inflation is insignificant for the full period through 2022.

Table 1: Baseline Mean Group and Common Correlated Effects Estimation for Full Sample (1974-2022) and Sample Ending in 2019

Dependent Variable		Model Estimation - Full Sample				Model Estimation - Sample Until 2019			
GDP Growth Rate		MG	MG (Tr.)	CCE	CCE (Tr.)	MG	MG (Tr.)	CCE	CCE (Tr.)
Investment-Output Ratio	Coef.	0.049	-0.157	0.072	0.037	0.079	-0.112	0.053	0.046
	s.e.	(0.067)	(0.100)	(0.072)	(0.086)	(0.073)	(0.091)	(0.081)	(0.091)
Inflation	Coef.	-0.019	-0.036	-0.132**	-0.159**	-0.0147**	-0.246***	-0.129*	-0.119
	s.e.	(0.047)	(0.057)	(0.058)	(0.069)	(0.067)	(0.065)	(0.069)	(0.076)
Effective Tax Rate	Coef.	-0.194	-0.105	0.044	-0.188	-0.224	-0.255	-0.276	-0.298
	s.e.	(0.263)	(0.366)	(0.258)	(0.289)	(0.284)	(0.379)	(0.279)	(0.309)
Capacity Utilization	Coef.	0.576***	0.620***	0.278***	0.338***	0.503***	0.565***	0.251***	0.310***
	s.e.	(0.051)	(0.052)	(0.059)	(0.051)	(0.050)	(0.059)	(0.060)	(0.000)
Trend	Coef.	N/A	-1.424*	N/A	-0.459	N/A	-2.464**	N/A	-0.400
	s.e.	N/A	(0.063)	N/A	(0.508)	N/A	(0.014)	N/A	(0.867)
CD Test	Test Statistic	-2.96	0.97	-1.54	-4.32	-1.54	-4.83	-0.99	-4.70
	p-value	0.003	0.334	0.123	0.000	0.123	0.000	0.324	0.000
F Test	Test Statistic	4.92	5.00	1.10	1.24	4.90	5.76	1.19	1.41
	p-value	0.000	0.000	0.200	0.020	0.000	0.000	0.060	0.000
Root MSE		0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01
R^2		0.57	0.51	0.71	0.66	0.55	0.45	0.67	0.60

Notes: a) For all estimation the number of observations 783 and number of Groups is 21. The full sample time period is 1974-2022 that varies by group with the frequency being annual with $T = 37$.Alternatively, the sample is from 1974-2019 with $T = 34$.
b) * - 10% significance, ** - 5% significance, and *** - 1% significance. Tr. denotes model with trend.
c) F Test is to test H_0 that the coefficients on the regressors are all jointly zero.
d) CD Test is the Juodis and Reese (2021) test of residuals, where H_0 : weak cross-sectional dependence or H_1 :strong cross-sect/depd is present

7 Robustness

For robustness, we also estimate the Pooled CCE and Two Way Fixed Effects (TWFE) regression results (Juodis et al. 2021a).[11] Table 3 shows that these confirm the Table 1 results in terms of the coefficient magnitudes, significance and signs for the inflation rate and capacity utilization rate. The trend of the pooled CCE estimation results is insignificant as in Table 1, with the inflation coefficient significant at -0.124 which compares closely to -0.13 in Table 1. Similar results hold for the data period ending in 2019. The capacity utilization rate has similar significant coefficients

[11] Note that Chudik et al. (2023) present a "novel pooled Bewley (PB) estimator of long-run coefficients for dynamic panels with heterogeneous short-run dynamics ...directly comparable to the widely used Pooled Mean Group (PMG) estimator, and ...shown to be consistent and asymptotically normal."

Table 2: Panel ECM and Pooled Estimation for Full Sample (1974-2022) and Sample Ending in 2019

Dependent Variable		Dynamic CCE Estimator (CS-ARDL)				Pooled Estimator	
GDP Growth Rate		Full Sample		Sample Until 2019		Full Sample	Sample Until 2019
		Dynamics	Cointegrating Vector	Dynamics	Cointegrating Vector		
Investment-Output Ratio	Coef	0.133*	0.112	0.079	0.034	0.025	-0.062
	s.e	0.079	0.078	0.066	0.118	0.045	0.130
Inflation	Coef.	-0.242***	-0.237***	-0.261***	-0.338***	-0.102	-0.161**
	s.e.	0.070	0.002	0.080	0.084	0.067	0.065
Effective Tax Rate	Coef.	-0.644	-0.643	-0.467	-0.501	-0.312	-0.313
	s.e.	0.430	0.068	0.501	0.453	0.258	0.215
Capacity Utilization	Coef.	0.376***	0.363***	0.237***	0.290***	0.233***	0.263***
	s.e.	0.070	0.070	0.068	0.070	0.056	0.055
Adjustment Term	Coef.	-1.062***		-0.967***		N/A	N/A
	s.e.	0.049		0.066		N/A	N/A
CD Test	Test Statistic	-2.92		-0.52		0.87	-1.11
	p-value	0.003		0.601		0.3837	0.267
F Test	Test Statistic	0.84		0.98		0.35	0.39
	p-value	0.96		0.590		1.000	1.000
Root MSE		0.02		0.01		0.02	0.01
R^2		0.61		0.53		0.88	0.85

Notes: a) For all estimation the number of observations 711 and number of Groups is 21.
The full sample time period is 1974-2022 that varies by group with the frequency being annual with $T = 37$.
Alternatively, the sample is from 1974-2019 with $T = 34$.
b) * - 10% significance, ** - 5% significance, and *** - 1% significance.
c) F Test is to test H_0 that the coefficients on the regressors are all jointly zero.
d) CD Test is the Juodis and Reese (2021) test of residuals, where H_0 : weak cross-sectional dependence or H_1 : strong cross-sectional dependence is present.

across the two tables. One difference is that the investment rate is also significant in the pooled CCE results for the data sample ending in 2022, but not in Table 1.

Table 3 also presents Two-Way Fixed Effects (TWFE) results for both data periods and the inflation rate and capacity utilization rate show significance with the same signs, and also find the investment rate significant for the full sample period. Coefficients for the inflation rate and capacity utilization rate have about half the magnitude compared to the pooled CCE and to Table 3. Taken together the pooled and TWFE results provides confirming evidence that indicates a lack of outliers as driving our results.[12]

As a last exercise, we eliminate insignificant variables one by one to check whether making the econometric model specification more parsimonious affirms the main results. For the CCE results without a trend (which is insignificant) and the panel ECM with CCE results, Online Appendix Tables 12 and 13 show results in which we delete first one insignificant variable from the four variable baseline, and then a second one, to reduce the model with inclusion of only the inflation and capacity utilization rate. The inflation rate and capacity utilization rate coefficients remain similarly significant. In the panel ECM dynamics and in the cointegrating vector, when the investment rate variable is removed for data ending in 2019, there results a sizable reduction in both the inflation rate and capacity utilization rate coefficient magnitudes, a similar reduction in

[12] For robustness checks regarding the MG results of Table 1, we found that the average time effect coefficient for the years of the sample were mostly between 0.03 and 0.05. For the years 2008-09 and 2020 the effects were somewhat elevated but not above 0.1. Similarly, examining individual country coefficients for capacity utilization and inflation found somewhat elevated coefficients for the inflation rate for two countries, Luxembourg and the Netherlands. We ran our estimation without these years and without the two countries and found little change in the results, indicating a lack of outliers driving the results.

Table 3: Pooled Common Correlated Effects, and Two Way Fixed Effect Estimation for Full Sample (1974-2022) and Sample Ending in 2019

Dependent Variable		Pooled Est. - 2022		Pooled Est. - 2019		TWFE - 2022	TWFE- 2019
GDP Growth Rate		CCE	CCE (Tr.)	CCE	CCE (Tr.)		
Investment-Output Ratio	Coef.	0.105***	0.059	0.012	-0.029	0.052**	0.004
	s.e.	(0.029)	(0.070)	(0.056)	(0.092)	(0.024)	(0.024)
Inflation	Coef.	-0.124**	-0.141	-0.149**	-0.157*	-0.074***	-0.066***
	s.e.	(0.051)	(0.104)	(0.064)	(0.088)	(0.024)	(0.023)
Effective Tax Rate	Coef.	-0.118	-0.311	-0.232	-0.331	-0.147	-0.138
	s.e.	(0.192)	(0.309)	(0.198)	(0.228)	(0.105)	(0.103)
Capacity Utilization	Coef.	0.223***	0.263***	0.263***	0.284***	0.131***	0.128***
	s.e.	(0.044)	(0.057)	(0.060)	(0.048)	(0.027)	(0.026)
Trend	Coef.	N/A	-0.235	N/A	-0.511	N/A	N/A
	s.e.	N/A	(0.245)	N/A	(0.480)	N/A	N/A
CD Test	Test Statistic	-0.79	0.50	1.72	-2.74	N/A	N/A
	p-value	0.428	0.617	0.086	0.000	N/A	N/A
F Test	Test Statistic	0.71	0.90	0.65	0.89	26.58	20.15
	p-value	0.990	0.770	1.000	0.790	0.000	0.000
Root MSE		0.02	0.02	0.02	0.02	N/A	N/A
R^2		0.90	0.85	0.90	0.84	0.61	0.56

Notes: a) For all estimation the number of observations 783 and number of Groups is 21.
The full sample time period is 1974-2022 that varies by group with
the frequency being annual with $T = 37$.Alternatively, the sample is from 1974-2019 with $T = 34$.
b) * - 10% significance, ** - 5% significance, and *** - 1% significance. Tr. denotes model with trend.
c) F Test is to test H_0 that the coefficients on the regressors are all jointly zero.
d) CD Test is the Juodis and Reese (2021) test of residuals, where H_0 : weak
cross-sectional dependence or H_1 :strong cross-sectional dependence is present.

the capacity utilization rate coefficient for the full sample, and such a reduction for both inflation and the capacity utilization rates in the dynamics of the full sample. These results suggest the importance of including the investment rate in the panel ECM model, along with the inflation rate and the capacity utilization rate.

8 Discussion

Variables that affect the return to capital robustly yield a single cointegrating vector with the GDP growth rate in the panel ECM results. For the baseline four variable full-sample model, Granger causality analysis finds that these variables jointly Granger cause economic growth, and that inflation, the capacity utilization rate and the investment rate individually Granger cause growth. The panel results use Mean Group estimators with independent errors and with CCE, with and without a trend, plus the panel ECM methodology. For robustness we use Two-Way Fixed Effects and pooled panel results for the CCE and panel ECM estimations. Additional robustness exercises involve alternative specifications of the econometric model and considering the data period ending in 2019 to exclude the pandemic period.

Results show robust effects from the inflation rate and the capacity utilization rate across specifications (Conjectures 4 and 1). Governments rely on the inflation tax to finance surges in government expenditure, with the result of a monetary-based continually changing tax that negatively effects growth. The capacity utilization rate that emerges as key for explaining real business cycles in recent work is significant and positive across all of our econometric methods. It also dominates the investment rate, as suggested in Conjecture 5. Dynamically, any change in the capital stocks causes transition dynamic towards the balance growth path equilibrium. For example any shocks to parameters with the model made stochastic, from which we abstract, cause such changes. Key variables such as the inflation rate and capacity utilization rate change in data often with trends dependent on monetary policy for the former and real business cycles for the latter. Because the capacity utilization rate is so highly procyclic, its movement up as real GDP growth rises, and down as growth falls, gives the basis for its strong impact on growth in the econometric results of this paper. This is true even as a trend down in capacity utilization is possible, as seen in US FRED data. The physical capital investment rate shows insignificance in all results except the TWFE for the full sample ending in 2022, and in the panel ECM dynamics for the full data period. However, robustness analysis finds that removing the investment rate from the panel ECM model substantially lowers the magnitude of the coefficients for the inflation and capacity utilization rate variables, suggesting its importance for inclusion in the model.

The investment to output ratio, or investment rate, variable still impacts our results, even if less directly than do inflation and the capacity utilization rate. Removal of common trends may take out international real business cycle changes in the investment rate, leaving perhaps more irregular changes in the capacity utilization rate to dominate results. In our theoretical model, capacity utilization responds to the inflation rate changes, which is a new extension of the Tobin (1965) effect that results in our endogenous growth monetary RBC model. Irregular changes in the inflation rate due to finance needs theoretically can induce changes in the capacity utilization rate that end up dominating the investment rate in the empirical results. To see this, consider that inflation increases drive factor input price changes that induce reallocation of factor inputs from human to physical capital, in what is physical capital deepening in our model. This increase in the use of physical capital already in place partly occurs through increases in the capacity utilization rate u. While this physical capital deepening lowers the real interest rate per se, the utilization adjusted real interest rate ru falls by less than it would without a variable capacity utilization rate in the model, such that a smaller decrease in the growth rate results from the inflation tax increase.

The combined personal and corporate income tax rate is insignificant in baseline results across models. However, we note that our experiments included deleting the only developed country that had data going back to the 1990s instead of 1974: Portugal. Exclusion of Portugal makes the income tax rate negatively significant in the panel ECM cointegrating vector as in Conjecture 3, while maintaining results for inflation and the capacity utilization rate. Further experiments find that in a developed country subsample (without Portugal) that the income tax negatively and significantly affects growth in the both panel ECM dynamics and the cointegrating vector (results available upon request), while maintaining results for inflation and capacity utilization. We find similar results for a remainder (transition) country subsample, but with qualification of a low N that can give biased results (not reported).

In sum, Conjectures 1 and 4 find the strongest support, on the capacity utilization rate and inflation; Conjecture 5 on the investment rate finds some support in the panel ECM and subsample experiments; Conjecture 3 on the income tax rate finds support if we exclude Portugal; and Conjecture 2 on the employment rate lacks support. These conjectures come from a return-to-capital approach in explaining economic growth. They illustrate advantages of using a theoretical model that combines elements of both real business cycles and endogenous growth, along with a monetary extension with inflation. It exemplifies an application by which general equilibrium theory guides estimation of economic growth with advanced estimation methods.

The paper updates the strong negative effect of inflation on growth found in previous work, as recently as Chudik et al. (2013, 2017), now framed in a return to capital approach to growth while using advanced panel data methods. It adds the capacity utilization rate also as a major determinate as unseen in previous work. Our favored model emerges as the panel ECM (CS - ARDL) that includes common correlated effects, dynamics, and the cointegrating vector, because it implicitly implies a "long run" economic growth estimation (the cointegrating vector) along with discerning the transition dynamics that might be interpreted as "short run" effects on growth. We find that both of these aspects of the CS - ARDL estimation remain quite similar, with inflation and capacity utilization prominent.

From the paper's results emerge several policy implications. Inflation remains a "bad" tax for growth. In times of crisis, common policy steps include reliance on an increased inflation tax. This acts against long term goals of promoting economic growth and wealth accumulation. What alternatives remain for crises times other than finance by the inflation tax? The main one is increasing the private sector ownership of government debt rather than increasing the central bank ownership of debt that is equivalent to "printing money," or more precisely "reserves." Relying instead on private markets to absorb increased debt would raise real interest rates instead of the inflation rate. The tax smoothing wisdom of Lucas and Stokey (1983) for both inflation tax rates and income tax rates is to set these tax rates at low stable levels and use increases in government debt to finance crisis-era government expenditure. That is their main result that laid the foundation for using a low stable inflation rate as the "nominal anchor" in a fiat world after the breakdown of the Bretton Woods gold standard.

Consistent with tax smoothing, our results entertain the policy alternative that the government debt should be increased through purchase by the public without central bank increasing their share of government debt. This would allow higher real interest rates to affect capital markets as may be appropriate for high government debt to GDP times. Although beyond our theoretical model, using private markets rather than the central bank to shoulder more of the burden of crisis spending and debt increases may cause a negative effect on the capacity utilization rate if real interest rates were to go up. Our empirical results suggest a trade-off in keeping inflation steady from a tax smoothing perspective, and causing minimal economic growth declines from the inflation tax, versus the specter of a rising real interest rate that could decrease economic growth through a lower capacity utilization rate. These separate effects during crises affect potential long-run trade-offs in public finance, of episodes of surges in the inflation tax and lower growth and revenue versus smoother, higher future statutory tax and inflation tax revenue to pay off crisis era increases in public debt not financed by the central bank.

This raises topics for further research that could involve business cycle modelling simultaneously with endogenous growth and both monetary and fiscal taxes in a world with shocks. Given the depth of capital markets in which fungibility of finance may allow greater depth in absorbing government demands for private finance, research might identify optimal crisis-period trade-offs for economic growth between sudden increases in inflation versus what may be a potential increase in real interest rates. The trade-off occurs because higher real interest rates from financing increased government spending induce a wedge on the return to capital that compares to the wedge from the inflation tax. The flip side to the price-theoretic distortionary trade-off between an inflation tax wedge versus a real interest rate wedge is the public finance trade-off of a long run gradual increase in tax revenue that sustains debt loads versus monetization of debt that decreases growth sharply through inflation. Speculatively, our results in combination with the tax smoothing literature suggest a higher real interest rate would be better for economic growth than surges in the inflation tax.

The endogenous growth literature finds a second-best level for flat personal and corporate income tax rates equal to the share of government spending in output (Turnovsky 2000, Azacis and Gillman 2010), which if extended to include the inflation tax would presumably include low inflation rates. With theory mirrored in experience, international policy has seen a steady historical trend towards lower, flatter income tax rates and lower inflation rates worldwide (Gillman and Kejak 2014). The goal of decreasing and flattening income tax rates while maintaining low inflation remains consistent with widening the tax base, increasing economic growth, and aiding the ability to pay off crisis-era debt in a virtuous cycle.

Using the debt to GDP ratio, a deficit measure, or an effective tax rate measure would be alternatives to explore relative to our use of the income tax revenue shares as a measure of the income tax rate; VAT tax rates could also be included. Other qualifications include that international trade variables and risk-return variables could be justified from a model extension that includes trade, a diversified portfolio of bonds and equity, and stochastic shocks. Further research might consider the real exchange rate, share of exports, fixed versus floating exchange rates, and the standard deviation of output in estimating growth.

9 Conclusion

The theory and results contribute a return-to-capital approach in explaining economic growth, illustrate the advantage of a theoretical model combining elements useful in explaining both business cycles and growth, and find evidence for how the inflation tax and capacity utilization rate of physical capital fundamentally explain growth. The paper constructs a theoretical model focusing on the returns to physical and human capital along the endogenous balanced growth path. Our emphasis on the variables affecting the returns to human and physical capital that determine growth provides a baseline econometric model with the inflation tax, a combined personal and corporate income tax rate, the physical capital capacity utilization rate, and the investment to output ratio. All four variables jointly Granger cause economic growth, while inflation and the capacity utilization rate individually Granger causing growth. These latter two variables robustly and significantly affect economic growth across our alternative panel data estimations that with Cross-Correlated Effects. The results of the panel ECM with CCE show significance of inflation and capacity utilization in both dynamics and the cointegrating vector. Policy implications consistent with the tax smoothing literature include allowing government debt surges to be financed through private lending rather than central bank purchase of government debt that increases the money supply growth rate and inflation rate.

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A Equilibrium Conditions

Using the allocation constraint (1) to substitute in for l_{Gt}, the consumer maximization problem is

$$\underset{c_t,x_t,u_t,i_Ht,q_t,d_t,m_{t+1},b_{t+1},k_{t+1},h_{t+1}}{Max} \sum_{t=0}^{\infty} \beta^t \{[\ln c_t + \alpha \ln x_t]$$
$$+\lambda_t \left\{ \begin{array}{c} (1-\tau) w_t h_t (1-x_t) + r_t u_t k_t (1-\tau) + R_t^d d_t + \Gamma_t - c_t - k_{t+1} + k_t [1-\delta(u_t)] - p_{Ht} i_{Ht} \\ -p_{Qt} q_t - m_{t+1}(1+\pi_{t+1}) + m_t - b_{t+1}(1+\pi_{t+1}) + b_t(1+R_t) \end{array} \right\}$$
$$+\mu_t(-c_t + m_t + q_t)$$
$$+\chi_t(c_t - d_t)$$
$$+\eta_t[-h_{t+1} + i_{Ht} + (1-\delta_H) h_t]\}.$$

The first order equilibrium conditions are as follows:

$$c_t : \quad \beta^t \frac{1}{c_t} - \beta^t \lambda_t - \beta^t \mu_t + \beta^t \chi_t = 0; \tag{29}$$

$$x_t : \quad \beta^t \frac{\alpha}{x_t} - \beta^t \lambda_t w_t h_t (1-\tau) = 0; \tag{30}$$

$$u_t : \quad -\beta^t \lambda_t \left[\delta'(u_t) + r_t k_t (1-\tau)\right] = 0; \tag{31}$$

$$q_t : \quad -\beta^t (\lambda_t p_{Qt} + \mu_t) = 0; \tag{32}$$

$$d_t : \beta^t \left(\lambda_t R_t^d - \chi_t\right) = 0; \tag{33}$$

$$i_{Ht} : \quad -\beta^t (\lambda_t p_{Ht} + \eta_t) = 0; \tag{34}$$

$$m_{t+1} \quad -\beta^t \lambda_t (1+\pi_{t+1}) + \beta^{t+1} \left(\lambda_{t+1} + \mu_{t+1}\right) = 0; \tag{35}$$

$$b_{t+1} \quad -\beta^t \lambda_t (1+\pi_{t+1}) + \beta^{t+1} \lambda_{t+1} (1+R_{t+1}) = 0; \tag{36}$$

$$k_{t+1} \quad -\beta^t \lambda_t + \beta^{t+1} \lambda_{t+1} \left[1 + r_{t+1} u_{t+1} (1-\tau) - \delta (u_{t+1})\right] = 0; \tag{37}$$

$$h_{t+1}: \quad -\beta^t \eta_t + \beta^{t+1} \lambda_{t+1} w_{t+1} (1-\tau) \, l_{t+1} + \beta^{t+1} \eta_{t+1} (1-\delta_H) = 0. \tag{38}$$

B Empirical Testing

Table 4: Summary of Balanced Panel: Countries and Range

Country	Country ID	Year (min.)	Year (max.)	No. of Years
Austria	1	1974	2022	49
Belgium	2	1974	2022	49
Czech Republic	3	1990	2022	33
Denmark	4	1974	2022	49
Finland	5	1974	2022	49
France	6	1974	2022	49
Germany	7	1974	2022	49
Greece	8	1974	2022	49
Hungary	9	1991	2022	32
Ireland	10	1974	2022	49
Italy	11	1974	2022	49
Luxembourg	12	1974	2022	49
Netherlands	13	1974	2022	49
Poland	14	1990	2022	33
Portugal	15	1996	2022	27
Slovakia	16	1992	2022	30
Slovenia	17	1995	2022	28
Spain	18	1974	2022	49
Sweden	19	1974	2022	49
United Kingdom	20	1974	2022	49
United States	21	1974	2022	49

Table 5: Tests for Cross Sectional Dependence

	Pesaran (2015) - Cross-Sectional Dependence Test					
Variables	g_y	i/y	π	τ	l	u
CD Statistic	70.27	24.13	64.21	9.05	19.72	60.64
p-value	0.000	0.000	0.000	0.000	0.000	0.000

Table 6: Slope Heterogeneity Test

	Full Dataset		Baseline Empirical Model (i/y, π, u, τ)	
	Δ	p-value	Δ	p-value
Unadjusted	7.005	0.000	4.568	0.000
Adjusted	7.997	0.000	5.062	0.000

Table 7: Estimation of Common Factors

Estimator	No. of Factors - Full Dataset	No of Factors - Baseline Empirical Model (i/y, π, u, τ)
GR	2	2
ED	0	2
ER	2	2
GOS	2	2

Table 8: CADF Unit Root Test

Variable	t-CADF	p-value	Order of Integration
y	4.714	1.000	I(1)
g_y	-8.006	0.000	I(0)
i/y	-2.565	0.005	I(0)
π	0.837	0.799	I(1)
l_g	0.923	0.822	I(1)
τ	-0.576	0.282	I(1)
u	-2.358	0.009	I(0)

Table 9: Cointegration Tests

Full Dataset including Employment Share										
Test Specific Statistic	Kao		Pedroni		Padroni with Same AR Term		Westerlund Some Panels		Westerlund in all Panels	
	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Variance Ratio							2.7168	0.0033	1.5166	0.0647
Modified Variance Ratio					-3.3315	0.0004				
Modified Phillips-Perron t			3.0266	0.0012	2.7569	0.0029				
Phillips-Perron t			3.3707	0.0004	2.9481	0.0016				
Augmented Dickey-Fuller t	-0.0760	0.4697	3.7994	0.0001	3.1692	0.0008				
Dickey-Fuller t	-1.6068	0.1138								
Modified Dickey-Fuller t	-2.7863	0.0027								
Unadjusted Modified Dickey-Fuller t	-1.0168	0.1546								
Unadjusted Dickey-Fuller t	-0.3146	0.3765								
Baseline Model Specification (i/y, π, u, τ)										
Variance Ratio							6.7149	0.0000	3.1007	0.0010
Modified Variance Ratio					-3.5498	0.0002				
Modified Phillips-Perron t			3.0404	0.0012	2.7514	0.0030				
Phillips-Perron t			3.2880	0.0005	2.8051	0.0025				
Augmented Dickey-Fuller t	3.2847	0.0005	3.4460	0.0003	2.7806	0.0027				
Dickey-Fuller t	3.8459	0.0001								
Modified Dickey-Fuller t	2.8727	0.0020								
Unadjusted Modified Dickey-Fuller t	3.6814	0.0001								
Unadjusted Dickey-Fuller t	5.3575	0.0000								

Table 10: Juodis, Karavias, and Sarafidis (2021) Panel Granger Causality Test Summary for Baseline Model

	Sample Ending in 2022	Sample Ending in 2019
Wald Test Statistic	67.029	97.945
p-value	0.000	0.000

Online Appendix: Alternative Specification Tables

B. Alternative Specification Tables

Table 11: Alternative Specifications: Panel Granger Causality Test for All Countries

		Cross-Sectional Heteroskedasticity-Robust Variance Estimation					
		Baseline	Alternative I	Alternative II	Baseline - 2019	Alt I - 2019	Alt II - 2019
i_{t-1}/y_{t-1}	Coefficient	0.129**	0.118**		-0.031	-0.056	
	s.e.	(0.057)	(0.047)		(0.060)	(0.039)	
π_{t-1}	Coefficient	0.391***	0.401***	0.411***	0.460***	0.463***	0.433***
	s.e.	(0.067)	(0.085)	(0.066)	(0.063)	(0.046)	(0.047)
τ_{t-1}	Coefficient	-0.052			0.249		
	s.e.	(0.275)			(0.260)		
u_{t-1}	Coefficient	-0.173**	-0.191***	-0.183***	-0.187***	-0.187***	-0.207***
	s.e.	(0.071)	(0.073)	(0.068)	(0.057)	(0.052)	(0.056)
	Wald Test	73.480***	71.100***	60.548***	62.128***	108.726***	84.123***
	p-value	0.000	0.000	0.000	0.000	0.000	0.000

Notes: a) * - 10% significance, ** - 5% significance, and ***- 1% significance.
b) Wald Test is to test H_0 that the coefficients do not Granger-cause the growth rate.

Table 12: Alternative Specifications: Mean Group CCE for All Countries

CCE Estimator - Pesaran (2006)							
		Baseline	Alternative I	Alternative II	Baseline - 2019	Alt I - 2019	Alt II - 2019
i_{t-1}/y_{t-1}	Coefficient	0.072	0.037		0.053	0.007	
	s.e.	(0.072)	(0.068)		(0.081)	(0.082)	
π_{t-1}	Coefficient	-0.132**	-0.164***	-0.206***	-0.129*	-0.149**	-0.161**
	s.e.	(0.058)	(0.059)	(0.058)	(0.069)	(0.075)	(0.066)
τ_{t-1}	Coefficient	0.044			-0.276		
	s.e.	(0.258)			(0.279)		
u_{t-1}	Coefficient	0.278***	0.260***	0.237***	0.251***	0.274***	0.260***
	s.e.	(0.059)	(0.061)	(0.052)	(0.060)	(0.056)	(0.045)

Table 13: Alternative Specifications: Panel ECM Estimation for All Countries

Dynamic Common Correlated Effects Estimator (CS - ARDL) - Ditzen (2016)							
Dependent Variable: $\Delta ln(GDP)$							
Dynamics							
		Baseline	Alternative I	Alternative II	Baseline - 2019	Alt I - 2019	Alt II - 2019
i/y	Coefficient	0.133*	0.092		0.079	0.071	
	s.e.	(0.079)	(0.049)		(0.066)	(0.057)	
π	Coefficient	-0.242***	-0.240***	-0.185***	-0.261***	-0.274***	-0.209***
	s.e.	(0.070)	(0.067)	(0.054)	(0.080)	(0.061)	(0.071)
τ	Coefficient	-0.644			-0.467		
	s.e.	(0.430)			(0.501)		
u	Coefficient	0.376***	0.346***	0.261***	0.237***	0.257***	0.167***
	s.e.	(0.070)	(0.067)	(0.047)	(0.068)	(0.055)	(0.044)
Adjustment Term							
		Baseline	Alternative I	Alternative II	Baseline - 2019	Alt I- 2019	Alt II - 2019
Long Run $ln(GDP)$	Coefficient	-1.062***	-1.001***	-0.982***	-0.967***	-0.929***	-0.904***
	s.e.	(0.049)	(0.049)	(0.054)	(0.066)	(0.057)	(0.054)
Cointegrating Vector							
		Baseline	Alternative I	Alternative II	Baseline - 2019	Alt I - 2019	Alt II - 2019
i/y	Coefficient	0.112	0.070		0.034	0.057	
	s.e.	(0.078)	(0.079)		(0.118)	(0.084)	
π	Coefficient	-0.237***	-0.275***	-0.225***	-0.338***	-0.320***	-0.251***
	s.e.	(0.068)	(0.084)	(0.073)	(0.084)	(0.074)	(0.082)
τ	Coefficient	-0.643			-0.501		
	s.e.	(0.042)			(0.453)		
u	Coefficient	0.363***	0.358***	0.265***	0.290***	0.305***	0.198***
	s.e.	(0.070)	(0.070)	(0.047)	(0.070)	(0.071)	(0.055)