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Growth under the Euro: Inflation, Competitiveness and Monetary Regimes in the European Union*

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Abstract

We study whether the macroeconomic determinants of growth differ across exchange rate regimes in the European Union, comparing pre-2004 euro members, post-2004 euro adopters and post-2004 members that kept their own currencies. Using quarterly data for 21 countries over 2007–2019 and common correlated effects estimators that separate short-run dynamics from long-run effects, we find that inflation is associated with lower growth in the long run: a one-point rise in quarterly inflation is associated with roughly 0.2–0.3 points lower quarterly growth. Investment and employment are associated with faster growth, whereas capacity utilization mainly tracks the common European cycle. Real appreciation is associated with slower growth only in the short run, most clearly when measured by relative unit labor costs, although this contemporaneous association may partly reflect how unit labor costs are constructed. We find no evidence that these relationships differ across exchange rate regimes, although our tests have limited power, and the larger real appreciation of the new euro adopters carries no measurable growth cost.

JEL code: C23, E31, F31, F33, F45, O47.
Keywords: Inflation, economic growth, monetary union, exchange rate regimes, real exchange rates, unit labor costs, common correlated effects, long-run effects.

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1. Introduction

Between 2007 and 2026, seven Central, Eastern and South-Eastern European (CESEE) EU countries adopted the euro. Four other CESEE EU countries, Czechia, Hungary, Poland and Romania, still retain their national currencies. According to the European treaties, these countries are also committed to adopting the euro once they fulfill the Maastricht convergence criteria on inflation, fiscal policy, exchange rate stability, and long-term interest rates. Experience has shown, however, that countries differ considerably in their ambition to adopt the euro. Some countries like Slovenia and Slovakia were very ambitious and managed to join the euro area a few years after entering the EU. Others, like the Baltic countries or Bulgaria, faced greater difficulties in satisfying the criteria and adopted the euro later than initially intended. In a third group of countries, the political ambition to adopt the euro has varied over time.

These differences are partly due to economic considerations and debates. In the early 1960s Robert Mundell started an academic debate about Optimum Currency Areas (OCA) with his seminal 1961 paper, A Theory of Optimum Currency Areas (Mundell, 1961). In Europe, the pros and cons of a single currency and its ideal composition were widely and controversially debated as soon as the idea of a single European currency became more concrete in the 1980s. As regards the CESEE EU countries, many economists discussed the problems associated with the then large gaps in per-capita income between CESEE countries and the rest of the EU. This resulted for example in a number of empirical assessments of the Balassa–Samuelson effect on inflation (Égert et al., 2003; Mihaljek and Klau, 2004), and in evidence that the exchange rate regime shapes this process: for countries that pegged to or adopted the euro, productivity differentials translate into inflation differentials considerably more strongly than under flexible regimes (D'Adamo and Rovelli, 2015). At the same time, it was pointed out that many CESEE countries already had pegged or tightly managed exchange rates by the time they entered the EU. For these countries euro adoption had a less significant impact on their macroeconomic policy framework than on countries that previously had a flexible exchange rate regime (De Luigi et al., 2025). Besides economic arguments, in some countries, the degree of ambition to adopt the common currency is mainly related to political considerations like national sovereignty and the symbolic value of a national currency, and public attitudes towards the euro and its institutions have themselves fluctuated with the economic cycle (Roth et al., 2016).

That some CESEE EU countries adopted the euro while others remain outside creates a valuable comparative setting with three different country groups: non-CESEE EU member states, CESEE countries in the euro area and CESEE countries with national currencies. All EU countries, including the CESEE countries, are part of the single market and the EU rulebook. All of them, although with some differences, are deeply integrated into European production networks through trade and FDI. The CESEE EU countries, however, unlike the rest of the EU, share a post-communist institutional legacy and per-capita income below the EU average, although income levels have converged substantially since these countries entered the EU. And within the CESEE EU country group, we can distinguish between euro area members and countries that retained their monetary independence and nominal exchange rate flexibility. The contrast is not a clean natural experiment, however: Estonia, Latvia and Lithuania ran currency boards or hard pegs long before adopting the euro, so the switch from a flexible to a fixed regime is observed only for Slovakia and, partly, Slovenia. We therefore complement the group comparison with a specification in which the exchange rate regime (euro, hard peg, or flexible) is assigned to each country and quarter.

In this paper we analyze the macroeconomic determinants of growth in these three groups of EU countries. In particular, we ask whether the determinants of growth, above all the roles of inflation and the real exchange rate, differ between the CESEE countries that adopted the euro and those that retained their national currencies. This is a highly relevant question for those EU countries that still retain their national currencies. In addition, it will become an important question for countries aspiring to join the EU in the years to come.

The theoretical background to this question is that fixed and flexible exchange rate regimes transmit shocks differently. Under a fixed exchange rate, of which euro membership is, from a purely economic perspective, a special case, inflation cannot be offset by nominal depreciation; cost pressures instead feed into the real exchange rate and directly affect competitiveness and growth. Under a flexible exchange rate, nominal adjustment can partially absorb inflationary cost pressures, potentially insulating growth but at the cost of exchange rate volatility and less discipline on domestic price setting (Friedman, 1953; Husain et al., 2003).

Our choice of growth determinants is guided by the endogenous growth model of Gillman et al. (2026), which extends a Lucas-type setting with an inflation tax, income taxes and variable utilization of physical and human capital; in that model, growth is determined by the after-tax

effective returns to capital, which inflation lowers and higher utilization rates raise. We use the model to motivate the specification rather than to test it structurally. Empirically, we use quarterly data and distinguish explicitly between two horizons. Short-run dynamics are estimated with the dynamic Common Correlated Effects Mean Group (CCEMG) estimator of Chudik and Pesaran (2015), which accounts for unobserved common shocks and heterogeneous country responses. Long-run effects, the object of interest in the growth literature, are estimated with the cross-sectionally augmented distributed-lag (CS-DL) and autoregressive distributed-lag (CS-ARDL) estimators of Chudik et al. (2016), which Chudik et al. (2017) use to study the long-run growth effects of public debt and inflation. We compare long-standing euro area members, post-2004 euro adopters, and post-2004 members that retained their own currencies. The analysis incorporates inflation, physical capital capacity utilization, human capital utilization through employment, investment, and both real and nominal exchange rate dynamics. As a central extension, we exploit the difference between the CPI-deflated and the unit-labor-cost-deflated real effective exchange rate to separate benign, productivity-driven real appreciation from growth-damaging cost appreciation.

A central lesson of the paper concerns the role of common European shocks. In conventional fixed-effects estimates, capacity utilization and employment appear as strong determinants of growth and inflation appears irrelevant; once the common factors are absorbed, inflation emerges as negatively associated with growth and the utilization effect largely disappears. Within this framework, the results point to four main findings. First, once common European shocks are absorbed, inflation is negatively associated with growth in the long run: a one-point rise in quarterly inflation lowers quarterly growth by roughly 0.2–0.3 points, and the result is robust to seasonally adjusted and year-on-year inflation measures, to measuring labor input by hours worked, and to extending the sample to 2025. The short-run association is also negative, but it loses significance when labor input is measured by hours worked rather than by the employment rate. Without the common-factor adjustment the association is insignificant, consistent with common demand shocks moving inflation and output together over the cycle. Second, investment is positively associated with growth at both horizons and in all country groups, and employment in the long run. Capacity utilization comoves strongly with growth, but mainly through the common European cycle; its country-specific effect is modest and not robust. Third, real appreciation is associated with slower growth in the short run but has no detectable long-run effect for the full sample, and the more robust component of the short-run

effect is the unit-labor-cost one. The one subgroup estimate that reaches significance, for the new euro adopters under CS-ARDL, is not confirmed by CS-DL. Relative unit labor cost appreciation is associated with slower growth in the pooled sample and within the mature euro area itself, where nominal adjustment is unavailable by construction, against both trading-partner baskets we consider, and in the own-currency group against the EU-27 basket; the CPI-based effect depends on the basket. Because total-economy unit labor costs are measured per unit of current output, part of this contemporaneous association may be mechanical, and it does not survive when the regressors are lagged one quarter, so we read it as suggestive evidence of a cost-competitiveness channel. The New EU euro group experienced larger real appreciation than the New EU own-currency group over the sample, most of it before 2009, which does not suggest that euro membership contained real exchange rate pressures; the ULC-based effect for this group is too imprecisely estimated to confirm or reject a growth cost, so their larger appreciation is consistent with, though not affirmative evidence of, Balassa–Samuelson convergence. Fourth, we find no evidence that these relationships differ across the three country groups or across exchange rate regimes assigned quarter by quarter: formal tests rarely reject equal coefficients, and the few rejections are not robust. With four or five countries per group these tests have limited power, so the finding is that we cannot distinguish the regimes, not that the channels are identical. We discuss the implications for the remaining non-euro EU members in light of these findings.

2. Literature Review

We structure the review around three strands of work most relevant to our contribution: (i) the relationship between inflation and growth; (ii) exchange rate regimes and the capacity for adjustment; and (iii) advances in panel data methods for growth empirics.

This study contributes to the literature by combining these three strands into a single analysis. It examines inflation and the role of exchange rate regimes on growth dynamics in the European Union and employs state-of-the-art panel methods to provide new evidence. By distinguishing 'old' euro area members, CESEE euro adopters, and CESEE non-euro countries, we assess how monetary regimes mediate the growth, inflation and competitiveness interaction.

2.1. Inflation and growth

The literature on the growth effects of inflation emphasizes its role as a distortionary "tax" on growth. The mechanism is similar to how fiscal taxes decrease growth within the endogenous growth setting (Stokey and Rebelo, 1995). Early cross-country work such as Kormendi and Meguire (1985) and Barro (2001, 2003) documented robust negative correlations between inflation and growth, though often relying on 5-year averages for sequential data points. Chudik et al. (2017) confirm the negative long-run association between inflation and growth in a heterogeneous panel of annual data, using long-run estimators that allow for common correlated effects. Because over the business cycle inflation and output can move together through Phillips-curve effects, while the growth literature concerns a negative long-run relationship, we report short-run and long-run estimates separately.

Recent empirical work explicitly incorporates fiscal distortions and capital utilization. Gillman et al. (2026) embed inflation and taxation in an endogenous growth framework and show empirically, with annual data for 21 countries over nearly four decades, that inflation lowers growth in a comparable way to income tax rates, while capacity utilization robustly and significantly raises growth. This work motivates our focus on inflation across groups of EU member states with and without the euro. Because the monetary regime determines whether inflation differentials are offset by nominal exchange rate movements or feed into the real exchange rate, we add nominal and real exchange rates to this set of determinants.

2.2. Exchange rate regimes and real adjustment

A long-standing debate concerns whether fixed or flexible exchange rates provide better insulation against shocks. Friedman (1953) argued for the stabilizing role of exchange rate flexibility, while Kindleberger (2013) defended fixed regimes. Formal analysis in Marston (1981) distinguishes the transmission of real versus monetary disturbances, while Gray (1976) highlights how indexation and labor market flexibility shape outcomes.

Empirical evidence points to important regime differences. Husain et al. (2003) document that fixed regimes have delivered low inflation and durability in developing countries without sacrificing growth, while flexible regimes have performed better mainly in advanced economies with deeper institutions. Edwards (2020) and Tavlas (2024) provide historical overviews of this

debate, including its modern application to the euro area. Direct evidence on euro adoption itself, based on synthetic control methods, finds heterogeneous effects on per-capita income across the founding members (Puzzello and Gomis-Porqueras, 2018). Euro membership reduces transaction costs and inflation volatility, which may increase competitiveness. At the same time, fixed nominal rates imply that adjustments must happen through the real exchange rate channel, i.e. country differences in inflation and labor costs. This makes the relationship between inflation, competitiveness, and growth potentially regime-dependent, with lessons for the costs and benefits of euro adoption for current and future EU countries. Membership of a monetary union is, however, not the same as a unilateral peg to it: a pegging country retains its own central bank and an exit option, and faces different risk premia. We therefore distinguish the two regimes in the empirical analysis.

A large literature starting with Basu et al. (2006) emphasizes the utilization of labor and capital, as well as human capital, as inputs into the production function. Fernald (2014); Fernald and Jones (2014); Fernald and Piga (2024) elaborate on how human and physical capacity utilization can be a significant growth factor.

A novel complementary perspective emphasizes the role of total factor productivity (TFP) in mediating the effects of exchange rate regimes. Buera and Fattal-Jaef (2025) show that in post-communist economies such as the CESEE countries, eliminating distortions increases aggregate TFP by reallocating resources toward more productive firms, even as average firm size falls. Their results suggest that the growth consequences of economic institutions, including the monetary regime, may operate through reallocation and productivity as well as through relative prices, a channel that our aggregate data cannot isolate.

2.3. Panel growth empirics and CCE methods

Empirical work increasingly relies on panel methods that account for cross-country heterogeneity and common shocks. Pesaran and Smith (1995) introduced the mean group estimator for panels with heterogeneous slopes, and Pesaran (2006) developed the Common Correlated Effects (CCE) approach, which addresses cross-sectional dependence arising from unobserved common factors by augmenting the regressions with cross-sectional averages. Chudik and Pesaran (2015) extend CCE estimation to dynamic panels with a lagged dependent variable and weakly exogenous regressors, showing that a sufficient number of lags of the cross-sectional

averages must then be included. Chudik et al. (2016) develop the CS-DL and CS-ARDL estimators of long-run effects in such panels, and Chudik et al. (2017) apply them to the long-run growth effects of debt and inflation.

The CCE toolkit is implemented in Stata by Ditzen (2018, 2021). Richer dynamic structures allow more complex adjustment but reduce degrees of freedom, reflecting the trade-off between capturing complexity and maintaining statistical power. We estimate short-run dynamics with the dynamic CCEMG estimator and long-run effects with the CS-DL and CS-ARDL estimators; since all series are stationary, no cointegrating relationship in levels is imposed.

Traditional growth regressions, as in Moral-Benito (2016), target long-run effects, typically by averaging data over multi-year periods, while Pedroni (1993) exploits equilibrium conditions from endogenous growth models. Durlauf and Quah (1999) note that modern growth empirics increasingly draw on diverse explanatory factors beyond factor accumulation. Our short-run estimates answer a different question from these studies, namely how growth moves with its determinants from quarter to quarter, and are not a substitute for them. Our long-run estimates address the same question as growth regressions, obtained from quarterly data while allowing for heterogeneous slopes and unobserved common factors.

3. Methodology

Our empirical specification draws on the endogenous growth model of Gillman et al. (2026), which extends a Lucas-type endogenous growth setting with an inflation tax, income taxes, and variable utilization rates of physical and human capital. Along the balanced growth path, growth is determined by the after-tax effective returns to capital, which inflation lowers and higher utilization rates raise. We use the model to select and interpret the regressors rather than to estimate its structural equations. The idea is to identify observable relationships between capital utilization, policy distortions, and monetary conditions that may explain the determinants of growth across monetary regimes within the European Union.

At its core, the model suggests that growth depends not only on the accumulation of inputs but also on the intensity with which existing resources are used. From this perspective, we extract four broad conjectures that motivate our variable selection:

1. A higher utilization rate of physical capital raises the effective return to capital and thereby growth (C1). Because the utilization rate is bounded, this prediction concerns its level;

changes in the rate affect growth only transitorily.

2. Human capital utilization, proxied empirically by employment growth, similarly enhances output by improving the mobilization of labor resources (C2).

3. Inflation is expected to have a negative effect on growth by increasing uncertainty, eroding real balances, and distorting financial intermediation (C3).

4. Investment, while traditionally growth-enhancing, may lose explanatory power once capital utilization is accounted for, as the latter captures the effective deployment of installed capital (C4).

We use these conjectures to inform the econometric specification rather than as formal restrictions. The baseline model therefore includes output growth as the dependent variable and four key drivers, consistent with conjectures (C1)–(C4): physical capital utilization, inflation, investment, and employment growth. Employment growth serves as a proxy for human capital utilization, reflecting the extent to which available labor resources are actively engaged in production. A measure of the income tax rate, which would be expected to reduce growth, proved insignificant in preliminary estimates and is excluded, as is a relative-income convergence variable.

To account for monetary-regime heterogeneity, we extend the model by incorporating both real and nominal exchange rate dynamics. These variables capture competitiveness effects and the degree of nominal rigidity faced by euro-area versus non-euro economies. In doing so, the empirical design allows the data to reveal whether the inflation–growth relationship operates differently under fixed versus flexible exchange rate regimes.

Because an aggregate CPI-deflated real exchange rate cannot distinguish between benign, productivity-driven appreciation and growth-damaging cost appreciation, we complement it with the real effective exchange rate deflated by unit labor costs in the total economy, measured against the same 27 EU trading partners as the CPI-deflated index so that the comparison is not confounded by partner composition. Both indices are set to 2015=100 and enter the regressions as quarterly log-differences; an increase denotes real appreciation. The CPI-deflated index captures relative consumer-price developments, which reflect non-tradable price growth and are therefore inflated by Balassa–Samuelson convergence; the ULC-deflated index rises only when wage growth outruns productivity relative to trading partners, which is the competitiveness-

relevant margin. The two series are far from redundant in our sample (correlation 0.72). Coverage is complete for all 21 analysis countries over 2007–2019, so the ULC specifications use the identical balanced panel as the baseline. A ULC-deflated index for the 42-partner group used in the baseline tables is not published by Eurostat; results using the 37-industrial-partner ULC index, the closest available counterpart, are reported alongside.

Our empirical analysis covers the baseline period 2007–2019, with a robustness extension to 2025, and is based on a balanced panel of EU member states (see specific list of countries in Appendix A), grouped by monetary regime. The start date ensures consistent data availability across key variables.

To capture structural heterogeneity within the European Union, we distinguish three groups of countries based on their monetary regime.

- **Group 1 – Old EU (euro area):** Original euro area countries that joined prior to the 2004 enlargement and used the euro continuously during the sample. Non-euro countries such as Denmark, Sweden, and the United Kingdom are excluded.[1]
- **Group 2 – New EU (euro area):** Member states that introduced the euro during the sample period, namely Slovenia (2007), Slovakia (2009), Estonia (2011), Latvia (2014), and Lithuania (2015). The group is defined by eventual euro membership and therefore mixes pre- and post-adoption quarters: before adoption, Slovakia operated a managed float within ERM II, while the three Baltic states ran currency boards or hard pegs. Section 4.4 therefore also reports a specification in which each country-quarter is assigned to its actual regime.
- **Group 3 – New EU (own currency):** Member states that retained their national currencies, namely Czechia, Romania, Poland, and Hungary. Bulgaria is excluded because its currency board[2] makes it neither a flexible own-currency country nor a euro member in-sample; it enters the regime specification of Section 4.4 as a hard-peg economy.[3] Malta

[1] Greece is included in this group, having adopted the euro in 2001. Greece operated under conditional financial assistance programs for much of 2010–2018, and its growth dynamics over part of the sample reflect this context. The CCEMG estimator's allowance for heterogeneous slopes accommodates this country-specific path; re-estimating the Old EU group without Greece leaves the results essentially unchanged (investment 0.093 versus 0.088, both $p<0.01$; ULC-deflated real exchange rate -0.254 versus -0.231, both $p<0.05$).

[2] The currency board was in place from 1997, pegging the lev first to the Deutsche Mark and then to the euro, until Bulgaria adopted the euro on 1 January 2026.

[3] Folding Bulgaria into the own-currency group leaves the estimates essentially unchanged (CPI-deflated real exchange rate -0.080 versus -0.079; ULC-deflated -0.168 versus -0.105), but would blur the flexible-regime interpretation of the group.

and Cyprus are excluded due to their small size and distinctive economic structures, which could introduce heterogeneity. Croatia is excluded because of its late EU entry.

3.1. Data and descriptive analysis

Our empirical analysis is built upon a balanced panel of 21 EU economies observed at a quarterly frequency over the baseline period of 2007–2019, with all underlying data series obtained from Eurostat as detailed with comprehensive variable definitions and transformations in Appendix B.[4] Commencing our analysis in 2007 captures the macroeconomic landscape immediately following the completion of the EU's Eastern enlargement. Conversely, concluding the baseline framework in 2019 intentionally insulates our baseline estimations from the macroeconomic distortions and supply chain disruptions brought about by the COVID-19 pandemic.

We additionally extend the sample period through 2025 in a series of robustness checks detailed in Appendix E. These results should, however, be interpreted with caution, in particular because of the profound structural anomalies, including the severe economic fallout from Russia's 2022 invasion of Ukraine,[5] and because data for 2025 are still provisional.

Table 1 outlines the key descriptive statistics for the baseline period, broken down by the full sample and each of our three distinct country groups.

As illustrated in Figure 1, real GDP growth averages 0.39 percent per quarter across the full sample. However, this aggregate figure masks distinct variations among the subgroups: growth averages 0.27 percent for long-standing euro area members, rising to 0.46 percent for CESEE euro adopters and 0.69 percent for CESEE countries retaining national currencies. The accelerated growth trajectories observed in both CESEE cohorts are highly consistent with transitional catch-up dynamics, reflecting their ongoing income convergence toward the euro area average.[6]

[4] All series were extracted from Eurostat in July 2026.

[5] This geopolitical shock triggered an exceptional energy and commodity price crisis that disproportionately impacted the new euro adopters subgroup, specifically the Baltic states (Estonia, Latvia, and Lithuania) due to their acute, legacy infrastructure dependence on Russian energy imports. The resulting localized inflation surge in the Baltics approached 15 percent and significantly outpaced the price dynamics of neighboring Visegrád (V4) economies, concentrating extreme macroeconomic volatility within a small subset of our panel.

[6] The wide range of the investment-growth series (minimum -72, maximum 301 percent) is driven by Ireland, whose chain-linked gross fixed capital formation reflects the well-documented relocations of intellectual property and aircraft-leasing assets by multinational enterprises rather than domestic capital formation. The heterogeneous-slopes CCEMG estimator confines their influence to the Irish country regression.

Table 1: Descriptive Statistics (Balanced Panel, 2007–2019)

	Obs	Mean	Std. Dev.	Min	Max
All countries					
GDP growth (%)	1092	0.39	1.63	-12.3	22.9
Inflation (HICP, %)	1092	0.49	0.87	-2.6	5.7
Investment change	1092	1.03	15.62	-72.4	300.9
Nominal ER (EU27, 2015=100)	1092	100.51	3.94	86.3	136.3
REER (EU27, CPI defl., 2015=100)	1092	100.21	3.39	86.6	118.7
REER (EU27, ULC defl., 2015=100)	1092	102.10	8.69	81.6	151.9
Capacity utilization (%)	1092	78.02	6.11	52.5	90.8
Employment rate (%)	1092	65.14	5.86	48.4	78.4
Old EU (Euro area)					
GDP growth (%)	624	0.27	1.53	-6.5	22.9
Inflation (HICP, %)	624	0.37	0.71	-2.6	2.7
Investment change	624	1.41	20.04	-72.4	300.9
Nominal ER (EU27, 2015=100)	624	99.80	0.57	97.6	101.8
REER (EU27, CPI defl., 2015=100)	624	99.96	2.12	94.7	109.4
REER (EU27, ULC defl., 2015=100)	624	101.58	9.23	86.7	151.9
Capacity utilization (%)	624	78.59	5.75	61.4	89.1
Employment rate (%)	624	65.37	6.40	48.4	78.4
New EU (Euro area)					
GDP growth (%)	260	0.46	1.89	-12.3	6.3
Inflation (HICP, %)	260	0.63	1.11	-1.9	5.7
Investment change	260	0.21	6.67	-28.7	25.2
Nominal ER (EU27, 2015=100)	260	99.48	1.93	86.3	102.1
REER (EU27, CPI defl., 2015=100)	260	99.30	3.66	86.6	107.4
REER (EU27, ULC defl., 2015=100)	260	99.69	6.58	81.6	114.2
Capacity utilization (%)	260	75.19	7.09	52.5	89.8
Employment rate (%)	260	66.06	4.53	56.3	75.9
New EU (Own currency)					
GDP growth (%)	208	0.69	1.52	-9.7	5.5
Inflation (HICP, %)	208	0.67	0.94	-1.7	3.8
Investment change	208	0.89	4.53	-25.1	18.7
Nominal ER (EU27, 2015=100)	208	103.93	7.84	93.4	136.3
REER (EU27, CPI defl., 2015=100)	208	102.12	5.05	91.2	118.7
REER (EU27, ULC defl., 2015=100)	208	106.70	7.58	92.8	130.0
Capacity utilization (%)	208	79.82	4.44	67.8	90.8
Employment rate (%)	208	63.29	5.25	54.1	75.4

Own calculations, Eurostat (vintage July 2026).

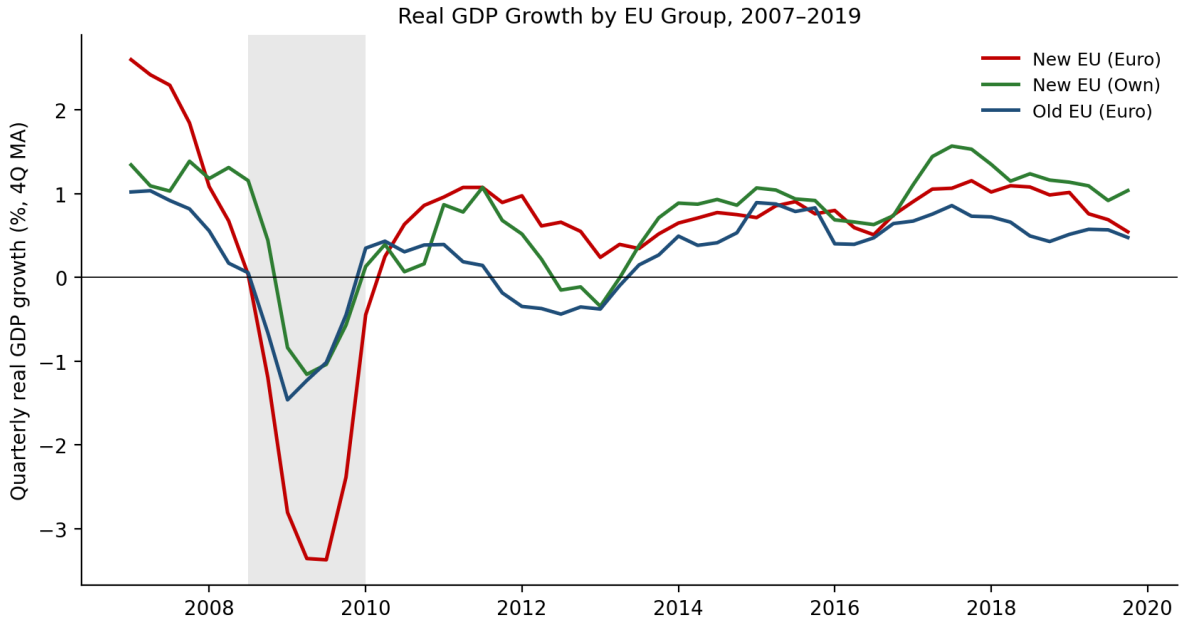


Figure 1: Real GDP Growth by EU Group, 2007–2019

Figure 2 shows the inflation rates for the three EU groups in the analyzed period. Mean quarterly HICP inflation for 'old' euro area members stands at 0.37, for CESEE euro area members at 0.63 and for CESEE EU non-euro area countries at 0.67. Again, a somewhat higher rate of inflation for the CESEE countries is expected given the ongoing catching-up process in the CESEE region.

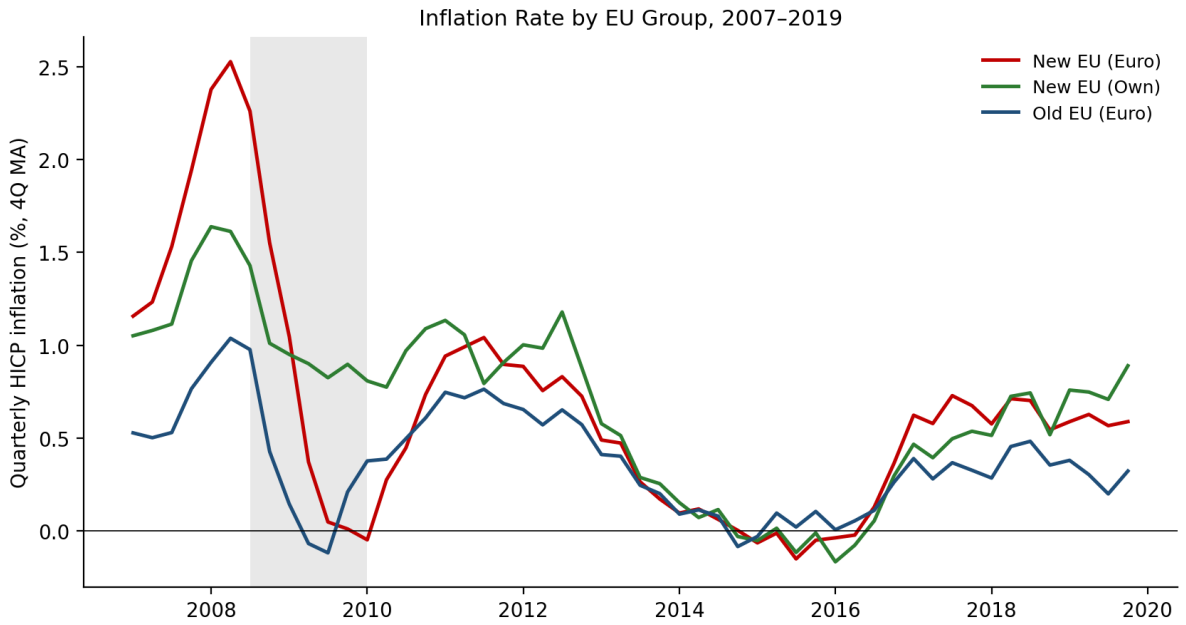


Figure 2: Inflation Rate by EU Group, 2007–2019

Finally, Figure 3 shows real exchange rate dynamics; an increase denotes real appreciation, that is, a loss of price competitiveness as exports become relatively more expensive. The old euro area members' real exchange rate was broadly flat over the sample. The new euro adopters appreciated strongly, and most of this appreciation occurred before 2009, during the pre-crisis boom and before most of them had adopted the euro. A decomposition of the cumulative real appreciation into its nominal and relative-price components sharpens this picture. Over 2007–2019, the own-currency group's CPI-deflated real exchange rate was on average roughly flat (-1.7 log points cumulatively), but this masks a nominal depreciation of 14.1 log points offset by a relative-price appreciation of 12.4 log points: the own-currency economies "imported" real appreciation through relative prices despite their nominal flexibility. The new euro adopters, by contrast, appreciated by 14.6 log points, of which 4.9 came through the nominal rate (largely before adoption) and 9.7 through relative prices.

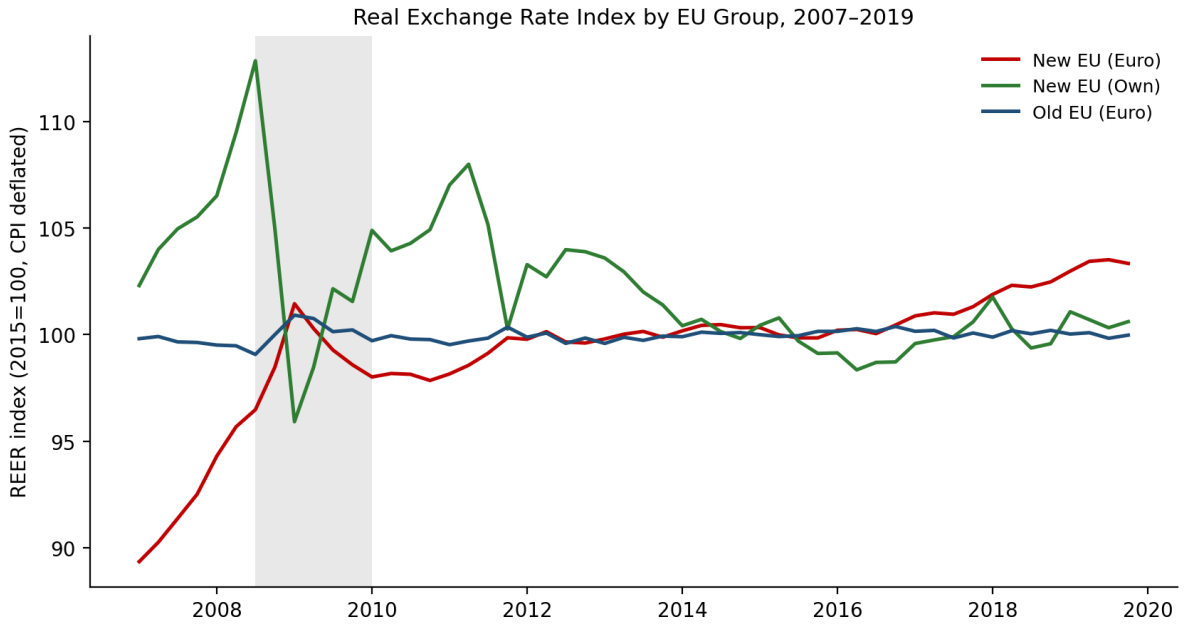


Figure 3: Real Exchange Rate Index by EU Group, 2007–2019

3.2. Estimation strategy

Preliminary diagnostics confirm that standard first-generation panel estimators would be inappropriate: the CD test of Pesaran (2021) rejects the null of cross-sectional independence for all variables (Appendix C), reflecting common EU-wide factors such as financial crises, energy price fluctuations, and monetary-policy synchronization. The cross-sectionally augmented Dickey–Fuller (CADF) tests of Pesaran (2007) indicate that all variables, as they enter the re-

gressions, are stationary. We therefore use estimators that allow for unobserved common factors with heterogeneous loadings and for heterogeneous slopes, and we distinguish explicitly between short-run and long-run effects.

Short run. Short-run dynamics are estimated with the dynamic CCEMG estimator of Chudik and Pesaran (2015). For each country i we estimate

$$\Delta y_{it} = \alpha_i + \lambda_i \Delta y_{i,t-1} + \boldsymbol{\beta}_i^\top \mathbf{x}_{it} + \gamma_i t + \sum_{\ell=0}^{p_T} \boldsymbol{\delta}_{i\ell}^\top \bar{\mathbf{z}}_{t-\ell} + \varepsilon_{it},$$

where Δy_{it} is quarterly real GDP growth and $\mathbf{x}_{it}$ contains HICP inflation, the quarterly log-change of the real effective exchange rate, investment growth, and the changes in capacity utilization and in the employment rate. Appendix H also reports all models with the capacity utilization rate in levels, the variable that enters the theoretical model; the baseline uses the change so that all regressors enter as quarterly flows. The mean-group estimates are the cross-country averages of the country-specific coefficients, with the nonparametric standard errors of Pesaran and Smith (1995). The model includes one lag of GDP growth: selecting the lag order country by country by the Bayesian information criterion (BIC), over one to four lags, yields one lag for 12 of the 21 countries, and the results are unchanged with four lags or with the BIC-selected lag order for each country (Appendix H). The vector $\bar{\mathbf{z}}_t$ contains the cross-sectional averages (CSAs) of GDP growth, inflation and the real exchange rate over all 21 countries. Following Chudik and Pesaran (2015), and as in the robustness analysis of Gillman et al. (2026), the CSAs enter contemporaneously and with $p_T = \lfloor T^{1/3} \rfloor$ lags, which gives $p_T = 3$ for the 52 quarters of the baseline sample and $p_T = 4$ for the 76 quarters of the extended sample; results are unchanged with $\lceil T^{1/3} \rceil = 4$ lags in the baseline. Including the CSA of the dependent variable is essential: it is the core proxy for the unobserved common factors, and with it the residuals of the country regressions are cross-sectionally independent (CD statistic 0.85). Augmenting the regressions with the CSAs of all regressors as well, each with three lags, would require 32 parameters per country on 52 quarters; the results are nevertheless similar (Appendix H). The baseline therefore uses the CSAs of the dependent variable and of the two monetary variables, 20 parameters per country. For the same reason, half-panel jackknife bias correction is not feasible: each half-sample would contain only 26 quarters. Subgroup estimates average the country-specific coefficients of the group members, all estimated with the same 21-country CSAs; with only four or five countries, group-specific averages would be noisy proxies for the

common factors and would give each country's own observations a weight of one quarter to one fifth.

In the baseline CCEMG specification, the real exchange rate is measured against 42 main international trading partners; the descriptive statistics and the fixed-effects benchmark use the EU-27 reference group, and the unit-labor-cost comparison in Section 4.3 is conducted on the EU-27 basis for both deflators because Eurostat does not publish a ULC-deflated index for the 42-partner group.

Long run. Long-run effects are estimated with the two estimators of Chudik et al. (2016). The CS-DL estimator regresses GDP growth on the levels of the regressors, their first differences, and the same CSAs,

$$\Delta y_{it} = c_i + \boldsymbol{\theta}_i^{\top} \mathbf{x}_{it} + \boldsymbol{\omega}_i^{\top} \Delta \mathbf{x}_{it} + \sum_{\ell=0}^{p_T} \boldsymbol{\delta}_{i\ell}^{\top} \bar{\mathbf{z}}_{t-\ell} + e_{it},$$

where $\boldsymbol{\theta}_i$ is the vector of long-run effects. The CS-ARDL estimator instead estimates an ARDL(1,1) model augmented with the same CSAs and a trend, and recovers the long-run effects as $\boldsymbol{\theta}_i = (\boldsymbol{\beta}_{i0} + \boldsymbol{\beta}_{i1})/(1 - \lambda_i)$. The two are complementary: CS-DL performs better in samples of moderate length but can be biased when growth feeds back on the regressors, while CS-ARDL is robust to such feedback but more exposed to small-sample bias (Chudik et al., 2016). We report both, as Chudik et al. (2017) do.

Exchange rate regimes. The three-group comparison classifies countries by their regime status at the end of the sample. To separate euro membership from a unilateral peg, we also estimate a pooled CCE model (Pesaran, 2006) in which the real exchange rate and, alternatively, inflation are interacted with a quarter-by-quarter regime indicator (euro, hard peg, or flexible), while country-specific constants, trends and loadings on the CSAs are retained. Pooling is necessary here because the pre-adoption windows of individual countries (8 to 32 quarters) are too short for country-specific regressions.

Interpretation. Employment, investment, inflation and the exchange rate all respond to expected as well as realized output, so we interpret the coefficients as conditional associations rather than causal effects. The CCE augmentation absorbs common shocks, including the common demand shocks that generate Phillips-curve comovement between inflation and output over the business cycle; it does not remove feedback from country-specific shocks. In particular,

a country-specific adverse supply shock raises inflation and lowers growth at the same time, so the inflation coefficient may partly reflect such shocks rather than an inflation-tax mechanism. We report specifications in which all regressors enter with a one-quarter lag, and tests of the timing of the capacity-utilization effect (Appendix H).

In line with our analytical setup, we estimate the models for the full sample and separately for the Old EU (euro area) members, the New EU (euro area) adopters, and the New EU countries with their own currencies.

4. Panel Estimation Results

We present results in four steps: fixed-effects (FE) estimates as a benchmark, the short-run CCEMG estimates, the long-run estimates, and the real exchange rate results by deflator and by regime. All results use the pre-COVID sample (2007–2019); the extension to 2025 is reported in Appendix E.

Table 2 reports the fixed-effects estimates. We present these as a benchmark rather than as our preferred specification: by construction they neither absorb the cross-sectional dependence documented in Appendix C nor permit the slope heterogeneity that the CCEMG framework accommodates. Capacity utilization and employment are significant regressors across the full sample and all subgroups by conventional standards. Capacity utilization enters positively at the one-percent level in every column. As the CCE estimates below show, this reflects mostly the comovement of utilization and growth over the common European cycle, which fixed effects do not absorb. Employment growth, our proxy for human capital utilization, is likewise positive and significant throughout, although with only four to twelve country clusters per column, conventional cluster-robust inference tends to overstate significance, and wild-cluster-bootstrap checks indicate that the own-currency employment result in particular is not robust to inference that accounts for the small number of clusters. Investment is positive and highly significant in the new CESEE member states, with markedly larger coefficients there (0.07–0.13) than in the mature euro area, consistent with capital deepening still carrying more growth content in less mature economies; for the old euro area it is essentially zero once capacity utilization is controlled for.

Inflation, entered with one lag, is statistically insignificant in every column. The real exchange rate carries its expected negative sign and is significant for the full sample, the old euro

Table 2: Fixed Effects Estimates (REER vs. EU27 trading partners, CPI-deflated, 2007–2019)

	All	Old EU (Euro)	New EU (Euro)	New EU (Own)
Lagged GDP	-0.017	-0.120	-0.043	-0.061
	(0.067)	(0.075)	(0.068)	(0.090)
	[0.949]	[0.772]	[0.467]	[1.000]
Inflation	-0.063	-0.124	-0.140	0.189
	(0.065)	(0.085)	(0.088)	(0.141)
	[0.322]	[0.128]	[0.251]	[0.392]
Capacity utilization	0.201***	0.175***	0.225***	0.118***
	(0.037)	(0.047)	(0.057)	(0.036)
	[0.000]	[0.002]	[0.115]	[0.000]
Investment	0.008	0.002	0.066***	0.127***
	(0.007)	(0.003)	(0.016)	(0.028)
	[0.002]	[0.616]	[0.048]	[0.065]
Employment	0.310***	0.208***	0.429***	0.101***
	(0.060)	(0.045)	(0.148)	(0.023)
	[0.000]	[0.001]	[0.000]	[0.502]
Real exchange rate	-0.058*	-0.175***	-0.161***	-0.007
	(0.031)	(0.043)	(0.054)	(0.032)
	[0.066]	[0.044]	[0.070]	[0.739]
Time Trend	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes
N	1071	612	255	204
R^2 (within)	0.179	0.158	0.403	0.256

*p < 0.1, **p < 0.05, ***p < 0.01, based on standard errors clustered by country (in parentheses). Wild cluster bootstrap p-values (Rademacher weights, null imposed, 999 replications) in brackets; with 4–5 clusters in the subgroup columns the bootstrap p-values are the reliable ones and conventional stars overstate significance. Dependent variable: real GDP growth. REER enters in levels (index); inflation enters with one lag.

area countries, and the new euro adopters, indicating that real appreciation is associated with slower growth where it binds. The own-currency CESEE group is the exception; this group experienced little net real appreciation over the sample period.

The model fit values remain modest (0.16–0.40) and the significance pattern shifts across subgroups; both are symptoms of the estimator's inability to net out the common EU-wide shocks that drive comovement across these highly integrated economies. We address this limitation with a move to the CCE estimators.

4.1. Short-run dynamics

Table 3 reports the short-run CCEMG estimates for the baseline sample 2007–2019, with a deterministic trend (Panel A) and without (Panel B). The residual CD statistics show that the augmentation absorbs the cross-sectional dependence.

Inflation is negatively associated with growth in the full sample (-0.196, p<0.05; -0.235, p<0.01 without trend). The subgroup coefficients are all negative but individually imprecise. The sign differs from the fixed-effects benchmark and from specifications that omit the CSA of

GDP growth, in which inflation is insignificant or positive (Appendix H, column 7). The difference is informative. Over the business cycle, common demand shocks move inflation and output in the same direction; once the common cycle is absorbed, the remaining country-specific variation in inflation is associated with slower growth. The negative association survives when inflation enters with a one-quarter lag (-0.139, $p<0.05$) and in every specification in Table A9 that includes the CSA of GDP growth. It is also robust to how inflation is measured: removing the country-specific seasonal pattern of the non-seasonally-adjusted HICP gives -0.218 and year-on-year inflation -0.588 (both $p<0.01$; Table A13). The short-run coefficient is, however, sensitive to the measure of labor input: with hours worked in place of the employment rate it is -0.098 and insignificant.

Investment is positively associated with growth in the full sample (0.071, $p<0.01$), the old euro area (0.088) and the own-currency group (0.069), and positive but imprecise for the new euro adopters. The real exchange rate enters negatively for the full sample (-0.171, $p<0.05$) and the new euro adopters (-0.249, $p<0.1$). This CPI-based result depends on the trading-partner basket: measured against the 27 EU partners, the full-sample coefficient is -0.048 and insignificant (Table 5). The ULC-deflated rate, by contrast, is significant for the full sample against both baskets; we return to it by deflator and regime below.

Capacity utilization, by contrast, is not significantly associated with growth once the common factors are absorbed: the full-sample coefficient is 0.029, compared with 0.146 ($p<0.01$) in a specification without the CSA of GDP growth (Table A9, column 7). The difference arises because roughly half of the variation in a country's quarterly change in capacity utilization is common to the panel, and that common component moves closely with common GDP growth (correlation 0.71). The positive association between utilization and growth in the fixed-effects and restricted specifications is therefore a comovement over the common European cycle rather than a country-specific effect. Table A11 probes the timing. The lagged change in utilization is unrelated to growth (0.014), and the change in utilization does not predict growth in the following quarter (-0.007). The lagged level of utilization relative to its country mean, an output-gap-type term, enters positively (0.057, $p<0.05$), not negatively as an error-correction role would require. Among the subgroups, the only exception is the new euro group, where the short-run coefficient on the change in utilization remains positive (0.172, $p<0.1$). In the model that motivates our specification, however, it is the utilization rate itself, not its change,

that raises the return to capital and hence growth, so the model predicts a positive coefficient on the level, where an output-gap interpretation would predict a negative one. Table A12 re-estimates all models with the level. In the full sample its coefficient is positive in every specification, as the model predicts, and significant in the short run (0.039, $p<0.05$) and in the long run with CS-ARDL (0.073, $p<0.05$). The effect is, however, modest, insignificant with CS-DL, and close to zero in the sample extended to 2025. In the short run, employment is positively and significantly associated with growth only for the new euro adopters (0.222, $p<0.01$). For the own-currency group the coefficient is small, negative and significant (-0.058, $p<0.05$), but this is not robust: it is insignificant in the specification without a trend (Panel B) and in the long run.

Because the mean-group estimator is an average of country-specific slopes, it is informative to inspect the underlying country coefficients directly. Figure 5 in Appendix D plots them, with 95 percent confidence intervals, for the short-run utilization and real exchange rate effects and the long-run inflation and investment effects. The long-run inflation coefficient is negative for most countries, and the long-run investment coefficient is positive for nearly all; the short-run utilization coefficients scatter around zero. The plot also shows why subgroup means must be read cautiously: single countries with wide intervals (Luxembourg, Ireland) can move a twelve-country average. Differences between the subgroup means are rarely statistically significant. In tests of equal mean-group coefficients across the three groups, equality is rejected at the 10 percent level only for the short-run capacity utilization coefficient (new euro adopters versus each of the other groups, $p\approx0.06$) and, in the long run, for employment (new euro adopters versus own-currency members, $p<0.01$); for inflation, the real exchange rate and investment, no difference between groups is significant. Non-rejection should not be read as equality, however. The 95 percent confidence interval for the difference between the ULC-REER coefficients of the new euro adopters and the own-currency members runs from -0.42 to 0.44, and the smallest difference detectable with 80 percent power is 0.34 to 0.61 for the real exchange rate and 0.68 to 0.92 for inflation, several times the size of the estimated coefficients.

4.2. Long-run effects

Table 4 reports the long-run effects. Inflation has a negative long-run effect on growth: -0.288 ($p<0.05$) with CS-DL and -0.213 ($p<0.1$) with CS-ARDL for the full sample. A one-point in-

Table 3: Short-run dynamics: dynamic CCE Mean Group estimates, 2007–2019 (real exchange rate vs. 42 trading partners, CPI-deflated)

	All (1)	Old EU (Euro) (2)	New EU (Euro) (3)	New EU (Own) (4)
Panel A. With trend				
Lagged GDP growth	-0.126**	-0.075	-0.239**	-0.139**
	(0.053)	(0.077)	(0.111)	(0.070)
Inflation	-0.196**	-0.165	-0.132	-0.373
	(0.089)	(0.105)	(0.230)	(0.237)
Real exchange rate	-0.171**	-0.169	-0.249*	-0.079
	(0.069)	(0.109)	(0.134)	(0.054)
Investment	0.071***	0.088***	0.034	0.069***
	(0.016)	(0.024)	(0.028)	(0.024)
Capacity utilization	0.029	-0.010	0.172*	-0.036
	(0.035)	(0.034)	(0.089)	(0.071)
Employment	0.089	0.083	0.222***	-0.058**
	(0.086)	(0.146)	(0.077)	(0.029)
Trend	-0.121	-0.206	-0.910	1.120
	(0.386)	(0.224)	(1.297)	(1.045)
N	1092	624	260	208
R^2 (MG)	0.757	0.751	0.760	0.768
Residual CD	0.85	2.16	-2.63	-1.16
Panel B. Without trend				
Lagged GDP growth	-0.098*	-0.068	-0.210**	-0.050
	(0.052)	(0.078)	(0.102)	(0.069)
Inflation	-0.235***	-0.170	-0.294	-0.357
	(0.085)	(0.109)	(0.188)	(0.230)
Real exchange rate	-0.170**	-0.180	-0.213*	-0.084
	(0.069)	(0.110)	(0.121)	(0.055)
Investment	0.071***	0.087***	0.036	0.068***
	(0.016)	(0.024)	(0.027)	(0.025)
Capacity utilization	0.027	-0.007	0.169*	-0.050
	(0.035)	(0.034)	(0.090)	(0.065)
Employment	0.105	0.083	0.273**	-0.039
	(0.090)	(0.148)	(0.123)	(0.041)
N	1092	624	260	208
R^2 (MG)	0.744	0.748	0.740	0.740
Residual CD	0.84	2.10	-2.58	-1.58

*** p<0.01, ** p<0.05, * p<0.1. Dependent variable: quarterly real GDP growth. Cross-sectional averages (CSAs) of GDP growth, inflation and the REER, computed over all 21 countries, enter contemporaneously and with $p_T = \lfloor T^{1/3} \rfloor$ lags ($p_T = 3$ for 2007–2019, $p_T = 4$ for 2007–2025), following Chudik and Pesaran (2015); subgroup columns average the country-specific slopes of the group members, all estimated with the same 21-country CSAs. Nonparametric mean-group standard errors in parentheses. One lag of the dependent variable (BIC selects one lag for the majority of countries; richer lag structures in Table A9). REER: quarterly log-difference (×100) of the CPI-deflated index vs. 42 industrial partners (Eurostat `REER_IC42_CPI`). Trend coefficients per 100 quarters. Residual CD: Pesaran CD statistic on the country-regression residuals (N(0,1) under cross-sectional independence).

crease in quarterly inflation, roughly four points at an annual rate, is thus associated with a long-run decline in quarterly growth of 0.2 to 0.3 points. The effect is largest and most precisely estimated for the new euro adopters in the baseline sample (-0.400, $p<0.01$, CS-DL). In the extended sample to 2025 it is estimated precisely for the full sample (-0.291, $p<0.01$), the old euro area (-0.371, $p<0.01$) and the own-currency group (-0.358, $p<0.01$), but not for the new euro adopters (Appendix E). These estimates support conjecture (C3) and align with the negative long-run relationship documented by Chudik et al. (2017) and Gillman and Harris (2010).

Investment has a positive long-run effect in every group and with both estimators (0.077–0.083 for the full sample, $p<0.01$). Employment has a positive long-run effect for the full sample (0.178, $p<0.1$, CS-DL; 0.243, $p<0.01$ in the extended sample) and particularly for the new euro adopters (0.350–0.384, $p<0.01$). Measuring labor input by total hours worked, which is closer to the model's concept of labor utilization, strengthens this result: hours growth is positively associated with growth at both horizons (0.093 in the short run and 0.234 in the long run, both $p<0.01$; Table A13). The long-run inflation effect is unchanged in that specification (-0.299, $p<0.01$), while the short-run inflation coefficient is smaller and insignificant (-0.098). Because the choice of labor measure matters for the short-run inflation coefficient, we report both measures and base our conclusions about inflation on the long-run estimates, which do not depend on it; the baseline retains the employment rate, the measure used in the fixed-effects benchmark and in Table 1. Conjecture (C2) is therefore supported at the long horizon, while conjecture (C4) is not: investment retains independent explanatory power, and it is the determinant most robust across horizons, estimators and samples.

The change in capacity utilization has no long-run effect on growth for the full sample or the old euro area, and a negative one for the own-currency group (-0.168, $p<0.01$). This is what the theory leads one to expect: the utilization rate is bounded, so its changes can raise growth only transitorily. The theory's long-run prediction concerns the level of the rate, which has a positive long-run coefficient in the full sample with CS-ARDL (0.073, $p<0.05$) but not with CS-DL or in the extended sample (Table A12). Conjecture (C1) is thus supported in sign but not robustly in magnitude; in the short run, utilization is chiefly the margin along which the common European cycle moves national output.

The real exchange rate has no statistically significant long-run effect for the full sample under

either estimator, with any deflator, or in the extended sample (Tables 4, A5, A7). Real appreciation is thus associated with slower growth in the short run, not with a permanently lower growth rate.

Table 4: Long-run effects on GDP growth, 2007–2019 (real exchange rate vs. 42 trading partners, CPI-deflated)

	All (1)	Old EU (Euro) (2)	New EU (Euro) (3)	New EU (Own) (4)
Panel A. CS-DL				
Inflation	-0.288**	-0.237	-0.400***	-0.297
	(0.124)	(0.189)	(0.137)	(0.323)
Real exchange rate	-0.327	-0.480	-0.191	-0.036
	(0.207)	(0.355)	(0.184)	(0.065)
Investment	0.077***	0.084***	0.077**	0.056**
	(0.017)	(0.025)	(0.035)	(0.022)
Capacity utilization	-0.045	-0.048	0.061	-0.168***
	(0.040)	(0.058)	(0.057)	(0.065)
Employment	0.178*	0.177	0.384***	-0.078
	(0.104)	(0.170)	(0.051)	(0.123)
N	1092	624	260	208
Residual CD	0.91	1.09	-2.21	-2.31
Panel B. CS-ARDL(1,1)				
Inflation	-0.213*	-0.220	-0.185	-0.231
	(0.109)	(0.159)	(0.180)	(0.288)
Real exchange rate	-0.283	-0.389	-0.241*	-0.019
	(0.180)	(0.310)	(0.146)	(0.060)
Investment	0.083***	0.099***	0.067*	0.052**
	(0.018)	(0.026)	(0.038)	(0.023)
Capacity utilization	-0.038	-0.051	0.076	-0.141**
	(0.041)	(0.058)	(0.069)	(0.069)
Employment	0.143	0.132	0.350***	-0.084
	(0.094)	(0.153)	(0.067)	(0.116)
N	1092	624	260	208

*** p<0.01, ** p<0.05, * p<0.1. Each cell is the mean-group long-run coefficient $\bar{\theta}$ of GDP growth on the regressor. Panel A: cross-sectionally augmented distributed-lag (CS-DL) estimator of Chudik et al. (2016): GDP growth regressed on the regressors and their first differences, θ_i read off the level terms. Panel B: CS-ARDL(1,1), $\theta_i = (\beta_{i0}+\beta_{i1})/(1-\lambda_i)$, averaged across countries. Both use the same cross-sectional augmentation as the short-run model: CSAs of GDP growth, inflation and the REER, contemporaneous and three lags, over all 21 countries. CS-DL is more reliable at moderate T but can be biased under feedback from growth to the regressors; CS-ARDL is robust to feedback but more affected by small-T bias (Chudik et al., 2016); we therefore report both. Nonparametric mean-group standard errors in parentheses.

4.3. Separating catch-up from competitiveness loss

The CPI-deflated REER conflates two economically opposite sources of real appreciation: benign Balassa–Samuelson convergence, in which non-tradable prices rise on the back of tradable-sector productivity gains, and cost-driven appreciation, in which unit labor costs outrun productivity and erode export competitiveness. Replacing the CPI-deflated REER with its ULC-deflated counterpart, with an identical specification and sample, helps discriminate between them: appreciation of the ULC-deflated rate captures the cost-competitiveness margin. Table 5

places the short-run REER coefficients side by side; Figure 4 plots the two indices and their gap by country group.

Table 5: Short-run real exchange rate coefficient: CPI- vs. ULC-deflated REER

	Baseline 2007–2019			Extended 2007–2025		
	CPI (EU27)	ULC (EU27)	ULC (IC37)	CPI (EU27)	ULC (EU27)	ULC (IC37)
All countries	-0.048	-0.174**	-0.174**	-0.055	-0.203**	-0.102
	(0.180)	(0.079)	(0.080)	(0.129)	(0.080)	(0.088)
Old EU (Euro)	0.072	-0.231**	-0.208*	0.176	-0.244**	-0.033
	(0.299)	(0.110)	(0.116)	(0.183)	(0.121)	(0.143)
New EU (Euro)	-0.300	-0.093	-0.145	-0.576***	-0.192	-0.270**
	(0.256)	(0.210)	(0.203)	(0.170)	(0.180)	(0.123)
New EU (Own)	-0.094	-0.105*	-0.107	-0.096**	-0.094*	-0.100**
	(0.058)	(0.060)	(0.082)	(0.042)	(0.050)	(0.042)

*** p<0.01, ** p<0.05, * p<0.1. Each cell is the mean-group REER coefficient from the short-run dynamic CCEMG specification of Table 3 (with trend), swapping only the REER series (in the regressors and in the CSAs). The CPI–ULC contrast holds the partner group fixed (EU27, 2020 composition); IC37 is the 37-industrial-partner ULC index, the closest published counterpart to the 42-partner CPI index. Long-run (CS-DL) REER coefficients are insignificant for every deflator and group (Appendix G). 2025 data provisional.

Holding the partner group fixed at the EU-27, the CPI-deflated REER is not significantly associated with growth in any group, whereas the ULC-deflated REER is: for the full sample (-0.174, p<0.05), the old euro area (-0.231, p<0.05) and the own-currency group (-0.105, p<0.1). With the 37-partner ULC index, the full-sample and old-euro-area coefficients remain significant (-0.174, p<0.05; -0.208, p<0.1), while the own-currency coefficient does not (-0.107, standard error 0.082). In the extended sample the EU-27 results are unchanged; with the 37-partner index the old-euro-area coefficient falls to -0.033, while the own-currency coefficient becomes significant (-0.100, p<0.05). The more robust growth-relevant component of real appreciation is therefore the cost-competitiveness one. The result for the old euro area is the clearest: within the mature monetary union, where nominal adjustment is unavailable, relative unit labor costs, the internal-devaluation margin, are the variable most closely associated with growth. The long-run ULC-REER coefficients are insignificant throughout (Appendix G), so the cost of ULC-based appreciation is a short-run one. This short-run result should be interpreted with care. Total-economy unit labor costs are compensation per unit of real output, so their quarterly change contains the change in real output with a negative sign, and a contemporaneous negative association between ULC-based appreciation and GDP growth can arise partly by construction. Consistent with this, the ULC-REER coefficient loses significance when all regressors enter with a one-quarter lag (-0.119, standard error 0.095, for the full sample). We therefore read the result as suggestive evidence of a cost-competitiveness channel rather than a clean estimate of it; separating the wage, productivity and nominal exchange rate components,

or using cost measures less closely tied to current output, is a natural next step.

The new euro adopters are the group for which the evidence is least conclusive. Figure 4 shows that their appreciation was substantially cost-side: the ULC-deflated index rose more than the CPI-deflated one, so their unit labor costs outran consumer prices, which is not the signature of pure productivity-driven convergence. Yet no short-run growth penalty is detectable: the ULC-REER coefficient is -0.093 with a standard error of 0.210, an imprecise null from a five-country panel. We therefore conclude only that the euro adopters' appreciation is not measurably growth-damaging. This is consistent with a Balassa–Samuelson interpretation in which convergence absorbs part of the cost pressure, but the estimate is too imprecise to confirm it. Two further caveats apply: with five countries the subgroup estimate cannot distinguish a moderate negative effect from zero, and the total-economy ULC index still embeds non-tradable cost dynamics that Balassa–Samuelson forces also drive, so the CPI–ULC contrast is suggestive about the composition of appreciation rather than a clean tradable-sector discriminator.

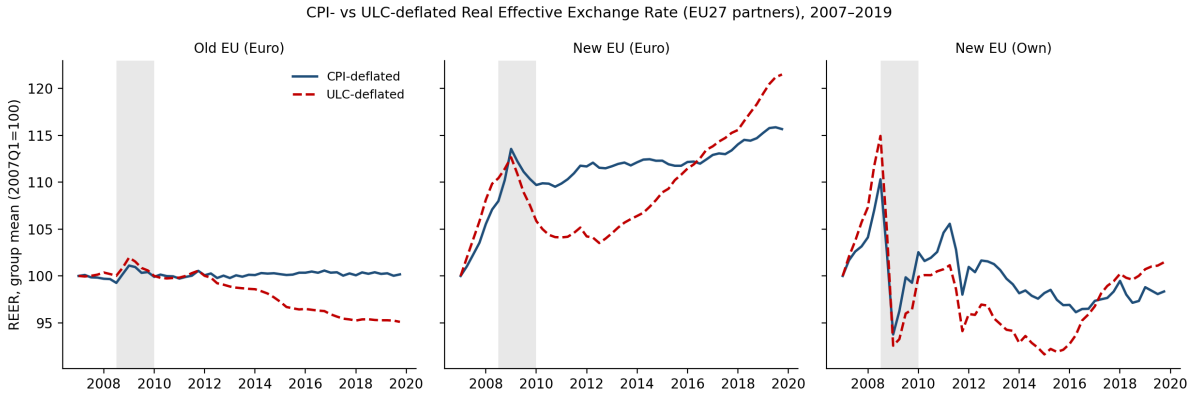


Figure 4: CPI-deflated versus ULC-deflated real effective exchange rate by EU group (EU27 partners, group means rebased to 2007Q1=100), 2007–2019

4.4. Monetary union versus pegs: time-varying regimes

The group comparison classifies the new euro adopters by their eventual status, although three of the five spent a large part of the sample under currency boards or hard pegs rather than in the monetary union. Table 6 therefore reports pooled CCE estimates in which the regime is assigned quarter by quarter. With the ULC-deflated REER, real appreciation is significantly associated with slower growth both under the euro (-0.581, $p<0.01$) and under flexible regimes (-0.168, $p<0.01$), but not under hard pegs; the euro coefficient is smaller but still significant

when Ireland is excluded (-0.303, p<0.01). With the CPI-deflated REER, the association is significant under flexible regimes (-0.134, p<0.01) but not under the euro, consistent with the deflator comparison above: inside the monetary union, it is relative unit labor costs rather than relative consumer prices that matter for growth. Adding Bulgaria as a further hard-peg economy leaves these results unchanged. The hard-peg cell rests on relatively few country-quarters: 76 Baltic pre-adoption quarters and, in the second and fourth columns, Bulgaria. In the 21-country ULC specification its coefficient is positive (0.288), and the tests reject equality with both the euro (p=0.003) and the flexible regimes (p=0.012). We do not attach an economic interpretation to this result. The Baltic pre-adoption quarters are dominated by the boom of 2007–2008 and the internal devaluation that followed, when falling relative unit labor costs coincided with a collapse in output; this plausibly produces a positive association between real appreciation and growth within the peg regime that is specific to that episode. Adding Bulgaria lowers the peg coefficient to 0.130, and equality with the flexible regimes is then no longer rejected (p=0.21), although equality with the euro still is (p=0.025). The evidence therefore does not allow a robust characterization of the peg regime. Formal tests of equal slopes (Table 6) reject equality between the euro and flexible regimes for the ULC-deflated rate (p=0.04), but not once Ireland is excluded (p=0.23), and never for the CPI-deflated rate. The data therefore show that ULC-based appreciation is costly under both the euro and flexible rates, but not robustly that it is more costly under one of them. The 95 percent confidence interval for the euro-minus-flexible difference is $[-0.81, -0.01]$ for the ULC-deflated rate and $[-0.18, 0.23]$ for the CPI-deflated rate.

Panel B interacts inflation with the regime instead. The negative association between inflation and growth is present under the euro (-0.167, p<0.01 in the ULC specification; -0.100, insignificant in the CPI specification) and its point estimate is largest under flexible regimes (-0.51, p<0.1 to p<0.01), but the difference between the euro and flexible regimes is not significant at the 5 percent level (p=0.09–0.13).

Table 6: Pooled CCE estimates with time-varying exchange rate regimes, 2007–2019

	CPI-deflated REER (IC42)		ULC-deflated REER (EU27)	
	21 countries	+ Bulgaria	21 countries	+ Bulgaria
Panel A. REER effect by regime				
REER × euro	-0.109	-0.102	-0.581***	-0.579***
	(0.089)	(0.083)	(0.201)	(0.201)
REER × hard peg	-0.350*	-0.220	0.288	0.130
	(0.194)	(0.149)	(0.177)	(0.233)
REER × flexible	-0.134***	-0.135***	-0.168***	-0.169***
	(0.050)	(0.050)	(0.042)	(0.042)
Inflation	-0.214*	-0.183	-0.249***	-0.226***
	(0.126)	(0.120)	(0.088)	(0.083)
Investment	0.003	0.003	-0.002	-0.002
	(0.004)	(0.004)	(0.004)	(0.004)
Capacity utilization	0.008	0.013	0.007	0.007
	(0.032)	(0.032)	(0.033)	(0.032)
Employment	0.126*	0.118*	0.093*	0.101**
	(0.071)	(0.062)	(0.050)	(0.045)
Lagged GDP growth	-0.218***	-0.214***	-0.329***	-0.324***
	(0.054)	(0.053)	(0.067)	(0.068)
N	1092	1144	1092	1144
Countries	21	22	21	22
p-value: euro = flexible	0.814	0.742	0.042	0.043
p-value: peg = flexible	0.285	0.599	0.012	0.207
p-value: euro = peg	0.144	0.399	0.003	0.025
Panel B. Inflation effect by regime				
Inflation × euro	-0.100	-0.080	-0.167***	-0.160***
	(0.075)	(0.075)	(0.058)	(0.061)
Inflation × hard peg	-0.384	-0.153	-0.228	-0.145
	(0.247)	(0.182)	(0.324)	(0.170)
Inflation × flexible	-0.511*	-0.510*	-0.515***	-0.513***
	(0.261)	(0.261)	(0.194)	(0.192)
Real exchange rate	-0.137***	-0.137***	-0.223**	-0.229**
	(0.045)	(0.043)	(0.096)	(0.094)
N	1092	1144	1092	1144
p-value: euro = flexible	0.132	0.116	0.087	0.081
p-value: peg = flexible	0.719	0.255	0.442	0.145

*** p<0.01, ** p<0.05, * p<0.1. CCE pooled estimator (Pesaran, 2006): country-specific projections on a constant, a linear trend and the CSAs of Table 3 are partialled out, and slopes are pooled across countries; standard errors clustered by country. The regime is assigned quarter by quarter: euro for euro area members (Slovenia from 2007Q1, Slovakia 2009Q1, Estonia 2011Q1, Latvia 2014Q1, Lithuania 2015Q1); hard peg for the Baltic currency boards/pegs before adoption and for Bulgaria's currency board; flexible for Czechia, Hungary, Poland, Romania and pre-2009 Slovakia. Regime intercepts included. p-values are for Wald tests of equal slopes across regimes. Pooled slopes on investment are close to zero because pooling weights Ireland's extreme GFCF variance heavily; excluding Ireland, investment is 0.023 and the REER × euro coefficients are -0.057 (CPI) and -0.303*** (ULC), with REER × flexible unchanged.

5. Discussion

Our results suggest that the macroeconomic determinants of real GDP growth are largely common to EU member states: we find no evidence that they differ across country groups or exchange rate regimes, although the small size of the groups limits the power of such comparisons. Separating short-run dynamics from long-run effects, and absorbing the common European cycle, changes several conclusions that a conventional panel analysis would suggest.

First, inflation is negatively associated with growth once common shocks are absorbed, and the effect is present in the long run. This is consistent with the view of inflation as a distortionary tax on growth (Stokey and Rebelo, 1995; Gillman et al., 2026) and with the long-run evidence of Chudik et al. (2017). Country-specific supply shocks, which raise inflation and lower growth together, offer an alternative explanation that our estimator cannot rule out; estimating the relationship separately for the main inflation components (energy, food, core goods and services) would help distinguish the two. It also reconciles our findings with Gillman and Harris (2010), who document a negative inflation–growth relationship for transition economies over 1990–2003. The contrast with the fixed-effects benchmark, and with specifications that omit the cross-sectional average of GDP growth, is instructive: over the business cycle, common demand shocks raise inflation and output together, masking the negative relationship that emerges once that common component is removed. Unlike the thresholds documented in broader international samples (Khan and Senhadji, 2001; Bick, 2010), we find no evidence of a threshold in the full sample once common factors are absorbed: the linear term remains negative and significant, and an additional term for inflation above one and a half to two and a half percent per quarter is insignificant, although for the Baltic states alone the penalty steepens at high inflation (Appendix I). The origins of the 2021–2023 inflation are themselves debated, with one strand emphasizing monetary–fiscal factors (Gillman, 2023) and another energy supply shocks; because our estimator absorbs the common component of inflation by construction, identification runs through country-specific variation, and our results are silent on the aggregate origin.

Second, capacity utilization's strong association with growth in conventional estimates reflects mainly the common European cycle. Country-specific changes in utilization carry no independent short-run information about growth, with a partial exception for the new euro adopters, and no long-run effect, as expected for a bounded rate. Its timing is also not that of a leading in-

dicator: utilization does not lead growth. The level of the utilization rate, which is what enters the model of Gillman et al. (2026), has the positive sign that model predicts, never the negative sign of an output-gap or error-correction term, but its effect is modest and not robust across estimators and samples. Our quarterly EU evidence on utilization is therefore weaker than the annual evidence of Gillman et al. (2026) for a longer sample of countries, where the utilization rate is a primary determinant of growth. One reason is that in thirteen years of quarterly data dominated by two large common shocks, the common cycle accounts for nearly two-thirds of the within-country variance of the utilization rate, leaving little country-specific variation to identify its effect once common factors are absorbed. A second is measurement: the survey-based utilization rate covers manufacturing only, and is therefore a weak proxy for the use of capital in service-intensive economies such as Luxembourg and Ireland.

Third, investment and employment are the robust real determinants. Investment is positively associated with growth at both horizons, in all groups, and with both long-run estimators. Its short-run association is, however, contemporaneous only (lagged investment growth carries no information about growth), so the short-run coefficient may partly reflect investment responding to expected demand, whereas the long-run estimates are less exposed to that concern. We interpret employment growth as a utilization margin, that is, the degree to which an economy engages its available workforce, rather than as human capital accumulation in the schooling sense of Lucas (1988); it is the deployment of the existing human capital stock that varies at quarterly frequency. Its effect is concentrated in the long run and in the new euro adopters; for the own-currency group there is no robust effect at either horizon.

The real exchange rate is the more informative monetary variable in the short run. Real exchange rate appreciation is associated with slower growth, but only in the short run, and its more robust component is the unit-labor-cost one, although part of that association may be mechanical (Section 4.3). Subgroup estimates should be read with caution because the subgroups are small. The descriptive evidence in Section 3 shows that the New EU euro group experienced larger real appreciation than the New EU own-currency group, most of it before 2009. This is difficult to reconcile with a simple "euro discipline" story in which euro membership contains cost pressures.

Two distinct mechanisms can generate real appreciation. The first is the Balassa–Samuelson effect. As a catching-up economy raises productivity in its tradable sector faster than in its

non-tradable sector, wages rise economy-wide, pushing up the relative price of non-tradables and appreciating the real exchange rate. Crucially, this appreciation is the by-product of genuine productivity gains: it reflects the economy growing richer, not losing competitiveness, and so we would not expect it to depress growth. The second mechanism is appreciation driven by demand pressure or rising unit labor costs that outpace productivity, for example because of credit-fueled domestic demand or wage growth in excess of productivity. Here the appreciation erodes the price competitiveness of exporters without any offsetting productivity improvement, and we would expect it to be associated with slower growth. The two are observationally similar in an aggregate CPI-based REER series, where both show up as the same upward movement in the index, but they are economically opposite in their consequences.

The unit-labor-cost decomposition in Section 4.3 addresses this distinction directly. The new euro adopters experienced larger real appreciation than the own-currency group, yet no growth penalty from ULC-based appreciation is detectable for them, even on the cost-competitiveness margin. This is consistent with a Balassa–Samuelson interpretation, but the estimate is imprecise enough that a moderate cost cannot be excluded, and it does not differ significantly from the estimates for the other groups. At the same time, the descriptive ULC–CPI gap cautions against reading the euro adopters' experience as pure, benign convergence, since their unit labor costs did outrun their consumer prices in the boom episodes. This is in line with D'Adamo and Rovelli (2015), who find that pegging to or adopting the euro can push price convergence beyond what the Balassa–Samuelson effect implies. The significant ULC-REER effect inside the old euro area, and under the euro in the regime specification, is consistent with relative labor costs becoming the binding real-adjustment margin once a country is in the union.

Taken together, the results for the 2007–2019 period indicate that inflation, investment and employment are the determinants of growth that survive at the long horizon, while utilization and the real exchange rate matter in the short run: utilization as the channel of the common cycle, and the unit-labor-cost real exchange rate as the most informative, if partly mechanical, competitiveness measure.

6. Conclusions

Three principal conclusions emerge from our investigation, all grounded in the pre-COVID baseline observation period (2007–2019); the full-sample inflation, investment and employment

results are confirmed on the sample extended to 2025.

First, inflation is negatively associated with growth. The long-run relationship is robust across estimators, inflation measures, labor measures and samples; the short-run relationship is also negative, but its significance depends on how labor input is measured. The negative relationship is masked in conventional estimates by the positive comovement of inflation and output over the common business cycle, and emerges once common European shocks are absorbed. The long-run effect is quantitatively meaningful: a one-point rise in quarterly inflation is associated with a decline in quarterly growth of roughly 0.2 to 0.3 points. It is present under both the euro and flexible exchange rates, and we cannot reject that it is equally large under both.

Second, among the real determinants, investment and employment (the utilization of human capital) carry long-run effects. The utilization rate of physical capital has the expected positive sign, but its effect is modest and not robust: its strong comovement with growth is mainly the common European cycle transmitting to national output. Investment is the determinant most robust across horizons, estimators, subgroups, and samples, which does not support the conjecture that utilization dominates investment.

Third, the real exchange rate matters in the short run, and its growth-relevant component depends on its source. Appreciation associated with unit labor costs outrunning those of trading partners is associated with slower growth for the pooled sample and within the mature euro area, where the internal-devaluation margin is the only one available, against both trading-partner baskets, and for the own-currency group against the EU-27 basket; with the regime assigned quarter by quarter, it is costly under the euro and under flexible rates alike. This contemporaneous association may, however, partly reflect the construction of unit labor costs, which are measured per unit of current output. Measured against the same EU-27 partners, CPI-based appreciation is not significantly associated with growth in the baseline sample. The euro adopters' larger appreciation carries no measurable growth penalty, though this estimate is imprecise and their unit labor costs did outrun their consumer prices over the sample. No real exchange rate effect is detectable in the long run. Nominal exchange rate movements are at most marginally significant on their own (Appendix F), and nominal flexibility did not translate into real depreciation for the own-currency countries: their currencies depreciated in nominal terms, but rising relative prices offset this almost entirely (Section 3).

For existing and future new EU members considering euro accession, our estimates do not

measure the effect of adoption itself: they condition on inflation, investment and the real exchange rate, the very channels through which adoption would operate. What they show is no evidence that these growth-relevant channels differ between the euro and own currencies, although our tests have limited power. This suggests that the growth consequences of joining depend on structural factors, such as investment, the capacity to mobilize labor, inflation performance and unit labor cost developments, rather than on nominal exchange rate flexibility as such. Direct evidence on the growth effects of adoption, for instance from synthetic-control studies (Puzzello and Gomis-Porqueras, 2018), complements ours. In conjunction with growth-friendly economic policies, the main benefits of euro adoption such as the elimination of exchange rate risk, lower transaction costs for households and firms and becoming part of a global reserve currency area may have a positive impact on growth.

The data show that new euro adopters have experienced larger real appreciation than own-currency members, so the case for euro membership cannot rest on a simple disciplinary mechanism that contains domestic cost pressures. The unit-labor-cost decomposition shows no detectable growth cost from the adopters' appreciation, which is consistent with, though not proof of, a predominantly convergence-driven episode. The same decomposition warns that within the euro area, relative unit labor costs become the margin on which short-run growth outcomes turn. Inflation, finally, matters for growth in the long run, with no evidence that this depends on the exchange rate regime, which makes price stability a growth-relevant objective for euro members and non-members alike.

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A. Appendices

Appendix A: Analyzed countries

Table A1: Countries included in the analysis (21 in total)

Group	Countries	Notes
Group 1: Old EU (euro area), $N = 12$	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain	Euro members before the 2004 enlargement (Greece from 2001).
Group 2: New EU (euro area), $N = 5$	Slovenia (2007), Slovakia (2009), Estonia (2011), Latvia (2014), Lithuania (2015)	Euro adoption year in parentheses. Estonia, Latvia and Lithuania operated currency boards or hard pegs well before adoption.
Group 3: New EU (own currency), $N = 4$	Czechia, Hungary, Poland, Romania	Floating or managed-float regimes throughout the sample.
Excluded from the three-group comparison		
	Denmark, Sweden	Pre-2004 members outside the euro (opt-out / no adoption).
	United Kingdom	Left the EU in 2020.
	Cyprus, Malta	Small size and distinctive economic structures.
	Croatia	Late EU entry (2013; euro 2023).
	Bulgaria	Currency board pegged to the euro since 1997 (euro adoption 1 January 2026, outside the estimation window): neither a flexible own-currency country nor a euro member in-sample. Included as a hard-peg economy in the regime specification (Table 6).

Appendix B: Dataset Variable List

Table A2: Dataset Variables Description and Sources

Variable	Description	Eurostat table
GDP (Dep. var.)	Quarterly real GDP growth (chain-linked volumes, seasonally and calendar adjusted, % change on previous quarter)	namq_10_gdp
HICP Inflation	Quarterly HICP inflation (% change of the end-quarter monthly index on the previous end-quarter month)	prc_hicp_midx
Investment	Quarterly gross fixed capital formation (chain-linked volumes, seasonally and calendar adjusted, % change)	namq_10_gdp
Capacity Util.	Quarterly capacity utilization rate, manufacturing, seasonally adjusted (regressions use the change)	ei_bsin_q_r2
REER (CPI)	Real effective exchange rate, CPI-deflated (index 2015=100; 42 industrial trading partners in the baseline CCE tables; 27 EU partners in descriptives, FE benchmark, and the ULC comparison)	ert_eff_ic_q
REER (ULC)	Real effective exchange rate deflated by unit labor costs, total economy (index 2015=100; 27 EU partners; 37 industrial partners as robustness)	ert_eff_ic_q
Nominal ER	Nominal effective exchange rate (index 2015=100; 27 EU partners)	ert_eff_ic_q
Employment	Quarterly change of employment rate (age 15–64)	lfsq_ergan

Appendix C: Pre-Estimation Diagnostics

Table A3 reports the CD test of Pesaran (2021) for cross-sectional dependence. All domestic variables show large, highly significant CD statistics with mean pairwise correlations of 0.21–0.51, confirming the presence of strong cross-sectional dependence driven by common EU-wide shocks. This rules out standard first-generation panel estimators and motivates the CCE approach. The much smaller (though still significant) CD statistic for the REER in log-differences reflects its construction relative to a common reference basket, which removes the dominant common component by design. Table A4 reports the CADF unit root tests (Pesaran, 2007); all variables reject the null of a unit root at the 1 percent level, confirming stationarity and supporting the specification of the model in first differences. The CD statistics of the residuals of the estimated models are reported in the notes to Tables 3, 4 and A5.

Table A3: Pesaran (2021) CD Test for Cross-Sectional Dependence (2007–2019)

Variable	CD statistic	p-value	Mean $\hat{\rho}$
GDP growth	47.57***	0.000	0.455
Inflation (HICP)	53.26***	0.000	0.510
Capacity utilization	48.78***	0.000	0.467
Investment change	22.21***	0.000	0.213
Employment change	52.15***	0.000	0.499
REER (dlog, EU27 CPI)	3.69***	0.000	0.035
REER (dlog, EU27 ULC)	3.75***	0.000	0.036
NEER (dlog, EU27)	37.22***	0.000	0.356

***p<0.01. H_0: cross-sectional independence; CD $\sim N(0,1)$ under H_0. N = 21, T = 52. REER/NEER enter as quarterly log-differences, matching the regression specification.

Table A4: Pesaran (2007) CADF Panel Unit Root Tests (lags = 1, constant, 2007–2019)

Variable	$\bar{t}$	cv10	cv5	cv1	Stationary
GDP growth	-4.221	-2.08	-2.16	-2.30	Yes
Inflation (HICP)	-5.165	-2.08	-2.16	-2.30	Yes
Capacity utilization	-5.921	-2.08	-2.16	-2.30	Yes
Investment change	-4.343	-2.08	-2.16	-2.30	Yes
Employment change	-5.180	-2.08	-2.16	-2.30	Yes
REER (dlog, EU27 CPI)	-5.316	-2.08	-2.16	-2.30	Yes
REER (dlog, EU27 ULC)	-3.882	-2.08	-2.16	-2.30	Yes
NEER (dlog, EU27)	-4.008	-2.08	-2.16	-2.30	Yes

H_0: unit root. $\bar{t}$ is the cross-sectionally augmented IPS statistic (CIPS). Critical values from Pesaran (2007), intercept case.

Appendix D: Country-level coefficients

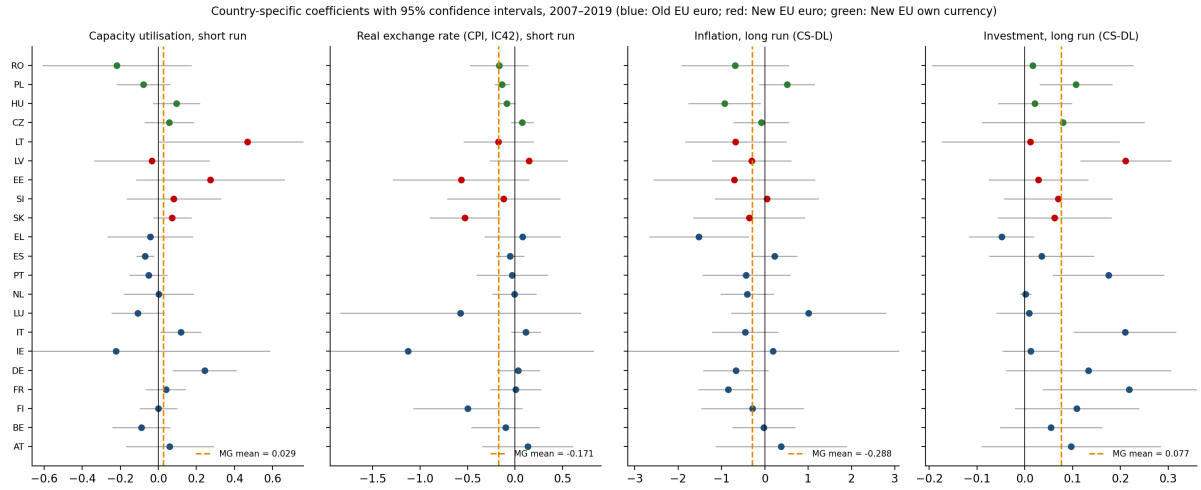


Figure 5: Country-specific coefficients with 95% confidence intervals, 2007–2019: short-run capacity utilization and real exchange rate (dynamic CCEMG), long-run inflation and investment (CS-DL)

Appendix E: Extended Sample 2007–2025

This appendix extends the estimation to 2007–2025; observations for 2025 are provisional and subject to revision, and the German employment rate series ends in 2024Q4. The augmentation uses $p_T = 4$ lags of the CSAs. The long-run results are confirmed and sharpened: inflation has a negative long-run effect for the full sample (-0.291, p<0.01, CS-DL; -0.246, p<0.05, CS-ARDL), the old euro area and the own-currency group, and investment and employment have positive long-run effects. The exception is the new euro group, whose long-run inflation coefficient is close to zero in the extended sample. In the short run, the full-sample inflation coefficient remains negative (-0.180, p<0.01). The CPI-based real exchange rate coefficient is significant for the new euro adopters and the own-currency group but not for the full sample, while the ULC-based coefficient remains significant for the full sample and the old euro area (Table 5). Some residual cross-sectional dependence remains in the extended short-run model (residual CD 3.20), reflecting the pandemic quarters.

Table A5: Extended sample 2007–2025: short-run and long-run estimates (real exchange rate vs. 42 trading partners, CPI-deflated)

	All	Old EU (Euro)	New EU (Euro)	New EU (Own)
Panel A. Short run: dynamic CCEMG (with trend)				
Lagged GDP growth	-0.028	0.015	-0.102*	-0.062
	(0.042)	(0.062)	(0.060)	(0.092)
Inflation	-0.180***	-0.256***	0.055	-0.244
	(0.069)	(0.061)	(0.188)	(0.184)
Real exchange rate	-0.101	-0.027	-0.285***	-0.093**
	(0.077)	(0.126)	(0.089)	(0.043)
Investment	0.070***	0.073**	0.055***	0.082***
	(0.018)	(0.030)	(0.014)	(0.031)
Capacity utilization	0.041	0.001	0.111***	0.074**
	(0.029)	(0.047)	(0.024)	(0.030)
Employment	0.125*	0.098	0.251*	0.046
	(0.066)	(0.096)	(0.149)	(0.081)
N	1591	907	380	304
Residual CD	3.20	8.03	-0.93	0.76
Panel B. Long run: CS-DL				
Inflation	-0.291***	-0.371***	-0.045	-0.358***
	(0.086)	(0.128)	(0.136)	(0.113)
Real exchange rate	-0.095	-0.041	-0.257*	-0.053
	(0.143)	(0.247)	(0.137)	(0.075)
Investment	0.071***	0.062***	0.080***	0.086***
	(0.014)	(0.023)	(0.014)	(0.032)
Capacity utilization	0.004	0.006	0.110***	-0.133***
	(0.043)	(0.069)	(0.030)	(0.025)
Employment	0.243***	0.264**	0.294***	0.114
	(0.073)	(0.120)	(0.065)	(0.109)
Panel C. Long run: CS-ARDL(1,1)				
Inflation	-0.246**	-0.371***	0.104	-0.308**
	(0.097)	(0.134)	(0.161)	(0.136)
Real exchange rate	-0.072	0.028	-0.328***	-0.052
	(0.152)	(0.261)	(0.108)	(0.067)
Investment	0.074***	0.071**	0.077***	0.078***
	(0.017)	(0.028)	(0.016)	(0.030)
Capacity utilization	0.008	0.003	0.104***	-0.097***
	(0.037)	(0.060)	(0.022)	(0.009)
Employment	0.214***	0.222*	0.286***	0.097
	(0.077)	(0.130)	(0.066)	(0.100)

*** p<0.01, ** p<0.05, * p<0.1. Specifications as in Tables 3 and 4, with $p_T = 4$ lags of the CSAs ($T = 76$). Observations for 2025 are provisional; the German employment-rate series ends in 2024Q4. Nonparametric mean-group standard errors in parentheses.

Appendix F: Nominal Exchange Rate (New EU Own Currency)

As a robustness check, we replace the REER with the nominal effective exchange rate (NEER, 27 EU partners), restricting attention to the New EU own-currency group, the only group for which nominal exchange rate variation is meaningful. The short-run NEER coefficient is negative and marginally significant (-0.136, $p<0.1$), with the expected sign (nominal appreciation is associated with slower growth), and the long-run coefficient is insignificant. Nominal exchange rate movements thus have at most a weak direct association with growth in this group; the economically relevant variation runs through the real rate.

Table A6: New EU own-currency countries: nominal effective exchange rate (27 EU partners), 2007–2019

	Short run, trend	Short run, no trend	Long run (CS-DL)
Lagged GDP growth	-0.168**	-0.100***	
	(0.085)	(0.037)	
Inflation	-0.408*	-0.403	-0.336
	(0.245)	(0.245)	(0.330)
Nominal exchange rate	-0.136*	-0.137*	-0.047
	(0.078)	(0.078)	(0.056)
Investment	0.073***	0.072***	0.050**
	(0.024)	(0.026)	(0.023)
Capacity utilization	-0.008	-0.029	-0.100
	(0.050)	(0.057)	(0.074)
Employment	-0.032	-0.022	-0.158
	(0.085)	(0.071)	(0.134)
N	208	208	208

*** p<0.01, ** p<0.05, * p<0.1. NEER (quarterly log-difference, 27 EU partners) replaces the REER in the regressors and in the CSAs; country slopes estimated with 21-country CSAs and averaged over Czechia, Hungary, Poland and Romania. Nonparametric mean-group standard errors in parentheses.

Appendix G: ULC-deflated REER

Tables A7 and A8 report the full short-run and long-run estimates with the ULC-deflated REER for the baseline and extended samples. The other coefficients are close to those of the CPI-based specifications; the long-run REER coefficients are insignificant throughout.

Table A7: Estimates with the ULC-deflated REER (27 EU trading partners), 2007–2019

	All	Old EU (Euro)	New EU (Euro)	New EU (Own)
Panel A. Short run: dynamic CCEMG (with trend)				
Lagged GDP growth	-0.205***	-0.166**	-0.351***	-0.138**
	(0.054)	(0.079)	(0.102)	(0.059)
Inflation	-0.276***	-0.272***	-0.229	-0.346
	(0.073)	(0.091)	(0.161)	(0.226)
Real exchange rate	-0.174**	-0.231**	-0.093	-0.105*
	(0.079)	(0.110)	(0.210)	(0.060)
Investment	0.063***	0.080***	0.020	0.067***
	(0.017)	(0.024)	(0.031)	(0.024)
Capacity utilization	0.034	-0.027	0.200*	0.009
	(0.036)	(0.031)	(0.103)	(0.036)
Employment	0.090	0.099	0.171**	-0.039
	(0.065)	(0.106)	(0.083)	(0.068)
N	1092	624	260	208
Panel B. Long run: CS-DL				
Inflation	-0.425***	-0.414***	-0.506**	-0.357
	(0.122)	(0.158)	(0.240)	(0.389)
Real exchange rate	-0.067	-0.100	0.012	-0.069
	(0.072)	(0.106)	(0.174)	(0.049)
Investment	0.070***	0.075***	0.070**	0.054**
	(0.017)	(0.025)	(0.034)	(0.026)
Capacity utilization	0.017	-0.009	0.143**	-0.061
	(0.031)	(0.035)	(0.060)	(0.062)
Employment	0.067	0.063	0.258***	-0.159
	(0.082)	(0.124)	(0.058)	(0.163)

*** p<0.01, ** p<0.05, * p<0.1. REER: quarterly log-difference of the ULC-deflated (total economy) index vs. 27 EU partners (Eurostat `REER_EU27_2020_ULCT`), in the regressors and in the CSAs. Otherwise as Tables 3 and 4.

Table A8: Estimates with the ULC-deflated REER (27 EU trading partners), extended sample 2007–2025

	All	Old EU (Euro)	New EU (Euro)	New EU (Own)
Panel A. Short run: dynamic CCEMG (with trend)				
Lagged GDP growth	-0.102**	-0.052	-0.241***	-0.080
	(0.048)	(0.069)	(0.083)	(0.086)
Inflation	-0.196***	-0.223***	-0.029	-0.325*
	(0.063)	(0.072)	(0.143)	(0.171)
Real exchange rate	-0.203**	-0.244**	-0.192	-0.094*
	(0.080)	(0.121)	(0.180)	(0.050)
Investment	0.074***	0.077***	0.059***	0.086**
	(0.018)	(0.029)	(0.013)	(0.034)
Capacity utilization	0.033	-0.013	0.102*	0.085**
	(0.031)	(0.046)	(0.056)	(0.033)
Employment	0.105**	0.125*	0.134*	0.010
	(0.048)	(0.073)	(0.068)	(0.096)
N	1591	907	380	304
Panel B. Long run: CS-DL				
Inflation	-0.298***	-0.256***	-0.285**	-0.442***
	(0.068)	(0.099)	(0.121)	(0.146)
Real exchange rate	-0.088	-0.131	0.000	-0.070
	(0.069)	(0.113)	(0.105)	(0.058)
Investment	0.083***	0.085***	0.084***	0.075**
	(0.015)	(0.025)	(0.013)	(0.035)
Capacity utilization	0.007	-0.013	0.115***	-0.070***
	(0.041)	(0.066)	(0.036)	(0.021)
Employment	0.200***	0.263**	0.187*	0.024
	(0.071)	(0.106)	(0.106)	(0.134)

*** p<0.01, ** p<0.05, * p<0.1. REER: quarterly log-difference of the ULC-deflated (total economy) index vs. 27 EU partners (Eurostat `REER_EU27_2020_ULCT`), in the regressors and in the CSAs. Otherwise as Tables 3 and 4. 2025 data provisional.

Appendix H: Specification Choices and Robustness

Table A9 examines the short-run specification choices for the full sample. The inflation, real exchange rate and investment coefficients are stable across richer lag structures for GDP growth (four lags, or the BIC-selected lag order for each country), four rather than three lags of the CSAs, and augmentation with the CSAs of all regressors. When all regressors enter with a one-quarter lag, the inflation coefficient remains significant (-0.139, p$<$0.05), while the real exchange rate and investment coefficients lose significance: their short-run association with growth is contemporaneous. Column 7 omits the CSA of GDP growth and uses a single lag of the remaining CSAs. In that specification the residuals remain cross-sectionally dependent (residual CD 14.0), capacity utilization and employment are highly significant and inflation is insignificant, which is the pattern that absorbing the common cycle removes.

Table A9: Short-run specification robustness, full sample 2007–2019

	Baseline	4 GDP lags	BIC lags by country	CSA lags $= 4$	All-variable CSAs	Regressors lagged 1q	No CSA of GDP growth
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Inflation	-0.196**	-0.238**	-0.237**	-0.234***	-0.280*	-0.139**	0.114
	(0.089)	(0.110)	(0.099)	(0.077)	(0.165)	(0.065)	(0.129)
Real exchange rate	-0.171**	-0.153*	-0.151**	-0.156**	-0.225**	-0.118	-0.402***
	(0.069)	(0.086)	(0.074)	(0.066)	(0.090)	(0.087)	(0.129)
Investment	0.071***	0.068***	0.066***	0.067***	0.060***	0.012	0.102***
	(0.016)	(0.018)	(0.018)	(0.017)	(0.015)	(0.009)	(0.018)
Capacity utilization	0.029	0.037	0.044	0.040	0.039	0.006	0.146***
	(0.035)	(0.037)	(0.037)	(0.029)	(0.035)	(0.032)	(0.031)
Employment	0.089	0.057	0.037	0.086	0.131	0.104	0.255***
	(0.086)	(0.095)	(0.081)	(0.083)	(0.144)	(0.081)	(0.093)
Lagged GDP growth	-0.126**	-0.164***		-0.147***	-0.136**	-0.159***	-0.001
	(0.053)	(0.044)		(0.051)	(0.055)	(0.060)	(0.042)

*** p$<$0.01, ** p$<$0.05, * p$<$0.1. Mean-group estimates for all 21 countries (42-partner CPI-deflated REER, with trend). (1) Baseline, Table 3. (2) Four lags of GDP growth (first-lag coefficient shown). (3) Country-specific lag order chosen by BIC over 1–4 lags (one lag: 12 countries; two: 4; three: 2; four: 3). (4) $\lceil T^{1/3} \rceil = 4$ lags of the CSAs. (5) CSAs of GDP growth and of all regressors, contemporaneous and three lags. (6) All regressors other than lagged GDP growth entered with a one-quarter lag (predetermined). (7) Without the CSA of GDP growth: CSAs of inflation and the REER only, contemporaneous and one lag. Nonparametric mean-group standard errors in parentheses.

Table A10 compares the subgroup estimates based on the 21-country CSAs with estimates based on group-specific CSAs. The investment results are unchanged, while the inflation and exchange rate coefficients shift, as expected given how noisy averages over four or five countries are.

Table A11 reports the tests of the timing of the capacity utilization effect discussed in Section 4.

Table A12 reports all estimators with the capacity utilization rate in levels, the variable that enters the model of Gillman et al. (2026), instead of its quarterly change; the results are discussed

Table A10: Subgroup estimates with 21-country vs. group-specific cross-sectional averages, 2007–2019

	Old EU (Euro)		New EU (Euro)		New EU (Own)	
	21-country	group	21-country	group	21-country	group
Inflation	-0.165	-0.002	-0.132	-0.358	-0.373	-0.068
	(0.105)	(0.178)	(0.230)	(0.380)	(0.237)	(0.151)
Real exchange rate	-0.169	-0.236	-0.249*	-0.438	-0.079	-0.140**
	(0.109)	(0.171)	(0.134)	(0.333)	(0.054)	(0.066)
Investment	0.088***	0.086***	0.034	0.020	0.069***	0.073*
	(0.024)	(0.023)	(0.028)	(0.026)	(0.024)	(0.042)
Capacity utilization	-0.010	-0.004	0.172*	0.054	-0.036	0.022
	(0.034)	(0.042)	(0.089)	(0.080)	(0.071)	(0.064)
Employment	0.083	0.028	0.222***	0.213	-0.058**	0.050
	(0.146)	(0.146)	(0.077)	(0.190)	(0.029)	(0.131)

*** p<0.01, ** p<0.05, * p<0.1. Short-run dynamic CCEMG (42-partner CPI-deflated REER, with trend). "21-country": baseline, CSAs over all 21 countries. "Group": CSAs computed within the subgroup only (4–12 countries). With four or five countries, group averages are noisy proxies for the common factors and put a weight of one quarter to one fifth on the country's own observations, which is why the baseline uses 21-country averages. Nonparametric mean-group standard errors in parentheses.

Table A11: Timing of the capacity utilization effect, full sample 2007–2019

	Baseline (1)	Lagged (2)	With level gap (3)	Growth at $t+1$ (4)
Δ capacity utilization$_t$	0.029		0.084*	-0.007
	(0.035)		(0.051)	(0.034)
Δ capacity utilization$_{t-1}$		0.014		
		(0.037)		
Capacity utilization gap$_{t-1}$ (level)			0.057**	
			(0.022)	
Lagged GDP growth	-0.126**	-0.125**	-0.169***	0.107**
	(0.053)	(0.050)	(0.049)	(0.054)

*** p<0.01, ** p<0.05, * p<0.1. Mean-group estimates for all 21 countries, baseline short-run specification. (2) Replaces the contemporaneous change in utilization by its first lag. (3) Adds the lagged level of utilization in deviation from its country mean, an output-gap-type term. (4) Dependent variable is GDP growth in $t+1$. Nonparametric mean-group standard errors in parentheses.

in Section 4.

Table A12: Capacity utilization rate in levels: short-run and long-run estimates

	Baseline 2007–2019			Extended 2007–2025		
	Short run (1)	CS-DL (2)	CS-ARDL (3)	Short run (4)	CS-DL (5)	CS-ARDL (6)
Panel A. All 21 countries						
Utilization rate (level)	0.039**	0.048	0.073**	0.004	0.008	0.005
	(0.018)	(0.042)	(0.034)	(0.018)	(0.010)	(0.012)
Inflation	-0.194**	-0.263**	-0.195	-0.199***	-0.289***	-0.279**
	(0.094)	(0.133)	(0.130)	(0.076)	(0.094)	(0.111)
Real exchange rate	-0.187**	-0.388	-0.341	-0.113	-0.092	-0.058
	(0.076)	(0.256)	(0.216)	(0.087)	(0.151)	(0.163)
Investment	0.079***	0.075***	0.080***	0.072***	0.067***	0.075***
	(0.017)	(0.016)	(0.016)	(0.019)	(0.016)	(0.019)
Employment	0.058	0.163	0.067	0.127*	0.230***	0.196**
	(0.083)	(0.101)	(0.087)	(0.065)	(0.072)	(0.081)
Panel B. Utilization rate (level) by group						
Old EU (Euro)	0.006	0.081	0.075	-0.035	-0.003	-0.018
	(0.019)	(0.072)	(0.057)	(0.022)	(0.014)	(0.017)
New EU (Euro)	0.110***	-0.009	0.084*	0.047*	0.009	0.026
	(0.041)	(0.020)	(0.043)	(0.025)	(0.013)	(0.020)
New EU (Own)	0.051	0.021***	0.054	0.070*	0.037*	0.045**
	(0.038)	(0.006)	(0.040)	(0.038)	(0.019)	(0.022)

*** p<0.01, ** p<0.05, * p<0.1. Identical to Tables 3 and 4 (and Table A5 for the extended sample) except that the manufacturing capacity utilization rate enters in levels, as in the neoclassical model and in Gillman et al. (2026), rather than as its quarterly change. Short run: dynamic CCEMG with trend. CS-DL: long-run coefficient on the level, with first differences of all regressors included. CS-ARDL(1,1): $\theta_i = (\beta_{i0} + \beta_{i1})/(1 - \lambda_i)$. CSAs of GDP growth, inflation and the REER with $p_T = 3$ (baseline) or 4 (extended) lags. The coefficient on the utilization rate measures the change in quarterly GDP growth (percentage points) associated with a one-point higher utilization rate. Nonparametric mean-group standard errors in parentheses. 2025 data provisional.

Table A13 examines measurement. The HICP index is not seasonally adjusted, and country-specific seasonal patterns account for about a third of the within-country variance of quarterly inflation; removing them, or using year-on-year inflation, leaves the inflation coefficients negative and significant at both horizons. Replacing the change in the employment rate with the growth of total hours worked gives a positive and significant labor-input effect at both horizons; the long-run inflation coefficient is unchanged, while the short-run inflation coefficient becomes smaller and insignificant.

Table A13: Measurement robustness: inflation seasonality and hours worked, full sample 2007–2019

	Short run (dynamic CCEMG)				Long run (CS-DL)			
	Baseline (1)	SA infl. (2)	Y-o-y infl. (3)	Hours (4)	Baseline (5)	SA infl. (6)	Y-o-y infl. (7)	Hours (8)
Inflation	-0.196**	-0.218***	-0.588***	-0.098	-0.288**	-0.204**	-0.421**	-0.299***
	(0.089)	(0.084)	(0.223)	(0.077)	(0.124)	(0.100)	(0.190)	(0.107)
Real exchange rate	-0.171**	-0.166***	-0.166**	-0.203***	-0.327	-0.330*	-0.251	-0.320
	(0.069)	(0.061)	(0.072)	(0.073)	(0.207)	(0.176)	(0.156)	(0.195)
Investment	0.071***	0.070***	0.069***	0.067***	0.077***	0.075***	0.068***	0.069***
	(0.016)	(0.016)	(0.018)	(0.015)	(0.017)	(0.015)	(0.016)	(0.013)
Capacity utilization	0.029	0.038	0.022	0.035	-0.045	-0.029	-0.045	-0.031
	(0.035)	(0.037)	(0.033)	(0.032)	(0.040)	(0.038)	(0.040)	(0.044)
Employment / hours	0.089	0.051	0.058	0.093***	0.178*	0.044	0.070	0.234***
	(0.086)	(0.073)	(0.084)	(0.035)	(0.104)	(0.089)	(0.098)	(0.047)

*** p<0.01, ** p<0.05, * p<0.1. Mean-group estimates for all 21 countries, specifications as in Tables 3 and 4 (42-partner CPI-deflated REER). "SA infl.": quarterly HICP inflation net of country-specific quarter-of-year means, removing the country-specific seasonal pattern of the non-seasonally-adjusted index. "Y-o-y infl.": year-on-year HICP inflation divided by four. In columns (2), (3), (6) and (7) the alternative inflation measure is used in the regressors and in the CSAs. "Hours": quarterly growth of total hours worked (Eurostat `namq_10_a10_e`, seasonally and calendar adjusted) replaces the change in the employment rate. Nonparametric mean-group standard errors in parentheses.

Appendix I: Inflation Threshold Specifications

Following the literature on inflation thresholds (Khan and Senhadji, 2001; Bick, 2010), we test whether the inflation effect is nonlinear by augmenting the extended-sample (2007–2025) short-run specification with a piecewise-linear inflation term, $\max(0, \pi_{it} - k)$, at knots between 1.5 and 2.5 percent per quarter. Table A14 reports the results. In the full sample, the linear term remains negative and significant at every knot, while the excess term is small and insignificant: once common factors are absorbed, the inflation effect is approximately linear. Only for the Baltic states, whose energy-shock inflation provides most of the high-inflation observations, does the effect steepen above the knot (-0.400, p<0.05). When the augmentation omits the CSA of GDP growth, the linear term is insignificant and the excess term significant instead; that pattern reflects the positive comovement of inflation and growth over the common cycle in the normal range of inflation.

Table A14: Inflation and growth: threshold specifications, extended sample 2007–2025

	Linear inflation term	Excess above knot (spline term)	Countries with excess term	Implied slope above knot
Panel A. All 21 countries				
Knot = 1.5% QoQ	-0.152*	-0.092	21	-0.244
	(0.078)	(0.107)		
Knot = 2.0% QoQ	-0.167**	-0.107	20	-0.274
	(0.077)	(0.127)		
Knot = 2.5% QoQ	-0.177**	-0.060	15	-0.237
	(0.073)	(0.110)		
Panel B. Baltic conditioning (knot = 2.0% QoQ)				
All excl. EE, LV, LT	-0.180**	-0.056	17	-0.235
	(0.084)	(0.143)		
Baltics only	-0.090	-0.400**	3	-0.491
	(0.243)	(0.191)		

*** p<0.01, ** p<0.05, * p<0.1. Mean-group estimates from the short-run specification (42-partner CPI-deflated REER, trend, $p_T = 4$) with the linear inflation term augmented by $\max(0, \pi_{it} - k)$. The excess term is included for a country only when it has at least three above-knot quarters; its mean-group statistics average over contributing countries (third column). Nonparametric mean-group standard errors in parentheses. 2025 data provisional.