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Output Divergence in Fixed Exchange Rate Regimes

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Output Divergence in Fixed Exchange Rate Regimes *

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Abstract

This paper presents empirical evidence for the violation of nominal exchange regime neutrality. We find that fixing the exchange rate is associated with real output losses among countries with a high pre-peg inflation rate. In particular, ten years after fixing the exchange rate a country with a +1 percentage point (ppt) pre-peg wage inflation differential has a 2% lower real GDP per capita level and a 1% lower TFP level. The tradable sector is more affected than the non-tradable sector, which accords with the former's greater exposure to international arbitrage.

Keywords: nominal exchange regime neutrality, open economy, nominal frictions
JEL Codes: E50, F40, O30, O47

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1. Introduction

Can fixing the exchange rate between two regions' currencies cause real economic outcomes between these regions to diverge? Upon fixing the exchange rate, international arbitrage commands nominal convergence of interest rates and inflation. Nominal convergence, however, may imply an episode of real economic divergence to the extent that frictions impede the necessary nominal adjustment. Consider a high-wage-inflation region that fixes its exchange rate vis-à-vis a low-wage-inflation region. If nominal rigidities in the high-wage-inflation region impede its nominal adjustment, then the required inflation convergence may be associated with a divergence in real economic outcomes.

This paper puts nominal exchange regime neutrality to the test. We begin with a descriptive analysis of the euro area – the largest fixed exchange rate project since the collapse of Bretton Wood in the early 1970s. When comparing post-euro accession outcomes across member states with high and low inflation rates before joining the euro, countries that had higher inflation rates prior to accession—facing a larger nominal adjustment challenge when fixing their exchange rates—tend to experience weaker real output growth. The euro area's first two decades thus present a juxtaposition of nominal convergence and real divergence that motivates a more thorough empirical analysis of whether fixing the exchange rate can generate real economic divergence.

To this end we use local projections to compare post-peg real outcomes across countries with different pre-peg inflation differentials for a sample of 27 developed countries from 1970 to 2019. We find that, for countries with a relatively high pre-peg inflation rate, real growth decelerates upon fixing the exchange rate: ten years after fixing the exchange rate a country with a +1 percentage point (ppt) pre-peg wage inflation differential has a 2% lower real GDP per capita level. We find that this change is accompanied by a 1% lower TFP level. These effects are more pronounced in the tradable sector than the non-tradable sector, which accords with the former's greater exposure to the nominal convergence force exerted by international arbitrage under a fixed exchange rate. The baseline findings are corroborated by a battery of robustness checks that, among others, use different productivity measures, different measures of the pre-peg inflation differential, and different econometric methodologies – incl. staggered difference-in-difference and synthetic control method analysis.

The first contribution of this paper is to the literature that assesses the costs and benefits associated with fixing the exchange rate. According to optimal currency area theory (OCA) fixing the exchange rate lowers transaction costs in international trade at the expense of a country's ability to conduct an independent monetary policy that is oriented towards local economic conditions (Mundell, 1961; Alesina and Barro, 2002; Fornaro, 2022). Beyond OCA, exchange rate regimes are often contrasted according to their ability to insulate an economy against various shocks. Proponents of flexible exchange rates have highlighted how the added nominal flexibility promotes an economy's ability to absorb real shocks (Friedman, 1953; Poole, 1970). Proponents of fixed exchange rates have emphasized the reduction in nominal shocks stemming from the elimination of speculation-driven exchange rate fluctuations and positive effects on monetary discipline (Calvo, 2000; Mundell, 2002).

A vast empirical literature has examined the data for indications that the exchange rate regime affects real economic outcomes. Initial studies have produced mixed findings (Baxter and Stockman, 1989; Ghosh et al., 1996; Rolnick and Weber, 1997; Ghosh et al., 2003; Levy-Yeyati and Sturzenegger, 2003; Dubas et al., 2005; Husain et al., 2005). More recent research has revealed how the exchange rate regime interacts with country-specific frictions to affect economic growth. Focusing on financial frictions, Aghion et al. (2009) find that exchange rate fluctuations negatively affect economic growth in countries with low financial development. The authors propose that this is due to credit-constraint firms cutting back on innovation investment whenever an exchange rate appreciation reduces firms' current earnings. In this paper we focus on nominal frictions and their interaction with the exchange rate regime. In particular, we document that high-inflation countries – i.e. countries which face a larger nominal adjustment challenge upon fixing the exchange rate – experience a post-peg growth slowdown. This finding is particularly relevant for high-inflation countries that consider importing monetary discipline from abroad.

Our paper's second contribution is to the literature that analyzes the euro area's growth performance over its first two decades. A slowdown in the euro area's overall growth rate, and a divergence in the fortunes of the euro area's core and periphery regions have been empirically highlighted by Estrada et al. (2013) and Franks et al. (2018). Schmöller and Spitzer (2021) document that endogenous growth mechanisms provide a compelling explanation for the euro area's slowdown in output and productivity growth. In this regard, our analysis reveals that the incidence of the growth slowdown in output and productivity within the euro area is closely linked to the magnitude of the nominal adjustment challenge that different countries faced upon accession.

Our paper's third contribution is to the literature that analyzes the economic mechanisms behind the euro area's core-periphery divide. Important mechanisms that have been highlighted so far include the following: Gopinath et al. (2017) propose that the large capital inflows into Southern Europe during the euro area's first decade were misallocated into sectors with low productivity growth. As a consequence, TFP growth in the euro area's South fell behind. Abbritti and Weber (2024) offer an explanation for widening TFP gaps within the framework of a two-region NK model with endogenous growth and heterogeneous product and labor market regulations. In their model, the core-periphery TFP gap emerges as the consequence of region-specific risk premium shocks that can be linked to the global financial crisis and the euro area debt crisis. Bonam and Goy (2019) propose a model in which home bias in (backward-looking) inflation expectations gives rise to a *Walters real interest rate effect* (Walters, 1994): region-specific inflation expectations, in conjunction with a common monetary policy, imply region-specific real interest rates that exacerbate asymmetric investment booms and busts across the euro area. In the context of this literature, our findings highlight an under-appreciated dimension along which euro area outcomes have diverged – heterogeneous inflation histories that resulted in differently sized nominal adjustment challenges upon euro area accession.

The rest of the paper is structured as follows: Section 2 introduces descriptive evidence from the euro area. Section 3 presents our data, econometric methodology, findings, and robustness checks. Section 4 concludes.

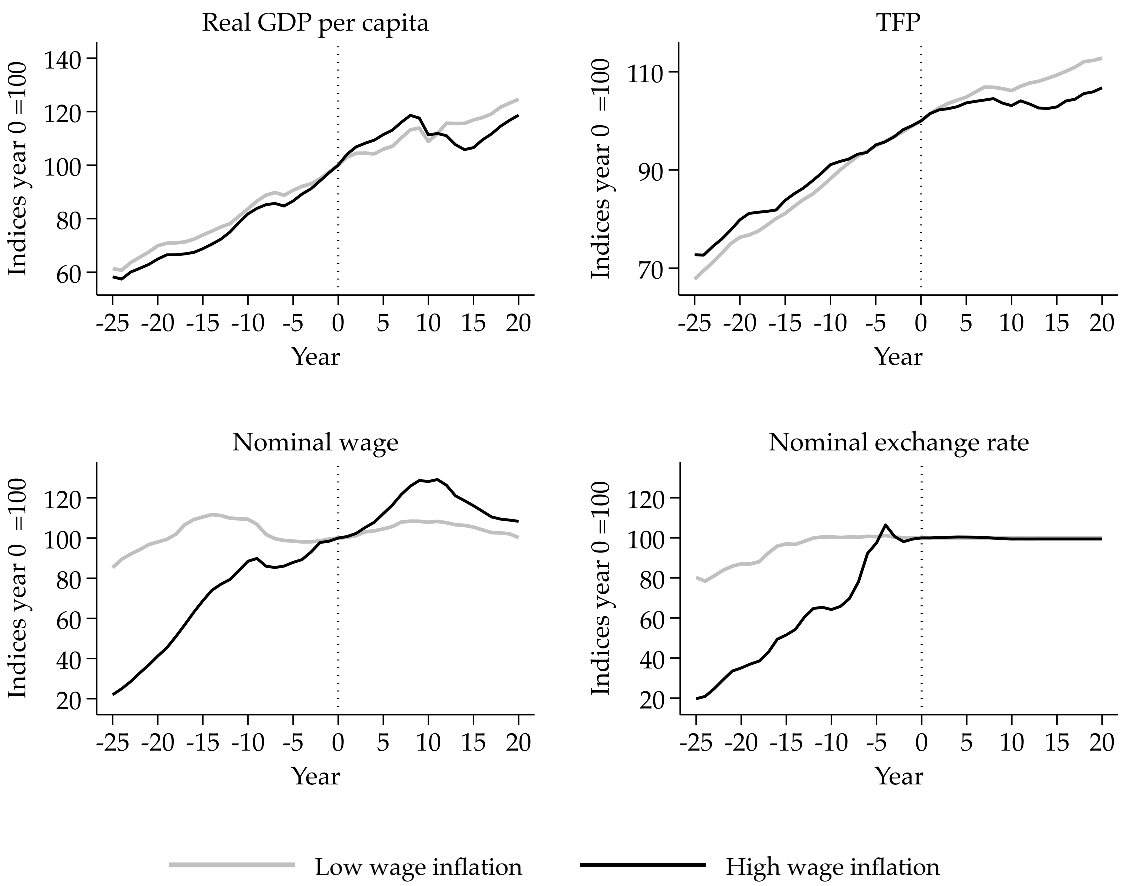
2. Euro area descriptives

The world's largest fixed exchange rate project since the collapse of the Bretton Woods system in the early 1970s was the creation of the euro area. Up to 1999, the European Monetary System (EMS) still allowed for exchange rate fluctuations among member states within a +/-2.25% band. Some currencies were allowed to fluctuate within a wider band of 6%, such as the currencies of Italy, Portugal, and Spain. In practice, nominal exchange rate adjustments could occasionally exceed predefined bands (e.g. Italy, 1973), and during the European currency crises of the early 1990s exchange rates were allowed to fluctuate within a wider +/-15% band. Two years before the introduction of the euro in 1999 euro area member states nominal exchange rate fluctuations began to stabilize as required by the Maastricht Treaty's convergence criteria. With the introduction of the euro in 1999 nominal exchange rates became irrevocably fixed. Did euro area members with relatively high pre-peg wage inflation differentials experience slower growth after adopting the euro?

To address this question we measure a country's pre-peg wage inflation differential relative to Germany as the log ratio of that country's wage inflation relative to Germany's wage inflation, $ln(\Pi_w/\Pi_w^{DEU})$. In particular, we use 15-year backward looking moving averages of nominal wage trend growth rates for this purpose. Trend growth rates are isolated using the HP-filter with smoothing parameter λ set to 6.25 (Hodrick and Prescott, 1997). We use the average trend growth rate rather than the raw data's average growth rate because the latter gives considerable weight to large single year fluctuations that reflect large shocks rather than systematic inflation differentials. Euro area countries are then classified as high-inflation countries if their wage inflation differential at the time of euro entry is positive. The low-inflation group consists of the complementary set of countries with a non-positive wage inflation differential.

Figure 1 compares the economic experience of low-inflation euro area members – Austria, Belgium, France, Germany, Luxembourg, and the Netherlands – and high-inflation

Figure 1: Nominal convergence and real divergence



Notes: All series are population-weighted averages. Nominal wages are expressed relative to Germany. The event window is based on data over the 1970-2019 period. Year 0 represents the date when a country adopted the euro. Data Appendix provides a detailed description of the data. Individual euro area member time series are presented in the Online Appendix (Figure A.3).

members – Cyprus, Finland, Greece, Ireland, Italy, Latvia, Malta, Portugal, Slovak Republic, Slovenia, and Spain. Prior to the euro, the development of real GDP per capita and TFP among high- and low-inflation members is very similar (top panels of Figure 1). After euro area accession, signs of real divergence emerge: 20 years after fixing the exchange rate, real GDP per capita and TFP in high-inflation members have fallen notably short of those in low-inflation members. For real GDP per capita, the marked boom-bust cycle associated with the euro area debt crisis around 2010 paints a somewhat ambiguous picture. For TFP growth, however, a more clearly discernible divergence commences in the aftermath of fixing the exchange rate.

On the nominal side, high- and low-inflation members exhibit very different pre-peg nominal wage trends (by construction). In the 25 years preceding the introduction of the euro, nominal wages increased 500% in the high-inflation group, while they only increased by 25% in the low-inflation group. Under the EMS this divergence in nominal wages was compensated for by a quantitatively equivalent depreciation in the high-inflation group's nominal exchange rate (bottom panels of Figure 1). After euro area accession, the nominal variables of the high- and low-inflation groups converge. The nominal wage level in the high-inflation group initially reflects the boom-bust cycle centered around 2010. However, 20 years after fixing the exchange rate the trend break towards nominal wage convergence with the low-inflation group is clearly discernible.

The juxtaposition of nominal convergence and real divergence in the euro area presents prima facie evidence for the presence of frictions that prevent nominal convergence without generating movement on the economy's real side.[1] Thus, the recent euro area experience motivates further analysis into whether fixing the nominal exchange rate impacts economic growth.

3. Evidence from local projections

This section presents local projection estimates that trace out the post-peg development of economies that face a nominal adjustment challenge. As before, we are interested in comparing the development of high- and low-inflation regions in the aftermath of fixing the exchange rate. In contrast to the unconditional euro area averages presented in the previous section, this section presents conditional estimates that hone in on a quantitative answer to the following question: how different is the post-peg development of an economy with a +1 ppt wage inflation differential that pegs its exchange rate compared to the post-peg development of an economy with a zero wage inflation differential, or the development of an economy with the same +1 ppt wage inflation differential that does not peg its exchange rate.

3.1. Data and methodology

The regression estimates presented in this section are based on a sample of 27 developed countries between 1970 and 2019. Our baseline empirical approach relies on the local projection (LP) method (Jordà, 2005). In particular, we estimate the following sequence of fixed effect models:

$$z_{i,t+h} - z_{i,t-1} = \alpha_{i,h} + (e_{i,t} * s_{i,t})\beta_h + \boldsymbol{x}_{i,t}\boldsymbol{\lambda}_h + u_{i,t+h}, \tag{1}$$

for horizons $h = 0, 1, ..., H,$ countries $i = 1, ..., N,$ and periods $t = t_0, ..., T.$ $\alpha_{i,h}$ denotes horizon-specific country fixed effects. $\boldsymbol{x}_{i,t}$ is a vector of control variables, and $u_{i,t+h}$ is a country- and horizon-specific error term. $z_{i,t}$ denotes the outcome variable of interest. Our main outcome variables of interest are the natural logarithms (ln) of real output per capita and utilization-adjusted TFP. So, $z_{i,t+h} - z_{i,t-1}$ is the h-year cumulated growth

[1] This pattern is also visible when considering only countries that joined the euro in 1999 (Figure A.1 in the Online Appendix). The slowdown in high-inflation countries' productivity growth around the time of joining the euro is also visible in two alternative TFP measures from the Penn World Table and EU KLEMS (Figure A.2 in the Online Appendix).

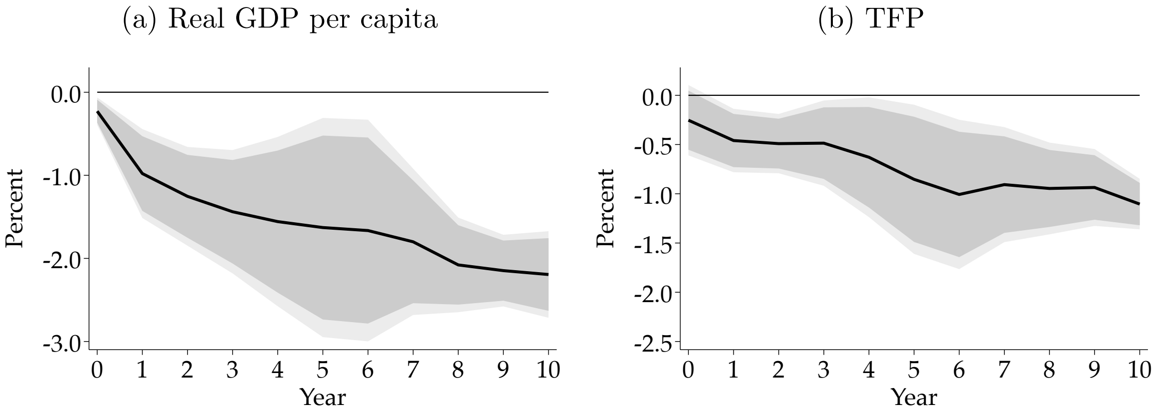
rate of these variables. For our baseline analysis we adjust the TFP series for capital and labor utilization following the procedure outlined in Imbs (1999). The Data Appendix provides details on the adjustment procedure.

Our independent variable of interest is the interaction term between the exchange rate regime, $e_{i,t}$, and the wage inflation differential, $s_{i,t}$. The accompanying coefficients of interest are $\{\beta_h\}_{h=0}^{H}$, which delineate a cumulative impulse response function (IRF) that describes the effect of fixing the exchange rate in a country whose structural inflation rate exceeds that of its base country by 1 ppt. We use Driscoll-Kraay standard errors to accompany each point estimate with a confidence interval that accounts for cross-sectional and temporal dependencies in the data (Driscoll and Kraay, 1998; Hoechle, 2007). Throughout, we consider a maximum projection horizon of 10 years, $H = 10$.

We set $e_{i,t}$ to 1 if country i has a peg in period t and remains a peg for the next H years. Analogously, $e_{i,t}$ equals 0 if country i has a flexible exchange rate in period t and stays floating for the next H years. This ensures a clean comparison between pegs and floats over the entire projection horizon, without confounding pegs with lapsed pegs, and floats with lapsed floats. $s_{i,t}$ measures the pre-peg wage inflation differential of country i relative to its base country. As before, we measure the pre-peg inflation differential relative to the base country using the same 15-year backward looking moving averages of nominal wage trend growth rates. Germany is the base country for euro area member states. Otherwise, base countries are set according to the exchange rate regime classification dataset by Ilzetzki et al. (2019). We consider a currency peg to begin in the year in which a country's exchange rate regime becomes classified as "no separate legal tender" or "pre announced peg or currency board arrangement".

The control vector $\boldsymbol{x}_{i,t}$ includes separate controls for the exchange rate regime, $e_{i,t}$, and the wage inflation differential, $s_{i,t}$. Otherwise, our choice of controls follows Aghion et al. (2009) and Jordà et al. (2024) – two related studies that are thematically and methodologically closely related. In particular, $\boldsymbol{x}_{i,t}$ includes the lagged dependent variable's growth rate and level, and a set of level controls including ln real GDP per capita, ln real consumption per capita, ln real investment per capita, ln domestic private credit to GDP ratio, ln trade to GDP ratio, ln government consumption to GDP ratio, ln schooling, the wage inflation differential, and the exchange rate regime indicator. Following Aghion et al. (2009), we also include the interaction term between the domestic private credit to GDP ratio and the exchange rate regime indicator to account for the negative relationship between exchange rate volatility and credit access. In addition to the control variables used in Aghion et al. (2009) and Jordà et al. (2024), we include the ln service sector share of GDP to account for slower TFP growth in the service sector (Mano et al., 2015). All slow-moving level controls are included in the control vector as contemporaneous values only, whereas fluctuations at the business cycle frequency are accounted for

Figure 2: Real effects of pegging with a +1 ppt wage inflation differential



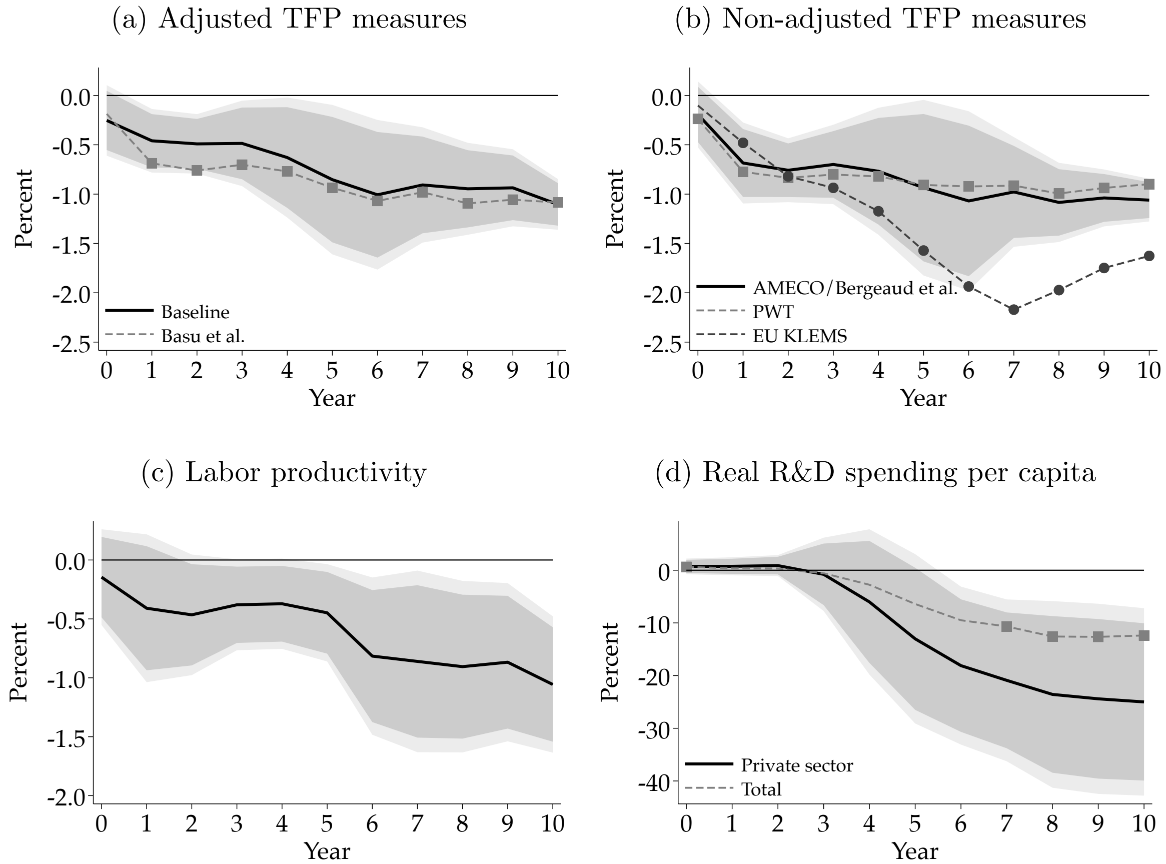
Notes: Black solid line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval.

by the contemporaneous values and two lags of CPI inflation and real GDP per capita growth (unless real GDP per capita is the dependent variable of interest, in which case no contemporaneous value for real GDP per capita growth is included in the control vector). By including the contemporaneous values of control variables, we implicitly assume that none of them exhibit an on-impact response to a change in the exchange rate regime. The results are robust to dropping the contemporaneous controls (Section 3.2.4). Following Jordà et al. (2024), we also include the contemporaneous and lagged values of global real GDP growth to account for global business cycle dynamics. We thus saturate the baseline specification with a rich set of controls (Stock and Watson, 2018). Results based on parsimonious specifications corroborate the baseline findings and are discussed in Section 3.2.4. Data Appendix gives a detailed description of all variables' definitions and the data sources.

3.2. Results

Does fixing the exchange rate negatively affect real economic outcomes for countries with high pre-peg wage inflation differentials? Figure 2 presents the answer provided by our cumulative IRF estimates: upon fixing the exchange rate, countries with a high wage inflation differential exhibit a shortfall in output growth. In particular, Figure 2a shows that ten years after pegging, a country with a wage inflation differential of +1 ppt has a 2% lower real GDP per capita level. An output loss that persists over a 10-year horizon can be indicative of a negative endogenous growth effect. The TFP response shown in Figure 2b substantiates this: the post-peg loss in real output is accompanied by a decline in the TFP level.[2]

Figure 3: Productivity effects of pegging with a +1 ppt wage inflation differential



Notes: Line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval. Marker: significant at 10% level. (a): baseline TFP and TFP with Basu et al. (2006) adjustment. (b): baseline non-adjusted TFP, non-adjusted TFP from the Penn World Table (PWT) (Feenstra et al., 2015) and non-adjusted TFP from EU KLEMS releases of 2023, 2012, 2011, and 2009 (O'Mahony and Timmer, 2009; Bontadini et al., 2023). (c): Labor productivity as real GDP per hour-worked. (d): Total and private sector performed real R&D spending per capita.

3.2.1 Productivity measures

Measuring an economy's productivity is a thorny problem and consequently different productivity measures exist. While our baseline analysis uses capital- and labor-utilization adjusted TFP according to Imbs (1999), this section explores the alternatives. The alternatives include non-adjusted TFP, differently adjusted TFP, labor productivity, and R&D spending. Without exception, the alternative measures confirm that countries with a positive pre-peg inflation differential see their productivity growth decline upon fixing the exchange rate.

Panel (a) of Figure 3 reproduces the baseline IRF estimate for the utilization-adjusted TFP measure according to Imbs (1999) (solid black line). The TFP adjustment proposed by Imbs (1999) is model-based in that it uses a partial equilibrium model to back out utilization rates as functions of observables and structural parameters (Data Appendix).

[2]The unemployment rate increases by around 1 ppt in the aftermath of fixing the exchange rate with a +1 ppt wage inflation differential (Figure B.1 in the Online Appendix).

By contrast, Basu et al. (2006) propose a regression-based approach that grounds in the observation that utilization levels move proportionally to total hours worked. This observation makes it possible to account for utilization rates by regressing unadjusted TFP on changes in total hours worked and thus obtain regression residuals that can be interpreted as a measure of utilization-adjusted TFP. Analogously, we add lead changes in total hours worked to the control vector to obtain an IRF estimate for utilization-adjusted TFP à la Basu et al. (2006). The dashed grey line in panel (a) depicts the resulting IRF estimate, with solid squares indicating statistical significance at the 90% level. The result is very similar to the baseline finding (solid black line).

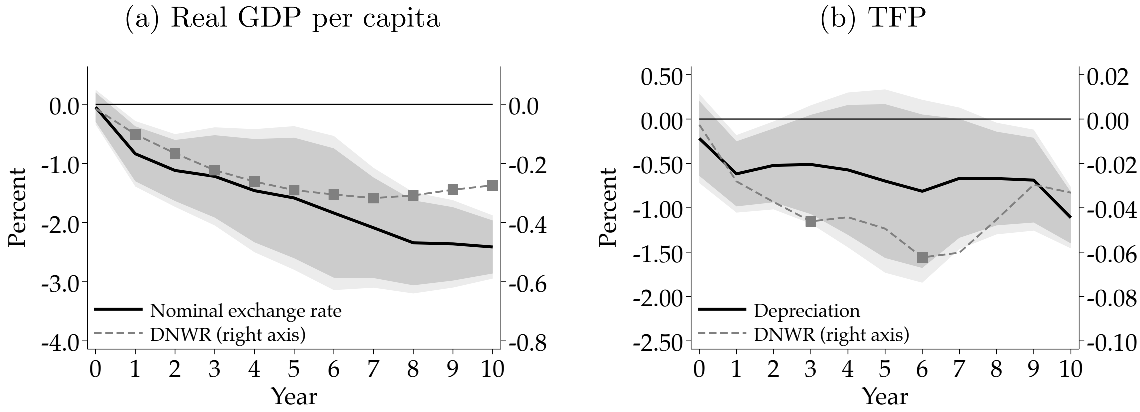
Comin et al. (2025) propose another utilization-adjusted TFP measure that accounts for imperfect competition and input factor adjustment costs. This measure is only available for shorter timer periods and fewer countries, which makes a straightforward robustness check impossible. As a robustness check, however, we substitute the adjusted TFP à la Comin et al. (2025) for the baseline TFP series where possible. This yields a very similar IRF estimate (Figure B.2 in the Online Appendix).

Panel (b) of Figure 3 depicts IRF estimates based on three different measures of non-adjusted TFP. While the conceptual framework for growth accounting is well-established, the actual implementation, in particular regarding the measurement of capital services, can differ across databases, leading to notably different productivity growth rates (Gouma and Inklaar, 2022). We therefore compare the IRF estimate based on non-adjusted TFP data from AMECO and Bergeaud et al. (2016) (solid black line) with IRF estimates that are based on non-adjusted TFP data from the Penn World Tables (dashed gray line) and the EU KLEMS database (dashed black line). The Penn World Table TFP yields an almost identical IRF estimate. The EU KLEMS TFP exhibits a stronger response from horizon 4 onwards.

Besides TFP, labor productivity and R&D spending are two alternative indicators of an economy's productivity. *Labor productivity* is simply calculated as real GDP divided by total hours worked. Panel (c) of Figure 3 displays our IRF estimate for this variable. Similar to TFP, labor productivity falls by around 1% in countries with a +1 ppt inflation differential upon fixing the exchange rate. Next, R&D spending is commonly considered a key driver of innovation. The solid black line in panel (d) of Figure 3 describes the IRF estimates for private sector R&D spending.[3] In countries with a +1 ppt pre-peg inflation differential it declines by around 25% in the decade after pegging. The dashed gray line in panel (d) describes the IRF estimate for total R&D spending, which includes public R&D

[3]Two additional controls are added when analyzing the R&D spending to account for substantial cross-country heterogeneity in the R&D tax credit during our sample period. These tax incentives can have a substantial effect on R&D spending (Thomson, 2017). We therefore include leads of the implied tax subsidy rate on R&D expenditure for SMEs and large enterprises. The implied tax subsidy rates are only available after 1995. The consequent lack of time variation in the wage inflation differential prevents us from also using country fixed effects.

Figure 4: Alternative measures of the post-peg nominal adjustment challenge



Notes: Line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval. Marker: significant at 10% level.

spending. This response bottoms out at around -10%, indicating a more stable public R&D spending stream.

3.2.2 Measures of the nominal convergence challenge

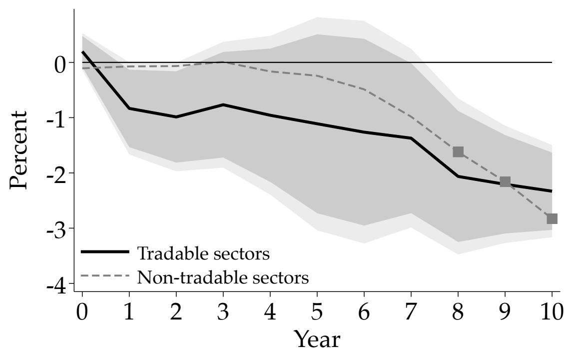
Pre-peg wage inflation differentials are not the only measure of the nominal adjustment challenge that a country faces after fixing its exchange rate. Here, we explore estimations of the local projection specification (1) that are based on two alternative measures for $s_{i,t}$: (i) pre-peg exchange rate depreciation trends and (ii) pre-peg differentials in the degree of downward nominal wage rigidity (DNWR) (Knoppik and Beissinger, 2009). The former mirror pre-peg wage inflation differentials to the extent that purchasing power parity (PPP) holds, the latter capture structural labor market differences that can impede nominal convergence.

Panel (a) of Figure 4 shows the real GDP per capita responses for these two alternative measures of the post-peg nominal adjustment challenge. The LP estimate based on pre-peg depreciation trends confirms the baseline finding of a gradual 2% decline in real GDP per capita (solid black line). The LP estimate based on DNWR differentials yields a similar response (dashed grey line, right axis). The lack of correspondence between a +1 ppt inflation differential and a 1 unit DNWR differential, however, impedes a more detailed quantitative comparison.

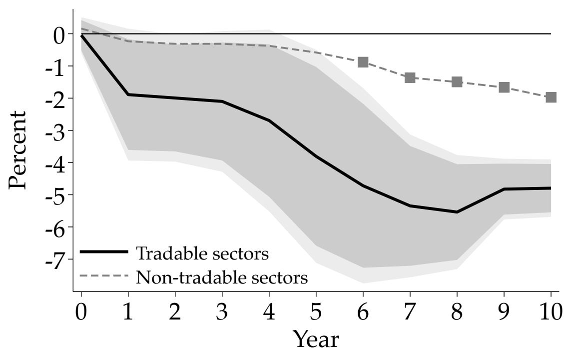
Panel (b) corroborates the disappointing post-peg TFP performance of countries that face a more challenging nominal adjustment upon fixing the exchange rate. The LP estimate based on pre-peg depreciation trends confirms the baseline finding of a gradual 1% decline in TFP (solid black line). The LP estimate based on DNWR differentials also indicates a slowdown in TFP growth, but the estimate is less precise with only two horizon-estimates achieving statistical significance (dashed grey line).

Figure 5: Sectoral effects of pegging with a +1 ppt wage inflation differential

(a) Real gross value added



(b) TFP



Notes: Line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval. Marker: significant at 10% level.

3.2.3 Tradable versus non-tradable sector

Fixing the exchange rate commands nominal convergence because of international arbitrage. The tradable sector is more exposed to arbitrage than the non-tradable sector. Consequently, fixing the exchange rate exerts a more immediate nominal convergence force in the tradable sector. This line of reasoning proposes a simple validity check: are the real effects of fixing the exchange rate more pronounced in the tradable sector than in the non-tradable sector? To address this question, we construct tradable and non-tradable outcome series (real gross value added and TFP) using Tornqvist-Domar weighted averages, following the methodology of Hulten (1978). For this, we utilize data from the EU KLEMS releases of 2023, 2012, 2011, and 2009 (O'Mahony and Timmer, 2009; Bontadini et al., 2023). We then separately analyze tradable and non-tradable sector outcomes using specification (1). Following Piton (2021), a sector is classified as tradable if its ratio of (import + export) to total production is larger than 10%.[4]

Figure 5 displays the results. The post-peg decline in value added reaches around 2.5% in the tradable and non-tradable sectors alike. In the tradable sector, however, the value added loss materializes more quickly, whereas value added in the non-tradable sector only declines with a considerable delay. This is consistent with the notion that the non-tradable sector enjoys a certain degree of short-term insulation from post-peg convergence pressures. The TFP trajectories paint a similar picture. Whereas tradable sector TFP begins to decline immediately upon fixing the exchange rate, non-tradable sector TFP only declines with a considerable lag. After 10 years, the tradable sector still exhibits a 3 ppt larger TFP shortfall than the non-tradable sector.

[4]Online Appendix B.4 provides detailed information on the classification of industries into the tradable and non-tradable categories, the applied aggregation methodology, as well as industry-level output and productivity effect estimates.

3.2.4 Control vector specification

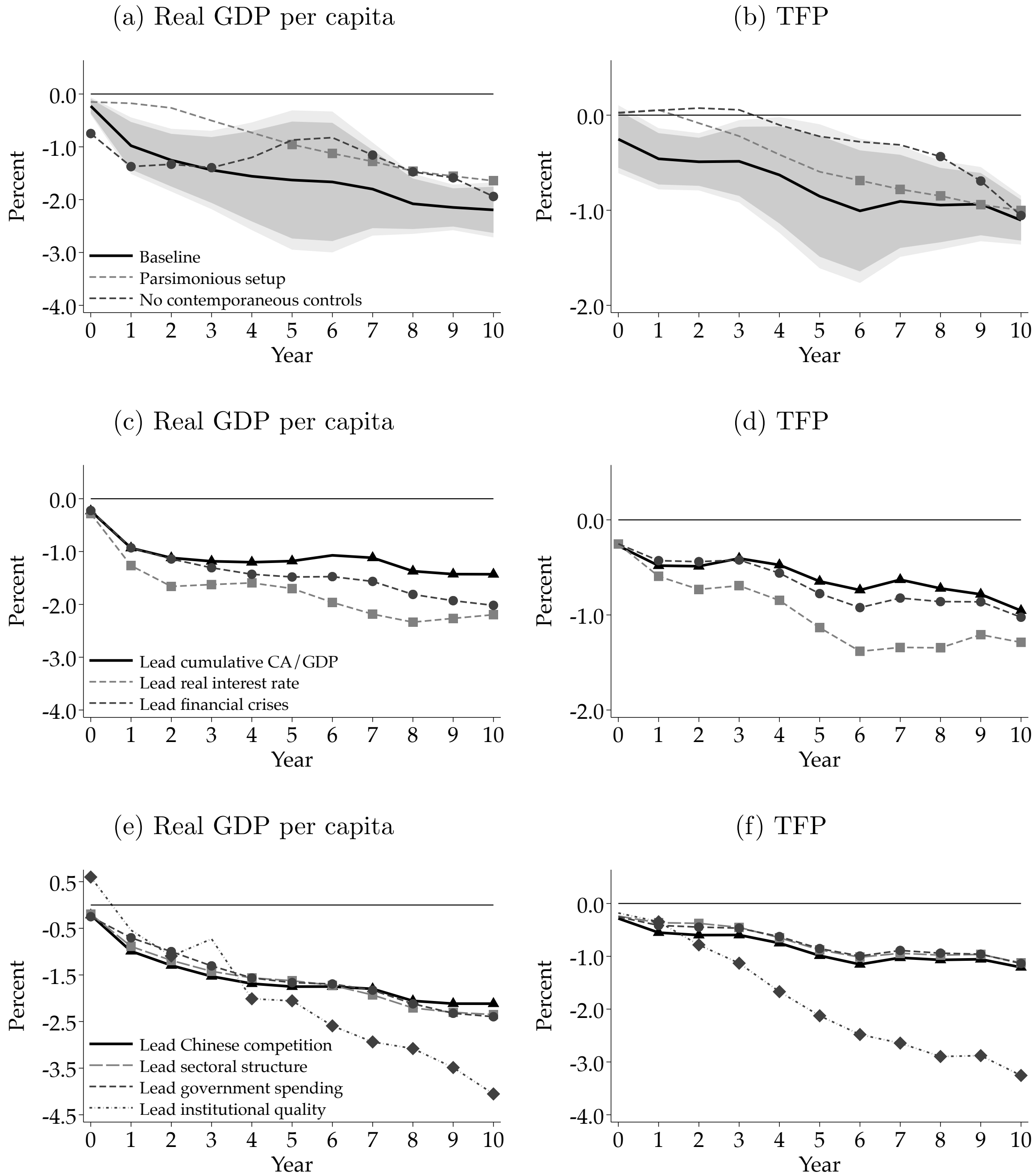
This section explores the robustness of the baseline results with respect to alternative specifications of the control vector $\boldsymbol{x}_{i,t}$. Among the alternatives are more parsimonious specifications that throw light on how the baseline controls shape the baseline IRF estimates. We also consider specifications that include additional controls to account for potentially correlated impulses and economic mechanisms other than nominal adjustment frictions, through which pegging can affect real outcomes.

Figure 6 shows the alternative control vector results for real GDP per capita (left panels) and TFP (right panels). For ease of comparison, panels (a) and (b) repeat the baseline IRF estimates (solid black lines). A parsimonious specification that, besides the interaction term between the exchange rate regime and the wage inflation differential, only includes two lags of the dependent variable's growth rate and the non-interacted components of the interaction term of interest, yields slightly smaller shortfalls in GDP and TFP, but the overall IRFs are qualitatively similar (dashed grey lines). Next, excluding contemporaneous controls from $\boldsymbol{x}_{i,t}$ results in a GDP response that stays close to the baseline response, whereas the TFP response only converges with the baseline response after a somewhat delayed onset (dashed black lines).

The specifications behind the results shown in panels (c) to (d) rotate in different control variables that address different endogeneity concerns. More particularly, we use lead cumulative change variables between $t-1$ and $t+h$ to purge our estimates of the influence of potentially correlated shocks and alternative mechanisms. We account for capital misallocation during the capital inflow bonanzas that often ensue when fixing the exchange rate by including leads of the cumulative change in the current-account-to-GDP ratio among the controls (Reis, 2013; Aguiar et al., 2014; Gopinath et al., 2017). The resulting responses for GDP and TFP are somewhat smaller, but qualitatively very similar to the baseline responses (solid black lines). Next, the dashed grey lines reflect a different way of accounting for post-peg financial conditions by including leads of the cumulative real interest rate change among the controls. The resulting GDP and TFP responses are almost identical to the baseline responses.

To which extent are our findings driven by the temporal confluence of euro area accession, global financial crisis, and euro area debt crisis? The dashed black lines in panels (c) and (d) report results for specifications that include leads of the cumulative change of a financial crisis indicator. For each country, the financial crisis indicator is set to 0 at the beginning of the sample. The indicator then increases by 1 unit for each year that a country subsequently finds itself in a financial crisis as defined by Reinhart and Rogoff (2009) and Lo Duca et al. (2017). By thus tracing the total number of years a country spent in financial crisis, we can use the cumulative change in this variable between t and $t+h$ to control for financial crisis effects throughout the projection horizon. The results

Figure 6: Robustness: other controls



Notes: Line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval. Marker: significant at 10% level.

remain robust, indicating that the baseline finding is not driven by crisis effects.

The onset of Chinese import competition in the aftermath of China's 2001 WTO accession constitutes a potentially confounding impulse when it comes to estimates that are informed by the establishment of the euro area (Bloom et al., 2016; Dorn et al., 2020). We account for Chinese import competition by including the h-year change between $t-1$ and $t+h$ in the share of imports from China in a country's total imports into the control vector for each projection horizon h. Panels (e) and (f) show that the resulting LP estimates (solid black lines) are very similar to the baseline responses. Equivalently, we control for the h-year change of the value-added share of the manufacturing sector. This accounts for potential post-peg shifts in comparative advantage and sectoral structure (Bergin and Corsetti, 2020), away from manufacturing towards sectors with lower TFP growth. No perceptible IRF changes occur as a consequence of this expansion of the control vector (dashed grey lines).

Our IRF estimates may also be affected by changes in fiscal stance that occur upon entering a fixed exchange rate regime. The example of the euro area illustrates two counteracting fiscal forces in this regard. First, upon euro area accession, countries face a new set of fiscal rules. These rules constrain government spending more in some countries than in others. Second, the introduction of the euro was accompanied by a deepening of financial integration (Lane, 2006; Kalemli-Ozcan et al., 2010; Fornaro, 2022). The ensuing large-scale capital flows relaxed some governments' borrowing constraints more than others, allowing for a differential increase in government spending. To account for such post-accession changes in fiscal stance, we include the h-year change in the government-consumption-to-GDP-ratio as an additional lead control for each projection horizon. The resulting LP responses are very similar to the baseline responses (short-dashed black lines).

Finally, we consider differences in institutional development that may affect the growth trajectory after pegging. For example, Papaioannou (2016) documents a growing gap among euro area member states' national institutional capacities. To control for such institutional divergence, we include the h-year change in an index of institutional quality among the lead controls. We use the index provided by the World Bank which is calculated as the average of six different measures of institutional quality: (1) control of corruption, (2) government effectiveness, (3) political stability and absence of violence/terrorism, (4) regulatory quality, (5) rule of law, and (6) voice and accountability. The index is available only from 1996 onwards. The consequent lack of time variation in the wage inflation differential prevents us from including country fixed effects. Qualitatively, the results remain robust, indicating that the baseline responses do not simply reflect changes in institutional quality across euro area member states. Quantitatively, the declines in GDP and TFP are larger after accounting for institutional changes (long-dashed black lines).

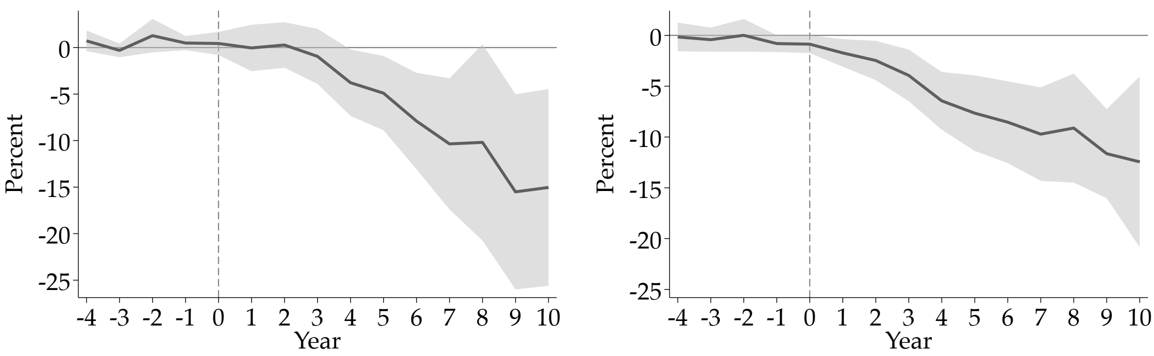
3.2.5 Econometric methodology

We use two alternative econometric methodologies to evaluate the sensitivity of our results to method choice: (1) staggered Difference-in-Difference and (2) the Synthetic Control Method.

Staggered Difference-in-Difference:

Figure 7: Staggered DiD: real effects of pegging with a high inflation differential

(a) Real GDP per capita (b) TFP



Notes: Black solid line – average treatment effect. Shaded area – 95% confidence interval. Negative horizons show pre-trends.

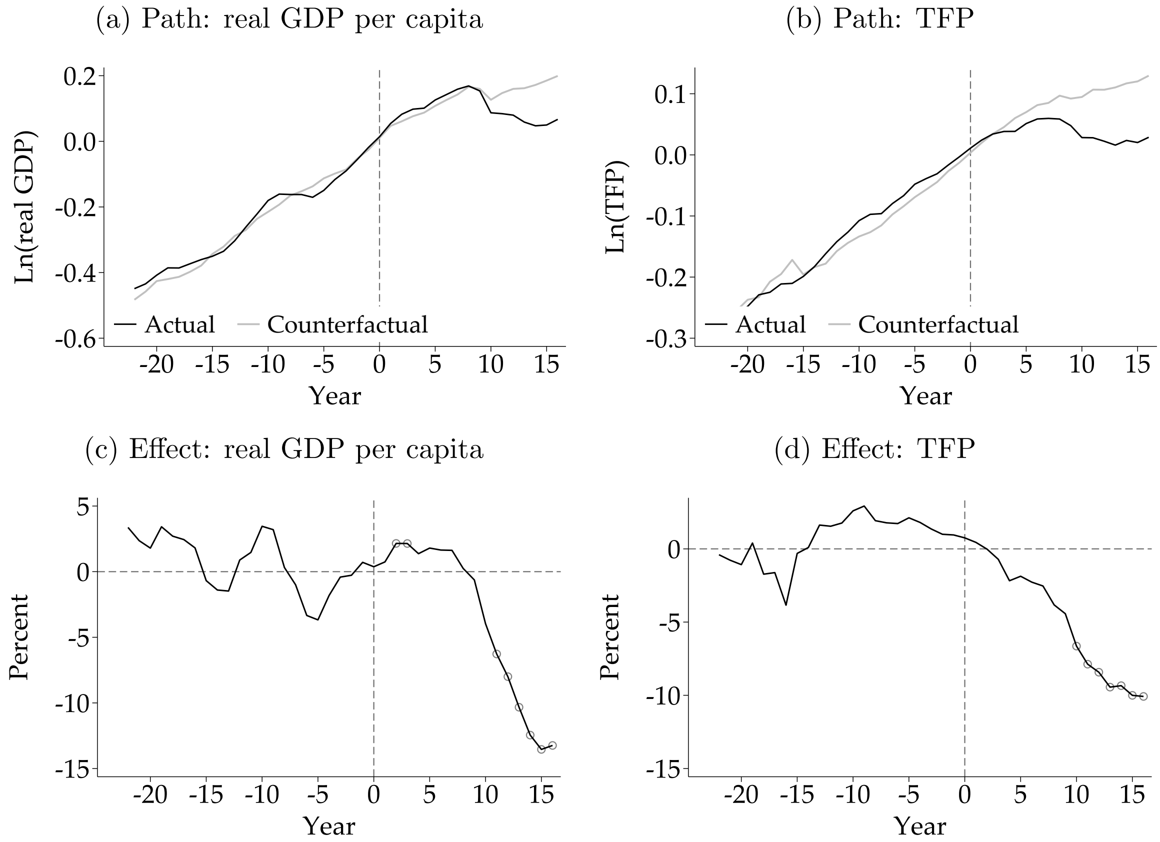
The staggered difference-in-differences (DiD) method extends the traditional DiD approach to account for treatments occurring at different times across units, which in our case is the staggered adoption of a fixed exchange rate regime. We employ the staggered DiD framework developed by Callaway and Sant'Anna (2021), as it allows for the inclusion of time-varying pre-treatment controls, a crucial feature for ensuring the validity of the parallel trends assumption in our analysis (Rios-Avila et al., 2023).[5]

We consider countries as treated in the year they fix their exchange rate while having an above median wage inflation differential (measured as above) – i.e. countries that face a nominal convergence challenge that involves either a *shift in* or a *movement along* their Phillips curve. All other countries, those that never joined the peg and those that joined with a below median wage inflation differential are considered as non-treated. We ensure the parallel trends condition by controlling for two lags of pre-treatment real GDP and real GDP growth. We obtain similar results when using only euro area countries (Online Appendix C.1).

Figure (7) displays the staggered DiD results, which reflect the growth performance of high-inflation countries in the aftermath of pegging. Panel (a) shows that, ten years after pegging, a high-inflation country has a 15% lower real GDP per capita level. How does this finding compare to the baseline LP estimates? The pre-peg inflation differential in the treated group averages around 5%. A comparison to the baseline LP response of -2% thus requires dividing the staggered DiD response by a factor of five. This yields a 3%

[5]Other established methods for staggered DiD are less suitable for our purpose, as they are limited in their ability to control for time-varying pre-treatment covariates (Sun and Abraham, 2021; Borusyak et al., 2024; De Chaisemartin and d'Haultfoeuille, 2024). Another alternative, the synthetic DiD approach (Arkhangelsky et al., 2021) addresses violations of the parallel trends assumption by combining elements of the synthetic control method with traditional DiD. Our results remain robust when applying the synthetic DiD method (Online Appendix C).

Figure 8: Synthetic control method: high vs. low structural wage inflation



Notes: Year 0 – start of fixed exchange rate regime. Markers – p-values pertaining to two-sided placebo test for equality of the post-treatment gap to zero according to (Abadie et al., 2015).

decline in GDP for each 1 ppt of the inflation differential, which locates the staggered DiD estimate in the same ballpark as the baseline estimate. For TFP, the staggered DiD results indicate a decline of around 10% for a typical high-inflation country. This translates into an approximately 2% decline for each 1 ppt of the pre-peg inflation differential, and thus somewhat exceeds the 1% decline indicated by the baseline estimate. Panels (a) and (b) also show that neither real GDP per capita nor TFP exhibit significant pre-treatment trends.

Synthetic Control Method:

The second alternative method we employ is the Synthetic Control Method (SCM). Instead of using actual not-yet treated units as the control group, as is the case for DiD-type estimators, SCM constructs a synthetic control group. The synthetic control group combines several unaffected units (the donor group) using a data-driven procedure. Different weights are applied to the donor units such as to mimic the treated unit's economic development prior to treatment. The treatment effect is then quantified by comparing the time path of an outcome variable in the treated unit to the (counterfactual) time path of the same outcome variable in the synthetic control group (Galiani and Quistorff, 2017; Abadie, 2021). As before, we define the treatment group as countries with an above median wage inflation differential in the year of pegging. The treatment year is the year in which the exchange rate is fixed. The outcome variables of interest are the natural logarithms of real GDP per capita and TFP. The regressions that determine the donor unit weights use the 20-year pre-peg average growth rate of the respective outcome variable of interest.

The implementation of the SCM requires a strongly balanced sample, sufficient data pre- and post-treatment for each unit, and a donor group that was never treated, i.e., never pegged (Abadie et al., 2011; Galiani and Quistorff, 2017). Thus, several adjustments to the sample are necessary. First, we exclude the years 1970 to 1974 to eliminate periods when some donor countries were still pegged, e.g., as members of the Bretton Woods System. Second, we also drop Switzerland from the donor group because it classifies as a peg between 2012 and 2014. Second, several euro area countries were dropped from the sample because of insufficient pre- or post-treatment data. This includes Estonia, Latvia, Ireland, Slovenia, Slovakia, Malta, and Cyprus. After these sample adjustments, the high wage inflation group consists of Finland, Greece, Italy, Portugal, and Spain. The low wage inflation group consists of Austria, Belgium, Denmark, France, Germany, Luxembourg, the Netherlands. The donor group includes Australia, Canada, Japan, New Zealand, the U.K. and the U.S.

Figure 8 displays the SCM results. The effect size estimates are of the same order of magnitude as those indicated by the staggered DiD analysis and the baseline LP responses (after division by five to account for the 5% average pre-peg inflation differential in the treated group). Panel (c) shows that around a decade after fixing the exchange rate, real GDP per capita is around 10% lower among high-inflation peggers than in the synthetic control group. Compared to the staggered DiD and LP results, however, the GDP response exhibits a delayed onset. Panel (d) shows a gradually increasing TFP shortfall after pegging. Around a decade after fixing the exchange rate, TFP is 5 to 10% lower in high-inflation peggers than in the synthetic control group.

4. Conclusion

Whether to fix or float the exchange rate is a key decision that policymakers in all economies face. Our analysis highlights that countries, for whom fixing the exchange rate presents a sizeable nominal adjustment challenge, as measured by pre-peg inflation differentials vis-à-vis the base country, suffer in terms of post-peg real performance. Ten years after pegging, real GDP per capita exhibits a 2% shortfall among countries with a +1 ppt pre-peg wage inflation differential. For TFP, the shortfall amounts to 1% indicating an endogenous growth effect. These real effects are more immediately felt in the tradable sector, where exposure to international arbitrage exerts a greater nominal convergence pressure. These findings caution against pre-maturely fixing the exchange rate between two regions whose inflation rates have not yet converged.

Data Appendix

Utilization-adjusted TFP

We adjust the TFP series for capital and labor utilization following the procedure outlined in Imbs (1999).[6] Consider the following production function:

$$y_t = A_t(u_t k_t)^{\alpha}(e_t l_t)^{1-\alpha},$$

where y_t is total output, A_t is utilization-adjusted TFP, u_t is the degree of utilization of capital k_t, and e_t is the effort level of employment l_t. The utilization rates u_t and e_t are calculated as

$$u_t = \left(\frac{y_t/k_t}{y/k}\right)^{\frac{\delta}{r+\delta}}; \quad e_t = \left(\alpha\frac{y_t}{c_t}\right)^{\frac{1}{1+\upsilon}},$$

where c_t denotes households' consumption.[7] Variables without a time index denote steady state values. δ is the depreciation rate of physical capital, r is the (net) real return on capital, υ is the inverse Frisch elasticity of labor supply, α is the capital share of income. To arrive at the adjusted TFP measure, the unadjusted TFP measure, $TFP_t = y_t/(k_t^{\alpha} l_t^{1-\alpha})$, is adjusted with the utilization rates as follows:

$$A_t = \frac{TFP_t}{u_t^{\alpha} e_t^{1-\alpha}}.$$

For the adjustment, we follow Jordà et al. (2020) in assuming $\delta = 0.08, r = 0.04, \alpha = 0.33, \upsilon = 1$. We use country-specific two-sided HP-filtered trend values with smoothing parameter $\lambda = 6.25$ for the steady-state ratio y/k. The results are robust to parameter changes within plausible ranges.

[6] Jordà et al. (2020) presents a more recent application.

[7] See Imbs (1999) for a detailed derivation.

Table 1: Variable definition and data sources

Variable	Detailed description	Source
Baseline total factor productivity	unadjusted	AMECO database, the European Commission, Bergeaud et al. (2016)
Alternative total factor productivity	unadjusted, total and at sectoral level	EU KLEMS releases of 2023, 2012, 2011, and 2009 (O'Mahony and Timmer, 2009; Bontadini et al., 2023)[a]
Gross value-added	total and at sectoral level	EU KLEMS releases of 2023, 2012, 2011, and 2009[a]
Gross output	total and at sectoral level	EU KLEMS releases of 2023, 2012, 2011, and 2009[a]
Sectoral hours worked	of people engaged	EU KLEMS releases of 2023, 2012, 2011, and 2009[a]
Alternative total factor productivity	utilization-adjusted	Comin et al. (2025)
Share of goods imports from China to total goods imports[b]	calculated as Chinese import / total import	IMF
Downward nominal wage rigidity	the share of counterfactual wage cuts that are prevented by nominal rigidity, 1994–2001	Knoppik and Beissinger (2009)
Cumulative current-account-to-GDP	calculated as sum of current account / GDP	Lane and Milesi-Ferretti (2018, 2022)
Real R&D spending per capita	calculated as real GDP * Gross domestic spending on R&D as percentage of GDP/population	see sources for individual items
Labor productivity	calculated as real GDP (PPP) / total hours worked	see sources for individual item
Real private sector R&D spending[b]	Annual R&D expenditure performed by business enterprises, in millions constant (2015 PPP) US Dollar	OECD
Gross domestic spending on R&D as percentage of GDP[b]		OECD
Implied tax subsidy rates on R&D expenditure	for SME and large firms (percentage points)	OECD
Total labor compensation of employees[c]	in local currency	OECD
Unemployment rates[d]	% of total labor force	OECD, World Bank
Alternative total factor productivity	unadjusted	Penn World Table 10.0 (PWT) (Feenstra et al., 2015)
Average annual hours worked	by persons engaged	PWT
Number of persons engaged	in millions	PWT
Nominal exchange rate	units of national currency per USD	PWT
Real consumption and investment	at constant 2017 national prices (in mil. 2017USD)	PWT
Real consumption	at constant 2017 national prices (in mil. 2017USD)	PWT
Real investment	calculated as real consumption and investment - real consumption	see sources for individual items
Human capital index	based on years of schooling and returns to education	PWT
Real GDP (PPP)	Expenditure-side real GDP at chained PPPs (in mil. 2017US$)	PWT
Capital stock	at constant 2017 national prices (in mil. 2017USD)	PWT
Nominal interest rates before 1999	country central bank official rate or call money/interbank rate (less than 24 Hours)	Center for Financial Stability & Deutsche Bundesbank, & OECD
Nominal interest rates after 1999	ECB marginal lending rate	European Central Bank (ECB)

[a]The latest EU KLEMS release is supplemented by earlier releases.

[b]For missing values, we linearly interpolated the series if the gap is less than four years.

[c]Compensation of employees includes gross wages and salaries payable in cash or in kind, and the value of social contributions payable by employers.

[d]We use OECD harmonized unemployment rates when available. We use World Bank (national estimates) to extend the OECD series to earlier periods by means of splicing.

Table 2: Variable definition and data sources (cont.)

Variable	Detailed description	Source
Population	total population	United Nations
Service share	% of total value added; calculated as the sum of gross value added from (1) other Activities (ISIC J-P) (2) transport, storage and communication (ISIC I) (3) wholesale, retail trade, restaurants and hotels (ISIC G-H) to total gross value added	United Nations
Manufacturing share	% of total value added; calculated as the gross value added from manufacturing (ISIC D) / total gross value added	United Nations
Consumer price index and inflation		World Bank
Real GDP per capita	GDP per capita, at constant local currency	World Bank
Real GDP per capita (USD)	GDP per capita, at constant 2015 USD	World Bank
General government final consumption expenditure to GDP ratio		World Bank
Institutional quality index	simple average of six governance indicators: (1) control of corruption; (2) government effectiveness; (3) political stability and absence of violence/terrorism; (4) regulatory quality; (5) rule of law; (6) voice and accountability	World Bank
Financial development[a]	private credit by deposit money banks and and other financial institutions to GDP ratio	World Bank
Trade to GDP ratio	import and export of goods and services to GDP ratio	World Bank
Schooling[a]	gross secondary school enrollment ratio, gross (%); the series is extended backwards using the human capital index from Penn World Table	World Bank, PWT
Financial crisis dummy	= 1 for a systemic crisis	Reinhart and Rogoff (2009) and Lo Duca et al. (2017) until 2016; 2017-2019= 0
Exchange rate regime	binary Dummy variable that classify a currency: peg or non-peg. Peg if fine classification = 1 "no separate legal tender" or 2 "Pre announced peg or currency board arrangement", non-peg otherwise	based on the fine classification from Ilzetzki et al. (2019) up to 2016[b]
Base country		Ilzetzki et al. (2019)[c]
Hourly nominal wage	calculated as total labor compensation of employees/(average annual hours worked per worker *number of persons engaged)	see sources for individual items
Total hours	calculated as average annual hours worked per worker *number of persons engaged	see sources for individual items
Long-run inflation expectation	10-year ahead trend of CPI inflation. The trend is obtained using HP-filter with smoothing parameter $\lambda = 6.25$	see sources for individual items
Global/sample real GDP	calculated using national real GDP per capita (USD)	see sources for individual items

[a] For missing values, we linearly interpolated the series if the gap is less than four years.

[b] We made a few adjustments to Ilzetzki et al. (2019) (IRR). First, IRR classify Greece as "no separate legal tender" starting from 1999. As Greece only officially joined the euro area in 2001, we classify Greece as non-peg before 2001 and as peg afterward. Second, a few countries were pegged to Russia, during which Russia was not pegged. We classify these episodes as non-pegged (vis-a-vis Germany/Euro). This concerns Slovak Republic before 1993, Estonia before 1993, and Latvia before 1991. Third, Slovenia was part of Yugoslavia till 1991. As during this time, Yugoslavia had a floating exchange rate, we classify the episode as non-pegged (vis-a-vis Germany/Euro). Fourth, IRR classify Latvia as having a pre-announced peg in 1994. However, 1994 is a period where Latvia experienced substantial variation in its exchange rate regimes, including peg, freely falling, and de factor crawling band (Ilzetzki et al., 2008). Thus, we code Latvia as non-peg in 1994. Fifth, we also adjust the classification of Estonia before 1995 to be floating, as there was substantial variations of its exchange rate vis-a-vis its base country Germany during that period. According to Ilzetzki et al. (2008), between 1992 and 1994, Estonia went through several exchange rate regimes: peg, currency board, freely falling. Finally, the IRR data set is available up to year 2016. We extend the data to 2019 while assuming no further change in the exchange rate regime after 2016.

[c] The Ilzetzki et al. (2019) data set is available up to year 2015. We extend the data to 2019 while assuming no further change in the base country after 2015.

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Online Appendix

to *"Output Divergence in Fixed Exchange Rate Regimes"*

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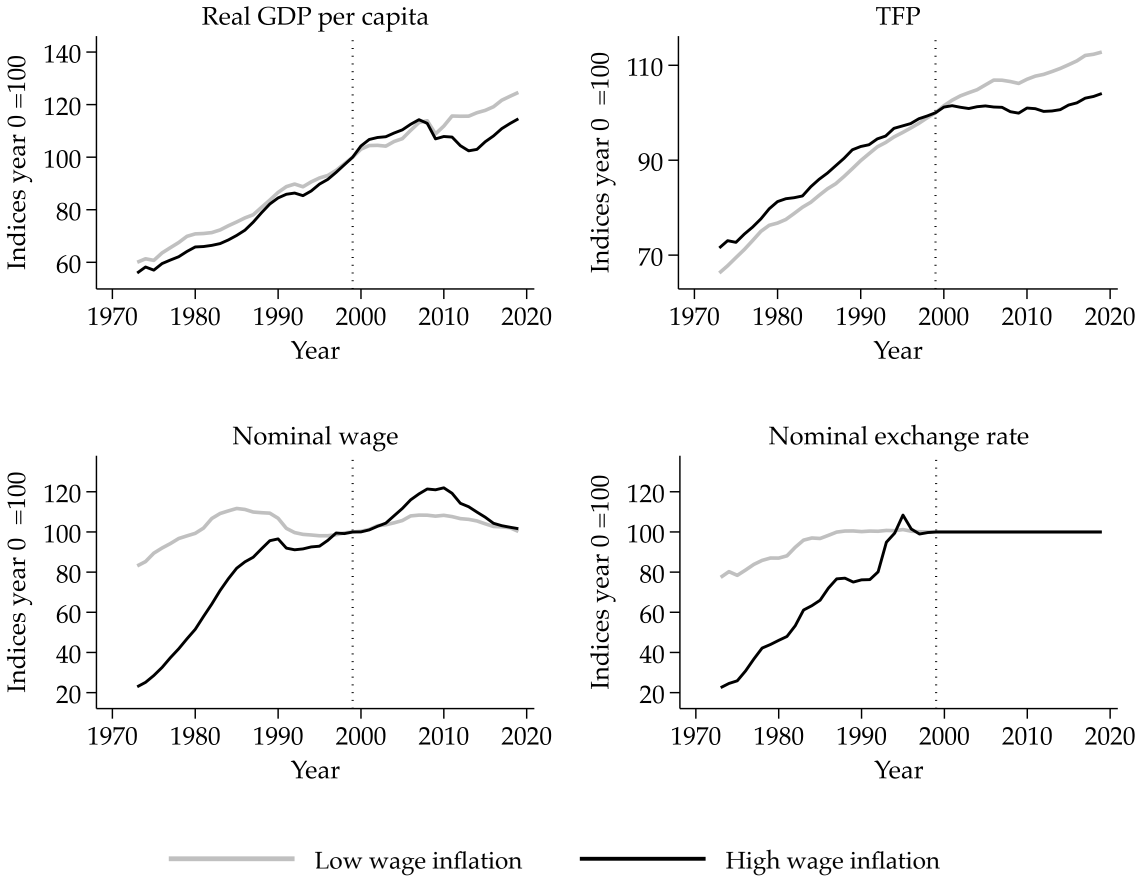
Contents

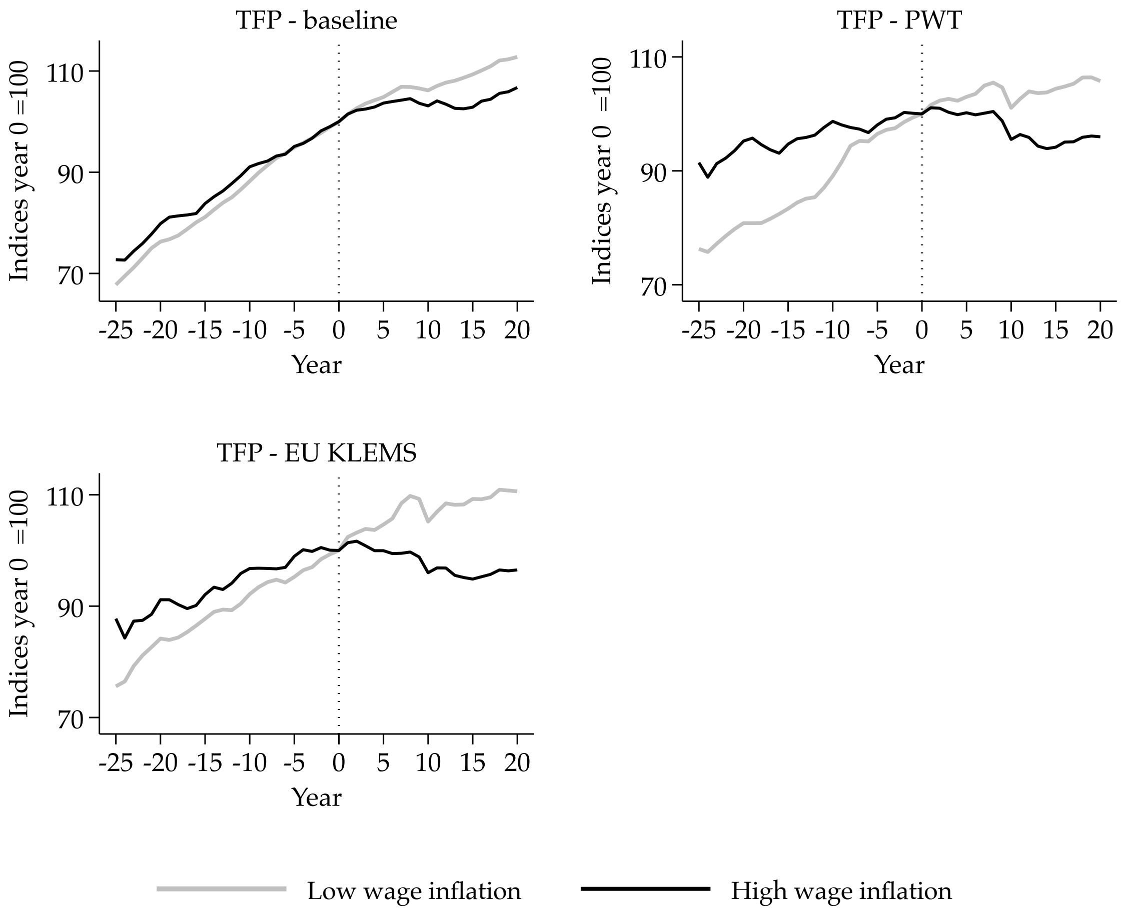
A. Euro area descriptives

Figure A.1: Only 1999 euro area accessions



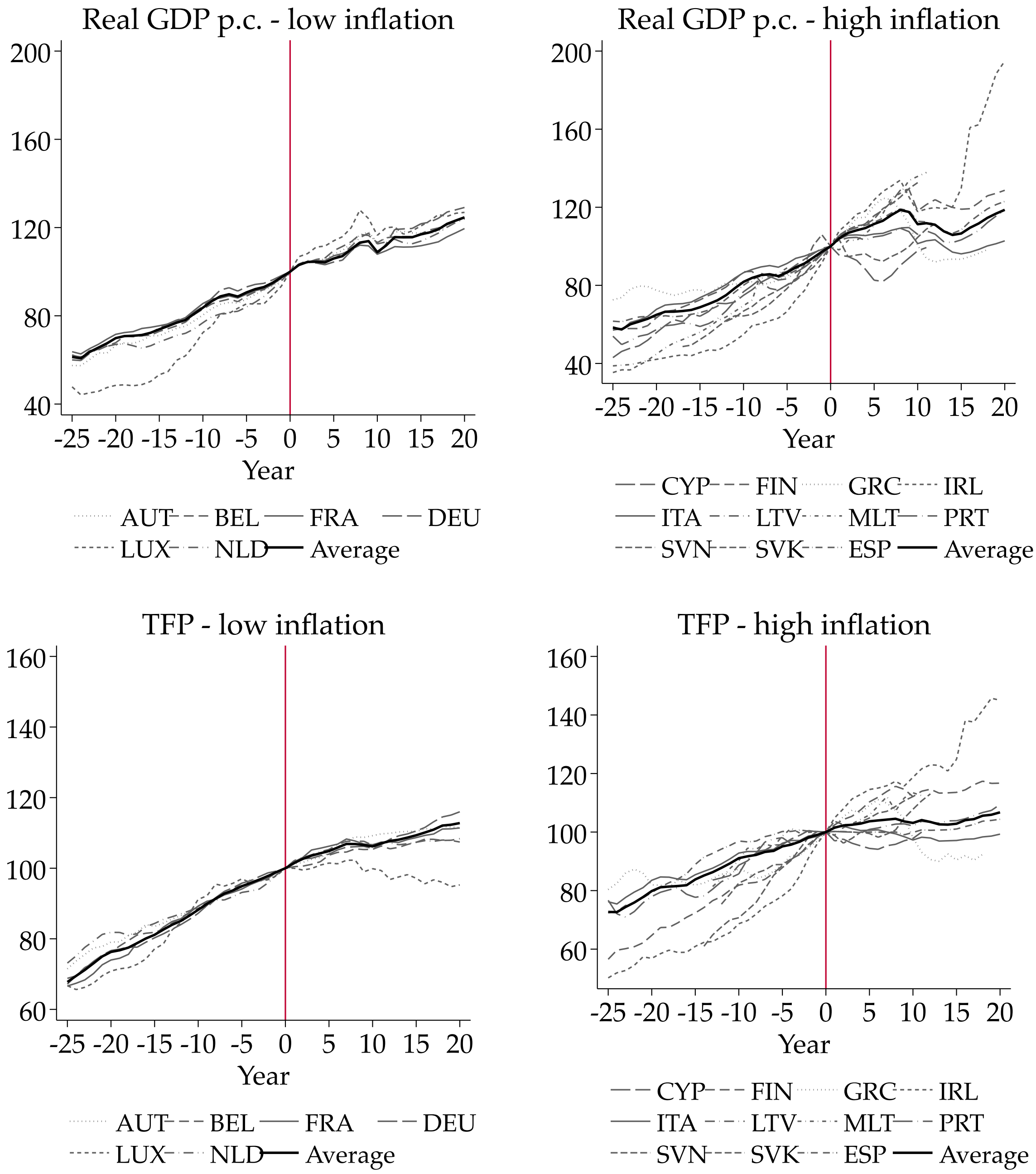
Notes: This figure depicts the time series around the initial introduction of the euro in 1999, with only countries that joined the euro in 1999 included. Low wage inflation countries: Austria, Belgium, France, Germany, Luxembourg, and the Netherlands. High wage inflation countries: Finland, Ireland, Italy, Portugal, Spain. All series are population-weighted averages. Nominal wages and nominal exchange rates are expressed relative to Germany.

Figure A.2: Alternative productivity measures



Notes: All series are population-weighted averages. Nominal wages are expressed relative to Germany. The event window is based on data over the 1970-2019 period. Year 0 represents the date when a country adopted the euro.

Figure A.3: Individual country time series



Notes: All series are indexed to 100 in year 0. Year 0 denotes the year of joining the euro.

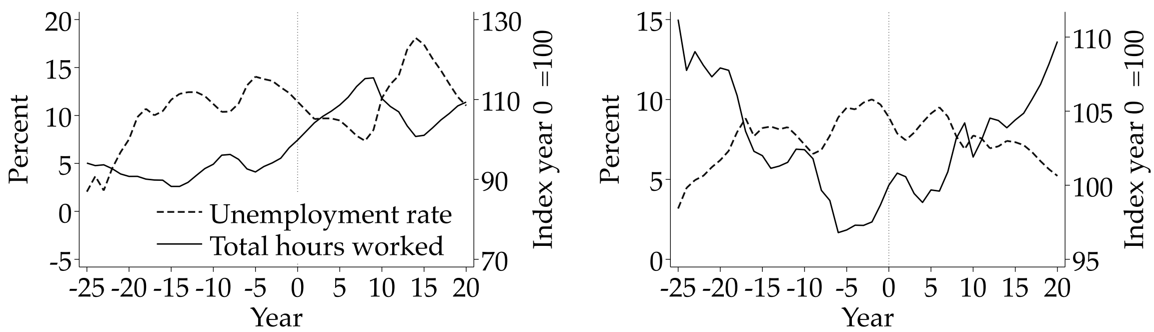
Unemployment rate and hours worked

This section analyzes labor market developments around the date of euro area accession for the tradable and non-tradable sectors.[3] As unemployment rates are not available on the sectoral level, we instead examine hours worked. As shown in Figure A.4, total hours worked is negatively correlated with the unemployment rate. This is the case in the (a) high- and (b) low-inflation groups. Thus, hours worked can serve as an alternative indicator of the state of the labor market.

In particular, the post-peg drop in the unemployment rate in the high-inflation group is accompanied by a marked increase in total hours worked (panel *a* of Figure A.4). This increase in total hours worked in the high-inflation group in turn is underpinned by a boom in hours worked in the high-inflation group's non-tradable sector (panel *a* in Figure A.5).

Figure A.4: Unemployment rate and hours worked

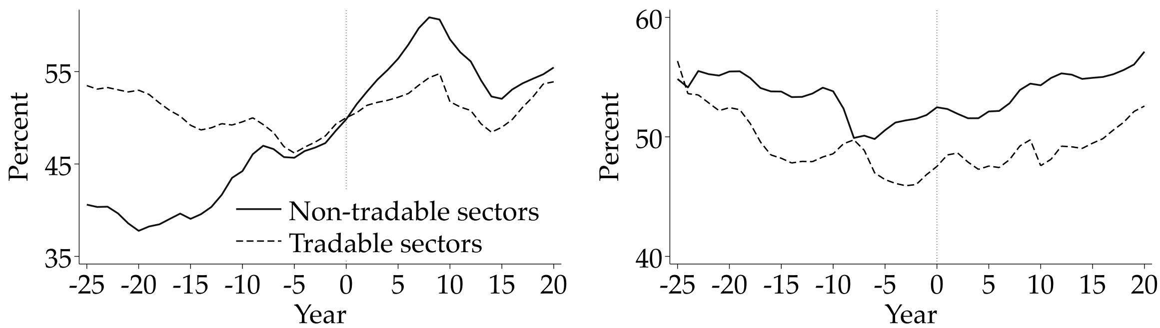
(a) High pre-peg wage inflation differential (b) Low pre-peg wage inflation differential



Notes: Year 0 denotes the year of joining the euro.

Figure A.5: Hours worked: tradable vs. nontradable sectors

(a) High structural wage inflation (b) Low structural wage inflation



Notes: Year 0 denotes the year of joining the euro. Nontradable and tradable sectors hours worked are normalized by the total hours worked in year 0, and thus sum up to the total hours worked in Fig A.4.

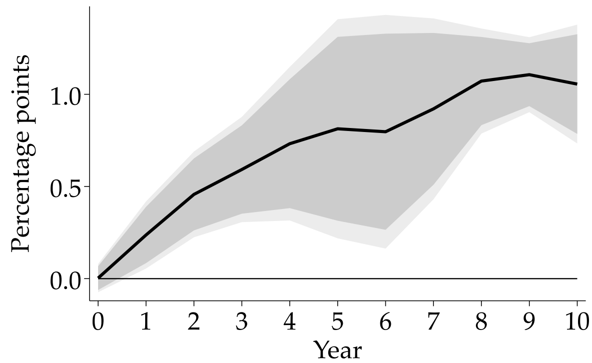
[3]Online Appendix B.4 provides details on the classification of tradable and non-tradable sectors.

B. Local projection evidence

B.1. Unemployment

According to the economic intuition provided in the introduction, the real effect of pegging in countries with high nominal wage inflation differentials stems from an incomplete adjustment of the Phillips curve. This implies that nominal convergence can only be achieved at a lower employment level. The IRF estimate presented in Figure B.1 is consistent with this: after fixing the exchange rate, a country with a pre-peg wage inflation differential of +1 ppt suffers from a rising unemployment rate after pegging.

Figure B.1: Unemployment after pegging with a +1 ppt wage inflation differential

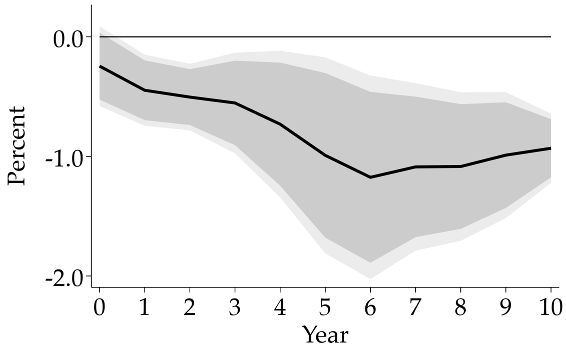


Notes: Black solid line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval.

B.2. Adjusted TFP according to Comin et al. (2025)

Comin et al. (2025) develop another method for deriving utilization-adjusted TFP that allows for imperfect competition and adjustment costs in different production inputs. TFP series based on this method are only available for a limited sample: Germany (1994 – 2015), France (1994 – 2015), Spain (1995 – 2015), Italy (1994 – 2014), and U.K. (1996 – 2014). Furthermore, the method proposed by Comin et al. (2025) requires data that is often not available for our sample. Thus, a direct implementation of the method is not feasible. To investigate the robustness of our result, we replace our baseline TFP measure with the TFP measure by Comin et al. (2025) where possible. Figure B.2 shows the resulting TFP trajectory, which closely resembles the baseline result.

Figure B.2: TFP after pegging with a +1 ppt wage inflation differential



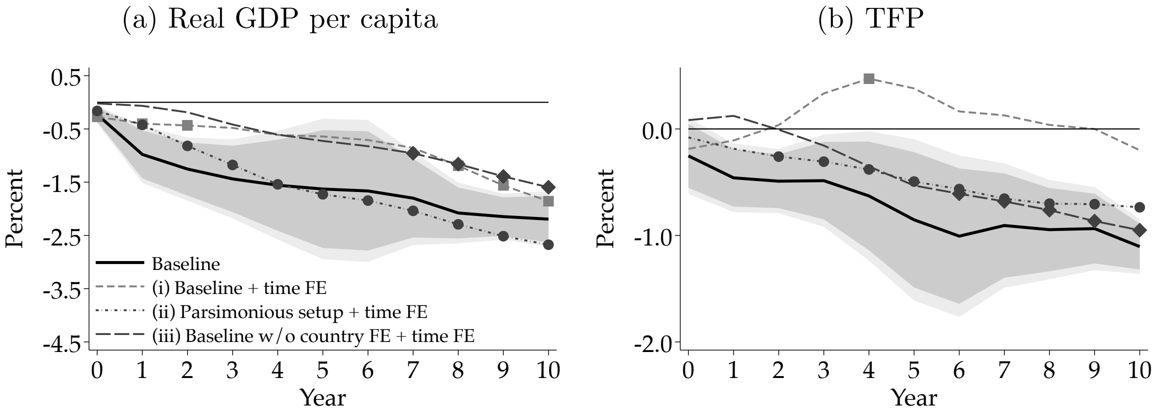
Notes: Black solid line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval.

B.3. Local projection with time fixed effects

In this section, we examine the effect of including time fixed effects (FE) in our baseline local projection (LP) specification. The baseline model does not incorporate time FE. Instead, following Jordà et al. (2024), we include contemporaneous and lagged values of global real GDP growth to parsimoniously account for global business cycle fluctuations. The need for parsimony springs from the combination of a limited sample size (around 350 observations in the baseline TFP regressions) and an already saturated control vector that requires the estimation of 24 parameters and 25 country fixed effects. In this context, the inclusion of an additional 49 time FE to the baseline specification overburdens the dataset and risks overfitting. Nevertheless, we can explore how the inclusion of time FE affects the results associated with LP specifications that are more parsimonious than our baseline specification.

Figure B.3 explores the effect of adding time FE in three different model variations: (i) the (saturated) baseline specification, (ii) the parsimonious model, that in the absence of time fixed effects, yields results very similar to the baseline specification (see Section 3.2.4), and (iii) a model that includes the full vector of control variables but omits country FE. In both, the parsimonious specification and the specification without country FE, the inclusion of time FE yields TFP and real GDP per capita trajectories that are similar to those of the baseline specification. By contrast, introducing time FE into the already saturated baseline model results in a markedly different TFP response that is close to zero and mostly statistically insignificant. Given that the baseline specification with time FE requires the estimation of close to 100 parameters based on a dataset of around 350 observations, the marked change in results is plausibly accounted for by increased estimator variability in light of overfitting.

Figure B.3: Robustness: time fixed effects



Notes: Line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval. Marker: significant at 10% level.

B.4. Sectoral output and TFP

We aggregate Nace rev. 2 sectors into tradable and non-tradable sectors as described in Table B.1. Non-market sectors are excluded. The classification mainly follows Piton (2021), where a sector is classified as tradable if its ratio of (import + export) to total production is larger than 10%. Piton (2021) Appendix 2.2 also shows that the classification is robust to different indicators for tradability.

The only exceptions are the classification of A: Agriculture, forestry and fishing and L: Real estate activities. These two sectors are excluded in Piton (2021)'s analysis. We follow the standard classification and classify sector A as tradable and sector L as non-tradable.

We calculate the aggregate TFP growth rate using Tonvqvist-Domar weights as proposed by Hulten (1978):[4]

$$\Delta ln(TFP_{j,t}) = \sum_i 0.5\,(\lambda_{i,t-1} + \lambda_{i,t})\,\Delta ln(TFP_{i,t}),$$

where $j \in \{\text{tradable, nontradable}\}$, i is the industry index, and $\lambda_{i,t}$ is the share of industry i's gross output in sector j's aggregate value added. The aggregate gross value added (GVA) growth rate is calculated analogously.

Figure B.4 describes the post-peg GVA trajectories for individual tradable industries in countries with a +1 ppt pre-peg wage inflation differential. Most sectors exhibit an output decline. The only exceptions are B: Mining and quarrying and H: transportation and storage, whose output growth stays on trend in the aftermath of pegging the exchange rate. Figure B.5 describes the post-peg TFP trajectories for individual tradable industries in high-inflation countries. In the tradable sector, most industries exhibit a decline in TFP after pegging. There are two exceptions – A: Agriculture, forestry and fishing shows an initial drop in TFP but recovers over the later horizons; B: Mining and quarrying shows a persistently positive estimate. However, as these two sectors together account for only 10% of total value added of the tradable sector, overall tradable sector TFP decreases.

Next, Figure B.6 displays the post-peg GVA trajectories for individual non-tradable industries in countries with a +1 ppt pre-peg wage inflation differential. Construction and trade/vehicle repairs experience output declines that are comparable to output declines in severely affected tradable sector industries. Real estate and other services exhibit more stable output paths and even modestly faster output growth in the aftermath of pegging. The output performance of utilities (electricity, gas, steam, etc.) falls somewhat below trend, but only with a considerable lag. Finally, Figure B.7 displays the post-peg TFP trajectories for individual non-tradable industries. Generally, non-tradable industries exhibit

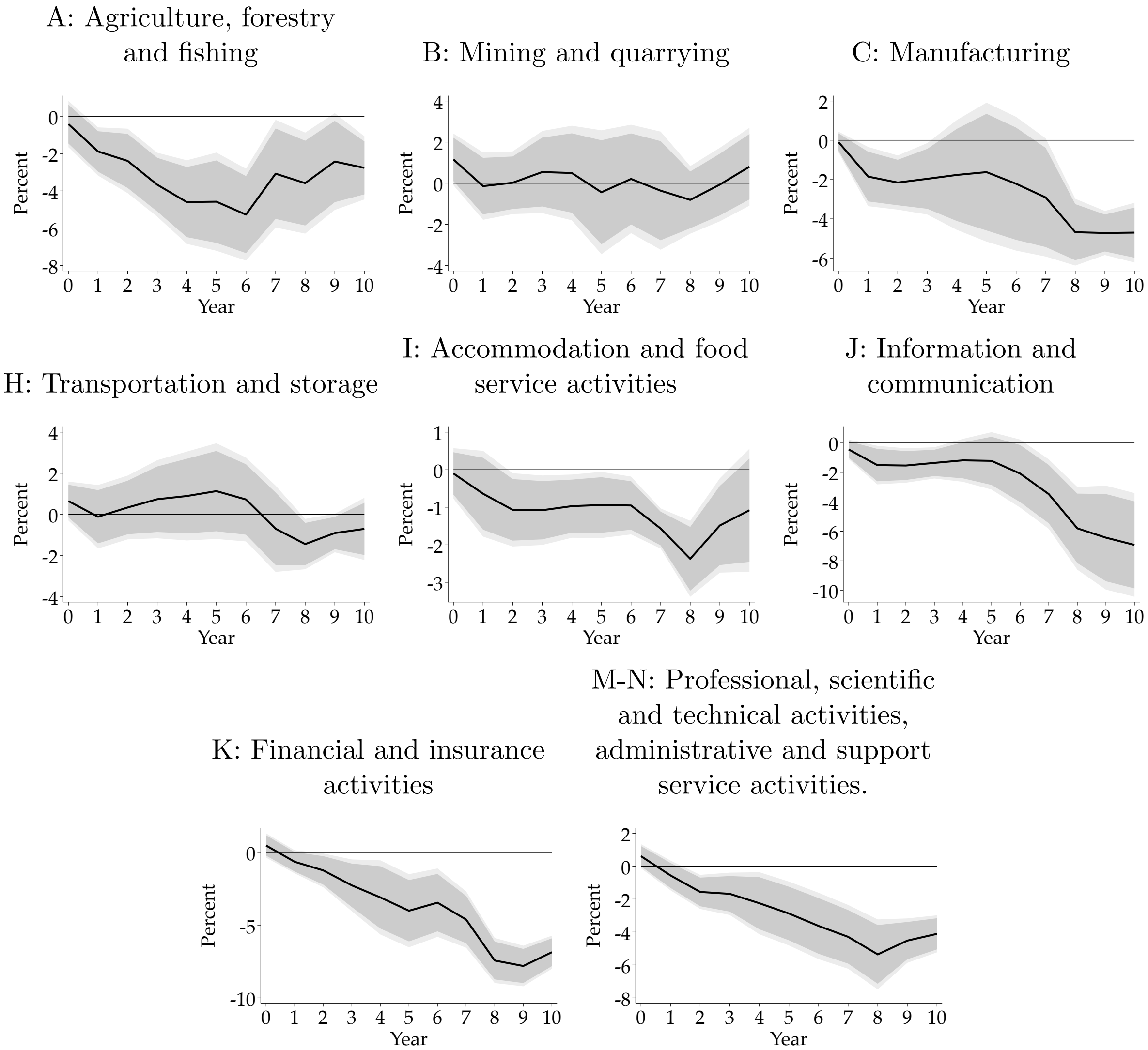
[4] Several papers have highlighted that this method is flawed when markups are present (Rotemberg and Woodford, 1993; Basu and Fernald, 2001), suggesting that an alternative approach yields more accurate aggregated TFP series (Comin et al., 2025). However, without historical data, we cannot adjust for markup in the aggregation.

more TFP stability than tradable industries in the aftermath of pegging.

Table B.1: Tradable vs. non-tradable classification

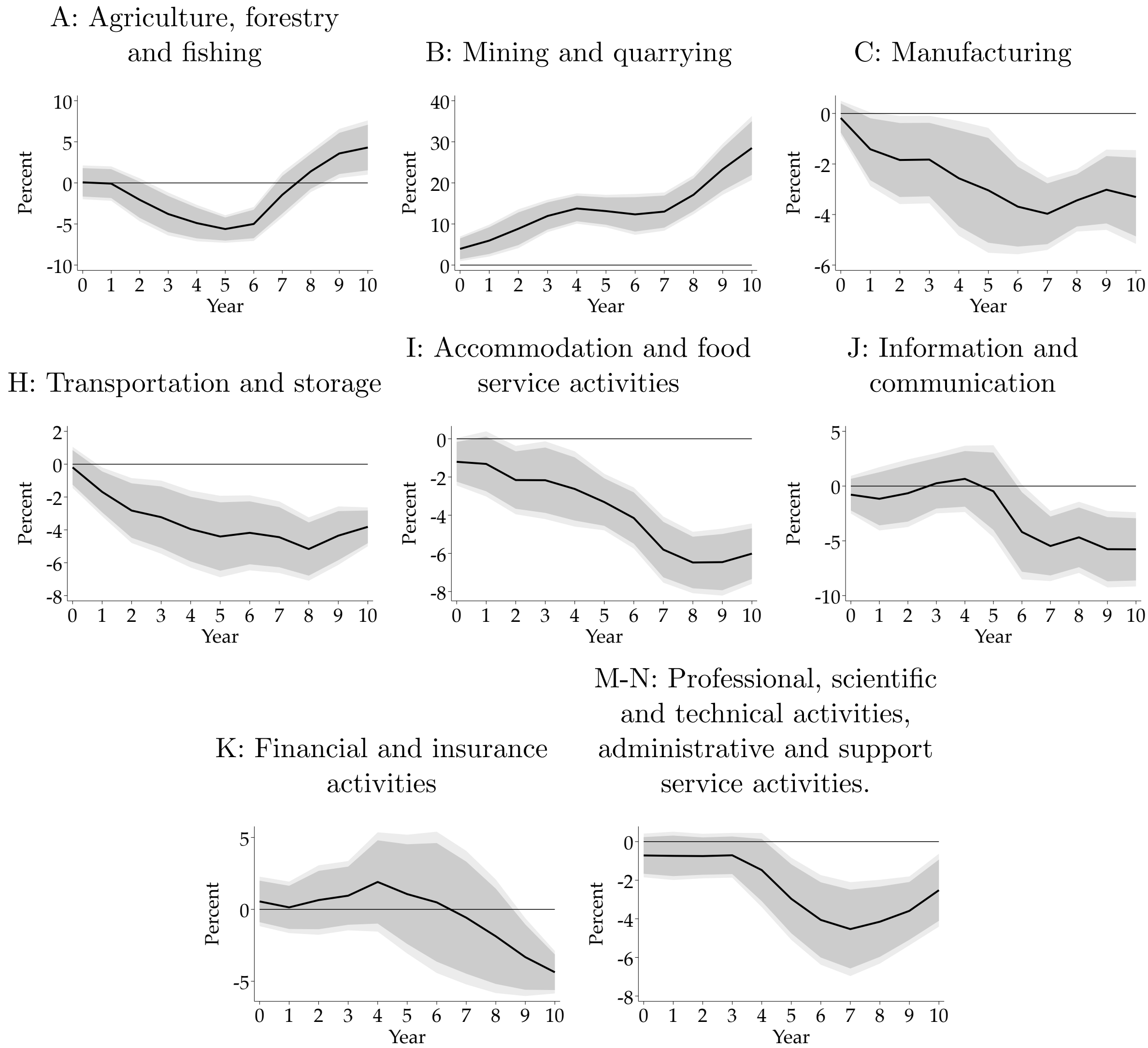
Sector code	Sector name
Tradable sectors	
A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Manufacturing
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
M-N	Professional, scientific and technical activities; administrative and support service activities
Non-tradable sectors	
D-E	Electricity, gas, steam; water supply, sewerage, waste management
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
L	Real estate activities
R-S	Arts, entertainment, recreation; other services and service activities, etc.

Figure B.4: Tradable industry real GVA after pegging with a +1 ppt wage inflation differential



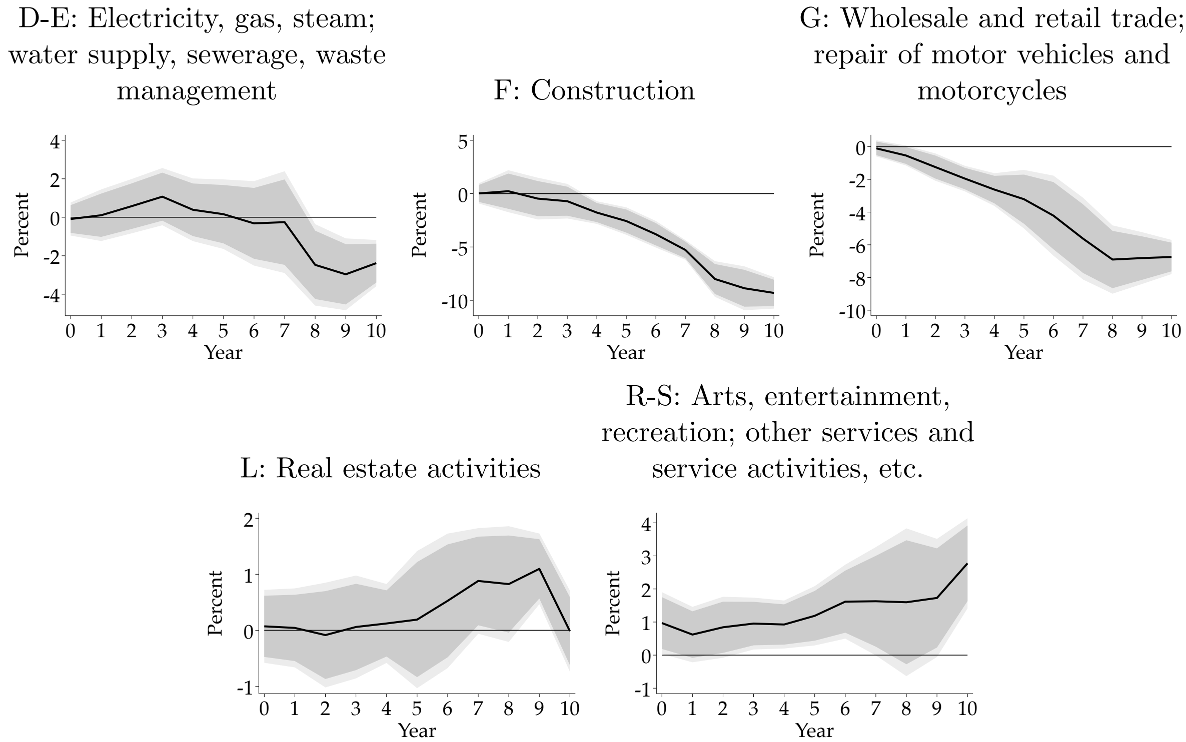
Notes: Black solid line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval.

Figure B.5: Tradable industry TFP after pegging with a +1 ppt wage inflation differential



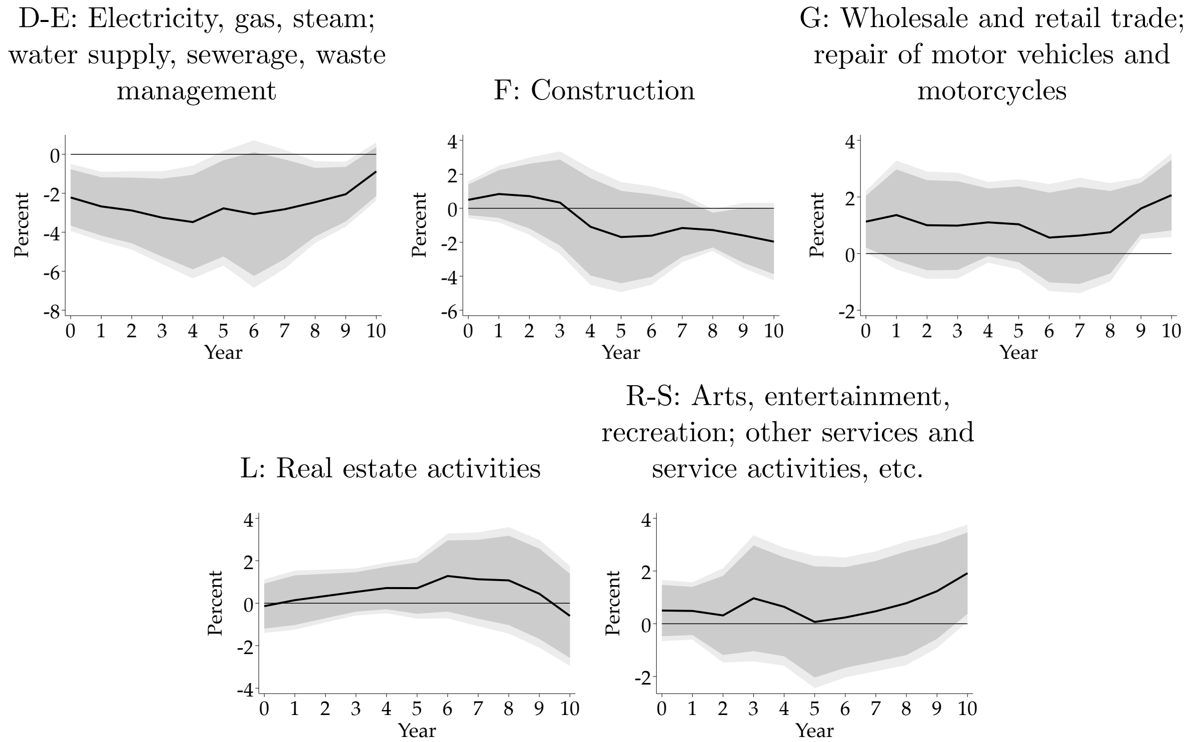
Notes: Black solid line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval.

Figure B.6: Non-tradable industry real GVA after pegging with a +1 ppt wage inflation differential



Notes: Black solid line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval.

Figure B.7: Non-tradable industry TFP after pegging with a +1 ppt wage inflation differential



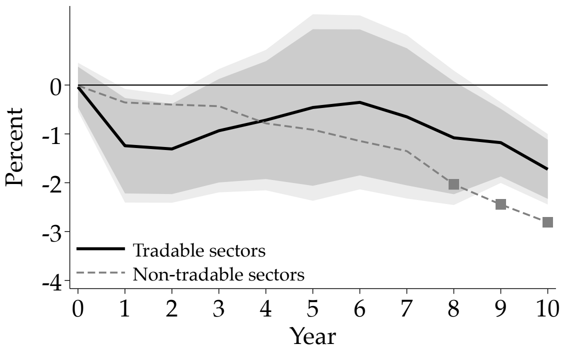
Notes: Black solid line – mean estimate. Dark shaded area – 90% confidence interval. Light shaded area – 95% confidence interval.

B.5. Tradable versus non-tradable sector: alternative definition

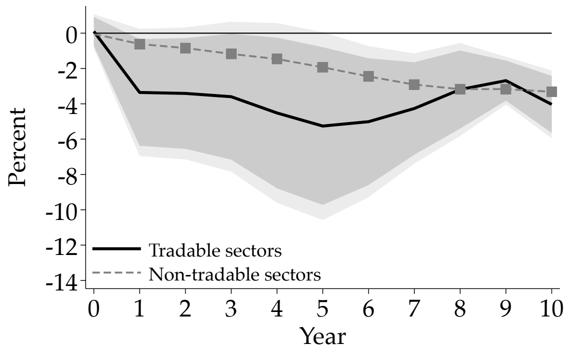
In this section, we examine the trajectories of the tradable and non-tradable sectors under an alternative industry classification. The tradable sector includes agriculture, forestry and fishing, mining and quarrying, and manufacturing, while the non-tradable sector comprises all service industries. The results based on this classification are consistent with those presented in the main text.

Figure B.8: Sectoral effects of pegging with a +1 ppt wage inflation differential

(a) Real GDP per capita: alternative classification



(b) TFP: alternative classification



Notes: Black solid line – average treatment effect. Shaded area – 95% confidence interval.

C. Alternative methodologies

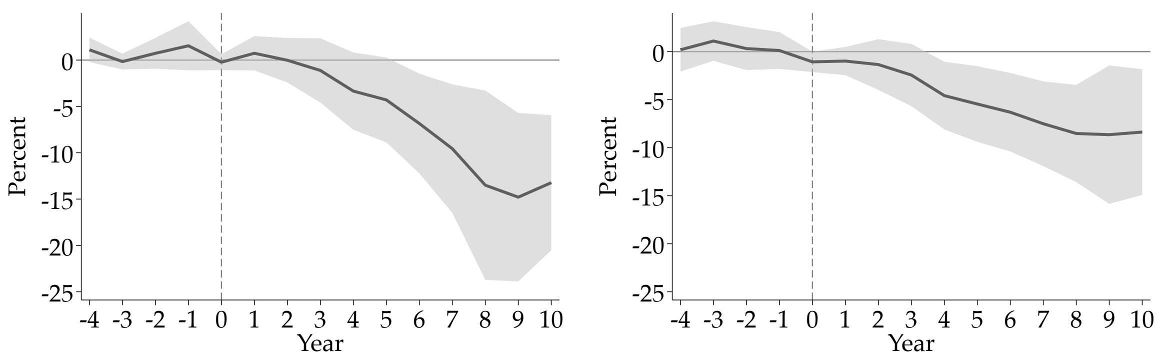
C.1. Staggered Difference-in-Difference: EA only

In this section, we present the results from the staggered Difference-in-Differences approach, focusing exclusively on euro area countries. The results, presented in Figure C.1, are very similar to the baseline results.

Figure C.1: Staggered DiD: real effects of pegging with a high inflation differential

(a) Real GDP per capita: EA only

(b) TFP: EA only



Notes: Non-EA countries are excluded from the control group. Black solid line – average treatment effect. Shaded area – 95% confidence interval. Negative horizons show pre-trends.

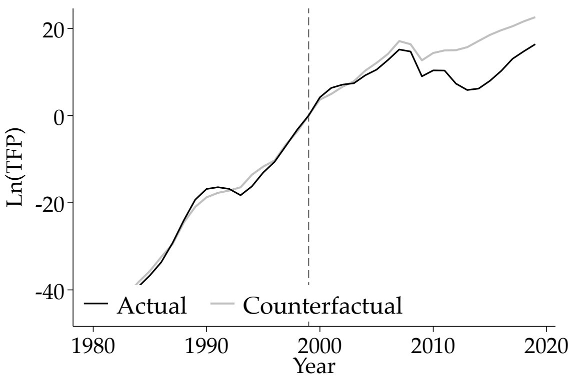
C.2. Synthetic Difference-in-Difference

In this section, we present the results obtained using the Synthetic Difference-in-Differences (SDiD) method developed by Arkhangelsky et al. (2021). This approach is specifically designed to address potential violations of the parallel trends assumption that is required in standard Difference-in-Differences (DiD) analyses. SDiD combines elements from the synthetic control method (SCM) with traditional DiD, allowing for more robust inference in cases where the treated and control units do not exhibit parallel trends prior to treatment.

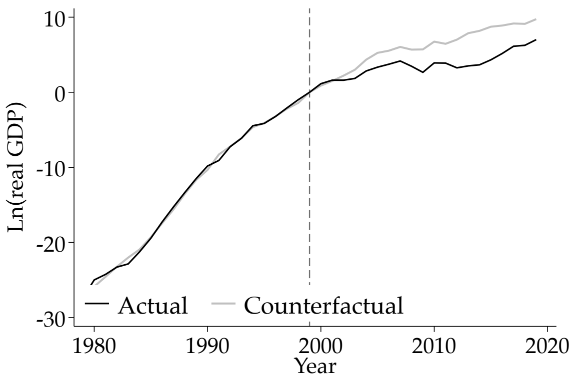
For our analysis, we utilize the Stata code provided by Pailañir and Clarke (2023). This implementation of SDiD is restricted to "block" treatments, where several units are treated simultaneously. As a result, we exclude late joiners to the euro area from this robustness check. Despite this exclusion, the estimated impacts in Year 10 on both real GDP per capita and TFP remain consistent with our baseline staggered DiD and SCM results, lending further support to our findings. Specifically, the Average Treatment Effect on the Treated (ATT) for TFP is -3.4%, significant at the 10% level. For real GDP per capita, the ATT is -3.1%, although the result is not significant.

Figure C.2: Synthetic DiD: high vs. low structural wage inflation

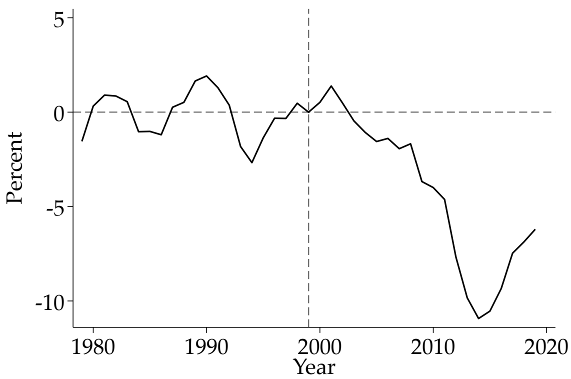
(a) Path: real GDP per capita



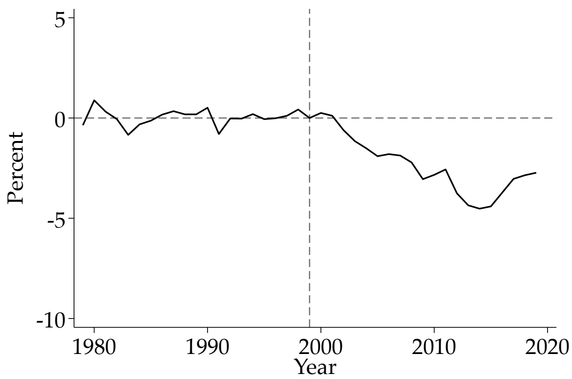
(b) Path: TFP



(c) Effect: real GDP per capita



(d) Effect: TFP



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