The EU Miracle: When 75 Million Reach High Income*

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Abstract

In 2004, 75 million people across ten countries joined the European Union (EU). Between 2004 and 2019, their GDP per capita doubled. Empirically, I show the new members' GDP per capita was 32% higher in 2019 thanks to EU accession. I do not find a significant effect on the pre-2004 members. These findings are robust to a wide range of tests. Standard growth accounting indicates that the Solow residual was the primary driver of growth. I interpret these results through a neoclassical growth model with heterogeneous firms facing idiosyncratic distortions. I quantify changes in the joint distribution of productivities and wedges. This wedge accounting exercise implies modest changes in allocative efficiency and substantial improvements in firm-level productivity, consistent with EU accession shifting the technology frontier. These results indicate that, to account for this economic miracle, allowing for technological change is fundamental.

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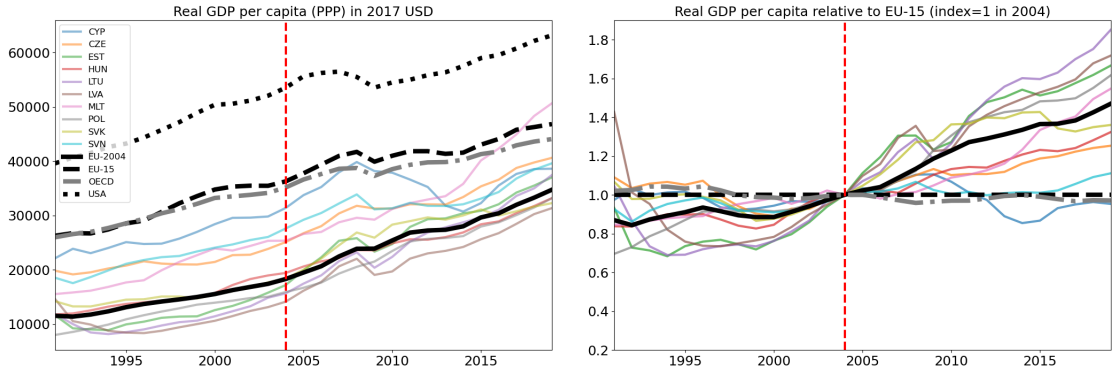
The European Union (EU), founded in 1957, aims to foster peace and prosperity in territories that have experienced war for at least 11 centuries. In 2024, this political union represents 450 million people and one-sixth of the world's GDP. In May 2004, in its largest expansion since its creation, 75 million people across 10 countries (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia) became members of the EU. Between 2004 and 2019, the gross domestic product (GDP) per capita of these countries almost doubled from 18,314 USD to 34,753 USD. The World Bank classified them in as high-income economies, whereas they were in the upper-middle-income group in 2004 (except for Cyprus and Malta). How large was the effect of EU accession on GDP per capita, and did it operate mainly through improved allocative efficiency or through a shift in the technology frontier?

Institutionally, EU accession is not a single policy change but a bundle of reforms. Any country wishing to join the EU must conform to the Copenhagen criteria, established in 1993 and strengthened in 1995 by the European Council. These criteria include the stability of institutions guaranteeing democracy, the rule of law, human rights, the rights of minorities, a functioning market economy, and the capacity to implement the rules, standards, and policies that make up the body of EU law. In March 1999, the then-EU countries agreed on the financial framework for the period 2000-2006, which allowed for potential EU enlargement. Implementation of this agreement made clear that the EU would be enlarged to Eastern European countries, Cyprus, and Malta. On May 1, 2004, 10 countries effectively joined the EU.

My empirical results are consistent with a causal effect of the regulatory and institutional changes associated with the 2004 EU enlargement on GDP per capita. My quantitative results suggest that this effect mainly reflects a shift in the technology available to firms rather than a reduction in misallocation. This paper makes three contributions. First, it provides new aggregate evidence on the macroeconomic impact of the 2004 EU enlargement by constructing counterfactual GDP per capita paths for both the new members (EU-2004) and the pre-2004 members (EU-15). Second, it complements these estimates with a quantitative interpretation: a neoclassical growth model with heterogeneous firms and wedges is used to distinguish changes in technology from changes in allocative efficiency. Third, the results inform a broader debate on whether large institutional and regulatory reforms –of the kind embedded in the EU accession process– can generate sustained growth and help economies transition from the middle-income to the high-income status.

In this paper, I first examine the effect of the EU enlargement on two aggregated economies: the EU-2004, which includes the new member states that joined the EU in 2004, and the EU-15, which consists of the 15 member states before the 2004 enlargement. Figure 1 shows the GDP per capita for the EU-2004, EU-15, and a few countries in levels in the left panel and relative to the EU-15 in the

Figure 1: GDP per Capita



DATA: Penn World Table 10.0. NOTE. Left panel: GDP per capita in current PPP expressed in 2017 US dollars. Right panel: ratio of GDP per capita and GDP per capita of the EU-15 normalized to one in 2004. EU-2004: aggregation of the 10 countries that joined in 2004. EU-15: aggregation of the 15 countries EU members before 2004. OECD: aggregation of OECD countries.

right panel. GDP per capita growth of the EU-2004 and the EU-15 were similar before 2004, but they differed consistently after the EU enlargement. I construct a counterfactual for the EU-2004 and the EU-15 to go beyond the raw data. The idea is to construct a counterfactual control economy for the EU-2004 or the EU-15 as a weighted average of countries from a donor pool. In the baseline specification, I use the synthetic control method (SCM) introduced by Abadie and Gardeazabal (2003). The donor pool is composed of OECD countries that never joined the EU. The effect of the treatment – here joining the EU – is defined as the difference between the post-treatment dynamics of the treated country and the synthetic control. I find that EU-2004 GDP per capita was 32% (8,433 USD) higher after 15 years than in its synthetic counterfactual. This difference represents about half of the increase in GDP per capita between 2004 and 2019. I do not find robust evidence of a difference between the synthetic and actual EU-15 GDP per capita. I assess robustness using (i) alternative weighting, (ii) leave-one-out tests, (iii) in-country and in-time placebos, and (iv) alternative donor pools, and (v) alternative matching specifications. Across these exercises, the EU-2004 estimate remains large and positive, whereas the EU-15 estimate remains small and sensitive to specification choices.

A simple growth accounting exercise, in the spirit of Solow (1957) and following Caselli (2005) and Hulten (2010), shows that the contribution of capital and labor to EU-2004 GDP growth is around 60% higher than in its counterfactual. By contrast, the contribution of the Solow residual is almost three times larger for the actual EU-2004 than for its synthetic control.

To interpret these results, I introduce a neoclassical growth model with monopolistic competition and heterogeneous firms facing idiosyncratic capital and output wedges. The model implies that aggregate dynamics can be summarized by

a small set of aggregate wedges (an aggregate productivity wedge, an aggregate labor wedge, and an aggregate capital wedge), which in turn are functions of the distribution of firm-level productivity and distortions. I then perform a wedge accounting exercise in two steps. First, I recover the change in aggregate wedges that matches (i) the growth-accounting factor contribution and (ii) the post-2004 GDP per capita path relative to the counterfactual. Second, I recover the implied change in the joint distribution of firm-level productivity and wedges using dispersion moments for marginal revenue products and revenue shares from CompNet (2021). This two-step procedure allows to identifies both the change in aggregate wedges together with the change in the average micro-wedges and productivity.

The wedge accounting results point to a large improvement in effective aggregate productivity and comparatively modest changes in allocative efficiency. In particular, the recovered long run productivity increases by about 43%, implying a GDP per capita gain in the long-run of about 40%. At the micro level, the estimated distribution shifts toward higher firm-level productivity after 2004, whereas the distribution of distortions improves only moderately. These results favor a "technology" interpretation of the EU miracle: the adoption of EU institutions appears to have raised the technology frontier more than it reduced within-economy distortions. In other words, the episode is best rationalized by sustained improvements in productivity rather than by a one-time reallocation boom.

Taken together, these results point to a robust positive effect of EU accession on the GDP per capita of the EU-2004 and no robust impact on the EU-15. Furthermore, this growth miracle seems to have primarily been driven by better technology rather than a reduction in factor misallocation.

Literature Review. This paper relates to several strands of literature. First, it contributes to the economics of European integration. A large body of work studies the political economy of the EU (Alesina et al., 2017), economic integration and trade (Head and Mayer, 2021), and monetary union (Lane, 2006). Brexit has also generated a substantial literature evaluating the economic costs of disintegration (e.g., Sampson 2017, Broadbent et al. 2023, and Born et al. 2019). Closer to this paper, a number of studies examine enlargement episodes. Baldwin et al. (1997) provide an early cost–benefit analysis of eastern enlargement, while Rapacki and Próchniak (2009) study growth correlates during the pre-accession period. Campos et al. (2019) use Norway's non-accession to estimate gains for Denmark, and Caliendo et al. (2021) analyze goods and factor integration after enlargement. More recently, Hagemejer et al. (2021) and Campos et al. (2022) use synthetic control methods to evaluate enlargement episodes at the country or region level. Whereas this literature often focuses on trade integration or cross-

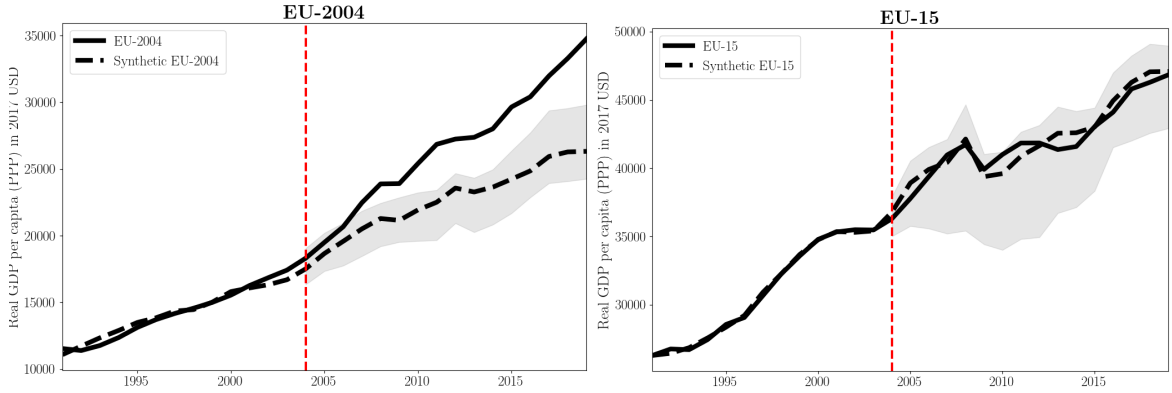
country heterogeneity, this paper studies the aggregate macroeconomic impact of the 2004 enlargement on both the *new* and the *old* members, and provides a structural interpretation in terms of productivity and misallocation.

More broadly, the paper contributes to the macro-development literature that studies large-scale institutional changes and growth accelerations. Episodes such as German reunification (Peters 2022, Dauth et al. 2021, Bachmann et al. 2023, Akcigit et al. 2023), China's post-reform growth (Song et al. 2011, Fernández-Villaverde et al. 2023, Fan et al. 2023), India's liberalization, and the transition from socialism to market economies (Cheremukhin et al., 2016) are often interpreted through the lens of distortions, reallocation, and technology adoption. A central question in this literature is whether growth episodes are primarily driven by reductions in wedges and misallocation (Hsieh and Klenow 2009) or by shifts in the technology frontier. In this spirit, Bergquist et al. (2026) emphasize that wedge-based measures of misallocation need not be purely distortionary: some wedges may reflect technological forces or other non-distortionary mechanisms, and interactions among wedges can be quantitatively important. This paper speaks directly to this debate. The 2004 EU enlargement can be viewed as a large and externally anchored institutional reform that imposed regulatory harmonization, market liberalization, and stronger legal frameworks. By combining counterfactual estimates with wedge accounting, the paper provides quantitative evidence that the growth of the EU-2004 is best interpreted as a shift in effective productivity rather than a pure reallocation episode.

Methodologically, this paper relates to a growing literature using synthetic control methods in macroeconomics and political economy, including Billmeier and Nannicini (2013) on economic liberalization, Born et al. (2019) on Brexit, and Funke et al. (2023) on populist governments. These studies build on the framework developed by Abadie and Gardeazabal (2003), Abadie et al. (2010), and Abadie (2021). Relative to this literature, the paper combines synthetic control estimates with a structural growth model and wedge accounting, and validates the empirical strategy using simulated transition paths. This integration of reduced-form counterfactual analysis and structural interpretation allows the paper to connect European integration to broader questions in macro-development about institutions, productivity, and the sources of growth.

Outline. The remainder of the paper proceeds as follows. Section 1 presents the counterfactual estimates of the 2004 enlargement for the EU-2004 and the EU-15 and discusses robustness exercises. Section 2 reports a growth-accounting decomposition that highlights the dominant role of the Solow residual in explaining the post-2004 divergence. Section 3 introduces a neoclassical growth model with heterogeneous firms and idiosyncratic distortions, and derives the mapping between micro-level wedges and aggregate outcomes. Section 4 implements the

Figure 2: Synthetic Control for EU-2004 and EU-15



DATA: Penn World Table 10.0. NOTE: Synthetic control estimated by matching real GDP per capita over 1991–2003. The red vertical line indicates 2004. Shaded areas report confidence intervals following Cattaneo et al. (2021, 2022). Left panel: EU-2004. Right panel: EU-15.

wedge-accounting exercise, first recovering the change in aggregate wedges and then the implied change in the distribution of firm-level productivity and distortions using CompNet (2021) moments. The final section concludes.

1 Empirics

This section estimates the causal effect of the 2004 EU enlargement on GDP per capita. I first construct a counterfactual path for the treated aggregates using synthetic control methods (SCM). I then assess robustness to alternative designs and specifications.

1.1 Counterfactual Estimate

This subsection constructs counterfactual GDP per capita paths for the treated aggregates. The key object is the (unobserved) trajectory that the treated unit would have followed absent EU accession. I estimate this counterfactual using weighted averages of outcomes from a donor pool of untreated economies. Different weighting schemes deliver different counterfactual estimators. In the baseline, I am using synthetic control methods from Abadie (2021).

Counterfactuals Estimates. Let Y_{it} denote real GDP per capita (PPP, 2017 USD) for unit i in year t. For the treated unit ($i = 1$), define potential outcomes $Y_{1t}(1)$ under EU accession and $Y_{1t}(0)$ under no accession. The estimand is the treatment

effect $Y_{1t}(1) - Y_{1t}(0), t \geq T_0$, where T_0 corresponds to 2004. Since $Y_{1t}(0)$ is not observed after T_0, I approximate it by a weighted average of donor outcomes:

$$\widehat{Y}_{1t}(0) \equiv \sum_{i=2}^{N+1} w_i \, Y_{it}, \tag{1}$$

There are several ways to choose the vector of weights w_i, in what follows I use the SCM as baseline and I keep the GDP weighting and equal weighting as a robustness.

Data and Donor Pool. The outcome is GDP per capita from Penn World Table 10.0 (Feenstra et al., 2015). The sample runs from 1991 to 2019, with 2004 as the treatment year. In the baseline specification, the donor pool consists of OECD countries that have never joined the EU (Australia, Canada, Chile, Colombia, Costa Rica, Iceland, Israel, Japan, Mexico, New Zealand, Norway, Republic of Korea, Switzerland, Turkey, and the United States).

I construct treated units as aggregates. The EU-2004 is the aggregation of the 10 countries that joined the EU in 2004. I sum the real GDP and the population, then divide the sum by the population to compute GDP per capita. The EU-15 is constructed as the aggregation of the 15 countries that were members of the EU before 2004: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the UK.

Baseline: SCM. In my baseline specification, the weights w_i are chosen to minimize the distance between the weighted average of the outcome variable across untreated countries and the treated-country outcome variable before the treatment. Formally, Y is the vector of the outcome variable for the treated unit before the treatment date, here in 2004. X is the $T_0 - 1 \times N$ matrix collecting GDP per capita for untreated countries before 2004. The vector W of weights w_i is chosen to minimize

$$(Y - X'W)'V(Y - X'W)$$

such that $w_i \geq 0$, $\sum_{i=2}^{N+1} w_i = 1$, and where the positive-semidefinite symmetric matrix V is chosen using a data-driven approach as recommended by Abadie et al. (2010). The constraints on the weights ensure that the estimator $\widehat{Y}_{1t}$ lies in the convex simplex defined by the untreated countries and avoids extrapolation.

Implicitly, this setup assumes no spillover across countries and no anticipation of the treatment. These assumptions are not perfectly satisfied in the case of the 2004 EU enlargement. Indeed, from 2000 onward, the EU's enlargement to some former communist countries, Cyprus, and Malta would clearly proceed. The treated unit considered is the aggregation of all its countries to limit the spillover.

As explained in Cattaneo et al. (2021, 2022), inference for SCM methods is constructed from randomness in the construction of the weights in the pre-treatment period (in-sample uncertainty) and from the out-of-sample prediction due to the stochastic error after the treatment (out-of-sample uncertainty). I use their methods to compute confidence intervals, using a simulation-based approach for both sources of uncertainty, with 200 simulations and sub-Gaussian bounds.

EU-2004. Using the SCM described above for the EU-2004 yields the estimates of GDP per capita displayed in the left panel of Figure 2 with simulation-based confidence intervals. Costa Rica, the Republic of Korea, and Norway have non-zero weights equal to 0.772, 0.126, and 0.102, respectively. The GDP per capita pre-treatment match is contained in a 5% bound around the true EU-2004 value. The treatment effect – the difference between the outcome variable for the treated unit and the synthetic control – is equal to 801 USD in 2004 and increases to 8,433 USD in 2019, with an average of 3,903 USD in the post-2004 period. The estimates fall outside the confidence intervals. According to these calculations, in 2019, joining the EU results in a 32% increase in GDP per capita for the new member states.

EU-15. The results are displayed in the right panel of Figure 2 with simulation-based confidence intervals. Australia, Iceland, Israel, Costa Rica, Norway, and Canada have non-zero weights equal to 0.290, 0.247, 0.215, 0.146, 0.072, and 0.030, respectively. The pre-treatment GDP per capita of the synthetic control is within 1.2% of the actual EU-15 level. The treatment effect averages -214 USD in the post-2004 period and is -247 USD in 2019. These calculations yield a fall in GDP per capita of about 0.5% after the EU's enlargement in 2004; however, these estimates fall within the confidence intervals.

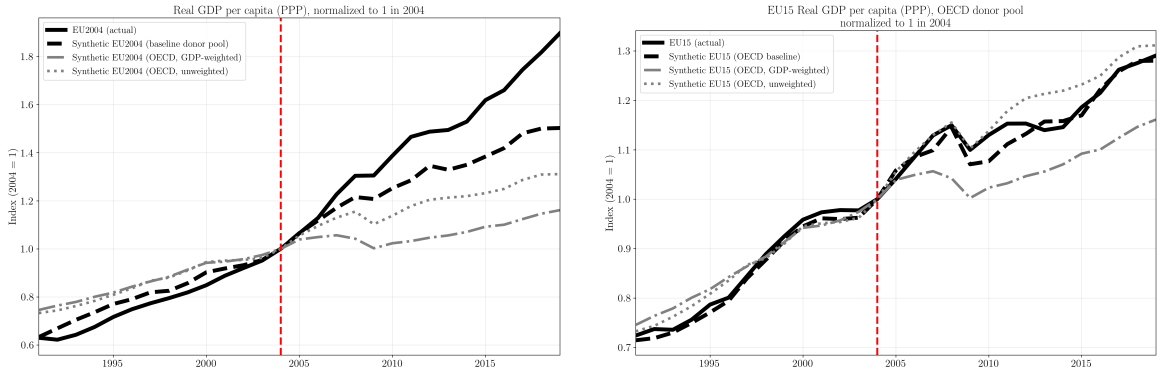
1.2 Robustness

In this section, I assess the robustness of the baseline results. First, I use a different weighting strategy beyond the SCM. Second, I explore alternative matching specifications, I perform a Leave-One-Out (LOO) test, an in-country placebo, an in-time placebo, and I explore alternative donor pools.[1]

Alternative aggregation and weighting. I also consider two alternative counterfactual estimates: (i) an equal-weighted average of donor countries and (ii) a

[1]Importantly, for each of the robustness exercises involving the SCM, a new set of weights is estimated. The implied synthetic control is thus a weighted average of different countries than the baseline.

Figure 3: Alternative Weighting



DATA: Penn World Table 10.0. NOTE: Left panel: EU-2004. Right panel: EU-15. Each panel compares counterfactual GDP per capita paths constructed using (i) equal weights over the donor pool, (ii) GDP weights computed from donors' average GDP over the pre-treatment period, and (iii) the baseline estimates. The lines are normalized to one in 2004. The vertical line marks 2004.

GDP-weighted average of donor countries, where GDP weights are computed using average donor GDP over the pre-treatment period. Figures 3 report these alternative counterfactual paths. While these estimates do not mechanically target a tight pre-2004 fit, they confirm the qualitative conclusion of the SCM baseline estimate. There is a large post-2004 divergence for EU-2004 and no robust divergence for EU-15. The baseline results are not an artifact of a particular weighting algorithm.

Alternative Donor Pool. I explore the role played by the donor-pool choice. The third row of Figure 9 shows the synthetic control for the EU-2004 (left) and EU-15 (right) with various donor pools. For both the EU-2004 and the EU-15, I use countries in geographical Europe with and without Norway, and countries from the same half of the income distribution. I also use ex-communist countries for the EU-2004 and non-EU G20 countries for the EU-15. For the EU-2004, these alternative specifications yield treatment effects in 2019 that are similar to the baseline. For the EU-15, varying the donor pool yields either negative or positive effects of the 2004 EU enlargement.

Leave-One-Out. I remove each country with non-zero weights from the donor-country pool and reestimate the synthetic control. The top row of Figure 9 shows the results. The effect of the EU enlargement in 2004 is robust and yields a large positive effect for the EU-2004 and a zero effect for the EU-15. The estimated baseline effect is not due to the particular dynamics of one country in the donor pool.

In-Country Placebo. In this exercise, I counterfactually assign the treatment status to each country in the donor pool iteratively. I then estimate the treatment effect for each of these countries and get a distribution of treatment effects. For

Table 1: Growth Accounting

	$\Delta \log Y$ GDP	$\Delta \log R$ Residual	$\overline{\frac{rK}{Y}}_{04-19} \Delta \log K$ Capital	$\overline{\frac{wl}{Y}}_{04-19} \Delta \log L$ Labor
EU2004	4.16	2.29	1.38	0.50
Synthetic EU2004	2.16	0.92	0.91	0.32
EU2004	1	0.55	0.32	0.12
Synthetic EU2004	1	0.43	0.42	0.15

DATA: Penn World Table 10.0. NOTE: the first row shows the decomposition for the actual EU-2004. The second row shows the synthetic EU-2004 with the baseline specification. A synthetic control is estimated for each variable used in the decomposition: $\frac{rK}{Y}$, K, $\frac{wl}{Y}$, and L.

the untreated countries, this treatment effect should be centered around zero, whereas if it is significant, it should be on the tails of that distribution for the treated country. The distribution of the treated effects for each country in the donor pool is shown in the left panel of the last row of Figure 9. The treatment effect of the EU-2004 (solid) is on the distribution's right tail and outside the interquartile range. The treatment effect is around zero and inside the interquartile range for the EU-15 (dashed).

In-Time Placebo. I reestimate the synthetic control with a counterfactual treatment date in 2000. The second row of Figure 9 shows the results. The synthetic control for the EU-2004 (left) estimated with the treatment date 2000 has similar dynamics to the baseline. The one for the EU-15 (right) yields a lower GDP per capita. The enlargement's large positive effect on EU-2004 is robust to an alternative treatment date, whereas the effect on EU-15 is not.

Alternative matching specification. Beyond matching pre-treatment GDP per capita levels, I consider specifications that match: (i) average pre-treatment growth and level, and/or (ii) additional covariates such as human capital, hours worked, and the labor share. The fourth row of Figure 9 shows the results. These alternative specifications yield similar qualitative conclusions: a large positive effect for EU-2004 and no robust effect for EU-15.

Overall, the empirical evidence points to a robust, economically large increase in GDP per capita for the 2004 entrants, while effects for the pre-2004 members are small and not robust across specifications.

2 Growth Accounting

In this section, I decompose GDP growth (Solow, 1957; Caselli, 2005; Hulten, 2010) into the contributions of capital, labor, and the Solow residual for the actual EU-2004 and the synthetic EU-2004. Formally, I decompose the growth rate of GDP $\Delta \log Y$ as follows:

$$\Delta \log Y = \Delta \log R \quad + \quad \overline{\frac{rK}{Y}}_{04-19} \Delta \log K \quad + \quad \overline{\frac{wl}{Y}}_{04-19} \Delta \log L \tag{2}$$

where $\Delta \log X$ is the growth rate of the variable X, which can be output Y, capital stock K, employment L, or the Solow residual R, and where $\overline{\frac{rK}{Y}}_{04-19}$ and $\overline{\frac{wl}{Y}}_{04-19}$ are respectively the average of the capital and labor share of GDP in 2004 and 2019.[2]

As in Funke et al. (2023), I estimate a separate synthetic control for each of the variables used in this decomposition (labor share $\frac{wl}{Y}$, capital share $\frac{rK}{Y}$, capital stock K, and employment L) using the baseline specification. Table 1 shows the value of each term of equation (2) for the EU-2004 in the first row and for the synthetic EU-2004 in the second row. The third and fourth rows give the share of each term in the growth of GDP.

This table provides three main takeaways. First, the annualized growth rate of GDP between 2004 and 2019 is around 4% for the actual EU-2004, whereas it would have been halved if these countries had not joined the EU. Second, the contribution to growth of capital and labor is respectively 51% and 56% larger for the EU-2004 than for the synthetic EU-2004. Finally, the Solow residual contribution to growth is almost 2.5 times larger for the EU-2004 than for the synthetic EU-2004. This decomposition shows that the additional growth due to EU accession was mainly driven by stronger growth in the Solow residual, whereas the extra mobilization of capital and labor made a smaller contribution.

3 Neoclassical Model with Frictions

This section introduces a neoclassical growth model with heterogeneous firms and facing distortions. After describing the environment, I derive the equilibrium conditions and show how the equilibrium allocation is characterized by aggregate wedges that depend on firm-level productivities and distortions.

[2] The variables used for this decomposition from the Penn World Table 10.0 dataset are K =`cn`, L =`emp`, rK =`irr*cn`, and $\frac{wL}{Y}$ =`labsh`.

3.1 Environment: Households, Firms, and Technology

The model is a standard neoclassical growth model with two modifications: monopolistic competition and heterogeneous firms. Time is discrete, $t = 0, 1, 2, \ldots$. There is a representative household and a continuum of differentiated varieties indexed by $i \in [0, 1]$. As it is standard in the neoclassical growth model, aggregate productivity evolves deterministically from A_0 according to $A_{t+1} = (1 + g)A_t$.

Households. The representative household chooses sequences $\{C_t, K_{t+1}\}_{t\geq 0}$ to maximize

$$\max_{\{C_t, K_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\gamma}}{1-\gamma}, \tag{3}$$

subject to the period budget constraint

$$C_t + K_{t+1} = w_t N_t + r_t K_t + (1 - \delta)K_t + T_t, \tag{4}$$

where K_t denotes the aggregate capital stock at the beginning of period t, w_t is the wage, r_t is the rental rate of capital, δ is the depreciation rate, N_t is labor supplied (in the quantitative exercise below I normalize $N_t = 1$), and T_t denotes lump-sum transfers and profits from firms. Households consume a CES composite of varieties $\{C_{it}\}_{i\in[0,1]}$, $C_t \equiv \left(\int_0^1 C_{it}^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}}$, with elasticity of substitution $\varepsilon > 1$. The capital good is the same CES composite of the varieties. These assumptions imply the standard CES price index P_t and demand system.

The model can be stationarized by detrending the variables. For a variable X_t, I denote detrended variables by $\widetilde{X}_t \equiv X_t/A_t$. The first-order condition of the household gives the Euler equation in its stationary form: $\beta \left(\frac{\widetilde{C}_{t+1}}{\widetilde{C}_t}\right)^{-\gamma} (1 + r_{t+1} - \delta)\,(1+ g)^{-\gamma} = 1$.

Firms. Each variety i is produced by a firm with Cobb–Douglas technology $Y_{it} = K_{it}^{\alpha} \left(A_t z_{it} N_{it}\right)^{1-\alpha}$, where z_{it} is an idiosyncratic productivity term that is heterogeneous across firms. Firms face two distortions: (i) an output wedge τ_{it}^{y} that scales down revenue, and (ii) a capital wedge τ_{it}^{k} that scales up the rental cost of capital. Firm i chooses its price and inputs, $\{P_{it}, K_{it}, N_{it}\}$, to maximize

$$\max_{P_{it}, K_{it}, N_{it}} (1 - \tau_{it}^{y}) P_{it} Y_{it} - w_t N_{it} - (1 + \tau_{it}^{k}) r_t K_{it}, \tag{5}$$

subject to the demand for its variety and its production function. The first-order condition implies that firms are equalizing their marginal product of each input with the after-tax rental or wage rate. They also charge a markup $\mu = \varepsilon/(\varepsilon - 1)$

over their marginal cost. The capital-labor ratio is given by $\frac{K_{it}}{N_{it}} = \frac{w_t}{r_t}\frac{\alpha}{1-\alpha}\frac{1}{1+\tau_{it}^k}$ and is determined by the capital wedge τ_{it}^k. Firm-level price is equal to $P_{it} = (1-\tau_{it}^y)^{-1}\frac{\varepsilon}{\varepsilon-1}MC_{it}$ where the marginal cost is $MC_{it} = (A_t z_{it})^{\alpha-1}(\frac{w}{1-\alpha})^{1-\alpha}(\frac{r_t(1+\tau_{it}^k)}{\alpha})^{\alpha}$.
Three firm-level variables are important for studying the allocation of factors and revenue: the revenue share, the marginal revenue product of capital (MRPK), and the marginal revenue product of labor (MRPL). As shown by Hsieh and Klenow (2009), we have

$$\text{MRPL}_{it} = \frac{w_t}{1-\alpha}\mu(1-\tau_{it}^y)^{-1} \quad \text{and} \quad \text{MRPK}_{it} = \frac{r_t}{\alpha}\mu(1-\tau_{it}^y)^{-1}(1+\tau_{it}^k). \tag{6}$$

When the wedges τ_{it}^k and τ_{it}^y are equal to zero, the allocation is optimal: MRPK and MRPL are equalized across firms. Importantly, these marginal products do not depend on the firm-level productivity z_{it}. This is not the case with the revenue share,

$$\frac{P_{it}Y_{it}}{P_tY_t} = \left[\frac{(1-\tau^y{}_{it})}{(1+\tau^k{}_{it})^{\alpha}}z_{it}{}^{1-\alpha}\right]^{\varepsilon-1}\left(\int_i\left[\frac{(1-\tau^y{}_{it})}{(1+\tau_{it}^k)^{\alpha}}z_{it}{}^{1-\alpha}\right]^{\varepsilon-1}di\right)^{-1}, \tag{7}$$

which is a function of both distortions ($\tau^k{}_{it}$ and $\tau^y{}_{it}$) and of productivity z_{it}.

3.2 Equilibrium Conditions and Aggregate Wedges

This subsection summarizes the equilibrium conditions in terms of three aggregate wedges: an aggregate productivity wedge Z_t, an aggregate capital wedge τ_t^K, and an aggregate labor wedge τ_t^N. These wedges are functions of the distribution of firm-level productivities and wedges $\{z_{it}, \tau_{it}^y, \tau_{it}^k\}$, and are sufficient to pin down the aggregate allocations along the balanced growth path and during transitions.
Aggregating the firm-level first-order conditions yields that factor prices, factor demand, and aggregate quantities satisfy:

$$\alpha\mu^{-1}\frac{Y_t}{K_t} = r_t(1+\tau_t^K), \tag{8}$$

$$(1-\alpha)\mu^{-1}\frac{Y_t}{N_t} = \frac{w_t}{A_t}(1+\tau_t^N), \tag{9}$$

$$Y_t = (A_tZ_tN_t)^{1-\alpha}K_t^{\alpha}. \tag{10}$$

These equations depend on three aggregate wedges discussed below: the productivity wedge Z_t, the capital wedge τ_t^K, and the labor wedge τ_t^N. Given these wedges, these equations together with the household's Euler equation and the

law of motion of capital ($K_{t+1} = Y_t - C_t + (1-\delta)K_t$) characterized the equilibrium allocations.

The aggregate wedges are functions of the distribution of firm-level productivities z_{it} and wedges $(\tau^y_{it}, \tau^k_{it})$. The labor and capital wedges, τ^N_t and τ^K_t, create a difference between aggregate marginal revenue products and factor prices. They are defined as:

$$(1+\tau^K_t)^{-1} \equiv \int_i (1+\tau^k_{it})^{-1}(1-\tau^y_{it})\frac{P_{it}Y_{it}}{P_tY_t}\,di \quad \text{and} \quad (1+\tau^N_t)^{-1} \equiv \int_i (1-\tau^y_{it})\,\frac{P_{it}Y_{it}}{P_tY_t}\,di, \tag{11}$$

where the revenue share is a function of $\{z_{it}, \tau^y_{it}$, and $\tau^k_{it}\}$ as show in equation (7). In other words, they are a revenue-weighted average of firm-level distortions. If firms are identical, these aggregate wedges are just equal to the common firm-level wedges. The aggregate productivity wedge Z_t can be interpreted as the distance to the technology frontier A_t, which is defined as:

$$Z_t^{1-\alpha} \equiv (1+\tau^N_t)^{1-\alpha}(1+\tau^K_t)^{\alpha}\left[\int_0^1 \left((1-\tau^y_{it})(1+\tau^k_{it})^{-\alpha} z_{it}^{1-\alpha}\right)^{\varepsilon-1} di\right]^{\frac{1}{\varepsilon-1}}. \tag{12}$$

Note that if all the firms are identical in terms of their productivities and wedges, the aggregate productivity wedge is just equal to the common productivity level.

Given a distribution of firm-level productivities and of wedges, one can compute these aggregate wedges, which $\{Z_t, \tau^K_t, \tau^N_t\}$ summarize the impact of misallocation and technology heterogeneity on aggregate outcomes.

3.3 Calibration

I calibrate the model at an annual frequency. The trend growth rate is set to match the average annual growth rate of the synthetic EU-2004 in the pre-accession period. The remaining parameters take standard values in the literature. The elasticity of substitution is chosen to imply a markup equal to 1.25.

The capital share is calibrated to match the US capital contribution to growth, where the U.S. is assumed to be undistorted ($\tau^K = \tau^N = 0, Z = 1$). The model implies a capital contribution to growth equal to $\alpha\mu^{-1}$. Targeting a U.S. capital contribution of 0.26 implies $\alpha \approx 0.33$.

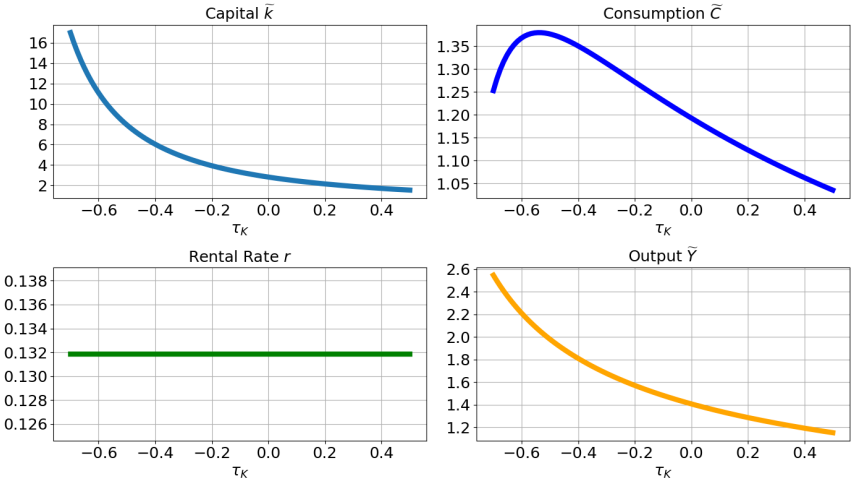
3.4 The Impact of Aggregate Wedges

This subsection illustrates how changes in aggregate wedges affect (i) the balanced growth path (BGP) and (ii) the transition dynamics. Throughout, I focus

Table 2: Calibration

Parameter	Value	Description
$\log(1+g)$	0.016	growth of synthetic EU-2004 (annual)
δ	0.06	depreciation rate
ε	5	elasticity of substitution (markup $\mu = \varepsilon/(\varepsilon-1) = 1.25$)
β	0.948	discount factor
γ	1	log utility
α	0.33	capital share

Figure 4: Balanced Growth Path and the Capital Wedge

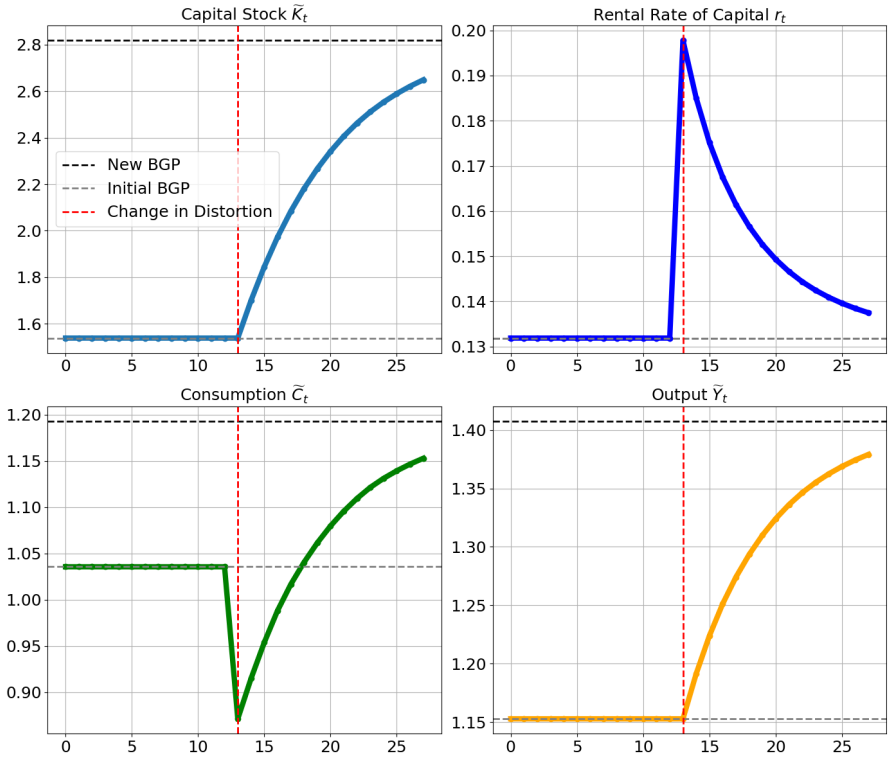


NOTE: Balanced growth path (BGP) levels as a function of the aggregate capital wedge τ^K.

on the aggregate capital wedge τ_t^K, which creates a wedge between the marginal revenue product of capital and the rental rate, as in equation (8). Intuitively, a higher τ_t^K raises the effective user cost of capital, depresses the capital-output ratio, and lowers output along the BGP. A permanent change in τ_t^K therefore shifts the economy to a new BGP and triggers a transition between the old and the new BGP.

Along a BGP, detrended quantities are constant: $\widetilde{K}_t \equiv K_t/A_t$ and $\widetilde{Y}_t \equiv Y_t/A_t$ are time-invariant (and similarly for $\widetilde{C}_t$), while A_t grows at rate g. The capital stock along a BGP is equal to $\tilde{K} = Z(\frac{r}{\alpha}\frac{(1+\tau^K)}{\mu^{-1}})^{\frac{1}{\alpha-1}}$ and decreasing in the aggregate capital wedge τ^K for given Z and τ^N. Aggregate output is also decreasing while consumption has an inverted U-shaped because $\widetilde{C} = Z^{1-\alpha}\widetilde{K}^{\alpha} - (g+\delta)\widetilde{K}$. Note that even if $\tau^N = 0$ and $Z = 1$, the optimal capital wedge is negative to compensate for the monopolistic competition distortions. Figure 4 illustrates how the capital, consumption, the interest rate, and output along a BGP move with the capital wedge.

Figure 5: Transition Dynamics After a Permanent Change in the Capital Wedge



NOTE: Transition dynamics of detrended capital, the rental rate of capital, detrended consumption, and output aggregates after a permanent, unanticipated change in the aggregate capital wedge τ^K from 0.5 to 0 after 13 periods.

Let us consider an unanticipated permanent change in the capital wedge from $\tau^K = 0.5$ to $\tau^K = 0$, with other wedges held fixed for simplicity. Since capital is predetermined, K_0 is fixed at impact, and the economy cannot jump directly to the new BGP. Instead, the lower wedge raises the rental rate of capital and leads households to increase investment and reduce consumption $\widetilde{C}_t$. As capital accumulates to its new higher BGP values, interest converges back to its unchanged BGP value, thereby driving a gradual transition of $\{\widetilde{C}_t$ and $\widetilde{Y}_t\}$ toward their new higher BGP values. Figure 5 plots the associated transition dynamics of the detrended variables and the interest rate.

4 Wedge Accounting

This section quantifies how accession to the EU maps into changes in aggregate wedges and micro wedges. The key idea is to interpret the estimated counterfactual and actual GDP per capita path for EU-2004 (Section 1) through the lens of the model (Section 3). The model implies that aggregate allocations can be sum-

marized by a small number of aggregate wedges (Section 3.2). I first recover the aggregate wedges that rationalize the post-2004 transition. I then recover a parsimonious change in the distribution of micro wedges and productivity consistent with these aggregate wedges and with firm-level dispersion moments.

4.1 Accession to the EU and Estimation Strategy

I model accession to the EU as a regime change at $t = 0$ (corresponding to 2004). In the pre-accession regime ($t < 0$), firm-level fundamentals (z_{it}, τ_{it}^k) are constant:[3]

$$\forall t < 0, \quad z_{it} = z_{i0}, \quad \tau_{it}^k = \tau_{i0}^k, \quad \Rightarrow \quad Z_t = Z_0, \quad \tau_t^K = \tau_0^K,$$

where Z_t and τ_t^K are the aggregate wedges defined in Section 3.2 by equations (11) and (12).

In the post-accession regime ($t \geq 0$), the economy transitions toward a new long-run regime characterized by $(z_{i\infty}, \tau_{i\infty}^k)$. I allow for a gradual catch-up process α_t in the productivity component. Specifically, I assume

$$\forall t \geq 0, \quad z_{it} = \alpha_t z_{i\infty}, \quad \tau_{it}^k = \tau_{i\infty}^k \quad \Rightarrow \quad Z_t = \alpha_t Z_\infty, \quad \tau_t^K = \tau_\infty^K,$$

where α_t follows a process as in Fernández-Villaverde et al. (2023) $\ln \alpha_t = (1 - \eta) \ln \alpha_{t-1}$ and $\alpha_0 = \frac{Z_0}{Z_\infty}$. With these assumptions, $\alpha_t \to 1$ as $t \to \infty$ and $Z_t = Z_0$ at time $t = 0$ and $Z_t = \alpha_t Z_\infty$ for $t \geq 0$.The parameter η governs the speed of convergence.

The wedge accounting proceeds in two steps. The first step estimates the change in aggregate wedges while the second step recovers the change in micro-wedges. Specifically, in the first step, I recover $(\tau_0^K, \tau_\infty^K, Z_\infty/Z_0, \eta)$ using (i) the growth accounting moments for the synthetic EU-2004 and EU-2004 (Section 2), and (ii) the post-2004 counterfactual treatment effect path estimated in Section 1.

In the second step, for each regime (before and after), I recover the in the joint distribution of idiosyncratic productivity and micro capital wedges, (z_{it}, τ_{it}^k), between the pre- and post-accession regimes, using: (i) a parametric distributional assumption (joint log-normal), (ii) the aggregate wedges recovered in the first step, and (iii) firm-level dispersion moments from CompNet: dispersion of MRPK and dispersion of revenue shares.

In the rest of this section, I describe how this strategy allows us to identify these changes in aggregate and micro-level wedges. I also described the implied results.

[3]For simplicity, I am assuming that firms only face a non-zero capital distortion, $\forall i, \tau_{it}^y = 0$.

4.2 Aggregate Wedges

This subsection describes how I recover the aggregate wedges $(\tau_0^K, \tau_\infty^K, Z_\infty/Z_0, \eta)$ from macro moments and the empirical estimate of the effect of the accession to the EU from Section 1. I also described the characteristics of the EU accession's long-term effects.

Recovering the pre-accession wedge τ_0^K. I interpret the synthetic EU-2004 as the no-accession counterfactual and assume it is on a balanced growth path (BGP). In the model, the capital wedge enters the aggregate capital condition (8) and therefore affects the implied contribution of capital to growth. Specifically, along the BGP, the capital contribution can be written as:

$$\frac{1}{2}\left(\frac{r_{t_1}K_{t_1}}{Y_{t_1}} + \frac{r_{t_0}K_{t_0}}{Y_{t_0}}\right)\Delta \ln\left(\frac{K_t}{N_t}\right) = \alpha\mu^{-1}\frac{1}{1+\tau_0^K}\Delta \ln A_t.$$

I target the capital contribution measured for the synthetic EU-2004 in the growth accounting exercise (Section 2), which equals 0.42 (Table 1, second row "Synthetic EU2004", capital share of growth). Equation (4.2) then pins down τ_0^K.

Recovering post-accession wedges $(\tau_\infty^K, Z_\infty/Z_0, \eta)$. I am assuming that after the EU accession, the EU-2004 enter the post-accession regime described in section 4.1. Its aggregate wedges and the dynamics are characterized by τ_∞^K, Z_∞ where $\forall t \geq 0, Z_t = \alpha_t Z_\infty$ with α_t following the catch-up process with parameter η.

For a given $(\tau_\infty^K, Z_\infty/Z_0, \eta)$, I compute the perfect foresight transition. I choose the triplet $(\tau_\infty^K, Z_\infty/Z_0, \eta)$ to jointly match two targets for the EU-2004: (i) the capital contribution to growth over 2004–2019 from Section 2, equal to 0.32 (Table 1, row "EU2004", capital share of growth), and (ii) the post-2004 relative GDP per capita path of EU-2004 compared to its counterfactual (the treatment-effect path estimated in Section 1).

This strategy identifies the parameters $(\tau_\infty^K, Z_\infty/Z_0, \eta)$. Indeed, the capital contribution to growth is equal to:

$$\frac{1}{2}\left(\frac{r_{t_1}K_{t_1}}{Y_{t_1}} + \frac{r_{t_0}K_{t_0}}{Y_{t_0}}\right)\Delta \ln \frac{K_t}{N_t} = \alpha\frac{\varepsilon-1}{\varepsilon}\frac{1}{2}\left(\frac{1}{1+\tau_\infty^K} + \frac{1}{1+\tau_0^K}\right)\Delta \ln \frac{K_t}{N_t}$$

and therefore identifies the change from τ_0^K to τ_∞^K given a dynamics of $\frac{K_t}{N_t}$. The long-term BGP levels are determined by τ_∞^K and Z_∞ while the speed of convergence is modulated by the process α_t and its parameter η.

Table 3: Aggregate Wedges Results

Pre-04 Wedge τ_0^K	Post-04 Wedge τ_∞^K	Pdty Gains Z_∞/Z_0	Catch-up Speed η	Output Gain $\widetilde{Y}_\infty/\widetilde{Y}_0$
-0.371	-0.352	1.425	0.111	1.403

Results. Table 3 reports the recovered aggregate wedges. Three results stand out. First, capital is subsidized in both regimes ($\tau_0^K < 0$ and $\tau_\infty^K < 0$). The optimal subsidy level is -0.2 due to the monopolistic distortion and the calibrated markup of 1.25. In both the pre- and post-accession regimes, capital is therefore over-subsidized compared to the first-best. Second, the subsidy becomes slightly smaller in absolute value after accession ($|\tau_\infty^K| < |\tau_0^K|$), decreasing from -0.37 to -0.35, and is thus closer to the first-best by only 2 percentage points. Third, the new BGP in the post-accession regime has aggregate productivity: $Z_\infty/Z_0 \approx 1.43$, corresponding to a long-run output gain of about 40%. The estimated catch-up speed is relatively fast, $\eta \simeq 0.11$.

Given the recovered wedges, the model implies that EU-2004 approaches its new BGP gradually and has reached 76% of the potential GDP gain in 2019 after 15 years in the EU. Based on the rate of adjustment, it will take 20 more years to reach 98% of the potential level. Note that the level of output in the new BGP will still be lower than the EU-15 level, which is 1.78 times the pre-accession level of the EU-2004. Figure 6 shows the dynamics of output relative to the pre-accession level 35 years after the accession. The yellow line is the model-implied dynamics while the black line is the treatment-effect estimated in Section 1.

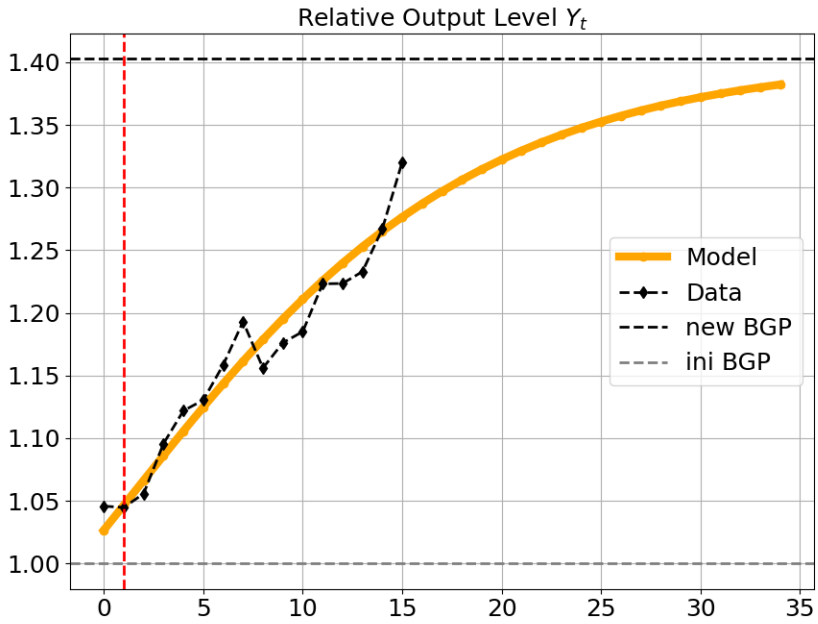
4.3 Micro Wedges

This subsection explains how to recover the joint distribution of idiosyncratic productivity and micro capital wedges, (z_{it}, τ_{it}^k), before and after the EU accession. The key idea is to match the (i) the aggregate wedges recovered above and (ii) moments of the firm-level distribution in CompNet (2021) data.

The strategy is identical for the pre- and post-accession. First, I assume that idiosyncratic productivity and micro capital wedges are jointly log-normal $\left(z_{it},\, 1+\tau_{it}^k\right) \sim \log\mathcal{N}(\mu, \Sigma)$, where μ is a 2×1 vector of means of $(\log z, \log(1+\tau^k))$ and Σ is a 2×2 covariance matrix. The goal is to estimate the parameters (μ, Σ) for the pre-accession regime ($t < 0$) and the post-accession regime ($t = \infty$).

For a given (μ, Σ), the model implies the aggregate wedges (Z, τ^K) through the aggregation formulas (12) and (11) in Section 3.2. Furthermore, given the joint distribution of $\left(z_{it},\, 1+\tau_{it}^k\right)$, we can compute the MRPK and revenue share using equations (6) and (7) and their standard deviation. The strategy is then to match

Figure 6: Post-Accession Dynamics



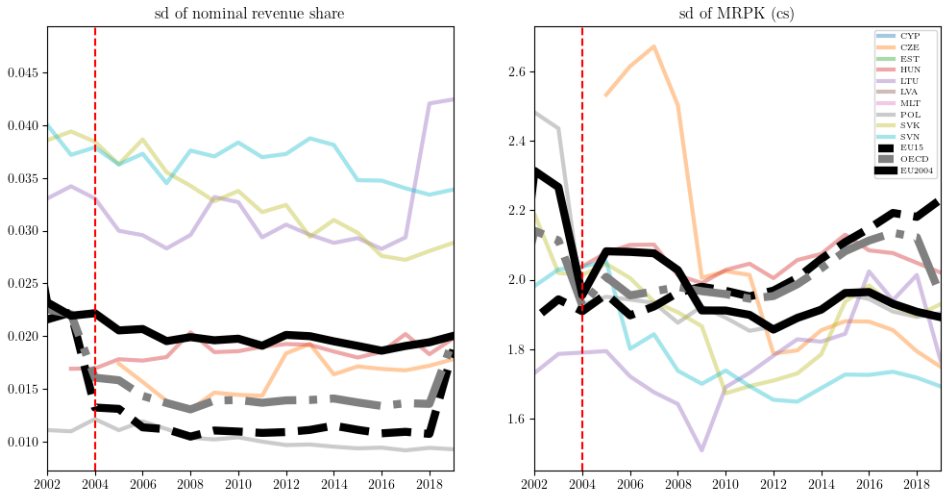
NOTE: Model-implied transition of detrended output (yellow) for EU-2004 after accession relative to before the accession. The black dashed line is the data counterpart: the treatment effect estimated in Section 1.

the aggregate wedges estimated above, and the measure of the standard deviation or MRKP and revenue share computed from CompNet (2021) data.

CompNet (2021) is producing moments of various firm-level distributions for several countries that are comparable across countries. Essentially, it is running the same code on administrative data from several countries. I use the version industry level version of these data that I aggregate at the country and at the EU-2004 level.Unfortunately, the coverage across countries and time is not as extensive as in the PennWorld data. Figure 7 shows the time series of the dispersion of MRPK and revenue share for the EU-2004 and for all the countries available in CompNet (2021). I use the averages before and after 2004 as targets: 2.29 and 1.95 for the dispersion of MRPK, and 0.023 and 0.02 for the dispersion of revenue share.

The mean of the joint distribution of productivity and capital wedges is identified by the aggregate wedges, while the variance is identified by the dispersion of MRPK and revenue share. Indeed, while the MRPk is just a function of τ_{it}^k, the revenue share is a function of the wedges and the productivities z_{it}. In the baseline, I assume the correlation between wedges and productivity is zero, an assumption I relaxed in the appendix.

Figure 7: Dispersion of MRPK and Revenue Share



NOTE: CompNet (2021)-based dispersion moments used to discipline micro wedges. Left: standard deviation of revenue share. Right: standard deviation of marginal revenue product of capital (MRPK) estimated with a cost-share method.

Table 4: Micro Wedges Results

	Idiosyncratic Productivity z_{it}		Micro Wedges $1+\tau_{it}^k$	
	μ_z	σ_z	$\mu_{1+\tau^k}$	$\sigma_{1+\tau^k}$
pre (<2004)	-0.037	0.484	0.426	0.697
post (≥ 2004)	0.362	0.426	0.371	0.661

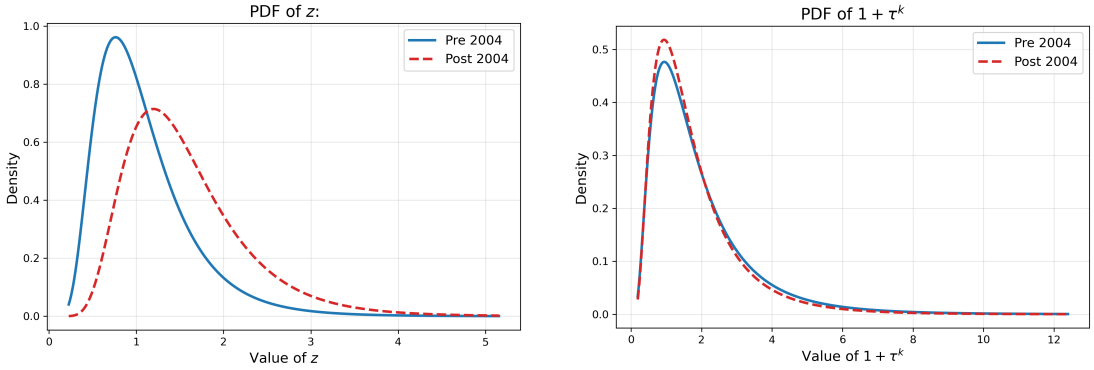
Results. Table 4 reports the estimated parameters of the joint distribution of $\log z_{it}$ and $\log(1+\tau_{it}^k)$ before and after the accession to the EU. Figure 8 plots the implied log-normal distribution before and after accession to the EU.

The distribution of productivity shifts to the right (from -0.04 to 0.36) while the standard deviation is reduced by only 12%. This indicates that firms in the post-accession period have become more efficient. The efficient frontier has significantly improved.

Interestingly, the distribution of wedges has barely shifted, with a 13% reduction in the mean and a 5% reduction in the dispersion. This indicates a moderate improvement in capital allocation across firms. The distance to the efficient frontier has barely moved.

To understand the extent to which the change in the productivity distribution is fundamental in matching the large aggregate effect of the accession to the EU. I

Figure 8: Estimated Distributions of Productivity and Capital Wedges (Pre vs. Post)



NOTE: Left : distribution of idiosyncratic productivity z_{it} before (blue solid) and after (red-dashed) 2004. Right : distribution of micro capital wedges $1+\tau_{it}^k$ before (blue solid) and after 2004 (red-dashed). The correlation between idiosyncratic productivity z_{it} and micro capital wedges $1+\tau_{it}^k$ is assumed to be zero.

redo the estimation of the micro-level capital wedge distribution after accession, but fix the distribution of productivity at the pre-accession level. I perform this exercise for three sets of targets: (i) matching the same targets as in the baseline, (ii) matching just the aggregate capital wedge and the dispersion of MRPK, and (iii) matching just the aggregate productivity wedge and the dispersion of revenue share. The results are displayed in Table 5. The main takeaway is that changes in distortions alone cannot match the large gain in aggregate productivity.

Robustness. The above results are robust to allowing correlation between productivity and distortions, $\text{Corr}(\log z_{it}, \log(1+\tau_{it}^k)) > 0$, and to alternative CompNet-based constructions of MRPK dispersion and revenue-share dispersion. These alternative measurement and specification choices affect the quantitative estimates but preserve the qualitative conclusion that the post-2004 regime is characterized by a sizable increase in effective productivity and a more modest change in distortions. See Appendix B for details.

5 Conclusion

In 2004, 75 million people joined the European Union. This paper studies the macroeconomic impact of that enlargement. Using counterfactual estimates based on weighted comparisons, I find that GDP per capita in the EU-2004 was 32%

Table 5: Fixing the Productivity Distribution: Fit to Post-2004 Moments

	Baseline	Fixed $(\mu_z, \sigma_z) = (-0.0370,\ 0.4840)$		
	(All moments)	All moments	$\sigma(\mathrm{MRPK})_{\text{post}}$ & τ_∞^K	$\sigma(\mathrm{rev})_{\text{post}}$ & Z_∞
Aggregate post-accession targets				
Z_∞	1.4250	**1.0362**	1.0270	**1.3186**
τ_∞^K	-0.3520	**-0.3520**	**-0.3520**	0.8478
$\sigma(\mathrm{rev})_{\text{post}}$	0.0200	**0.0222**	0.0224	**0.0180**
$\sigma(\mathrm{MRPK})_{\text{post}}$	1.9500	**1.8472**	**1.9500**	0.0001
Implied post-accession micro distributions				
μ_z	0.3620	-0.0370	-0.0370	-0.0370
σ_z	0.4260	0.4840	0.4840	0.4840
$\mu_{1+\tau_k}$	0.3710	0.3416	0.3693	0.6140
$\sigma_{1+\tau_k}$	0.6610	0.6504	0.6619	0.0001

NOTE: This table reports a robustness exercise where the firm-level productivity distribution is *fixed* at its pre-2004 parameters $(\mu_z, \sigma_z) = (-0.0370, 0.4840)$ and the post-2004 distribution of micro wedges $(1 + \tau_{it}^k)$ is re-estimated under alternative moment sets. "Baseline" reproduces the baseline estimation for comparison, where both productivity and wedges can change. Under "Fixed productivity," columns vary, which post-2004 moments are targeted: (i) all moments, (ii) MRPK dispersion and the aggregate capital wedge τ_∞^K, or (iii) revenue-share dispersion and aggregate productivity wedge Z_∞.Bold entries indicate moments explicitly targeted in that column.

higher in 2019 than in the no-accession counterfactual. I do not find robust evidence of a significant effect for the EU-15. The enlargement appears to have been, at least in aggregate terms, a positive-sum event.

Growth accounting shows that the additional growth of the EU-2004 relative to its counterfactual is primarily accounted for by the Solow residual. To interpret this result, I develop a neoclassical growth model with heterogeneous firms and idiosyncratic capital wedges and implement a wedge-accounting exercise. The quantitative results point to a large increase in effective aggregate productivity: the recovered long-run productivity wedge rises by about 43 percent, implying an output gain on the new balanced growth path of roughly 40 percent. By contrast, the aggregate capital wedge changes only modestly and remains negative in both regimes. At the micro level, the post-2004 regime is characterized by a sizable rightward shift in the distribution of firm-level productivity and comparatively limited improvements in allocative efficiency.

Taken together, these findings suggest that the EU enlargement operated primarily through a shift in the effective technology frontier rather than through a large reduction in within-economy distortions. The estimated speed of convergence, around 10 percent per year, implies relatively rapid transition dynamics: after fif-

teen years, the EU-2004 had already realized a substantial fraction of its long-run gain.

This analysis has limitations and should be interpreted with caution. The counterfactual estimates rely on weighted comparisons, and the structural interpretation depends on the maintained assumptions of the model. Nevertheless, the results are robust across a wide range of specifications and micro-moment constructions. More broadly, the 2004 enlargement provides evidence that large, externally anchored institutional reforms—combining regulatory harmonization, market integration, and legal convergence—can generate sustained productivity gains and facilitate the transition to high-income status.

Future work could further disentangle the specific channels behind the productivity shift, including technology diffusion, competition, financial integration, migration, and fiscal transfers. Understanding these mechanisms is particularly relevant as, in 2024, nine countries are candidates to join the EU, including Ukraine.

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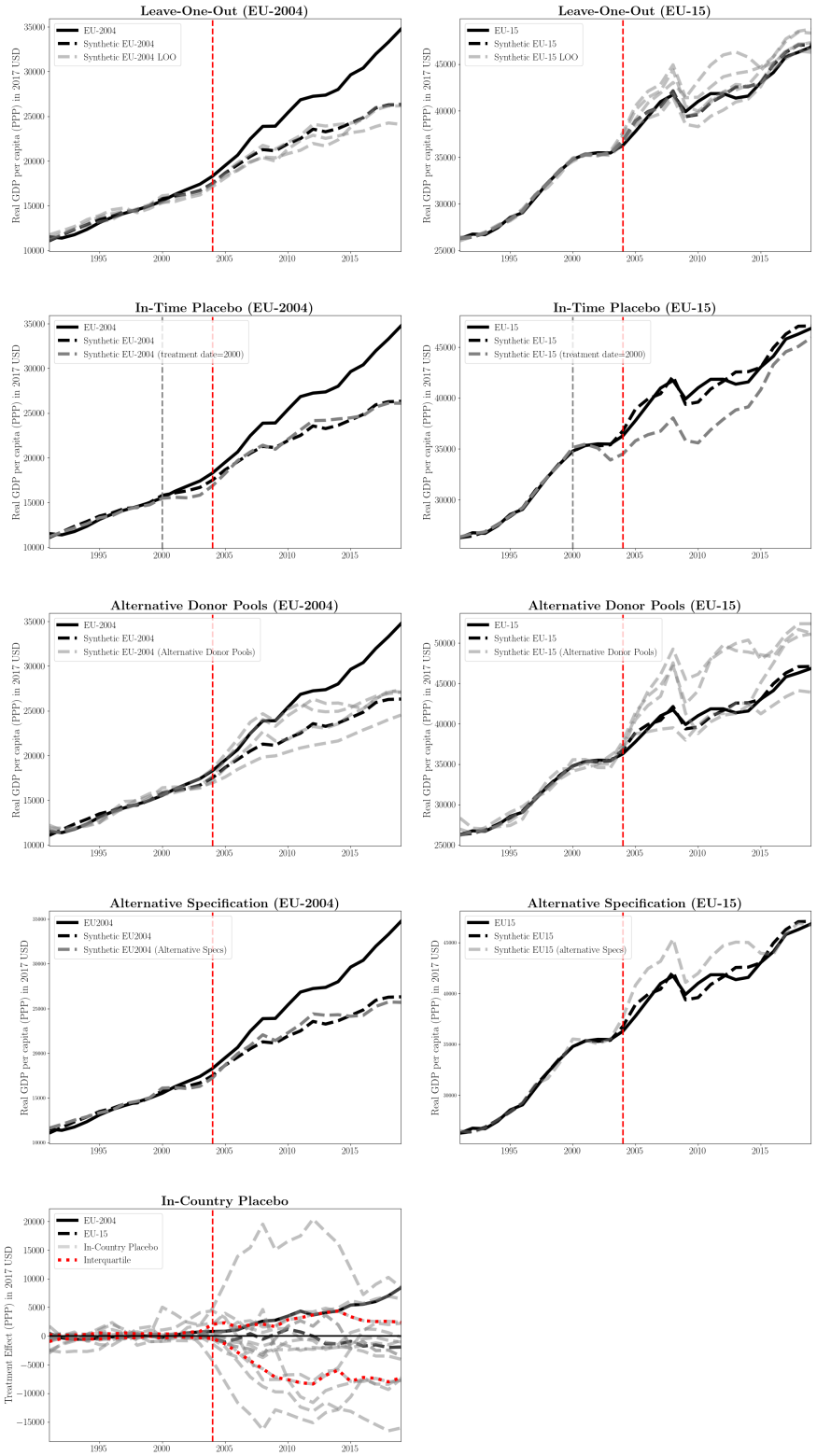
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Figure 9: Robustness of Synthetic Control



DATA: Penn World Table 10.0. NOTE: First column: EU-2004; second column: EU-15. Row 1: leave-one-out (LOO). Row 2: in-time placebo (treatment set to 2000). Row 3: alternative donor pools. Row 4: in-country placebo / falsification and additional placebo design. (This figure excludes simulated data exercises, which are presented separately in Appendix **??**.)

Appendix

A Evolution of Aggregate Variable Around 2004

In this section, I explore the dynamics of a few aggregates of the EU-2004 to evaluate what could be the mechanism behind this growth episode.

Panel (1) of Figure 10 shows the dynamics of consumption, government spending, investment, and export and import share. These demand components have converged to a stable level relative to EU-15 before or around 2004. Notably, the export and import share have converged respectively to a level 10% and 20% higher than the EU-15, whereas they were 50% lower in 1991.

Panel (2) of Figure 10 shows the relative dynamics of the inflow of FDI stock as a share of GDP. The FDI inflow stock has grown since 1991 and experienced an upward shift in 2004 mainly due to a sudden and large increase in this measure for Cyprus and Malta.[4] As the demand components, FDI seems to have converged to a stable level related to the EU-15.

Panel (3) of Figure 10 displays the dynamics of the employment rate. Starting from a level close to the EU-15 in 1991, the relative employment rate declined until 2004 to a level more than 10% lower than the EU-15. Between 2004 and 2019, the employment rate increased to its initial level. This peculiar dynamic might indicate intense labor reallocation around 2004, consistent with the evidence in Dauth et al. (2021) on the labor market in East Germany after reunification.

Panel (4) of Figure 10 shows the dynamics of TFP, as computed by the Penn World Table (Feenstra et al., 2015) relative to the EU-15 level. TFP seems to grow faster after 2004 relative to EU-15. In 2019, the TFP gap between the EU-2004 and the EU-15 is less than 10%.

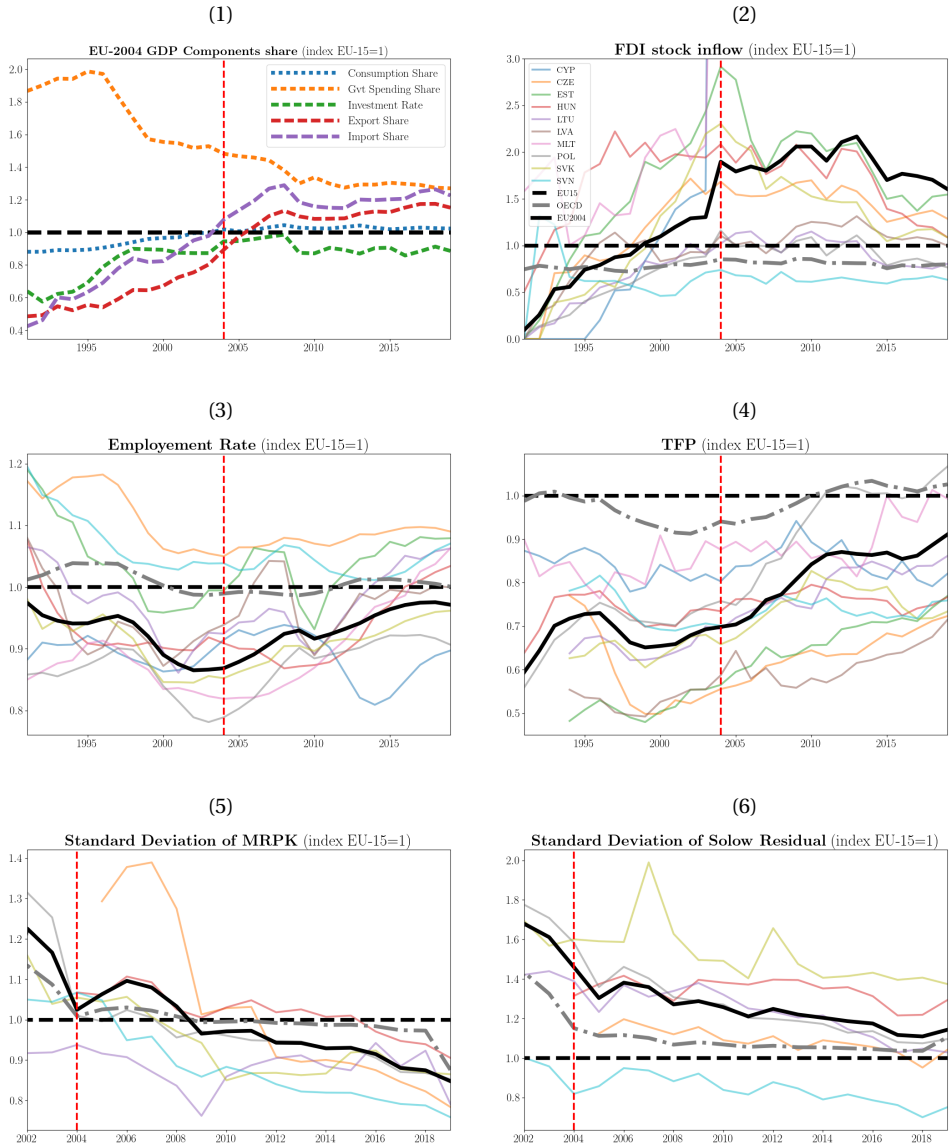
Figure 10 displays the standard deviation of the firm-level marginal revenue product of capital (MRPK) in panel (5) and the Solow residual in panel (6) relative to their industry average. These measures are computed from CompNet data (CompNet, 2021) by aggregating from 2-digit industries to countries and to the EU-2004 and EU-15 aggregates. These variables are usual measures of static factor misallocation (Hsieh and Klenow, 2009). Although the coverage across time and countries is sparse, these measures sharply declined around 2004 and kept decreasing to a level close to or lower than the EU-15.

Indicators of product market regulation (PMR) as computed by the OECD show similar convergence dynamics for the EU-2004.[5] In the EU-2004, the PMR indi-

[4] To improve readability the y-axis of the FDI panel is restricted to the range 0 to 3 and crop out the post-2004 dynamics for Cyprus and Malta.

[5] Lower values indicate better regulation. These indicators are only available for a few years

Figure 10: Mechanism



DATA: Penn World Table 10.0. NOTE: the panels show (1) consumption, government spending, investment, and export and import share, (2) FDI stock inflow share, (3) employment rate, (4) TFP as estimated by the Penn World Table 10.0, (5) standard deviation of MRPK, and (6) Standard Deviation of Solow Residual where the last two panel are computed using CompNet firm-level moments based on a cost-share estimation of the production function.

Table 6: Micro-Wedge Estimates with Correlation $= 0.3$

	Idiosyncratic Productivity z_{it}		Micro Wedges $1+\tau_{it}^k$	
	μ_z	σ_z	$\mu_{1+\tau_k}$	$\sigma_{1+\tau_k}$
pre (<2004)	-0.128	0.591	0.255	0.768
post (≥ 2004)	0.280	0.529	0.219	0.723

cator for barriers to trade and investment went from 2.83 in 1991 to 0.38 in 2008, while it was 0.73 and 0.42 for the EU-15. The PMR indicators for state control or barriers to entrepreneurship have similar dynamics. These numbers indicate a convergence in regulation indices of the EU-2004 to the level of the EU-15.

B Robustness: Micro-Wedge Estimates

This appendix reports robustness checks for the micro-wedge estimation described in Section 4.3. Recall that, for each regime (pre and post 2004), I recover the joint distribution of $(z_{it}, 1+\tau_{it}^k)$ under the maintained assumption $(z_{it}, 1+\tau_{it}^k) \sim \log\mathcal{N}(\mu, \Sigma)$, by matching (i) the aggregate wedges (Z, τ^K) recovered in Section 4.2 and (ii) micro dispersion moments from CompNet (dispersion of MRPK and dispersion of revenue shares). The robustness exercises below vary either the correlation structure or the measurement of the micro targets, and re-estimate the distributional parameters accordingly.

B.1 Correlated Productivity and Distortions

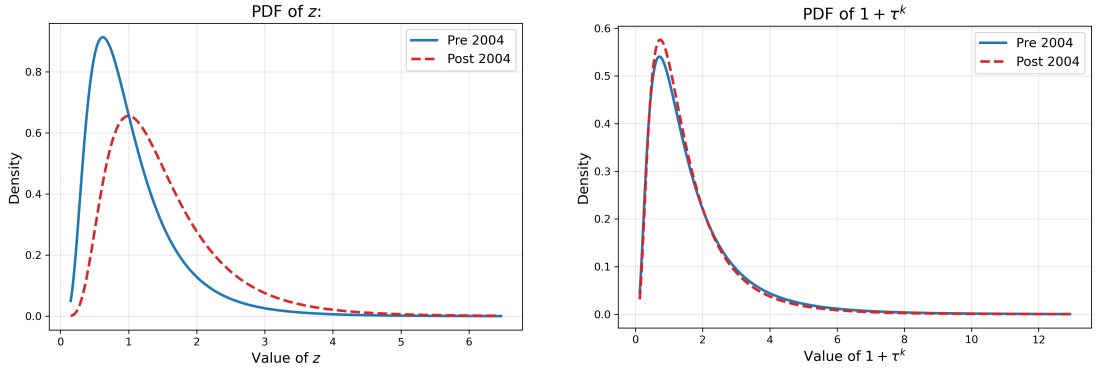
The baseline micro-wedge estimation in Section 4.3 assumes zero correlation between $\log z_{it}$ and $\log(1+\tau_{it}^k)$. Since more productive firms could face systematically different wedges (e.g., via differential access to finance, policy exposure, or selection), this subsection allows for positive correlation.

In this robustness exercise, I assume $\mathrm{Corr}\big(\log z_{it}, \log(1+\tau_{it}^k)\big) = 0.3$ in both regimes and re-estimate the remaining parameters (means and variances) to match the same set of targets as in the baseline: aggregate wedges (Z, τ^K) and CompNet dispersion of MRPK and revenue shares.

Table 6 reports the implied parameters. The qualitative pattern is unchanged: the post-2004 regime features a rightward shift in productivity and a modest improvement in capital wedges. Figure 11 visualizes the pre/post distributions under this correlation restriction.

and a small subset of the new member countries.

Figure 11: Estimated Micro Distributions with Correlation $\rho = 0.3$ (Pre vs. Post)



NOTE: Left : distribution of idiosyncratic productivity z_{it} before (blue solid) and after (red-dashed) 2004. Right : distribution of micro capital wedges $1+\tau_{it}^k$ before (blue solid) and after 2004 (red-dashed). The correlation between idiosyncratic productivity z_{it} and micro capital wedges $1+\tau_{it}^k$ is assumed to be 0.3.

B.2 Alternative Measures of MRPK Dispersion

CompNet dispersion moments depend on how MRPK is constructed, which in turn depends on the production-function estimation used to compute firm-level marginal products. This subsection checks that the recovered micro parameters are not driven by one particular MRPK construction.

I repeat the micro-wedge estimation using three alternative MRPK measures provided by CompNet: (i) Cobb–Douglas with time-varying coefficients (TV), (ii) Cobb–Douglas estimated in (Ackerberg et al. (2015)), (iii) Translog estimated as in (Ackerberg et al. (2015)), in addition to the baseline cost-share measure. For each MRPK measure, I re-target the pre/post dispersion of MRPK and re-estimate the distributional parameters, while still matching the same aggregate wedges (Z, τ^K) and the revenue-share dispersion target.

Table 7 shows that the main conclusions are stable across MRPK constructions: post-2004 productivity is higher, and changes in the wedge distribution are comparatively modest.

B.3 Alternative Measures of Revenue-Share Dispersion

Revenue-share dispersion can also be measured using nominal or real revenue shares in CompNet (2021). Since the micro estimation uses revenue-share dispersion to discipline the joint distribution of productivity and wedges (in complement to MRPK), it is important to verify that results are robust to this choice.

I repeat the micro-wedge estimation using two alternative dispersion targets:

Table 7: Robustness to Alternative MRPK Measures (CompNet)

	Baseline (Cost-Share)		Cobb–Douglas (TV)		Cobb–Douglas (ACF)		Translog (ACF)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
$\sigma(\text{MRPK})$	2.2903	1.9539	2.0030	1.9851	2.0450	1.9617	1.9722	1.7639
μ_z	-0.0367	0.3625	-0.0723	0.3666	-0.0669	0.3636	-0.0764	0.3364
σ_z	0.4839	0.4259	0.4942	0.4246	0.4927	0.4256	0.4954	0.4344
$\mu_{1+\tau_k}$	0.4265	0.3711	0.3562	0.3792	0.3669	0.3732	0.3482	0.3193
$\sigma_{1+\tau_k}$	0.6970	0.6616	0.6690	0.6649	0.6734	0.6624	0.6658	0.6400

NOTE: Each column pair reports (i) the targeted pre/post MRPK dispersion from CompNet under the specified MRPK construction and (ii) the corresponding estimated parameters of the joint log-normal distribution of $(z_{it}, 1+\tau_{it}^k)$ in each regime. In each case, the estimation continues to match the aggregate wedges (Z, τ^K) recovered in Section 4.2, while varying only the MRPK dispersion target. ACF stand for Ackerberg et al. (2015).

Table 8: Robustness to Alternative Revenue-Share Measures (CompNet)

	Revenue Share (Nominal)		Revenue Share (Real)	
	Pre	Post	Pre	Post
$\text{std}(\text{rev})$	0.0230	0.0200	0.0226	0.0198
μ_z	-0.0367	0.3625	-0.0239	0.3676
σ_z	0.4839	0.4259	0.4740	0.4215
$\mu_{1+\tau_k}$	0.4265	0.3711	0.4261	0.3710
$\sigma_{1+\tau_k}$	0.6970	0.6616	0.6967	0.6615

NOTE: Columns report pre/post revenue-share dispersion targets and the implied estimated parameters of the joint log-normal distribution of $(z_{it}, 1+\tau_{it}^k)$. The estimation matches the same aggregate wedges (Z, τ^K) and MRPK dispersion as in the baseline, and varies only the revenue-share dispersion target (nominal vs. real).

(i) dispersion of *nominal* revenue shares (baseline) and (ii) dispersion of *real* revenue shares. For each case, I re-estimate the joint log-normal parameters to match (a) aggregate wedges (Z, τ^K), (b) MRPK dispersion, and (c) the corresponding revenue-share dispersion target.

Table 8 shows that switching from nominal to real revenue-share dispersion barely changes the estimated wedge distribution and yields very similar productivity estimates.