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Public Investment under EU Cohesion Policy: The Case of Slovakia*

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Abstract

This paper examines the impact of European Union (EU) funding on associated public investment dynamics in Slovakia, focusing on the interaction between externally and domestically financed investment. The analysis combines dynamic panel model with the synthetic control method (SCM). Panel estimates indicate a negative association between EU capital transfers and domestically financed public investment. Counterfactual simulations are consistent with a substitution mechanism between EU-funded and domestically financed public investment and point to domestic investment in Slovakia being higher on average 1.2 percentage points of GDP annually after 2016 in the absence of EU funding. SCM results show a negative deviation of Slovakia's domestically financed investment from the trajectory implied by comparable economies, emerging after the mid-2000s and robust across specifications. The results suggest that sustained EU funding is associated not only with higher total public investment, but also with a shift in its financing structure and greater dependence on investment dynamics on EU programming cycles. The analysis identifies this reallocation within public investment financing, while the subsequent use of the resulting domestic fiscal space across the broader government budget lies beyond its scope. The findings highlight that the composition of public investment by source of financing provides important information about domestic investment effort that aggregate investment indicators alone may obscure.

JEL codes: C33, C53, O16, H54, H77

Keywords: EU funding, capital transfers, dynamic panel models, synthetic control method

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Executive summary

Public investment plays a key role in supporting economic growth and convergence across EU Member States. In countries with high absorption of EU funds, however, investment dynamics are shaped not only by domestic fiscal conditions but also by the scale and timing of external financing. This paper examines how EU funding is associated with public investment dynamics in Slovakia, with a particular focus on its interaction with domestically financed investment.

The analysis combines two complementary approaches. Dynamic panel model is used to estimate the relationship between EU funding and domestically financed investment across Central and Eastern European countries, while the synthetic control method is applied to assess whether Slovakia's investment trajectory diverges from that of comparable economies. The two approaches address related but distinct questions and are interpreted as complementary evidence rather than separate estimates of the same effect.

The results point to a consistent pattern. Higher EU fund absorption is associated with lower domestically financed public investment. Counterfactual simulations suggest that, within the model framework, domestic investment in Slovakia would have been approximately 1,2 p.p. of GDP higher per year after 2016 in the absence of EU transfers.

At the same time, higher EU-funded investment is associated with higher total public investment, but also with changes in its financing structure and timing. The SCM results provide complementary evidence that Slovakia's domestically financed investments persistently falls below the trajectory implied by comparable economies. The divergence emerges after the mid-2000s, when EU funding became an increasingly important source of public investment. Investment also becomes more unevenly distributed over time, reflecting the programming structure and absorption dynamics of EU funds.

The findings suggest that sustained EU funding is associated not only with the level of public investment, but also with the way investment is financed and distributed over time. In Slovakia, aggregate investment has become more closely linked to EU funding cycles, while domestically financed investment has remained relatively subdued. This implies that aggregate public investment alone may provide an incomplete picture of the underlying domestic investment effort.

From a policy perspective, the key challenge is not only to maximise absorption of EU funds but integrate external financing into a stable domestic investment framework. This requires better coordination of EU-funded and domestically financed investment, stronger medium-term planning and measures to reduce investment volatility across programming cycles.

Key Findings

EU funding is associated with a substitution effect

- Higher EU fund absorption is consistently associated with lower domestically financed public investment.
- The estimated relationship is significant and robust across model specifications, although it should not be interpreted as a fully identified causal effect.

The magnitude of substitution is substantial

- Counterfactual simulations within the estimated PVAR framework suggest that, in the absence of EU-funded investment, domestically financed public investment could have been on average 1.2 percentage points higher.
- The implied differences are economically non-negligible but remain subject to considerable uncertainty and depend on the structure of the estimated model.
- The simulations should therefore be interpreted as an illustration of the potential scale of the substitution mechanism rather than as a precise estimate of the effect of EU funding.
- Fiscal consolidation, institutional changes and other country-specific developments may also have contributed to the observed evolution of domestic public investment; therefore, the results should be viewed with this factor in mind.

Total investment increases, but its composition changes

- Higher EU-funded investment is associated with higher overall public investment. However, this increase is largely driven by externally financed projects, while the domestic component remains subdued.

Slovakia's investment trajectory diverges from comparable economies

- The synthetic control analysis shows that domestically financed investment in Slovakia persistently falls below the trajectory implied by the synthetic benchmark.
- This divergence emerges after the mid-2000s and is robust across specifications but should not be attributed exclusively to EU funding.

Investment becomes more cyclical over time

- EU funding is associated with a more uneven temporal distribution of investment.
- Investment activity is concentrated around programming cycles, contributing to volatility.

Evidence supports three channels of impact

- Scale dimension: higher EU-funded investment is associated with higher total public investment.

- Composition dimension: a shift from domestically financed towards EU-funded investment.
- Timing dimension: concentration of investment in specific phases of the funding cycle.

Policy challenge: integration, not just absorption

- Maximising EU fund absorption is not sufficient.
- Effective policy should better integrate EU and domestic investment, support, stable medium-term investment planning and reduce investment volatility across funding cycles.

1. Introduction

In several EU Member States, public investment is heavily financed by EU structural and investment funds. In some cases, financing from EU budget account for a large share of total public investment, raising questions about the interaction between externally and domestically financed investment.

In Slovakia, EU funds represent a substantial source of public investment financing. While they have contributed to expanding the overall volume of investment, they may also influence the behaviour of domestically financed capital expenditure. Co-financing requirements and the multiannual programming structure may affect both the allocation and timing of investment.

This issue can be framed in terms of complementarity versus substitution within the public sector, specifically between EU-funded and domestically financed investment. EU transfers may strengthen overall investment capacity by relaxing financing constraints but may also lead to a reallocation of domestic fiscal resources and changes in the timing of investment activity.

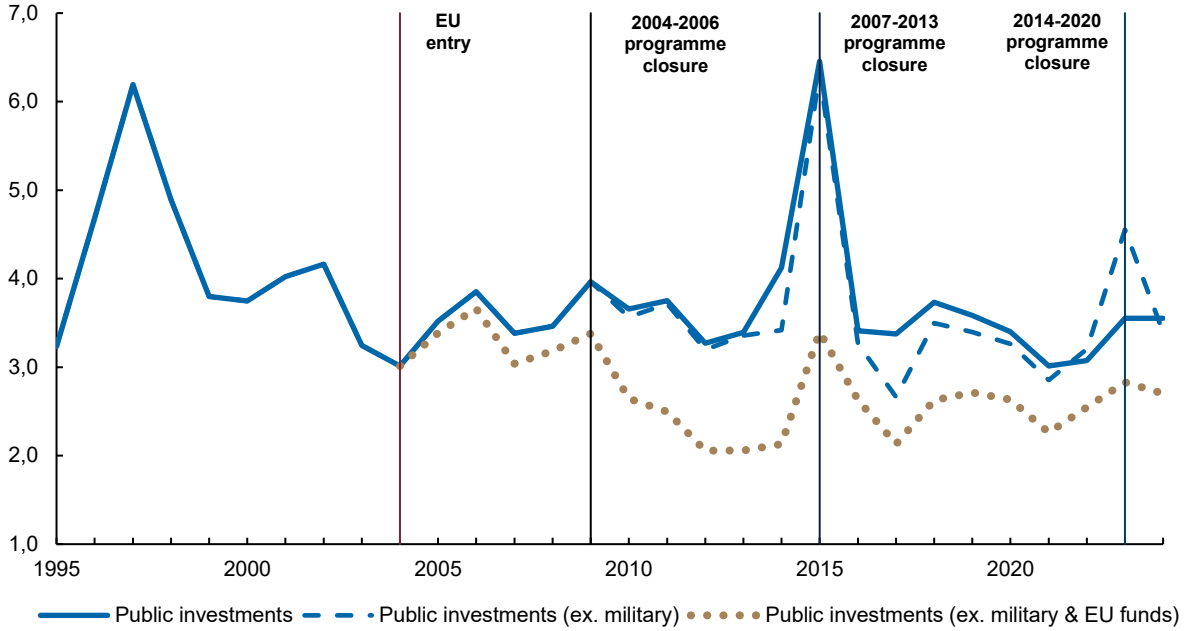
Figure 1 illustrates the evolution of public investment in Slovakia as a share of GDP, highlighting pronounced fluctuations that broadly coincide with EU programming periods.

This paper examines whether Slovakia exhibits a distinct public investment pattern relative to comparable European economies and to what extent EU funding contributes to it. To this end, we combine two complementary approaches: panel-based models to analyse the relationship between EU-funded and domestically financed investment, and the synthetic control method to assess deviations from a counterfactual trajectory.

The analysis is guided by a conceptual framework in which EU funding affects public investment through three channels: by increasing overall investment, by influencing the allocation between funding sources, and by affecting the timing of investment through programming cycles.

The results indicate that EU funding is associated with changes in both the composition and timing of public investment, alongside its overall level. Together, these findings suggest that EU funds play a central role in shaping public investment dynamics in Slovakia relative to comparable economies.

Figure 1: Public investment in Slovakia (% GDP)



Note 1: In 2023, the dashed line (excl. military) is higher due to the donation of military equipment. This transfer is recorded as a reduction in public investment in accounting terms, which lowers the level of total public investment. As a result, overall investment appears lower than it would have been in the absence of these military donations.

Note 2: COFOG data on defence investment for Slovakia are available from 2010 onwards; the defence adjustment is therefore applied only from that year. No adjustment is made for the earlier period due to the absence of comparable data. Given the transformation and EU pre-accession context, this is assumed not to materially affect the interpretation of the long-run investment pattern.

Source: Eurostat, ECB, own calculations

1.1 Literature review

This framework has been widely discussed in the literature on EU Cohesion Policy, particularly in relation to the additionality principle. A key question is whether EU Structural Funds complement domestic public finance or partly replace it. Early contributions already point to the possibility that both effects can occur at the same time. Del Bo et al. (2011), for example, show that the outcome depends on institutional design and monitoring, suggesting that additionality is not automatic and that EU funding may influence domestic fiscal behaviour in more complex ways.

More recent empirical work provides a more detailed picture using disaggregated data. Del Bo and Sirtori (2016), based on regional panel data for Italy, show that substitution does not

necessarily imply lower total investment. Instead, it often takes place within public budgets, through reallocations across sectors, meaning that EU funds can indirectly shift domestic spending priorities. A similar point is made by Janský et al. (2016), who use municipal-level data from the Czech Republic. They do not find a clear substitution effect at the aggregate level, but highlight substantial heterogeneity across municipalities, indicating that local fiscal conditions and administrative capacity play an important role.

Evidence at the cross-country level paints a somewhat different picture. Using a dynamic panel for EU countries, Staehr and Urke (2022) find a close-to one-to-one relationship between Cohesion Fund transfers and public investment, pointing to strong additionality on average. At the same time, other studies note that these aggregate relationships may conceal important differences within public budgets. Durand and Espinoza (2021) and Alexopoulos et al. (2025) also report positive effects of EU funding on investment, especially in less developed regions, but at the same time point to heterogeneity and diminishing returns. González Alegre (2010) finds that only part of EU transfers translates into higher public investment, with a substantial share being offset by reallocation within government budgets This suggests that the impact of EU funds is not uniform and may weaken at higher levels of funding intensity.

Despite these contributions, most studies rely on aggregate indicators of public expenditure or total public investment, which only indirectly reflect capital expenditure. Existing evidence is largely based on cross-country analyses or selected case studies, with little attention to country-specific investment dynamics. To the best of our knowledge, no comprehensive empirical study examines substitution versus additionality in public capital investment in Slovakia.

2. Data and methodology

The empirical analysis relies on two related but distinct datasets, reflecting the different objectives of the panel model and the synthetic control approach. While both are constructed from harmonised macroeconomic data sources, they differ in country coverage, variable selection and modelling purpose.

To complement the analysis of public investment and its sources of financing, Annex A provides country-level descriptive statistics based on Eurostat and ECB data. For EU-funded public investment, the statistics account for differences in EU accession dates across countries.

The empirical strategy combines two complementary approaches reflecting the dual structure of the analysis. Dynamic PVAR is applied to a relatively homogeneous group of countries to estimate

the average relationship between EU-funded and domestically financed public investment, including potential substitution effects.

The synthetic control method, in turn, assesses whether Slovakia's post-treatment trajectory[4] of domestically financed public investment diverged from that of a weighted combination of comparable economies.

The two approaches therefore address related but distinct empirical questions. In particular, the SCM gap should not be interpreted as an additional estimate of the effect of EU funding or added to the panel estimate. The panel and SCM results are interpreted as complementary evidence rather than as separate components of a single treatment effect.

2.1 PVAR data

The panel analysis is based on annual data covering the period 1995–2024. The sample includes Central and Eastern European countries[1] that joined the European Union in 2004 and were exposed to EU cohesion funding under broadly similar institutional conditions as Slovakia. Small economies such as Cyprus and Malta are excluded due to structural differences that limit comparability.

The dataset is constructed using publicly available data from Eurostat and the European Central Bank. All variables are expressed as percentages of GDP.

The panel dataset is designed to capture the joint dynamics of EU funding and domestically financed public investment within a relatively homogeneous group of economies. The model specification is kept parsimonious to ensure stability and interpretability of the estimated relationships. The PVAR framework is used because the relevant fiscal variables are likely to be jointly determined over time. Domestically financed investment, EU-funded investment, public savings and public debt are therefore treated as elements of a dynamic fiscal-investment system rather than as variables linked by a one-directional causal relationship.

The baseline specification includes the following variables:

- CAPEX_D: domestically financed public investments (general government gross fixed capital formation net of EU-funded capital transfers),
- CAPEX_E: EU capital transfers received by general government,
- S: public gross savings (current revenues minus current expenditure),

[4] The baseline specification uses 2007 as the treatment year, marking the start of Slovakia's first full EU programming period (2007–2013). The date is used as an analytical break rather than as a discrete exogenous treatment, and alternative treatment years (2004, 2012 and 2016) are examined for robustness.

[1] CZ, EE, LT, LV, HU, PL, SI

– DEBT: general government gross debt (Maastricht debt).

Variable selection is guided by economic relevance, model stability and parsimony, with statistical diagnostics used as supporting checks rather than as the primary criterion for inclusion[2]. Public savings captures the availability of domestic fiscal resources, while public debt captures the broader fiscal position that may constrain investment decisions. However, both variables are themselves affected by past spending decisions, macroeconomic conditions and fiscal-policy choices. The use of lagged relationships in the PVAR helps to reduce contemporaneous simultaneity, but it does not provide an external source of identification. In particular, the model does not exploit exogenous debt shocks, fiscal surprises or external instruments. The estimated responses should therefore be interpreted as reduced-form dynamic relationships within the fiscal-investment system, rather than as structural causal effects of public debt, public savings or EU funding.

Stationarity of the variables is assessed using the cross-sectionally augmented panel unit-root test (Pesaran, 2007), which accounts for cross-sectional dependence arising from common shocks. The null hypothesis of non-stationarity is rejected for all variables included in the model (Annex A, Table A1).

2.2 PVAR methodology

The empirical analysis relies on dynamic panel vector autoregression (PVAR). PVAR captures dynamic interactions and feedback among the variables and serves as the main framework for the analysis. Lag length in both models is selected based on information criteria.

The PVAR model is specified as a first-order panel VAR:

$$y_{i,t} = c + \boldsymbol{A}_1 y_{i,t-1} + \varepsilon_{i,t},$$

where $y_{i,t}$ is a vector including CAPEX_D, CAPEX_E, S, and DEBT, expressed in first differences (year-on-year changes) as a percentage of GDP. The matrix $\boldsymbol{A}_1$ captures dynamic effect of the previous year, c is a vector of constants, and ε is a vector of residuals.

The model satisfies standard stability conditions (all characteristic roots lie inside the unit circle; see Annex B, Figure B1), supporting its use for dynamic simulations.

To assess the role of EU funding, we conduct a counterfactual simulation within the estimated PVAR framework. Starting in 2017, EU-funded investment (CAPEX_E) is set to zero. The remaining

[2] Pairwise cross-correlations were examined as a diagnostic for excessive collinearity among the included variables. This diagnostic does not address potential endogeneity arising from the joint determination of fiscal variables.

variables are not fixed at their observed values but evolve endogenously according to the estimated PVAR equations. This allows domestically financed investment, public savings and government debt to adjust to the absence of EU-funded investment through the dynamic relationships captured by the model.

The counterfactual scenario should be interpreted as stylised benchmark rather than realistic policy path.

2.3 Data for synthetic control analysis

The synthetic control analysis is based on a broader cross-country dataset constructed to approximate Slovakia's public investment trajectory using comparable economies. The outcome variable is consistent with the panel analysis and is defined as domestically financed public investment expressed as a percentage of GDP.

In contrast to the panel dataset, the SCM framework prioritises the quality of the pre-treatment fit rather than the modelling of dynamic relationships. The selection of predictors and donor countries is therefore tailored to match Slovakia's pre-treatment investment trajectory and relevant structural characteristics.

Several donor pools are considered, including Central and Eastern European economies (CEE), an extended CEE group (CEE+), cohesion countries and a broader EU benchmark sample (for the specification of groups, see Annex C, Table C1).

Expanding the donor pool beyond the panel sample improves the flexibility of the synthetic match and reduces the risk that results are driven by a narrow set of comparators.

Predictor variables are selected to capture structural and macroeconomic characteristics associated with investment dynamics rather than short-term fiscal interactions. These include real GDP growth, public savings, trade openness, foreign direct investment and governance efficiency (Annex C, Table C2). The variables represent different dimensions relevant for public investment: GDP growth captures the macroeconomic environment; public savings proxy the domestic fiscal capacity to finance investment; trade openness and FDI capture differences in economic structure and external integration; and governance efficiency captures broader institutional and administrative capacity relevant for the preparation and implementation of public investment.

These predictors do not, however, reproduce every institutional or fiscal constraint faced by Slovakia and the donor countries. In particular, the SCM does not explicitly match countries according to their Excessive Deficit Procedure (EDP) status. Fiscal consolidation requirements may affect the capacity to finance investment from domestic resources independently of EU

funding. Similarly, governance efficiency provides only a broad proxy for public-sector implementation capacity rather than a direct measure of investment capability. These factors should therefore be considered when interpreting the post-treatment divergence.

Given the sensitivity of the synthetic control method to model specification, the analysis considers multiple donor pools and alternative predictor sets. This approach allows for a systematic robustness assessment and helps ensure that the estimated divergence is not driven by a particular modelling choice.

Although the panel and SCM datasets differ in scope and specification, they are conceptually aligned. In both cases, the analysis focuses on the relationship between EU funding and domestically financed public investment, with variables expressed in comparable units and drawn from harmonised sources. The two approaches nevertheless answer different questions: the panel estimates the average relationship across countries, whereas the SCM assesses whether Slovakia's investment trajectory diverged from a synthetic benchmark. This alignment ensures that the findings obtained from the two datasets can be interpreted within a common analytical framework despite differences in country coverage and model specification.

2.4 Synthetic control methodology

The synthetic control method, originally developed by Abadie and Gardeazabal (2003) and further formalised in Abadie et al. (2010), is employed to assess whether Slovakia's domestically financed public investment evolved differently from that of comparable European economies during periods of expanded EU cohesion policy funding. Rather than constructing a scenario in which EU funding would be absent, the analysis focuses on whether Slovakia's investment trajectory diverged from that observed in similar economies operating within a broadly comparable institutional and policy environment.

Let Y_{it} denote the outcome variable, defined as domestically financed public investment as a percentage of GDP for country i in year t. Slovakia is treated unit, $i = 1$, while $i = 2, \dots, J+1$ denotes the countries in the donor pool. The synthetic is defined as

$$Y_{1t}^{S} = \sum_{j=2}^{J+1} w_j Y_{jt},$$

where the donor weights satisfy $w_j \geq 0$ and $\sum_{j=2}^{J+1} w_j = 1$.

The weights are chosen to minimise the discrepancy between Slovakia and the synthetic control using information from the pre-treatment period. In the implemented specification, the optimisation matches the full available pre-treatment trajectory of domestically financed public

investments and selected macroeconomic predictors. Let X_1 denote the vector of predictors for Slovakia and X_0 the corresponding matrix for donor countries. The weights are obtained by minimising

$$W^* = arg \min_W \left[\sum_{t<T_0} v_t \left(Y_{1t} - \sum_{j=2}^{J+1} w_j Y_{jt} \right)^2 + \lambda \| X_1 - X_0 W \|^2 \right]$$

subject to $w_j \geq 0$ and $\sum_j w_j = 1$. In the baseline specification, v_t assigns progressively greater weight to more recent pre-treatment outcome observations, while an alternative specification assigns equal weight to all pre-treatment years. The parameter λ determines the relative contribution of predictor component and is set to 1.

The timing of the predictors is aligned with each treatment year T_0. The outcome component uses all available observations prior to treatment, excluding 1997, while structural predictors are averaged over the 4 years immediately preceding treatment. The same rule is applied to the alternative treatment years for robustness check.

Once the weights are estimated, they are held fixed in the post-treatment period. The difference between observed and synthetic variable is

$$Gap_{1t} = Y_{1t} - Y_{1t}^S,$$

where a negative gap indicates that domestically financed public investment in Slovakia falls below the trajectory implied by the synthetic benchmark.

To account for potential structural changes, several treatment years are considered: 2004, 2007, 2012 and 2016. These correspond to key institutional and macroeconomic phases such as EU accession, the start of the first full programming period, post-global financial crisis adjustment and the completion of the 2007–2013 funding cycle.

The donor pool includes CEE economies as well as broader comparator groups (see Annex C, Table C1). Predictor variables capture structural and macroeconomic characteristics associated with investment dynamics, including real GDP growth, trade openness, foreign direct investment, public savings and governance efficiency (Annex C, Table C2). Given the sensitivity to specifications, we consider alternative combinations of predictors, together with pre-treatment weighting and donor-pool trimming variants.

To assess robustness, placebo tests are conducted by iteratively applying the SCM procedure to comparison countries, treating each as if it were the treated unit. Inference is based on the ratio of post-treatment to pre-treatment root mean squared prediction errors (RMSPE),

$$R_i = \frac{RMSPE_i^{post}}{RMSPE_i^{pre}}.$$

Higher values indicate a larger deterioration in model fit after the treatment year and therefore a stronger divergence from the synthetic counterfactual. The relative position of Slovakia within the distribution of placebo RMSPE ratios provides an indication of how unusual the estimated post-treatment divergence is relative to the placebo units.

3. Results

3.1 Panel model results

The dynamic panel VAR provides evidence of a negative relationship between EU-funded and domestically financed public investment. The coefficient on lagged CAPEX_E is negative and statistically significant, indicating that higher EU fund absorption in the previous year is associated with lower domestic CAPEX_D (Table 1). This finding is consistent with a degree of substitution between alternative sources of investment financing, whereby the availability of external funding is associated with a reallocation of domestic fiscal resources. At the same time, EU-funded investment should not be viewed as an exogenous driver of public investment decisions. Governments simultaneously determine the scale and composition of public investment, including project applications, national co-financing and the allocation between domestic and EU-funded expenditure. The estimated relationship therefore reflects the dynamic interaction of these policy choices rather than a purely one-way effect from EU funding to domestic investment.

Gross public savings (S) enter positively and robustly, consistent with a positive association between fiscal space and domestically financed public investment. Gross debt (DEBT) is close to conventional significance thresholds, suggesting a modest relationship with investment dynamics. The CAPEX_D equation exhibits relatively high explanatory power, with an R^2 of 0.66.

The remaining equations provide additional insights into the dynamics of the system. The DEBT equation exhibits a high degree of persistence, with significant effects from lagged debt and EU-funded investment. The CAPEX_E equation is also highly persistent, reflecting the multiannual nature of EU cohesion policy programmes and investment implementation cycles. In the savings equation, lagged savings remain the main determinant of current savings, pointing to the persistence of fiscal positions over time.

Table 1: PVAR estimation (1996 – 2016)

Variable	Coefficient			
	CAPEX_D eq.	*DEBT eq.*	*CAPEX_E eq.*	*S eq.*
$CAPEX_D_{t-1}$	**0.664** ***	0.885 ***	0.007	- 0.069
$DEBT_{t-1}$	**0.006** *	0.927 ***	- 0.003	- 0.006
$CAPEX_E_{t-1}$	**- 0.191** **	0.893 **	0.778 ***	0.222
S_{t-1}	**0.110** ***	- 0.671 ***	- 0.053 ***	0.756
Intercept	**1.129** ***	0.229	0.308 *	0.748

Source: Own calculations

*Note: Significance stars indicate statistical significance: * p < 0.10, ** p < 0.05, and *** p < 0.01*

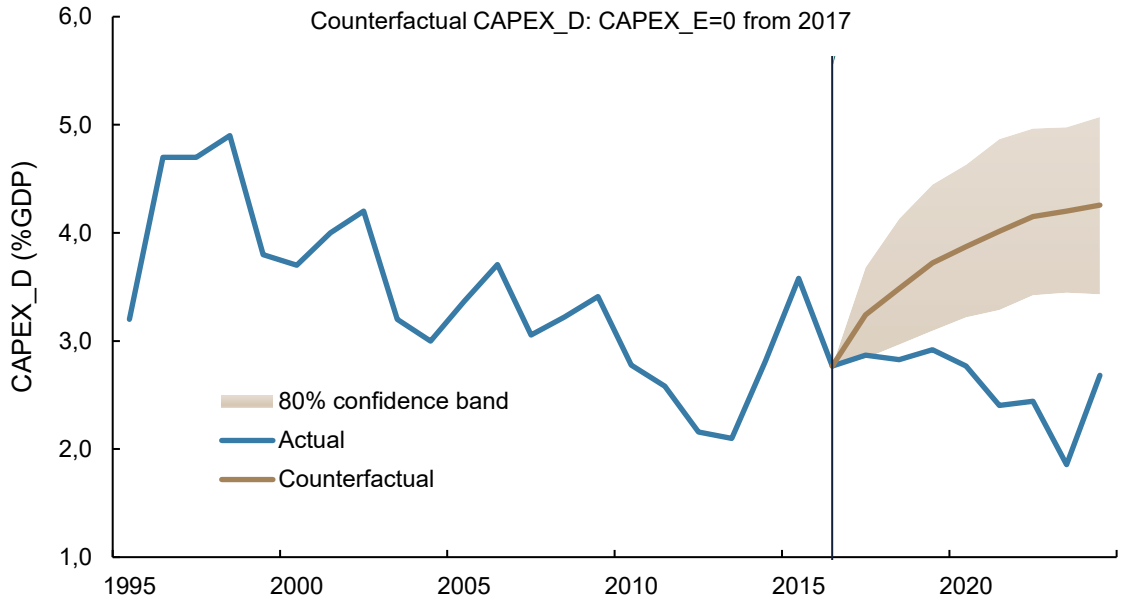
Counterfactual simulation

To assess the quantitative implications of the estimated relationship, a counterfactual simulation is conducted within the PVAR framework. The year 2016 is selected as the break point, reflecting the completion of the 2007-2013 programming period and providing a fully observed pre-simulation period. Starting in 2017, EU-funded investment (CAPEX_E) is exogenously set to zero. The remaining endogenous variables, including domestically financed public investment (CAPEX_D), gross debt (DEBT) and public savings (S), evolve recursively according to the estimated PVAR system. As a result, debt and savings are allowed to adjust endogenously to the removal of EU-funded investment together with all feedback effects implied by the model.

Figure 2 presents the counterfactual trajectory. The simulated path of domestically financed public investment lies above the observed path after 2016, consistent with the negative relationship between EU-funded and domestically financed investment identified in the panel estimates. The divergence between the two series suggests that higher EU fund absorption may be associated with lower levels of domestically financed public investment, pointing to a potential substitution mechanism between the two financing sources.

At the same time, the counterfactual should be interpreted with caution. The exercise does not aim to describe how the Slovak economy would have evolved in the complete absence of EU funds. Such a scenario would likely affect a broader set of economic and fiscal outcomes, including economic growth, government revenues, debt dynamics and policy choices, which are outside the scope of the model. Instead, the simulation isolates the implications of removing EU-funded investment within the relationships captured by the estimated PVAR system.

Figure 2: Counterfactual simulation based on PVAR



Source: Own calculations

Note: The shaded area shows the 80% bootstrap confidence interval around the median counterfactual path. The interval is constructed from 1,000 bootstrap simulations using resampled model residuals.

The average difference between the observed and simulated paths amounts to approximately 1,2 p.p. of GDP per year over the period 2017-2024 (Table 2). This suggests that the substitution mechanism identified in the panel estimates may also be economically meaningful.

The confidence bands around the counterfactual trajectory point to a non-negligible degree of uncertainty surrounding the estimated magnitudes. Consequently, estimates should be viewed primarily as an illustration of the potential scale rather than as a precise estimate of the effect.

Table 2: Estimated substitution effect of EU funds on domestic public investment after 2016

Model	Counterfactual scenario	Average annual impact on CAPEX_D 2017-2024 (% of GDP)	Cumulative impact 2017-2024 (% of GDP)
PVAR	EU = 0 from 2017	−1,2	-9,6

Source: Own calculations

3.2 Synthetic control results

The comparison between the observed trajectory of domestically financed public investment and the synthetic counterfactual provides an indication of how investment dynamics in Slovakia evolved relative to comparable benchmark economies. The baseline specification uses 2007 as

the treatment year and constructs synthetic Slovakia from the CEE donor pool using government gross savings (S), foreign direct investment (FDI), and trade openness (OPEN) as predictors.

The composition of the synthetic control is reported in Table 3. Five of the seven countries in the donor pool receive positive weights. The synthetic benchmark is therefore not driven by a single donor. The donor weights should not be interpreted as a ranking of countries according to their overall similarity to Slovakia. Rather, they identify the combination of countries that best reproduces Slovakia's pre-treatment investment trajectory and the predictor characteristics included in the specification. Consequently, an economically relevant comparator may receive a zero weight in one specification if its contribution to the synthetic match is replicated by a combination of other donors.

Table 3: Donor weights in the baseline synthetic control

Country	Weight (%)
EE	31.2
PL	23.0
SI	21.6
LT	12.4
HU	11.9
CZ	0.0
LV	0.0

Note: Weights are constrained to be non-negative and to sum to one. The baseline specification uses the CEE donor pool and treatment year 2007.

Source: Own calculations

The donor weights should not be interpreted as a ranking of countries according to their overall similarity to Slovakia. An economically close comparator may therefore receive no weight, as in the case of the Czech Republic in the baseline specification, if other donors provide a better pre-treatment match; importantly, the Czech Republic receives positive weights in several alternative specifications. Economic plausibility is further supported by using the relatively homogeneous CEE group as the baseline donor pool, drawing predominantly on economies sharing similar regional and structural characteristics with Slovakia. The negative post-treatment gap is most pronounced within this group and becomes weaker as the donor pool is broadened to more heterogeneous economies. This supports placing greater interpretative weight on the regionally comparable CEE benchmark, while the broader donor pools serve primarily as robustness checks. Table 4 reports the balance of the three predictors together with the pre-treatment fit. The match is not exact. Synthetic Slovakia has a higher value of government gross savings than observed Slovakia, while it has lower FDI and trade openness. These differences should be read together with the outcome fit, since the optimisation simultaneously seeks to reproduce the pre-

treatment CAPEX_D trajectory and the selected predictors rather than matching each predictor exactly.

Table 4: Predictor balance and post/pre-treatment fit

Predictor	Slovakia (X_1)	Synthetic (X_0W)	Difference
Government gross savings (S)	1.23	2.52	-1.29
Foreign direct investment (FDI)	5.06	3.73	1.33
Trade openness (OPEN)	1.45	1.12	0.33
Pre-treatment RMSPE (% of GDP)	0.56		
Post-treatment RMSPE (% of GDP)	1.26		
post/pre-treatment RMSPE ratio	2.25		

Note: Predictor values are the four-year pre-treatment averages used in the baseline specification (2003–2006). Difference = Slovakia − synthetic Slovakia. RMSPE is calculated over 11 available pre-treatment observations; 1997 is excluded.

Source: Own calculations.

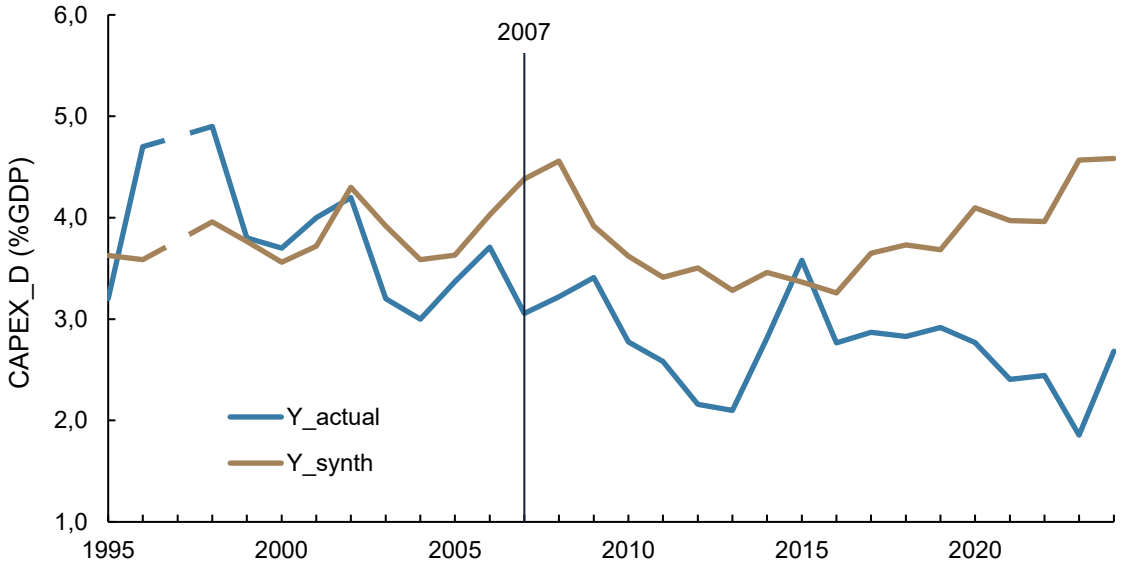
There is no generally accepted absolute threshold for pre-treatment RMSPE, as its interpretation depends on the scale and variability of the outcome. The baseline pre-treatment RMSPE indicates an imperfect, but not unusually poor, fit within the broader set of SCM specifications considered in this paper. Within the CEE specifications using the same 2007 treatment year, however, several alternative specifications achieve a closer pre-treatment fit. This uncertainty is considered by assessing results across alternative specifications and by scaling the post-treatment divergence relative to the pre-treatment fit. A post/pre-treatment RMSPE ratio of 2.25 means that the root-mean-square deviation between actual and synthetic Slovakia after 2007 is more than twice as large as during the pre-treatment period, indicating a marked deterioration in fit after the treatment date.

The comparison between the observed trajectory of CAPEX_D and the synthetic counterfactual provides an initial indication of how investment dynamics in Slovakia evolved relative to comparable economies (Figure 3).

The synthetic control reproduces the broad pattern of the pre-treatment trajectory, although the fit is not exact. This reflects, in part, the specific macroeconomic conditions of the 1990s and early 2000s, including the structural transition period. The imperfect pre-treatment fit is reflected in the pre-treatment RMSPE and is considered when interpreting the post-treatment results.

Following the treatment year, the trajectories begin to diverge more visibly. The observed CAPEX_D series gradually falls below the synthetic, indicating that domestically financed public investment in Slovakia evolved below the level implied by comparable economies. This divergence should not be interpreted as the trajectory of a hypothetical "Slovakia without EU funds". As the distance from the treatment year increases, the gap may increasingly capture other Slovakia-specific developments that are not reproduced by the synthetic control.

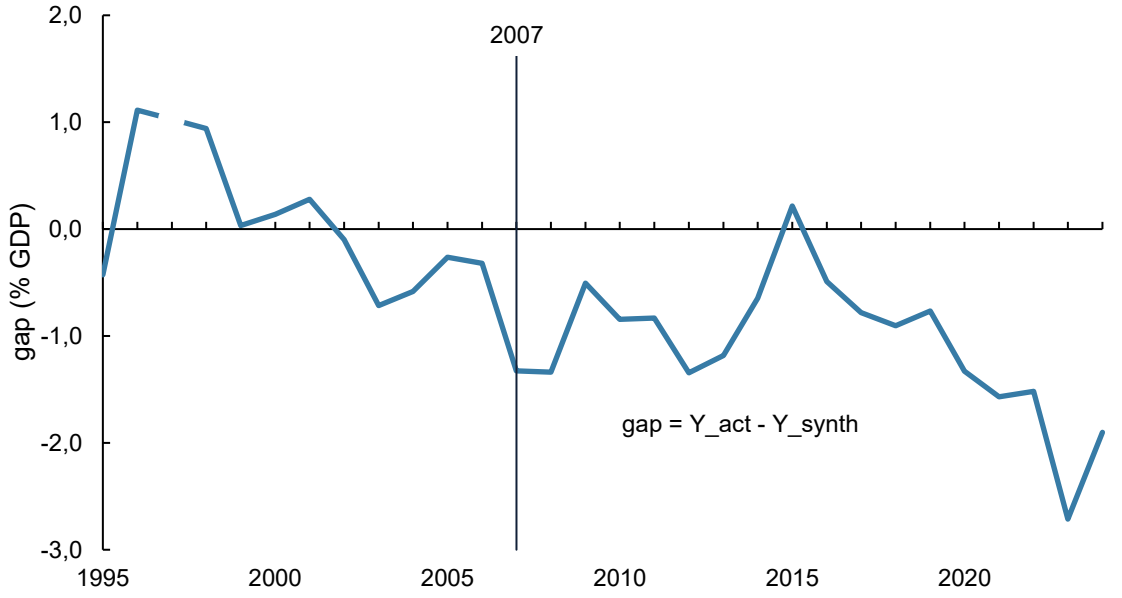
Figure 3: SCM fit for Slovakia



Note: The figure reports the baseline SCM specification for the CEE donor pool with 2007 as the treatment year. The predictor set includes public gross savings (S), foreign direct investment (FDI) and trade openness (OPEN), averaged over the four years preceding treatment (2003–2006). The baseline specification uses linear time weighting, assigning progressively greater weight to more recent pre-treatment observations. The year 1997 is exclude from the SCM estimation due to an exceptional high level of public CAPEX in Slovakia associated with macroeconomic imbalances (see Figure 1).

Source: Own calculations

Figure 4: SCM gap plot



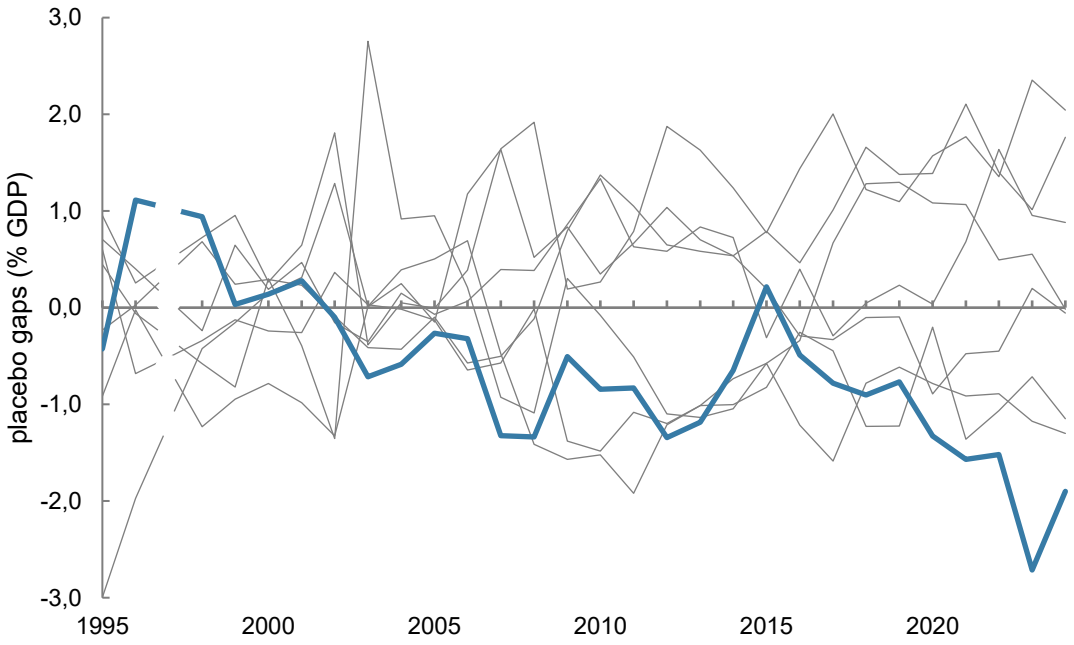
Note: The gap represents the difference between the observed value of domestically financed public investment in Slovakia and the value predicted by the synthetic control ($Gap_t = Y_t^{Actual} - Y_t^{Synthetic}$). Negative values indicate that actual investments fall below the level implied by the synthetic counterfactual.

Source: Own calculations

This pattern becomes more apparent when examining the gap between the observed and synthetic series (Figure 4). While the pre-treatment gap exhibits some variability, the post-treatment period is characterised by a predominantly negative and persistent deviation. The negative post-treatment divergence is not specific to the 2007 treatment date. When the treatment year is moved forward to 2012 or 2016, the CEE specifications continue to produce predominantly negative post-treatment gaps, with median gaps of around -1 p.p. of GDP. This suggests that the observed divergence is not driven solely by the choice of the baseline treatment year. As mentioned earlier, the post-treatment gap may reflect other specifics in Slovakia.

Placebo tests confirm the robustness of this result (Figure 5). The post-treatment deviation observed for Slovakia is among the largest within the donor distribution, while most placebo trajectories remain centred around zero and do not display comparable deviations.

Figure 5: Placebo gap distribution in CEE donor pool with treatment in 2007

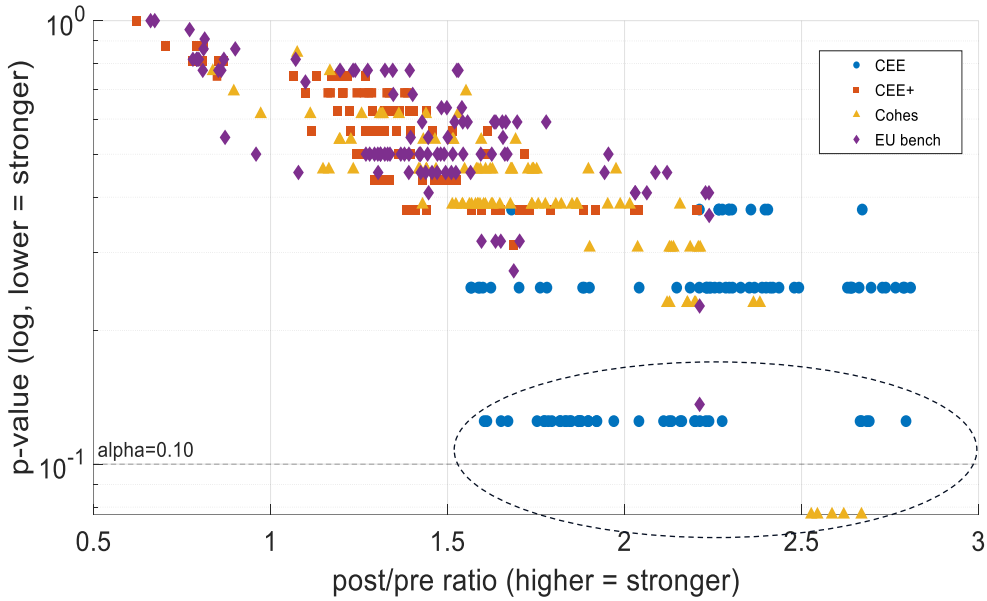


Source: Own calculations

Additional robustness analysis across alternative specifications further examines the sensitivity of the results to model design choices (Figure 6). To assess sensitivity to model design choices, the analysis evaluates alternative donor pools, treatment years and weighting schemes. The complete specification grid is reported in Annex C, Table C2. Figure 6 shows that specifications generating larger post-treatment divergences relative to their pre-treatment fit are associated with lower placebo-based p-values. This relationship is consistent with the construction of the placebo inference, whereby larger post/pre-treatment RMSPE ratios place Slovakia further into the placebo distribution. The figure should therefore be interpreted primarily as a summary of how

the magnitude of the estimated divergence and placebo-based inference vary across the specification space, rather than as an independent validation of the donor pool.

Figure 6: Evidence map of SCM estimates (post/pre ratio vs p-value)

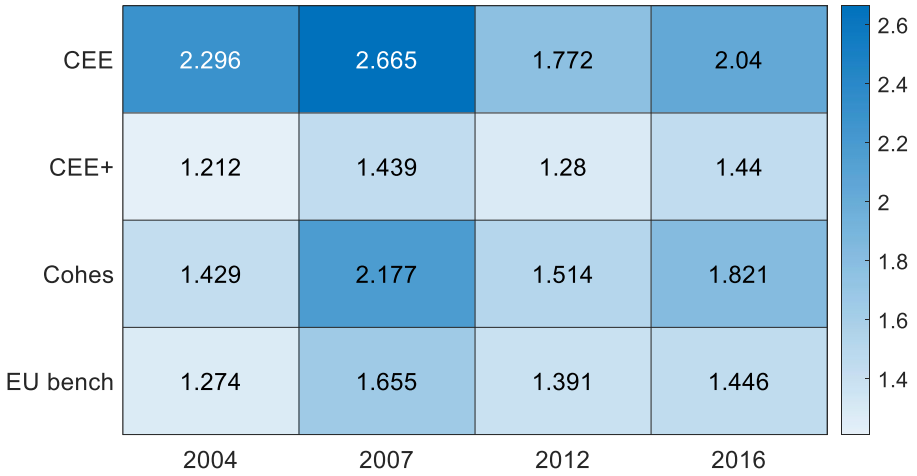


Note: The evidence map summarizes results across all SCM specifications by plotting the relationship between the post/pre RMSPE ratio and placebo-based p-values. The horizontal axis reports the post/pre ratio, which measures the deterioration of model fit after the treatment period relative to the pre-treatment period. Higher values therefore indicate stronger divergence from the synthetic counterfactual. The vertical axis reports placebo p-values on a logarithmic scale, where lower values indicate stronger statistical significance.

Source: Own calculations

The heatmap of median post/pre ratios (Figure 7) confirms that stronger divergences are consistently observed for specifications based on regional comparator groups and earlier treatment periods, particularly around the mid-2000s. Across donor pools and model configurations, the negative post-treatment gap remains a stable feature of the data.

Figure 7: Median post/pre ratios across donor clusters and treatment years



Note: The heatmap reports median post/pre RMSPE ratios across SCM specifications grouped by donor pool and treatment year. Each cell represents the median ratio obtained from the corresponding set of model specifications. Higher values

indicate a larger deterioration of model fit after the treatment year and therefore stronger divergence between the observed trajectory of CAPEX_D in Slovakia and the synthetic counterfactual.

Source: Own calculations

The robustness analysis reported in Annex C further demonstrates that the estimated effect is not driven by a particular model configuration. Across all 400 SCM specifications, negative post-treatment gaps dominate the results irrespective of donor pool selection, treatment year, or weighting scheme. The most statistically consistent effects are observed in specifications based on CEE donor pools, while broader comparator groups (see Annex C, Table C3).

The SCM results indicate a persistent divergence of domestically financed public investment in Slovakia from the trajectory implied by comparable economies. This finding is consistent with the presence of composition and timing effects associated with EU funding, as outlined in the conceptual framework. The consistency of the estimated effect across a large set of alternative specifications strengthens confidence that the observed divergence reflects a systematic feature of the data rather than a consequence of a particular modelling choice.

4. Discussion

The results suggest that EU funding is associated with a shift in the structure of public investment in Slovakia rather than a proportional increase in domestically financed investment. The panel estimates point to a reallocation of domestic fiscal resources, while the synthetic control results provide complementary evidence that Slovakia's domestically financed public investment followed a weaker post-treatment trajectory relative to comparable economies. The SCM evidence should not, however, be interpreted as an additional estimate of the effect of EU funding, as the observed divergence may also reflect other Slovakia-specific developments. This interpretation is consistent with previous cross-country evidence showing that EU transfers do not fully translate into higher public investment and are partly absorbed through reallocation within government budgets (González Alegre, 2010). The findings also point to the importance of timing, as the EU programming cycle appears to contribute to a more uneven distribution of investment over time.

A key limitation of the empirical analysis is the relatively short time dimension of the panel, which restricts the ability of the dynamic models to identify long-run adjustment dynamics. With a limited number of observations, both the dynamic panel regression and the PVAR estimates are sensitive to lag selection and model specification, increasing uncertainty around simulated dynamic paths. The small sample size also reduces the power of statistical tests and limits the scope for more flexible dynamic structures without risking overparameterisation.

The SCM is subject to a different set of limitations. Its results depend on the choice of treatment year, donor pool, predictors and pre-treatment weighting, although these sensitivities are addressed through alternative specifications. More fundamentally, the treatment dates capture periods associated with changes in EU funding rather than a discrete exogenous intervention. The post-treatment gap may therefore reflect both EU-funding-related developments and other Slovakia-specific fiscal, institutional or macroeconomic factors not reproduced by the synthetic control.

The findings should therefore be interpreted as complementary reduced-form evidence consistent with a reallocation of public investment financing, rather than as precise structural or causal estimates of the effect of EU funds.

5. Conclusion

This paper examines how large and persistent inflows of EU funding have shaped not only the level of public investment in Slovakia, but also its financing structure and dynamics. The results point to a broader mechanism than a simple increase in investment financed by additional external resources.

Dynamic panel estimates show that higher EU-funded investment is systematically associated with lower domestically financed public investment. PVAR Counterfactual simulation suggest that domestic investment could have followed a somewhat higher path after 2016 in the absence of EU transfers. The results are consistent with a degree of substitution between EU-funded and domestically financed investment, suggesting that part of the additional financing provided by EU funds may have been associated with a reallocation of domestic fiscal resources rather than a proportional increase in investment financed from both sources.

The synthetic control analysis adds a country-specific perspective. Slovakia's domestically financed public investment follows a persistently weaker trajectory than that implied by comparable European economies, with the divergence emerging after the mid-2000s and remaining visible across a broad range of specifications. The SCM gap is not an additional estimate of the effect of EU funding but shows that Slovakia's investment trajectory evolved differently from its synthetic benchmark as EU funding became an increasingly important source of investment.

The main contribution is therefore not simply evidence of substitution between EU and domestic financing. The results suggest that sustained access to external funding can change the financing regime of public investment. In Slovakia, domestic resources appear to play a weaker role in

determining investment dynamics, while aggregate investment has become more closely linked to the EU implementation cycle. This helps explain the coexistence of substantial EU transfers, subdued domestic investment and pronounced investment peaks around the ends of programming periods.

This distinction also changes how public investment performance should be assessed. High aggregate investment during periods of intensive EU fund absorption does not necessarily imply a corresponding strengthening of the underlying domestic investment effort. The composition of investment by source of financing therefore provides information that aggregate investment indicators alone may obscure.

Policy implications

The findings shift the policy question from how much EU funding is absorbed towards how EU funding interacts with the domestic investment system. The objective is not to prevent fiscal reallocation when EU financing becomes available, but to ensure that domestic investment capacity does not become excessively dependent on the EU programming cycle.

This requires better integration of EU-funded and domestically financed projects within a common medium-term investment framework. Domestic resources should continue to support economically justified priorities that are not covered by EU programmes, rather than being mechanically reduced as external financing increases.

Investment planning should also explicitly address the cyclicality associated with EU funding. A mature pipeline of domestic and EU-funded projects, supported by multiannual budgeting, could reduce expenditure peaks at the end of programming periods and make investment less dependent on absorption deadlines.

Finally, fiscal surveillance should monitor the financing composition alongside the aggregate level of public investment. Separating domestic and EU-funded investment helps distinguish a durable domestic investment effort from temporarily high investment supported by external financing.

The broader lesson extends beyond Slovakia. For economies receiving large and persistent EU transfers, success should not be assessed only by whether EU funds raise investment during periods of high absorption, but by whether they expand investment capacity without weakening the domestic ability to sustain public investment across funding cycles. This shifts the policy objective from maximising absorption towards integrating EU funding into a stable domestic investment framework.

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Annex A

Table A1. Descriptive statistics of public investment by country and source of financing

		CAPEX_T					CAPEX_D					CAPEX_E				
Geo	**EU entry**	**Mean**	**SD**	**Min**	**Max**	**N**	**Mean**	**SD**	**Min**	**Max**	**N**	**Mean**	**SD**	**Min**	**Max**	**N**
		% GDP				**No. obs.**	**% GDP**				**No. obs.**	**% GDP**				**No. obs.**
AT	1995	3.1	0.4	2.5	3.9	30	3.1	0.3	2.5	3.9	30	0.0	0.0	0.0	0.2	30
BE	1958	2.4	0.3	1.9	3.1	30	2.3	0.3	1.9	3.0	30	0.0	0.0	0.0	0.1	30
BG	2007	3.5	1.3	0.5	6.6	30	3.0	1.1	0.5	5.2	30	0.9	0.8	0.3	3.7	18
CY	2004	3.5	0.9	2.3	5.2	30	3.3	1.0	1.7	5.2	30	0.3	0.2	0.0	0.7	21
CZ	2004	4.6	0.8	3.2	7.6	30	4.0	0.9	2.7	7.6	30	0.8	0.4	0.1	1.7	21
DE	1958	2.6	0.2	2.2	3.1	30	2.4	0.2	2.1	3.0	30	0.1	0.0	0.1	0.2	30
DK	1973	3.1	0.3	2.6	3.8	30	3.1	0.3	2.6	3.8	30	0.0	0.0	0.0	0.1	30
EE	2004	5.3	0.6	4.4	6.5	30	4.7	0.6	3.5	5.9	30	0.9	0.4	0.3	1.8	21
EL	1981	4.3	1.1	2.5	6.1	30	4.0	1.1	2.2	5.9	30	0.3	0.1	0.1	0.7	30
ES	1986	3.4	0.9	2.0	5.2	30	3.4	0.9	2.0	5.2	30	0.0	0.0	0.0	0.0	30
FI	1995	4.0	0.3	3.3	4.9	30	3.9	0.4	3.2	4.9	30	0.1	0.0	0.0	0.1	30
FR	1958	4.3	0.3	3.8	4.8	30	4.3	0.3	3.8	4.8	30	0.0	0.0	0.0	0.0	30
HR	2013	4.8	1.0	2.6	6.3	30	4.5	1.3	2.2	6.3	30	0.9	0.6	0.1	2.2	12
HU	2004	4.2	1.3	0.6	6.5	30	3.3	1.1	0.6	5.0	30	1.2	0.9	0.0	3.7	21
IE	1973	2.9	0.9	1.7	5.3	30	2.6	1.0	1.1	5.3	30	0.3	0.3	0.0	1.2	30
IT	1958	2.8	0.4	2.1	3.6	30	2.8	0.4	2.1	3.6	30	0.0	0.0	0.0	0.0	30
LT	2004	3.6	0.9	2.3	5.4	30	2.8	0.5	2.1	4.3	30	1.1	0.6	0.4	2.7	21
LU	1958	4.3	0.5	3.5	5.5	30	4.2	0.5	3.5	5.4	30	0.1	0.0	0.0	0.2	30
LV	2004	4.2	1.6	1.5	6.3	30	3.5	1.2	1.5	5.6	30	1.0	0.4	0.5	1.7	21
MT	2004	3.5	0.7	2.2	4.6	30	2.6	1.0	0.6	4.5	30	1.2	0.6	0.4	2.5	21
NL	1958	3.8	0.3	3.2	4.4	30	3.8	0.3	3.2	4.4	30	0.0	0.0	0.0	0.0	30
PL	2004	4.0	0.9	2.7	6.0	30	3.3	0.5	2.6	4.5	30	0.9	0.4	0.0	1.7	21
PT	1986	3.5	1.2	1.6	5.6	30	2.7	1.0	1.3	4.4	30	0.8	0.3	0.3	1.3	30
RO	2007	4.1	1.3	1.6	6.5	30	3.5	1.2	1.6	6.5	30	0.9	0.7	0.0	2.6	18
SE	1995	4.6	0.5	3.8	5.5	30	4.6	0.4	3.8	5.4	30	0.0	0.0	0.0	0.1	30
SI	2004	4.3	0.6	3.1	5.5	30	3.9	0.5	2.9	4.9	30	0.5	0.4	0.1	1.8	21
SK	2004	3.8	0.8	3.0	6.5	30	3.2	0.9	1.9	6.2	30	0.8	0.6	0.0	2.9	21

Note: CAPEX_T denotes total public investment, CAPEX_D domestically financed public investment, and CAPEX_E EU-funded public investment. Descriptive statistics for CAPEX_T and CAPEX_D is calculated over all available observations from 1995 onwards for each country. For CAPEX_E, statistics are calculated from the year of EU accession onwards (or from the 1995 for countries that joined before the beginning of the sample). N denotes the number of observations used in calculating the respective statistics.

Source: Eurostat, ECB, own calculations

Annex B

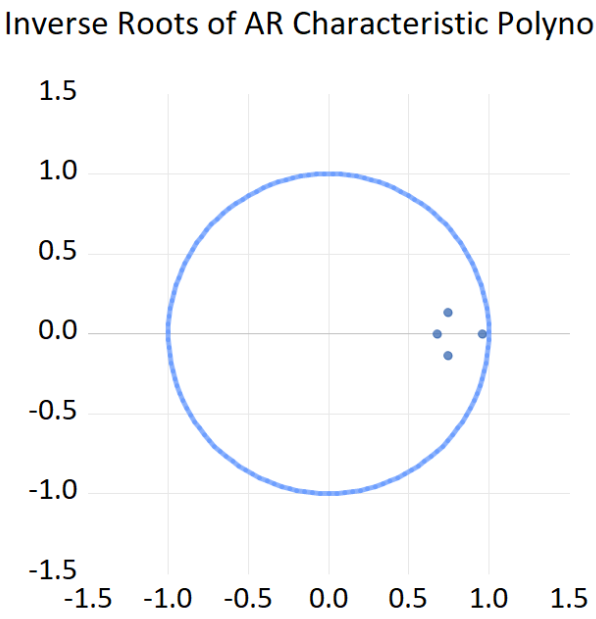
Table B1: Stationarity test results (CIPS) for individual variables

Variable	t-stat.	p-value	Conclusion
CAPEX_D	–3.0123	<0.01	H0 rejected → stationary
DEBT	–3.2445	<0.05	H0 rejected → stationary
CAPEX_E	–2.2226	<0.10	H0 rejected → weaker evidence of stationarity
S	–3.0301	<0.01	H0 rejected → stationary

Note: CIPS = Cross-sectionally Augmented IPS panel unit root test.

Source: Own calculations

Figure B1: Stability test of the PVAR (1) model



Source: Own calculations

Note: The figure plots the inverse roots of the panel VAR (1) model. Each point represents one root, and the circle marks the unit-root boundary. A VAR model is considered stable when all inverse roots lie inside the circle.

Annex C

Summary of Synthetic Control Model Specifications

This annex summarises the full set of synthetic control method (SCM) specifications used in the robustness analysis. The model space combines four donor pools, four alternative treatment years, five predictor specifications and five robustness variants, yielding 400 SCM specifications in total. Tables C1 and C2 document the specification design and predictor universe.

Table C1. SCM specification design

Dimension	**Values**
Treatment years	2004, 2007, 2012, 2016
Donor pools	CEE: CZ, HU, PL, SI, EE, LT, LV CEE+: CEE, BG, RO, CY, MT, HR Cohesion: CEE+, EL, IE, PT EU benchmark: Cohesion + AT, BE, NL, DK, FI, SE
Predictor specifications	1: none predictors 2: S + GE 3: S + FDI + OPEN 4: GDPg + FDI + GE 5: GDPg + OPEN + GE
Robustness variants	Baseline – linear time weighting (W_lin) Baseline – uniform time weighting (W_uniform) Trim-median – correlation-based donor trimming, W_lin Trim-top 5 – five most correlated donors, W_lin Trim-top 3 – three most correlated donors, W_lin
Total SCM specifications	4 donor pools × 4 treatment years × 5 predictor sets × 5 robustness variants = 400

Note: Country codes follow the codes used in the SCM dataset. Slovakia is the treated unit and is not part of the donor pools. The predictor sets listed above are combined with each donor pool, treatment year and robustness variant.

Source: Own elaboration

Table C2: Predictor universe used in the SCM specifications

Predictor	Description	Rationale for inclusion	Source
FDI	Net FDI flows/exposure	Accounts for capital inflows (integration) associated with EU accession.	Eurostat
GDPg	Real GDP growth	Anchors macro-cycle differences between Slovakia and donors.	Eurostat
S	Public gross savings	Captures the availability of public-sector resources that may contribute to investment financing; it is used as a broad fiscal indicator rather than a direct measure of fiscal constraints or investment capacity.	Eurostat
GE	Governance efficiency	Captures the government's ability to implement policies and deliver public services and investments effectively.	World Bank
OPEN	Trade openness (exports + imports over GDP)	Captures for trade-integration dynamics around 2004.	Eurostat

Source: Own elaboration

Table C3 summarises the resulting estimates. The results are strongest within the CEE donor pool, where the median post-treatment gap is negative for every treatment year and all specifications produce negative average post-treatment gaps. The EU new Member States pool (CEE+) shows a similar, although somewhat weaker, pattern. Results are less pronounced for the broader Cohesion and EU benchmark pools, where median RMSPE ratios are lower and placebo p-values generally higher. Across all four donor pools, however, median post-treatment gaps remain negative for every treatment year.

Table C3: Summary of SCM estimates by donor pool and treatment year

Panel A. CEE donor pool

Break year	Models	Median post/pre RMSPE ratio	Median post-gap	Median p-value	Share negative gaps
2004	25	2.30	-1.08	0.25	1.00
2007	25	2.67	-1.19	0.25	1.00
2012	25	1.77	-1.03	0.13	1.00
2016	25	2.04	-1.23	0.13	1.00

Panel B. CEE+ donor pool

Break year	Models	Median post/pre RMSPE ratio	Median post-gap	Median p-value	Share negative gaps

2004	25	1.43	-0.61	0.62	0.80
2007	25	2.18	-0.86	0.23	1.00
2012	25	1.51	-0.46	0.46	1.00
2016	25	1.82	-0.90	0.38	1.00

Panel C. Cohesion donor pool

Break year	Models	Median post/pre RMSPE ratio	Median post-gap	Median p-value	Share negative gaps
2004	25	1.21	-0.39	0.69	0.84
2007	25	1.44	-0.53	0.63	0.96
2012	25	1.28	-0.03	0.50	0.52
2016	25	1.44	-0.56	0.44	0.80

Panel D. EU benchmark donor pool

Break year	Models	Median post/pre RMSPE ratio	Median post-gap	Median p-value	Share negative gaps
2004	25	1.27	-0.51	0.77	0.92
2007	25	1.65	-0.71	0.59	0.96
2012	25	1.39	-0.43	0.50	0.68
2016	25	1.45	-0.59	0.45	0.80

Note: Each row summarises 25 specifications for the indicated donor pool and treatment year (five predictor sets × five robustness variants). The post/pre RMSPE ratio is the ratio of post-treatment to pre-treatment root mean squared prediction error; higher values indicate a larger deterioration in fit after the treatment year. The post-gap is the average post-treatment difference between observed CAPEX_D and its synthetic counterpart within each specification; the table reports the median of these average gaps across specifications. The p-value is derived from placebo post/pre RMSPE ratios. Share negative gaps is the proportion of specifications with a negative average post-treatment gap.

Source: Own calculations

All specifications estimate non-negative donor weights constrained to sum to one. The robustness variants alter either the relative importance of pre-treatment outcome observations or the composition of the donor pool; they do not impose equal donor-country weights.

The two baseline variants use the full donor pool. Under linear time weighting (W_lin), progressively greater weight is assigned to more recent pre-treatment observations of CAPEX_D. Under uniform time weighting (W_uniform), all available pre-treatment outcome observations receive equal time weight. Donor-country weights remain endogenously estimated in both cases.

The three trimming variants assess sensitivity to donor-pool composition. Potential donors are ranked by the correlation of their pre-treatment CAPEX_D trajectory with that of Slovakia. Trim-median retains donors with correlations at or above the median, while Trim-top 5 and Trim-top 3 retain the five and three most highly correlated donors, respectively. Donor weights are then re-estimated within the restricted pool using linear time weighting. These variants therefore test whether the results depend on the inclusion of less closely matched donor countries.