Stimulating Avenues:
EIB Loans and Returns to Public Investment

Morteza Ghomi and Evi Pappa*

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Abstract

We study the macroeconomic effects of persistent public investment shocks using a local-projection instrumental-variables framework and European data. For identification, we exploit European Investment Bank loans for public infrastructure projects and address potential endogeneity in loan approval with an inverse-probability-weighted regression-adjustment estimator. Public investment shocks raise employment and output in the medium term, without crowding out private investment and consumption, or generating inflation and additional debt burden. The cumulative output multiplier reaches 3.38 after five years and is significant and larger when credit conditions are favorable. We report significant positive spillover effects from spending in public infrastructure in both output and employment.

JEL: E62, H41, H54

Keywords: local projections, instrumental variables, multipliers, government investment, spillovers.

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*Morteza Ghomi: morteza.ghomi@bde.es, Bank of Spain; Evi Pappa: ppappa@eco.uc3m.es, Universidad Carlos III de Madrid and CEPR; We are very grateful to Samuel Bentolila, Ambrogio Cesa-Bianchi, Juanjo Dolado, Plutarchos Sakellaris, Valerie Ramey, Debora Revoltella, George Weiers, and an anonymous referee for useful suggestions. We also thank seminar participants at the Bank of Spain internal seminar, the Public Finance Workshop at the Bank of Italy, UC Louvain, and the Spanish Macro Network (UAM). Evi Pappa acknowledges financial support from grants CEX2021-001181-M and PGC2018-094321-B-I00 financed by MICIU/AEI /10.13039/501100011033, and Comunidad de Madrid, grant CLIMAD-CM, PHS-2024/PH-HUM-126. Any views expressed in this paper are those of the authors and do not necessarily reflect the views of the Bank of Spain or the Eurosystem.

1 Introduction

Public investment is a key driver of infrastructure development, and policymakers increasingly use it to stimulate economic growth and mitigate cyclical downturns. Recent policy initiatives in Europe underscore the need to scale up infrastructure spending. The Draghi (2024) report on EU competitiveness calls for significantly higher investments in innovation, infrastructure, and green technology. It estimates that roughly 800 € billion additional investment per year is needed to keep Europe competitive. In parallel, Germany has announced a 500 € billion infrastructure fund over twelve years to modernize networks and advance the green transition. Besides this progress in the policy arena, most existing studies find only modest short-run effects of public infrastructure investment and, at best, moderate medium-term impacts (see Ramey (2020)).

Our paper revisits this conventional view. Unlike most prior research, which focuses on the United States or relies on annual data for OECD economies, we study quarterly European data and uncover sizeable medium-term effects of public investment. To identify exogenous variation, we exploit European Investment Bank (EIB) loans for infrastructure projects granted to public firms and government entities. Using a local projection instrumental variables framework, we estimate the dynamic effects of public investment shocks. EIB loans are primarily funded through capital market borrowing backed by EU Member States' capital, which serves as a guarantee and confers an AA rating, enabling very low borrowing costs. Importantly, the EIB does not use the EU budget to fund its lending. Instead, it passes through the low-cost funding it raises in financial markets to support projects aligned with EU policy objectives. As a result, borrowing by one country does not crowd out financing for others.

Using a probit model, we show that the variation in the EIB loan treatment variable is predictable: the likelihood of receiving a loan increases with higher public debt-to-GDP ratios and productivity growth, EU accession, lower trade openness, and higher share in the EIB's subscribed capital. To address potential endogeneity in loan approvals, we apply the Inverse-Probability-Weighted Regression-Adjustment (IPWRA) estimator proposed by Jordà and Taylor (2016). This doubly robust procedure corrects for selection bias by reweighting observations according to their estimated probability of treatment and including relevant controls correlated with both loan approvals and outcomes, improving the credibility of our causal estimates.

Our results show that EIB loans provide a valid and powerful instrument for identifying changes in public investment, generating persistent and sizable increases in this spending component. The resulting public investment shocks boost medium-term output and employment, and to a lesser extent private investment, without creating inflationary pressures. Employment rises markedly in the medium term, while unemployment and real wages remain largely unchanged, indicating a labor-supply shift similar to that documented by Brückner and Pappa (2012) for government spending shocks. Productivity gains emerge with a delay and are sometimes statistically weak, reflecting the strong employment response. Importantly, the debt-to-GDP ratio does not rise, private consumption remains stable, and inflation does not react significantly to the shock.

Because the shock is anticipated, output multipliers are statistically insignificant in the first year. They increase steadily over time, becoming significant thereafter and exceeding one after one year, driven primarily by delayed employment responses and, to a lesser extent, private investment. The insignificant short-run multipliers we obtain reflect the persistent nature of the shock: EIB announcements convey information about spending increases that materialize gradually, reaching their peak about three years after the shock. After five years, the cumulative output multiplier of public investment reaches approximately three, a magnitude considerably larger than most estimates reported in the existing literature. We document positive output spillovers from increases in neighboring countries' infrastructure investment. These spillovers are driven by higher labor productivity, plausibly reflecting improved knowledge diffusion, the expansion of cross-border commuting zones, and reductions in trade and input costs that foster deeper integration into regional value chains.

Owing to the limited time span of European data, our analysis relies on panel regressions and identifies relative multipliers (see Nakamura and Steinsson, 2014). To complement this evidence, we exploit a longer quarterly time series for Spain and estimate government investment shocks in a single economy, instrumented with EIB loans. The resulting multipliers are not statistically different from the relative multipliers obtained in the panel analysis. While reassuring, this evidence does not validate the magnitude of the multipliers for all countries in the sample and constitutes a caveat of our analysis.

Unlike government consumption, public infrastructure investment is inherently productive and operates through an additional supply-news channel: higher investment signals future productivity gains, mitigating Ricardian and interest-rate effects, particularly in fiscally constrained economies (Canova and Pappa, 2025; Huidrom et al., 2020). These expectations relax financial constraints and amplify the stimulus. Consistent with this mechanism, we find larger investment multipliers under favorable financial conditions, when firms can respond more readily to persistent public investment shocks. By contrast, business-cycle states emphasized by Alloza (2022); Auerbach and Gorodnichenko (2012); Berge et al. (2021); Ghassibe and Zanetti (2022) do not materially affect investment-specific multipliers, in line with evidence for government consumption (Caggiano et al., 2015; Corsetti et al., 2012; Owyang et al., 2013; Ramey and Zubairy, 2018).

Prior studies using alternative identification strategies often find low, insignificant, or even negative short-run effects of public investment on output and employment (e.g., Ilzetzki et al., 2013; Pereira and De Frutos, 1999). Related work reports that short-run multipliers for public investment are smaller than those for government consumption (Boehm, 2020), and that highway spending can even be counterproductive as a short-run stimulus (Leduc and Wilson, 2014; Ramey, 2020). Leeper et al. (2010) provide a theoretical justification for such findings by showing that implementation lags in public capital formation can generate negative short-run output responses.

Medium-run estimates in the literature are also generally below those we obtain. Fernald (1999), studying the U.S. interstate highway system, finds that road investments were not unusually productive and yielded low output multipliers. Similarly, Wilson (2012), examining infrastructure spending under the American Recovery and Reinvestment Act, estimates multipliers below two and documents a positive but modest employment response after one year. Acconcia et al. (2014) report multipliers between 1.5 and 1.9 using variation from construction slowdowns induced by Mafia interference in Italy. Brueckner et al. (2023) and Gabriel et al. (2023), using regional European data, report estimates of total government spending multipliers around 2. Kraay (2012) estimates spending multipliers of about 0.5 using World Bank lending in developing countries. While methodologically related, our results differ for two reasons: we employ an instrument directly tied to infrastructure investment rather than total spending, and we explicitly address the non-random allocation of loans. Our estimates are consistent with the broader evidence in Jovanovic (2017), who show that cuts in government investment during fiscal consolidation had substantially larger adverse effects on subsequent output growth than equivalent reductions in government consumption.

Several factors may explain the relatively high multipliers we obtain. First, most of the existing literature estimates multipliers for total government spending rather than for public investment alone. Second, because monetary policy in the euro area is centralized, national public investment shocks are unlikely to elicit offsetting interest-rate responses. Third, financing matters: reliance on external funding limits domestic crowding-out and strengthens the expansionary effects of investment (Priftis and Zimic, 2021). The high persistence of the shocks we identify further contributes to the large multipliers. Consistent with our findings, Kanazawa (2021), using excess returns of narrowly defined road-pavement firms in Japan to instrument government infrastructure shocks, finds persistent and significant effects, with cumulative multipliers reaching six after four years. Finally, the labor-supply shift induced by the public investment shock, allowing employment to expand without raising unit labor costs, also helps explain the sizable medium-term multipliers we estimate.

The rest of the paper is structured as follows. Section 2 describes the aggregate data and the European Investment Bank loan dataset, provides summary statistics, and examines the predictability of EIB loans. Section 3 explains the econometric approach for estimating the effects of government investment shocks, and Section 4 collects the results of our analysis. It reports the estimated probabilities of receiving loans, presents the baseline findings, explores nonlinearities across economic conditions and spillover effects and reports robustness checks. Section 5 concludes. The appendix includes further data details and supplementary analyses.

2 Data

2.1 Macroeconomic Variables

Our dataset comprises quarterly observations for the period 1995Q1–2020Q1. National accounts variables for all 27 EU member states are obtained from Eurostat and include: GDP, private consumption, disaggregated components of public expenditure, gross fixed capital formation, employment, unemployment, real wages and total exports and imports. We also measure private investment as total gross fixed capital formation minus gross fixed public capital formation. All series are in real values, seasonally adjusted, and expressed in logarithmic levels. From the same source, we also collect quarterly data on public debt and the consumer price index (CPI), and yearly data for the total length of motorways. Stock market indices are obtained from the OECD, with data for Cyprus and Malta sourced from national statistical releases and other official publications. Interest rates are retrieved from the ECB's statistical database. The Global Financial Cycle index, capturing the common component in risky asset prices, capital flows, and leverage across countries, is taken from Miranda-Agrippino and Rey (2020).

2.2 EIB Project Financing Data

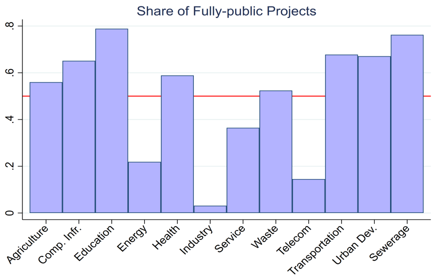
The European Investment Bank (EIB) is the European Union's long-term financing institution and is owned by the 27 EU Member States. Its mandate is to support EU policy objectives by financing investment projects in areas such as infrastructure, climate and environmental sustainability, innovation, and support for small and medium-sized enterprises. EIB lending is financed primarily through bond issuance in international capital markets, backed by the paid-in and callable capital of EU Member States, which underpins the Bank's high credit rating and low funding costs. The EIB does not rely on the EU budget or national fiscal resources; instead, it intermediates low-cost market funding to public firms and government entities. Because lending volumes are determined at the Bank level rather than by national budget constraints, loan allocations to one country do not mechanically crowd out financing available to others.

Each EIB-financed project proceeds through seven stages: (1) proposal preparation by a public or private promoter, including detailed descriptions of capital investment and financing plans; (2) appraisal by the EIB, which involves a comprehensive assessment of financial, economic, social, environmental, and technical aspects, including cost–benefit analysis, cash-flow projections, profitability, and borrower creditworthiness; (3) approval by the EIB Board; (4) contract signature; (5) disbursement of funds; (6) monitoring during implementation and operation; and (7) loan repayment by the borrower.

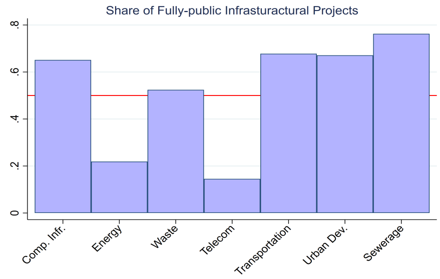
The EIB publicly discloses project-level information, including the signature date, financing amount, project title, financing status, sector of activity, and country. Loans are classified into 13 sectors: agriculture, composite infrastructure, credit lines (mainly to SMEs), education, energy, health, industry, services, solid waste, telecommunications, transportation, urban development, and water sewerage. Due to macroeconomic data availability, we focus on loans granted between 1995 and 2020 [1] to EU-27 countries, covering a total of 12,342 projects. For each country, we aggregate the total loan value at the quarterly frequency and exclude canceled projects and credit lines, as these do not constitute public investment and are typically directed toward small and medium-sized enterprises rather than public entities. A detailed description of the data, their sectoral and regional composition, and summary statistics of the quarterly aggregates are provided in Appendix A.2.

For our empirical analysis, we restrict attention to loans allocated to infrastructure-related sectors, as these can be clearly classified as public investment. According to the EIB Statistical Report (European Investment Bank, 2020), these sectors include composite infrastructure, energy, solid waste, telecommunications, transportation, urban development, and water sewerage. Although financing is extended to both public and private promoters, the EIB does not disclose the exact public–private composition of each project. However, the data identify projects in which the public share of beneficiaries exceeds 90% that we term as "fully public" projects. Figure 1 reports the proportion of such projects relative to total financed projects, both overall and within infrastructure sectors. As shown in Panel (b) of

[1] The EIB loan data cover 1959–2025. We restrict the baseline sample to 1995–2020 due to macroeconomic data availability and to focus on the pre-COVID period, thereby avoiding contamination from the exceptional fiscal interventions of 2020–2021.



(a) all sectors



(b) infrastructural sectors

Figure 1: Share of fully public projects in each sector (average for 1995Q1-2020Q1). Public projects are defined as those with at least a 90% public beneficiary share.

Figure 1, the share of public projects in the energy and telecommunications sectors is below 20%, whereas in other infrastructure sectors it averages above 60%. This pattern suggests that roughly two-thirds of loans in these sectors are directed to fully public projects, with the remainder involving lower public sector participation. Since we are looking for a good instrument for public investment, the main analysis is restricted to these sectors. Between 1995 and 2020, the EIB allocated 3,801 loans to projects in these categories. As a robustness check, we extend the sample to include energy and telecommunications and verify that excluding them does not materially affect the results.

To merge the infrastructure project financing data with country-level national accounts and other macroeconomic indicators, we construct a quarterly series by summing all infrastructure-related loans received by each country in a given quarter over the period 1995Q1–2020Q1. Table 1 reports descriptive statistics for this series. On average, EU member states received 146.4 € million per quarter (s.d. 295.9 million €), with the largest quarterly inflow amounting to 3,103.6 € million. When expressed as a share of total public investment, these loans account on average for 6.6 percent (s.d. 18.9 percent), reaching a peak of 373.2 percent in Romania in 1999Q4 [2].

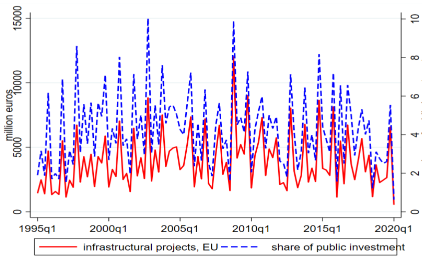
	Mean	SD	Min	Max	N
Infrastructural Projects (million euros)	146.4	295.9	0	3103.6	2703
Infrastructural to Public Investment (%)	6.6	18.9	0	373.2	2359

Table 1: Summary statistics for the aggregated quarterly infrastructure projects, 1995Q1-2020Q1

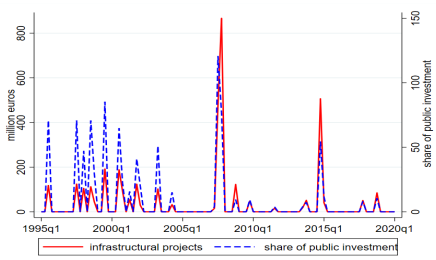
Figure 2 plots the evolution of the aggregate volume of infrastructure loans and their share in public investment for the EU-27, as well as for three illustrative cases: Bulgaria, Denmark, and Spain. Cross-country and time variation in these measures is further illustrated in Figures A.1 to A.3 in the Appendix, which include heatmaps for the sample period

[2]To ensure that our results are not unduly influenced by outliers, we exclude the top one percent of the infrastructure loans to public investment distribution from the sample.

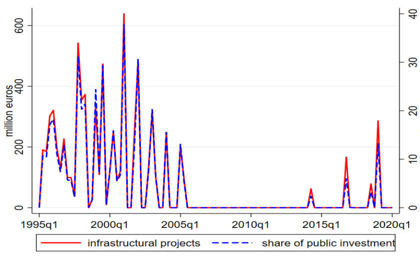
we consider of the total loan volume and the corresponding share in public investment. All figures confirm substantial variation in EIB loan volumes over time and across countries. Larger economies receive higher volumes, an expected level difference absorbed by country fixed effects in all our regressions. In the subsequent analysis, we use the constructed series as an instrument to identify exogenous changes in government investment across the EU countries in our sample.



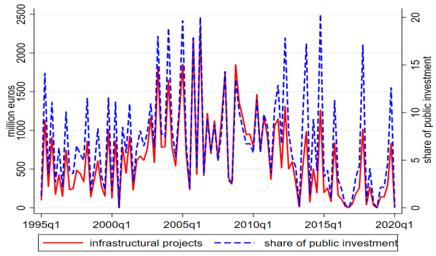
(a) EU



(b) Bulgaria



(c) Denmark



(d) Spain

Figure 2: EIB-financed infrastructure projects and their contribution to public investment for the EU27 and for three illustrative countries: Bulgaria, Denmark, and Spain. The solid red line plots the total value of EIB infrastructure loans each quarter (left axis), while the dashed blue line shows their share in total public investment (right axis).

2.3 Predicting the EIB Loan Allocation

Examining the average allocation of EIB loans across EU countries (Table A.2 in the Appendix) reveals that EIB lending is far from random. Between January 1995 and March 2020, approximately 55% of total loans were allocated to France, Germany, Spain, and Italy. However, as shown in Figure A.2 in the Appendix, relative to total investment, larger loan shares were directed toward peripheral and newer EU member states, including Bulgaria, Hungary, Slovenia, Cyprus, Croatia, and Greece. Since EIB project selection is carried out by specialized financial and engineering teams, it is plausible that certain macroeconomic or structural factors systematically influence loan allocation decisions.

Table 2 reports the results of pooled probit regressions that test whether variables such as the debt-to-GDP ratio, trade openness, GDP growth, EU accession status, previous EIB loans, a country's EIB capital share, stock market growth, infrastructure endowment (measured by motorway intensity), and labor productivity growth predict the probability of receiving a new loan at time $t+1$.

	(1)	(2)	(3)	(4)
Macroeconomic conditions				
Debt to GDP	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Openness	-0.191***	-0.120***	-0.202***	-0.100***
	(0.015)	(0.016)	(0.020)	(0.022)
GDP growth	0.045	0.273	-0.815	-0.674
	(0.652)	(0.658)	(0.930)	(0.938)
Accession to EU	0.314***	0.213***	0.331***	0.218***
	(0.030)	(0.031)	(0.032)	(0.033)
Financial / institutional factors				
Receiving a loan at t	0.115***	0.066***	0.087***	0.046**
	(0.020)	(0.020)	(0.021)	(0.021)
EIB capital share		0.022***		0.021***
		(0.002)		(0.002)
Stock market growth		-0.050		-0.071
		(0.085)		(0.089)
Infrastructure / productivity				
Motorway intensity			0.001*	-0.000
			(0.001)	(0.001)
Productivity growth			1.289*	1.449**
			(0.747)	(0.723)
Observations	2207	2176	1982	1952
Model AUC	0.781	0.799	0.773	0.790

Table 2: Pooled probit estimates of receiving an EIB loan at time t+1

The results indicate that countries with higher public debt-to-GDP, faster productivity growth, larger EIB capital shares, and EU accession are more likely to receive subsequent EIB loans, whereas greater trade openness, defined as the ratio of total exports plus imports to GDP, is associated with a lower likelihood. The predictive performance of the model is assessed using the Area Under the Receiver Operating Characteristic Curve (AUC). The AUC statistics, reported in the last row of Table 2, demonstrate strong predictive performance for the probit models.

3 Empirical Analysis

We examine the dynamic effects of public investment shocks—proxied by European Investment Bank (EIB) infrastructure loan contracts—on real GDP, private investment, consumption, labor market outcomes, productivity, public debt, and inflation across 27 EU economies. The analysis employs the instrumental-variable local projections (IV-LP) method of **?**, using the longest available quarterly panel of aggregated data from 1995Q1 to 2020Q1,[3] exclud-

[3]Quarterly national accounts are available for most countries from 1995, with exceptions (Italy and the Netherlands (1996) and Malta (2000)). For most countries in our sample, government gross fixed capital formation data begins in 1999, with the first available year varying in a few cases (1999–2002). Exceptions are Belgium, Cyprus, France, Romania, Spain, and Sweden, for which quarterly public investment data are available from 1995.

ing the post-pandemic period. For each outcome variable and forecast horizon $h \geq 0$, we estimate the following specification:

$$y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \gamma_{t,h} + \beta_h \hat{I}^g_{i,t} + \sum_{k=1}^{2} \Theta_{k,h} \mathrm{X}_{i,t-k} + \varepsilon_{i,t+h}, \quad h = 0, 1, 2, ... \tag{1}$$

Here, $y_{i,t+h}$ denotes the logarithm of the variable of interest for country i at horizon h, so that $y_{i,t+h} - y_{i,t-1}$ measures its cumulative growth over h periods. The terms $\alpha_{i,h}$ and $\gamma_{t,h}$ represent country and time fixed effects, respectively. The variable $\hat{I}^g_{i,t}$ corresponds to public investment instrumented with the constructed series of EIB infrastructure logged loan values. The vector $\mathbf{X}_{i,t}$ contains control variables, including two lags of GDP, public investment, total public expenditure, inflation, EIB infrastructure loans, and lags of the dependent variable (when distinct from the other controls). All series are expressed in logarithms, except unemployment rate and inflation, which is measured as the annual percentage change in the CPI. The coefficient β_h traces the dynamic response of each macroeconomic variable $y_{i,t}$ to a one-percent innovation in EIB-financed public investment. Standard errors are computed using the Driscoll and Kraay (1998) correction, which is robust to heteroskedasticity, serial correlation, and cross-sectional dependence in panel data. [4]

Given the results in Section 2.3, we adopt the Augmented Inverse Propensity-Score Weighted (AIPW) estimator to account for predictable components in treatment assignment, following the recommendations of Jordà and Taylor (2016). Specifically, we estimate the effect of EIB-financed public infrastructure investment on macroeconomic outcomes using weighted regressions, where the weights correspond to the inverse probability of receiving an EIB loan by country i in quarter t. The propensity scores are estimated using a saturated probit model that includes the control variables from equation (1), along with two lags of the public debt-to-GDP ratio, productivity growth, trade openness, a dummy variable for each country's EU accession date and countries' EIB capital share.

Figure 3 displays kernel density estimates of the propensity score distributions for treated and control observations, showing considerable overlap between the two groups.[5] The overlap indicates that both treated and untreated country–quarters share comparable observable characteristics, ensuring adequate common support for the weighting procedure. In other words, no subset of control observations is entirely unmatched to the treated ones in terms of

[4] This approach accounts for common shocks and spillovers across countries over time. As a robustness check, we also report results based on two-way clustered standard errors at the country and time levels, allowing for arbitrary correlation within countries and within periods. (see Figure B.2 in the Appendix.)

[5] Because some observations exhibit propensity scores close to zero, we truncate probabilities to the [0.05, 0.95] range, which yields weights as high as 20. Following Jordà and Taylor (2016), this truncation has minimal impact on the AIPW estimates.

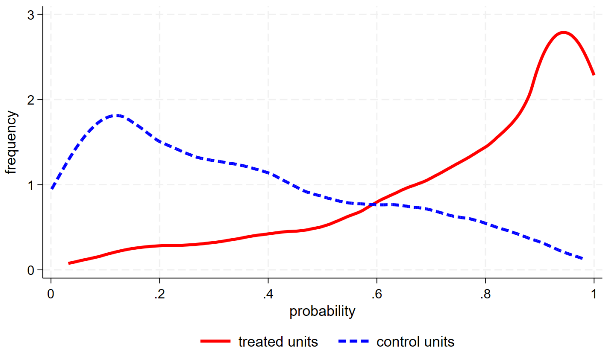


Figure 3: Distribution of the propensity score for control and treated units. The probabilities correspond to the likelihood of receiving an EIB loan in a given quarter, estimated using a saturated probit model that includes all control variables from equation 1, as well as the public debt-to-GDP ratio, economic openness, country share in EIB capital, productivity growth, and an EU accession dummy.

their predicted probability of receiving an EIB loan. This overlap strengthens the credibility of the AIPW estimator, as it suggests that the reweighted sample effectively balances observable characteristics between treated and untreated groups, reducing bias in the estimated dynamic effects of EIB-financed public investment. Figure B.1 in the Appendix plots the estimated weights for each country over time. The figure shows that smaller open economies tend to receive higher weights on average, whereas larger economies that receive EIB loans more frequently are assigned lower weights.

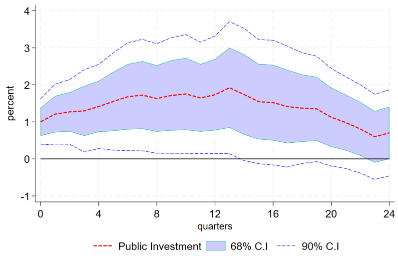
4 Results

4.1 Macroeconomic responses to a public investment shock

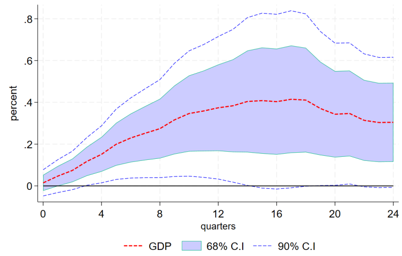
Figure 4 plots the estimated coefficients β_h from equation (1), along with 68% and 90% confidence intervals, for a range of macroeconomic variables.[6]

Panel (a) shows the response of public investment to EIB-financed infrastructure projects. Because the loan data capture the timing of financing announcements, while actual disbursements unfold gradually over several quarters, the response displays a hump-shaped pattern: the effect builds over time, peaks at roughly 1.8% after three years, and then gradually returns toward zero. This pattern indicates that EIB-financed projects generate a sustained and statistically significant increase in public investment and that the recovered shocks can be interpreted as persistent shocks to public investment.[7]

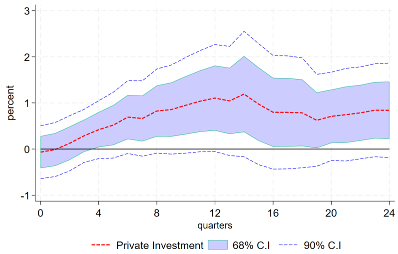
[6]The figure reports impulse response functions constructed using a five-quarter centered moving average of the estimated coefficients to improve visual smoothness. The corresponding unsmoothed IRFs are presented in Figure B.4 in the Appendix. Both the qualitative patterns and the quantitative magnitudes are very similar



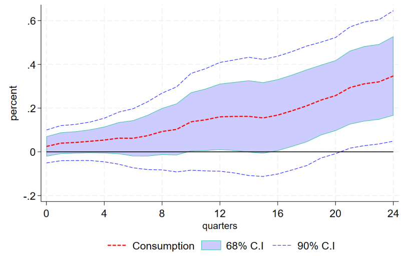
(a) public investment



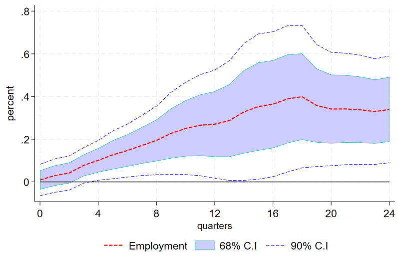
(b) GDP



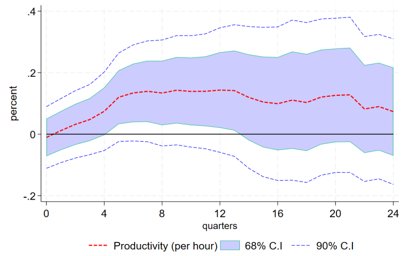
(c) private investment



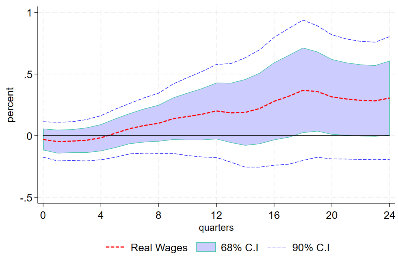
(d) consumption



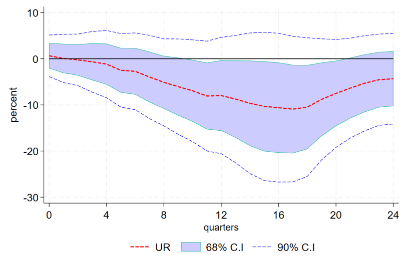
(e) employment



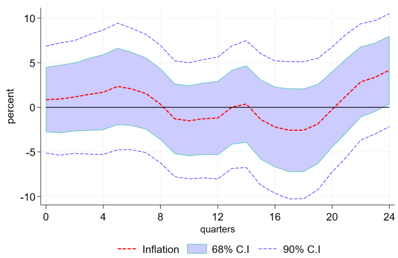
(f) labor productivity



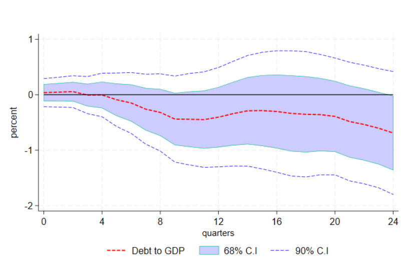
(g) real wage



(h) unemployment



(i) inflation



(j) debt-to-GDP

Figure 4: Effect of a one-percent increase in public investment, instrumented with EIB-financed infrastructure loans, on selected macroeconomic variables. Each panel plots the estimated β_h from equation (1), together with 68 percent (shaded) and 90 percent (dashed) confidence intervals. The estimates are obtained from an unbalanced panel of EU countries over 1995Q1–2020Q1, with standard errors clustered at the country and time levels. Response functions are smoothed using a centered moving average.

Real GDP (Panel b) responds positively and persistently to a one-percent increase in public investment. While the immediate response is close to zero, it becomes positive and statistically significant after approximately three quarters, reaching a peak of about 0.4% after five years. The cumulative effect on output therefore builds gradually over time and is both economically and statistically significant in the medium term.

The response of private investment (Panel c) is not statistically significant at the 90 percent confidence level at any horizon. This pattern indicates no evidence of displacement and, if anything, suggests a crowding-in effect that is significant at the 68 percent level. Real private consumption also increases persistently, broadly tracking the rise in real GDP (Panel d). The cumulative response to a one-percent increase in public investment reaches about 0.4 percent after five years, comparable in magnitude to the GDP response, although statistical significance is attained only at longer horizons.

The dynamic response of employment in Panel (e) closely mirrors that of GDP, with a synchronous delayed profile and a peak increase of about 0.4 percent. Productivity (Panel f), measured as output per hour worked, does not respond significantly, and real wages in Panel (g) also show no statistically significant reaction at any horizon.

The combination of a sizable increase in employment with flat real wages indicates that labor supply adjustments play an important role alongside the labor demand effects induced by the fiscal expansion. If the public investment shock operated solely through labor demand, one would expect real wages to rise and unemployment to decline markedly. Instead, real wages remain broadly unchanged and unemployment does not respond significantly (Panel h), despite the expansion in employment. This pattern implies that the employment response reflects simultaneous shifts in labor demand and labor supply. In the absence of quarterly participation data, the muted unemployment response together with rising employment points to an increase in labor force participation, consistent with the labor supply adjustments documented by Brückner and Pappa (2012) for broader government spending shocks, or to inflows of migrants in response to the fiscal expansion.

Public infrastructure loans do not generate inflationary pressures or raise debt-sustainability concerns. CPI inflation remains statistically indistinguishable from zero at all horizons (Panel i), likely reflecting the lack of significant real wage increases and productivity gains, which provide supply-side offsets to any initial demand impulse. The public debt-to-GDP ratio also remains broadly stable (Panel j); if anything, faster GDP growth works to reduce the ratio over time, although the effect is not statistically significant.

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across the two representations.

[7] Note that the EIB loan shocks we recover using the inverse weighting scheme, per se are not persistent. Appendix Figure B.3 plots the identified EIB shocks, which are clearly transitory and exhibit no persistence.

Overall, the evidence shows that persistent public investment shocks generate sizable and persistent medium-run increases in output and employment, with peak effects emerging several years after the initial shock, while neither raising inflation nor creating fiscal pressures.

4.2 Public Investment Ouptut Multiplier

A key metric in macroeconomic analysis is the public investment multiplier, defined as the dollar increase in GDP generated by an additional dollar of government investment. A straightforward way to compute it is to take the ratio of the cumulative GDP response to the cumulative public investment response in Figure 4 at each horizon h. Alternatively, following Ramey and Zubairy (2018), the multiplier can be estimated by regressing cumulative GDP on cumulative public investment, instrumenting the latter with exogenous EIB loan shocks. We adopt this approach and estimate the following local-projection specification:

$$\sum_{j=0}^{h} y_{i,t+j} = \alpha_{i,h} + \gamma_{t,h} + \beta_h^m \sum_{j=0}^{h} \hat{I}^g_{i,t+j} + \sum_{k=1}^{2} \Theta_{k,h} \mathrm{X}_{i,t-k} + \varepsilon_{i,t+h}, \quad h = 0, 1, 2, ... \tag{2}$$

To estimate (2), we proceed in two steps as before: First, we estimate $\sum_{j=0}^{h} \hat{I}^g_{i,t+j}$ using EIB loans for public infrastructural projects, conditioning on the same set of control variables included in vector $\mathbf{X}_{i,t}$. In the second step, we use the fitted value to estimate equation (2). Because both output and public investment enter in logs, coefficient β_h^m then measures the cumulative elasticity of output with respect to public investment at each horizon h. We transform elasticities into multipliers by multiplying the estimated β_h^m by the sample average ratio of GDP to public investment [8]

The first two rows of Table 3 and Figure 5 report the cumulative elasticities and corresponding output multipliers at different horizons h. The impact effect on output is zero but increases over time. After three years, the cumulative elasticity is 0.11 and statistically significant and 0.12 after five years. This implies that a 1% increase in public investment raises GDP by about 0.12% after five years. Converting these elasticities into multipliers yields statistically significant three- and five-year public investment multipliers of 3.13 and 3.38, respectively.

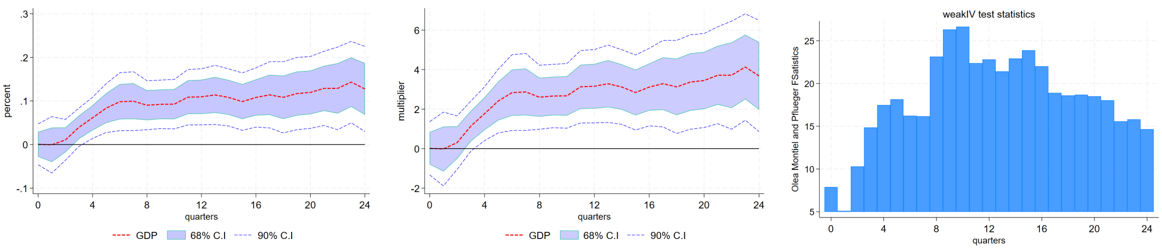
[8] To compute cumulative multipliers, we discount future responses using an average discount factor of 2 percent annually. Moreover, Ramey and Zubairy (2018) caution that ad hoc transformations of estimated elasticities may yield biased multiplier estimates and instead recommend scaling national accounts variables by trend GDP. Because infrastructure investment is likely to affect the output trend, this approach is not appropriate in our setting. As an alternative, Figure B.5 reports multipliers estimated by scaling all cumulative values by the lagged value of GDP. The resulting dynamics closely resemble the benchmark specification, although the estimated multipliers are bigger and less precisely estimated.

	Horizon			
	t=0	1-year	3-years	5-years
Output Elasticity	**0.00**	**0.04**	**0.11*** **	**0.12** **
	(0.03)	(0.03)	(0.04)	(0.06)
Output Multiplier	**0.02**	**1.14**	**3.13*** **	**3.38** **
	(0.93)	(0.91)	(1.20)	(1.74)
Private Investment Elasticity	**−0.57***	**0.04**	**0.18**	**0.24**
	(0.28)	(0.18)	(0.17)	(0.19)
Private Investment Multiplier	**-3.17***	**0.25**	**0.99**	**1.36**
	(1.56)	(1.03)	(0.92)	(1.05)
Employment Elasticity	**-0.05**	**0.03**	**0.10*** **	**0.14*** **
	(0.04)	(0.03)	(0.04)	(0.05)
Employment Multiplier	**-0.09**	**0.06**	**0.21*** **	**0.27*** **
	(0.07)	(0.06)	(0.08)	(0.09)
Productivity Elasticity	**0.04**	**0.002**	**0.04**	**0.05**
	(0.06)	(0.04)	(0.04)	(0.05)
Productivity Multiplier	**0.0009**	**0.000**	**0.0009**	**0.0011**
	(0.0011)	(0.0008)	(0.0010)	(0.0013)

Table 3: Cumulative effect of public infrastructure on different variables and at different horizons, estimated from equation (2). Standard errors in parentheses. Estimates are based on an unbalanced panel of EU countries, 1995Q1–2020Q1. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.3 Instrument Quality

The first-stage regression confirms that EIB loan allocations are a strong and statistically significant predictor of public investment growth, with F-statistics well above conventional weak-instrument thresholds after one year (Panel (c) of Figure 5). Those statistics support the instrument's relevance. The estimated pattern is consistent with the gradual disbursement of EIB loans and the well-documented "time-to-build" delays typically associated with public investment projects.



(a) cumulative elasticity **(b)** cumulative multiplier **(c)** F statistics

Figure 5: Public investment cumulative elasticity and multiplier at different horizons. Panel (a) plots the estimated β_h^m from equation (2), together with 68% (shaded blue area) and 90% (dashed blue lines) confidence intervals. Panel (b) plots the corresponding multipliers, and panel (c) reports the first-stage weak-IV test F-statistics for equation (2) as developed by Olea and Pflueger (2013). The estimation is based on an unbalanced panel of EU countries over the period 1995Q1–2020Q1, with standard errors clustered at the country and time levels.

The identification strategy assumes that EIB lending decisions are guided primarily by project-specific and technical criteria and long-term considerations and planning rather than by short-term macroeconomic conditions. This suggests that the instrument is plausibly exogenous to contemporaneous demand shocks, reinforcing the validity of using EIB loan allocations to identify exogenous variation in public investment.

4.4 Other Multipliers

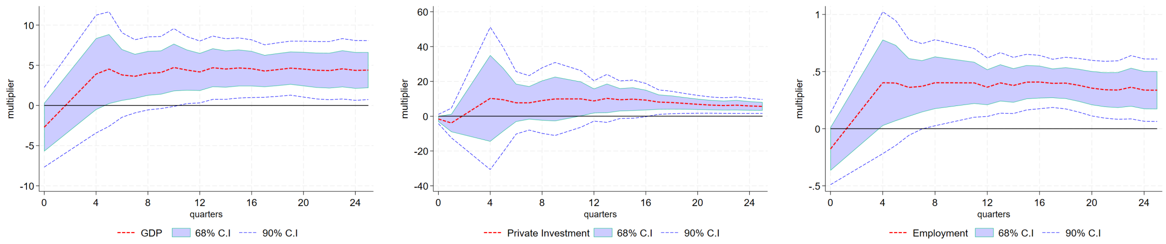
The remaining rows of Table 3, together with Figure B.7 in the Appendix, report cumulative elasticities and multipliers for private investment, employment, and labor productivity. These estimates are obtained by estimating β_h^m in equation (2) and transforming into multipliers separately for each outcome variable.

A one-percent increase in public investment generates a mildly significant impact decline in private investment. However, the cumulative elasticity and multiplier rise to 0.24 and 1.36, respectively, after five years, while remaining statistically insignificant. Employment does not move statistically on impact but increases significantly thereafter, rising by 0.10 percent after three years and by 0.14 percent after five years. These responses correspond to approximately 0.21 and 0.27 thousand additional jobs per million euros of public investment. Labor productivity, measured as output per hour worked, shows no statistically significant response at any horizon. Overall, consistent with the results in Figure 4, the medium-run output multiplier is driven primarily by the substantial expansion in employment.

4.5 Discussion

By construction, our estimates capture relative effects: they identify the impact of higher government investment in one euro-area country relative to another on relative economic activity (see Nakamura and Steinsson, 2014; Wolf, 2023). As a result, they are not directly informative about the effects of a unilateral increase in infrastructure investment by a single country. To address this limitation, we exploit the long Spanish time series assembled by Alloza et al. (2019) and estimate government spending multipliers for Spain, instrumenting spending with EIB loans (see Appendix D for details on the Spanish data).

Figure 6 presents government investment multipliers for output, private investment, and employment in Spain using the longer sample. The government investment shock generates statistically significant medium-run increases in output and employment, in line with the panel LP-IV multipliers. Although the estimated multipliers for Spain are quantitatively larger, they are not statistically different from our baseline estimates. This exercise cannot validate our full set of results, as it pertains to a single country for which sufficiently long data are available to conduct a country-specific local projection analysis. Outcomes could differ for other countries if similarly long time series were available. We therefore view this evidence as indicative of sizable and persistent output effects associated with sustained



(a) GDP **(b)** private investment **(c)** employment

Figure 6: Cumulative multiplier of public investment on GDP, private investment, and employment, instrumented with EIB-financed infrastructure loans. The figures report 68% confidence intervals (shaded blue areas) and 90% confidence intervals (dashed blue lines). The estimation is based on data for Spain over 1980Q1–2020Q1. For readability, we omit wide confidence bands at a few early horizons. Standard errors are robust to serial correlation.

increases in public infrastructure investment.

In general, our estimated relative or single-country multipliers exceed those in much of the existing literature, reflecting several contributing factors. First, national public investment shocks in the EU do not interact with domestic monetary policy, which limits crowding-out effects and amplifies fiscal responses (Klein and Winkler, 2021; Ramey and Zubairy, 2018). Second, external financing plays a central role: as emphasized by Broner et al. (2022) and Priftis and Zimic (2021), when the EIB finances a large share of project costs, domestic private spending is less constrained. Third, most of the existing literature estimates multipliers for total government spending rather than for public investment alone. For example, Kraay (2012), in a similar spirit to ours, uses World Bank project loans to less developed countries as an instrument for changes in total government spending and finds relatively weak stimulative effects. If we were to follow this approach and instrument total government spending with EIB loans, we would face weak-instrument problems, as illustrated in Figure B.6 in the Appendix. Accordingly, the conclusions of our analysis would change substantially: cumulative multipliers would fall to values close to one after three years and would otherwise be statistically indistinguishable from zero. Hence, it is important to emphasize that the multipliers we report pertain exclusively to public investment, as EIB loans constitute a weaker instrument for changes in total government spending.

Finally, the high persistence of EIB-induced shocks, consistent with Dupaigne and Fève (2016) and Alloza et al. (2025), generates larger and more durable output effects than those typically found in SVAR models identified through timing restrictions (e.g., Blanchard and Perotti, 2002). [9]

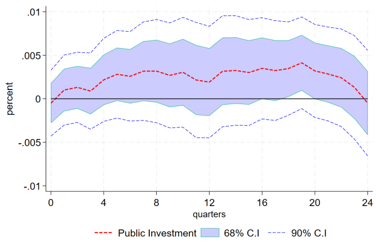
[9] Appendix D shows that BP-identified public investment shocks fail to generate a persistent increase in government investment, yield only modest short-run output responses, and are followed by sustained contractions in private investment and employment. The on-impact output multiplier is 0.26, rising to 0.65 after three years and 0.71 after five years—substantially smaller than the corresponding IV-LP estimates using EIB loans as an instrument.

4.6 Spillover effects

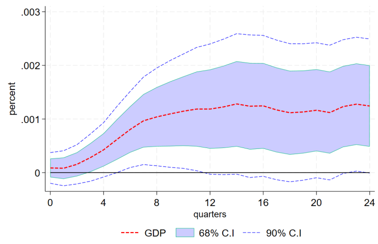
In integrated economic areas such as the European Union, public investment or credit allocations to one country may affect output and demand in economically connected countries through trade, financial, confidence, and migration channels. Large infrastructure projects can also generate positive externalities by reducing trade costs and improving cross-border connectivity, thereby facilitating trade between European countries (see, Donaldson and Hornbeck (2016) for the historical impact of railroads on the U.S. economy). Moreover, major infrastructure investments often attract foreign labor, particularly in the European context. For instance, Bentolila et al. (2012) documents that Spain's infrastructure and construction boom during the 1990s–2000s drew substantial inflows of foreign workers, especially low- and medium-skilled migrants.

Accounting for such cross-country spillovers is therefore crucial for the correct interpretation of estimated fiscal multipliers. Ignoring spillover effects may bias domestic multiplier estimates and lead to a substantial mismeasurement of their aggregation into area-wide effects.

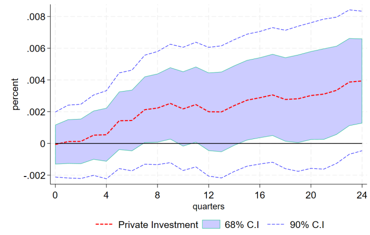
To assess these mechanisms, we examine cross-country spillovers by re-estimating equation (1), replacing a country's own public investment with a weighted sum of infrastructure-related EIB loans received by neighboring countries, including maritime borders. The weights reflect each neighbor's estimated probability of receiving a loan, although the results are very similar when no weighting scheme is applied. We then evaluate the effect of this neighboring lending measure on domestic economic outcomes, controlling for current and lagged domestic EIB loans. Figure 7 reports the impulse response functions of public and private investment, GDP, and employment following an increase in regional EIB infrastructure lending that is orthogonal to a country's own infrastructure investment.



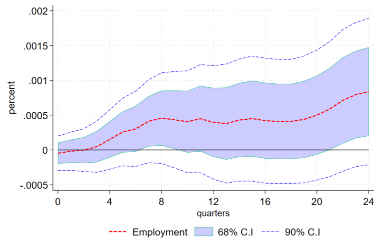
(a) public investment



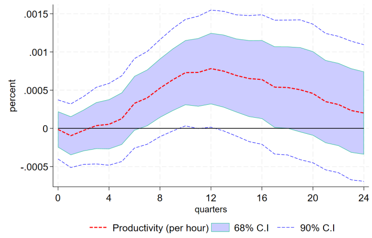
(b) GDP



(c) private investment



(d) employment



(e) labor productivity

Figure 7: Effect of a one-percent increase in EIB infrastructure loans in neighboring countries on selected macroeconomic variables. Each panel plots the estimated β_h from equation (1), together with 68 percent (shaded) and 90 percent (dashed) confidence intervals. The estimates are obtained from an unbalanced panel of EU countries over 1995Q1–2020Q1, with standard errors clustered at the country and time levels. Response functions are smoothed using a centered moving average.

By construction, domestic public investment does not respond to a neighboring public investment shock. Output nevertheless exhibits statistically significant spillover effects, while private investment and employment responses are not statistically different from zero. The combined output and employment responses imply that labor productivity rises and significantly so in the medium run. Two points are worth noting. First, the increase in domestic labor supply in Figure 4 does not reflect migration from neighboring countries and thus does not indicate negative migration spillovers. Second, the positive spillovers we document are most plausibly driven by productivity gains, arising from lower trade and input costs, shorter delivery times, expanded market access, and deeper integration into regional value chains. Improved infrastructure may also facilitate knowledge diffusion and the expansion of cross-border commuting zones. Gabriel et al. (2023) also document delayed spillover effects of total government spending across European regions, though with small magnitudes. Our results are consistent with theirs: public investment represents only a small share of total spending, and delayed spillovers can plausibly reflect lagged effects of government spending on neighboring GDP, as illustrated in Figure 7. Overall, these findings suggest that in economically integrated areas, infrastructure investment generates positive productivity spillovers beyond national borders, even in the absence of direct domestic public investment (See also, Veld, 2016). The larger productivity effects relative to a domestic public investment shock reflect the stronger labor-supply response associated with the latter.

Given the presence of positive spillover effects in output, we re-estimate our baseline specification while controlling for spillovers. Because we cannot directly control for neighboring countries in the panel regressions, we group countries into five macro-regions—Nordics, Core Europe, Southern Europe, Central and Eastern Europe, and the Baltics—and replace time fixed effects with region–time fixed effects. This specification absorbs region-specific common shocks and coordinated investment patterns, thereby mitigating bias arising from cross-country spillovers within integrated regional blocs. Figure B.8 in the Appendix reports the cumulative output multipliers when controlling for region–time fixed effects. The estimated multipliers are not statistically different from the baseline results.

4.7 State-dependent multipliers

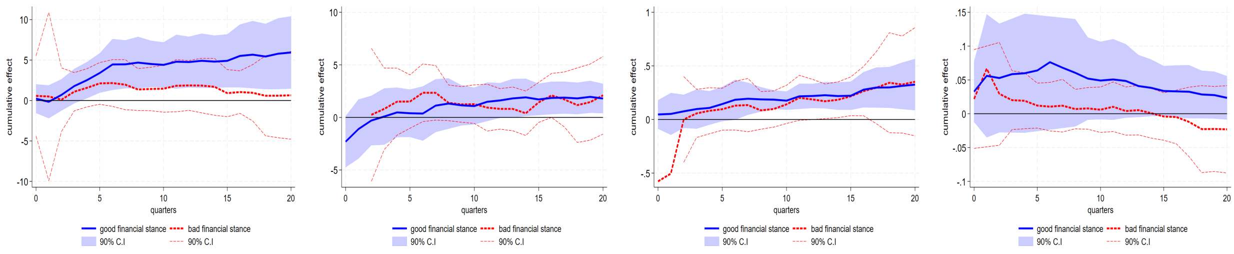
We next examine whether the public investment multiplier varies with the state of the economy. Specifically, we estimate the following state-dependent local projection model at different horizons h:

$$\sum_{j=0}^{h} y_{i,t+j} = \alpha_{i,h} + \gamma_{t,h} + I_{t-1}\left[\beta^{m}_{A,h}\sum_{j=0}^{h} I^{g}_{i,t+j} + \sum_{k=1}^{2}\Theta_{A,k,h}\mathrm{X}_{i,t-k}\right] + (1 - I_{t-1})\left[\beta^{m}_{B,h}\sum_{j=0}^{h} I^{g}_{i,t+j} + \sum_{k=1}^{2}\Theta_{B,k,h}\mathrm{X}_{i,t-k}\right] + \varepsilon_{i,t+h} \quad (3)$$

where I_t is a state indicator. We consider three types of state dependency and define ($I_t = 1$) when (i) global financial conditions are favorable, (ii) the EU economy is in recession, or (iii) public debt is above a high threshold, and ($I_t = 0$) otherwise. Global financial conditions are captured by the quarterly Global Financial Cycle index from Miranda-Agrippino and Rey (2020), while recession periods follow the OECD Euro Area dating (peak to trough). High-debt episodes are defined as country–quarter observations with debt-to-GDP ratios above the 50th percentile of the full sample distribution. The vector ($\mathbf{X}_{i,t}$) includes the same control variables as in equation (2). In this setup, ($\beta^{m}_{A,h}$) and ($\beta^{m}_{B,h}$) represent the public investment cumulative elasticities under the two economic states.

Appendix Figure B.9 shows that corresponding multipliers are broadly similar in recessions and expansions, consistent with U.S. evidence in Ramey and Zubairy (2018) for government consumption shocks. We also condition the estimates on the public debt-to-GDP ratio by comparing countries below and above the median. Again, we find no statistically significant differences in the responses of GDP, private investment, or employment. Only share prices react more strongly in low-debt countries (Figure B.10).[10]

[10] Confidence intervals widen slightly because of smaller sample sizes. Results are similar when using the



(a) GDP **(b)** private investment **(c)** employment **(d)** share prices

Figure 8: Public investment cumulative effect for good vs. bad financial cycles. Each panel plots the corresponding multipliers based on the estimated $\beta_{A,h}$ and $\beta_{B,h}$ from equation (3), together with 90% confidence intervals. States are defined as explained in the text. For readability, we omit wide bad-financial-cycles confidence bands at a few horizons due to small sample size.

The only state variable that meaningfully alters the size of the multipliers is global credit conditions. As shown in Figure 8, cumulative multipliers are larger in magnitude and statistically significant when global financial conditions are favorable. This pattern is consistent with the easing of credit constraints, in line with the mechanism emphasized by Huidrom et al. (2020).

4.8 Robustness Checks

We assess the robustness of our baseline results through several complementary exercises. First, we vary the number of lags in the controls and augment the specification with additional variables, including private investment, consumption, tax rates, and stock market indices[11], to check for sensitivity to dynamic choices or omitted variables. The results, shown in Appendix Figures C.1 and C.2, remain qualitatively unchanged. Second, to ensure that no single country drives the findings, we re-estimate the baseline multipliers while excluding each country in turn. The resulting impulse responses and cumulative multipliers closely match the baseline and lie within its confidence bands (Figures C.3 and C.4). In a separate exercise, we exclude the four largest EU economies (Germany, France, Italy, and Spain) from the sample and re-estimate the dynamic responses and multipliers. The resulting output multipliers (Figure C.5) remain within the confidence bands of the benchmark specification. Consistent with positive output spillovers, the cumulative GDP multiplier decreases slightly, suggesting that such spillovers are most likely to originate from these large economies. Third, we estimate the model using ordinary least squares, regressing outcomes directly on EIB loans without instrumenting public investment. As shown in Appendix Figure C.6, the results are broadly similar—though somewhat more precisely estimated, indicating that the

seventy-fifth percentile of the debt distribution.

[11]Controlling for stock market prices may be important because EIB loan allocation is partly forward looking. If lending responds to expectations about future growth or fiscal capacity, the instrument could be correlated with positive news about future GDP, potentially biasing the estimated output responses upward.

shocks capture shocks to public investment beyond EIB financing.

We also perform several checks related to data definition and sample weighting. As shown in Figures C.7 and C.8 in the Appendix, re-estimating the model without inverse propensity score weights yields similar dynamics for public investment, but results in moderately larger standard errors and some notable differences in other macroeconomic responses. Unlike the AIPW estimates, consumption exhibits a persistent crowding-out, private investment crowds in on-impact, labor productivity falls, and the implied output multiplier is smaller. Moreover, as shown in panel (b) of Figure C.8, the first stage F-statistics are significantly lower, indicating weak-instrument concerns when using the original (unweighted) loans data. We further re-specify the probit models to estimate the probability of receiving exclusively infrastructural loans, rather than total loans, and in a separate exercise expand the infrastructure definition to include telecommunications and energy projects. The estimation results are consistent with the main estimates[12].

Furthermore, we address extreme values of the regression weights by winsorizing the top 5 percent of their distribution. The results remain similar to those of the baseline specification[13]. To account for potential dynamic heterogeneity (Canova, 2024) and given the relatively short sample, we conduct two exercises. First, we estimate the effects of EIB infrastructure loans on macroeconomic variables separately for each country and then compute a cross-sectionally weighted average of the responses. The results are robust to this alternative aggregation method and display dynamics similar to the baseline specification (Appendix Figure C.10). Second, to address concerns about nontrivial EU-wide components affecting EIB activity, we replace time fixed effects with common factors that capture shocks to economic activity and EIB financing at the EU level. Specifically, we include the contemporaneous value and two lags of the first principal component of GDP growth across EU countries, together with aggregate EIB infrastructure financing. The results, summarized in Figure C.11, are similar to our benchmark findings. Finally, using the Spanish data, we further show that, in the absence of narrative information, shocks identified through maximum forecast-error variance restrictions yield similar multipliers. By contrast, the standard Cholesky identification approach of Blanchard and Perotti (2002) recovers shocks that are largely anticipated and transitory and therefore do not generate large output multipliers (see Appendix D).

[12]The results for these exercises are not reported for reasons of space and are available upon request.
[13]The results are available upon request.

5 Conclusion

Public investment is a central instrument for infrastructure development and a key policy lever for stimulating economic activity. Yet much of the existing literature finds only modest short-run effects and limited medium-term gains from such spending.

This paper introduces a new source of exogenous variation in public investment to reassess its macroeconomic effects in EU countries. Using European Investment Bank (EIB) loan approvals as an instrument, we identify persistent public investment spending shocks. We find that government investment generates large and sustained increases in output and employment, without inducing inflationary pressures or raising the public-debt-to-GDP ratio. After five years, the cumulative output multiplier of public investment reaches approximately three and is significantly larger when credit conditions are favorable. We further document positive productivity spillovers across national borders and show that accounting for these spillovers does not qualitatively or quantitatively alter our conclusions regarding the effectiveness of public investment in stimulating European economies in the medium run.

Finally, a caveat of our analysis is that the baseline estimates identify relative government investment multipliers. Using long-span data for Spain, we provide country-specific estimates that are directly relevant for assessing the effects of a unilateral increase in infrastructure investment. The Spanish multipliers are not statistically different from, and if anything larger than, the relative multipliers we report. This evidence is suggestive, however, as results may differ for other countries in our sample for which sufficiently long time series are unavailable.

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A Appendix

A.1 Macroeconomic Data Description

This section provides additional information on data construction and variable definitions. Table A.1 reports descriptive statistics for the EU27 panel (1995Q1–2020Q1). Quarterly national accounts series for EU member states are obtained from Eurostat and include GDP, private consumption, government consumption, public investment, gross fixed capital formation, exports, and imports. All quarterly macro series are seasonally adjusted, expressed in real terms (using the GDP deflator), and transformed into logarithmic levels. When a seasonally adjusted series is not available, we apply seasonal–trend decomposition by LOESS (STL) to seasonally adjust the series.

Employment, unemployment rate, wages, general government debt, and CPI are also obtained from Eurostat. Stock market indices are sourced from the OECD; for Cyprus and Malta, data are taken from national statistical releases and other official publications. Interest rates are retrieved from the ECB Statistical Data Warehouse. The Global Financial Cycle (GFC) monthly index is taken from Miranda-Agrippino and Rey (2020) and aggregated to quarterly frequency using a simple within-quarter average. Inflation is defined as the annual change in the CPI, and trade as the sum of exports and imports for each country and quarter. Annual motorway-length data are collected from Eurostat, converted to quarterly frequency via linear interpolation, and scaled by country area to construct a motorway-intensity measure. We also control for the share of each EU member state in the EIB's subscribed capital, using the breakdown of capital shares as of March 2020 as reported in EIB governance documents. [14].

[14] https://www.eib.org/en/about/governance-and-structure/shareholders/index

	mean	sd	min	max	N
GDP (million euros)	104341	168258	1457	813645	2703
total consumption	78583	127245	1176	595525	2699
total investment	21823	34973	148	170778	2699
public consumption	21519	34358	293	165755	2699
public investment	3611	5133	27	22142	2359
exports	40411	59773	747	404496	2699
imports	37744	53335	836	353805	2699
trade to GDP (%)	107	62	22	369	2699
debt to GDP (%)	59	34	3	187	2273
employment (thousands)	7214	9617	145	45240	2707
unemployment rate	9	4	2	28	2615
real wage	38441	65381	566	357190	2703
CPI inflation	3	6	-4	187	2500
stock market index	131	437	5	8443	2580
output per worker (index)	90	15	38	130	2703
output per hour (index)	88	16	38	126	2703
labor productivity growth	1	2	-10	21	2676
motorway intensity	20	19	0	83	2432
GFC index	53	93	-254	251	2727

Table A.1: Descriptive Statistics for macroeconomic variables, EU27 countries from 1995Q1 to 2020Q1

A.2 EIB Loans Summary Statistics

According to Article 309 of the Treaty on the Functioning of the European Union (Official Journal C 202/2016), the task of the European Investment Bank is to contribute to the balanced and steady development of the internal market in the interest of the Union by having recourse to the capital markets and by using its own resources. To this end, the Bank operates on a non-profit basis and provides loans and guarantees that facilitate the financing of investment projects. The EIB finances its loans primarily by borrowing in international capital markets, supported by EU Member States' capital, and supplemented by retained earnings, without relying on direct EU budget funding.

The EIB classifies loans into 13 sectors of economic activity. We focus on loans granted between 1995Q1 and 2020Q1 to EU-27 countries, which cover 12,342 projects (Table A.3). For each country, we aggregate the total value of approved loans at the quarterly frequency. These loans do not mechanically correspond to public investment and, in many cases, finance private or mixed-ownership entities (including SMEs and state-owned firms). To account for this heterogeneity, we classify each project into two groups based on the share of public beneficiaries: fully public projects ((public share $\geq$ 90 percent) and *other projects* (public share $<$ 90 percent). Table A.2 shows the distribution of projects by beneficiary type across countries, and Table A.3 shows the same distribution across sectors of activity.

Country	Fully public	Other	Total	Share (%)
Austria	117	386	503	4.08
Belgium	92	271	363	2.94
Bulgaria	25	75	100	0.81
Croatia	31	65	96	0.78
Cyprus	28	94	122	0.99
Czechia	56	234	290	2.35
Denmark	89	159	248	2.01
Estonia	41	37	78	0.63
Finland	143	201	344	2.79
France	419	797	1,216	9.85
Germany	471	1,399	1,870	15.15
Greece	100	284	384	3.11
Hungary	83	202	285	2.31
Ireland	76	90	166	1.35
Italy	301	1,510	1,811	14.67
Latvia	32	42	74	0.60
Lithuania	30	52	82	0.66
Luxembourg	8	81	89	0.72
Malta	14	11	25	0.20
Netherlands	88	182	270	2.19
Poland	393	362	755	6.12
Portugal	145	394	539	4.37
Romania	80	124	204	1.65
Slovakia	21	165	186	1.51
Slovenia	17	94	111	0.90
Spain	685	1,089	1,774	14.37
Sweden	158	199	357	2.89
Total	**3,743**	**8,599**	**12,342**	**100.00**

Notes: “Fully public” refers to projects with public beneficiaries’ share $\geq 90\%$; “Other” includes mixed or private beneficiaries. Share is the country’s share of total loans in percent.

Table A.2: Number of EIB loans by country and beneficiary type, 1995:Q1–2020:Q1

Table A.4 reports descriptive statistics for the quarterly country-level aggregates. “Total projects” refers to the sum of all financed projects in a given quarter. We also separately report aggregated volumes for fully public projects and other projects. In addition, we provide summary statistics for aggregated loan volumes by sector of activity. All series are expressed in millions of euros.

Sector of activity	Fully public	Other	Total	Share (%)
Agriculture, fisheries, forestry	34	25	59	0.48
Composite infrastructure	121	61	182	1.47
Credit lines	14	3,629	3,643	29.52
Education	379	92	471	3.82
Energy	219	1,054	1,273	10.31
Health	224	179	403	3.27
Industry	60	1,543	1,603	12.99
Services	227	449	676	5.48
Solid waste	99	89	188	1.52
Telecommunications	56	357	413	3.35
Transport	1,445	800	2,245	18.19
Urban development	409	189	598	4.85
Water, sewerage	456	132	588	4.76
Total	**3,743**	**8,599**	**12,342**	**100.00**

Notes: "Fully public" refers to projects with public beneficiaries' share $\geq$ 90%; "Other" includes mixed or private beneficiaries. Share is the sector's share of total loans in percent.

Table A.3: Number of EIB loans by sector and beneficiary type, 1995:Q1–2020:Q1

	mean	sd	min	max	N
Total projects (million euros)	386.9	714.7	0.0	5832.5	2727.0
- public sector projects	128.7	289.4	0.0	2789.7	2727.0
- other projects	258.1	523.2	0.0	5068.1	2727.0
Sectors:					
- agriculture	1.7	22.3	0.0	700.0	2727.0
- composite infrasturacture	6.9	48.2	0.0	1063.0	2727.0
- credit lines	117.8	296.2	0.0	4638.1	2727.0
- education	14.6	70.1	0.0	1317.5	2727.0
- energy	42.5	129.9	0.0	1535.0	2727.0
- health	9.5	42.9	0.0	615.0	2727.0
- industry	38.7	124.7	0.0	2186.6	2727.0
- services	16.1	85.6	0.0	1552.0	2727.0
- solid waste	2.3	15.2	0.0	360.0	2727.0
- telecommunication	17.0	74.7	0.0	950.0	2727.0
- transportation	89.9	214.4	0.0	2221.4	2727.0
- urban development	15.9	66.0	0.0	1000.0	2727.0
- water, sewerage	14.0	53.5	0.0	690.2	2727.0

Table A.4: Descriptive Statistics for the aggregated quarterly EIB loan data,, EU27 countries from 1995Q1 to 2020Q1

A.3 Between and within-country variation of EIB infrastructural loans

Figures A.1 to A.3 document cross-sectional and time-series variation in EIB-financed infrastructure projects. Figure A.1 shows a heatmap of quarterly loan volumes (million euros) by country and quarter, revealing pronounced between- and within-country variation. Larger economies receive higher volumes—an expected level difference absorbed by country fixed effects in all our regressions.

Figure A.2 plots the same EIB loans data scaled by total public investment; dispersion is substantially larger in relative terms. A small number of country–quarters observations exhibit exceptionally high loans to public investment ratios; we drop these outliers to avoid their impact on our estimates. Figure A.3 presents the time series of total loans for the EU as a whole and separately for each EU27 country, highlighting within-country dynamics over the sample.

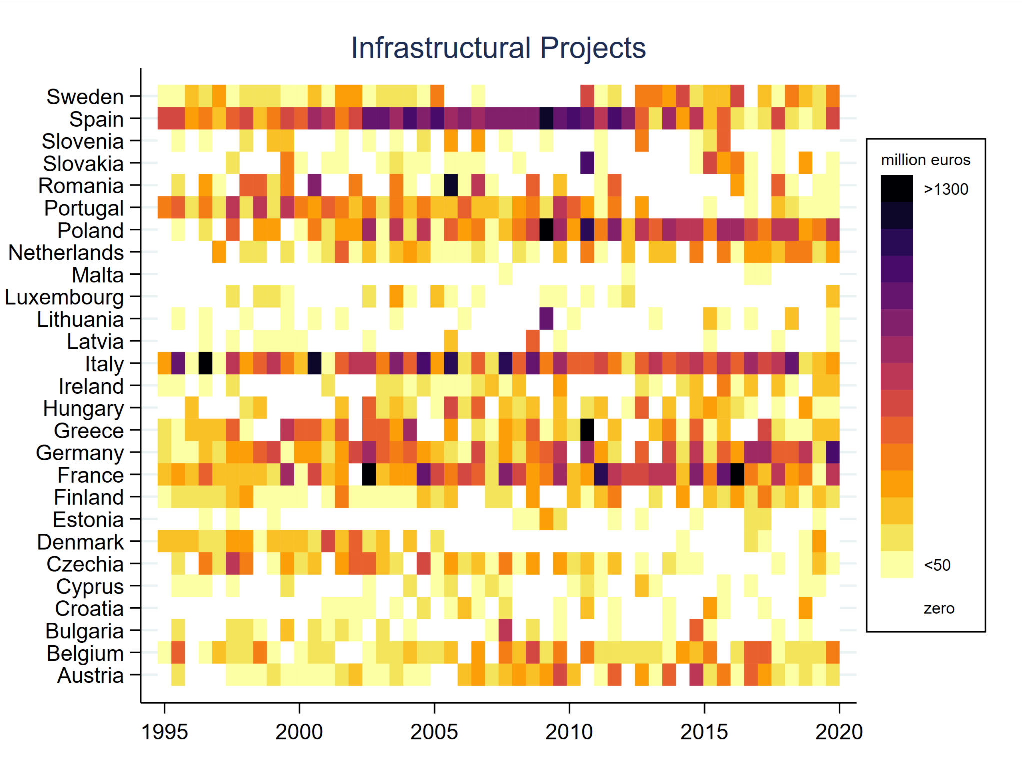


Figure A.1: Infrastructural projects (million euros, , 1995q1 to 2020q1)

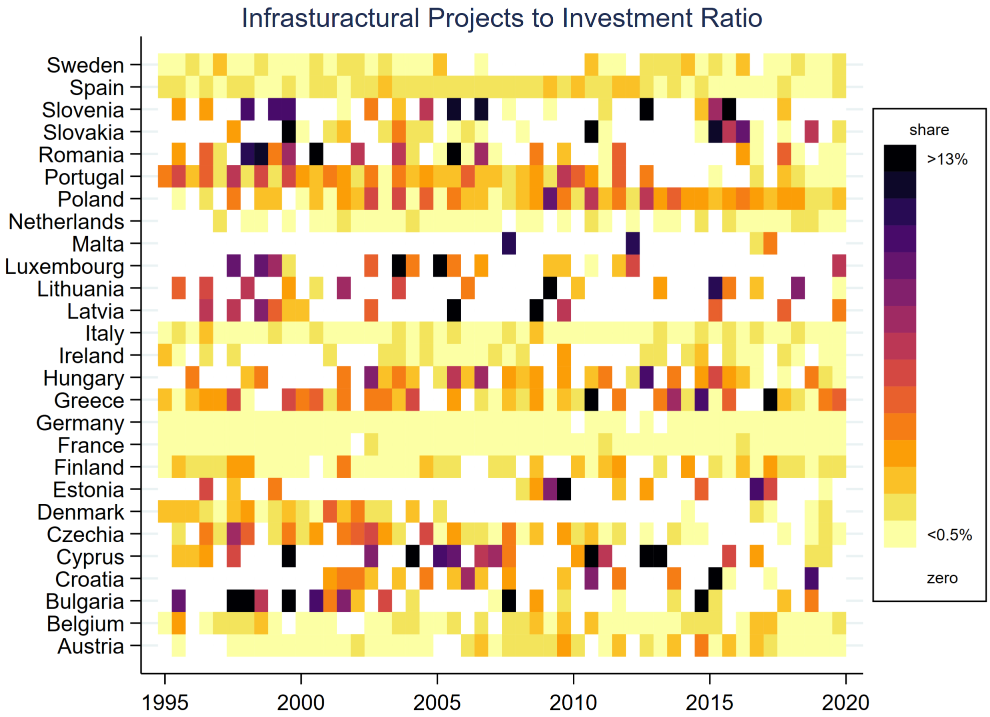


Figure A.2: Infrastructural projects as share of public investment, 1995q1 to 2020q1

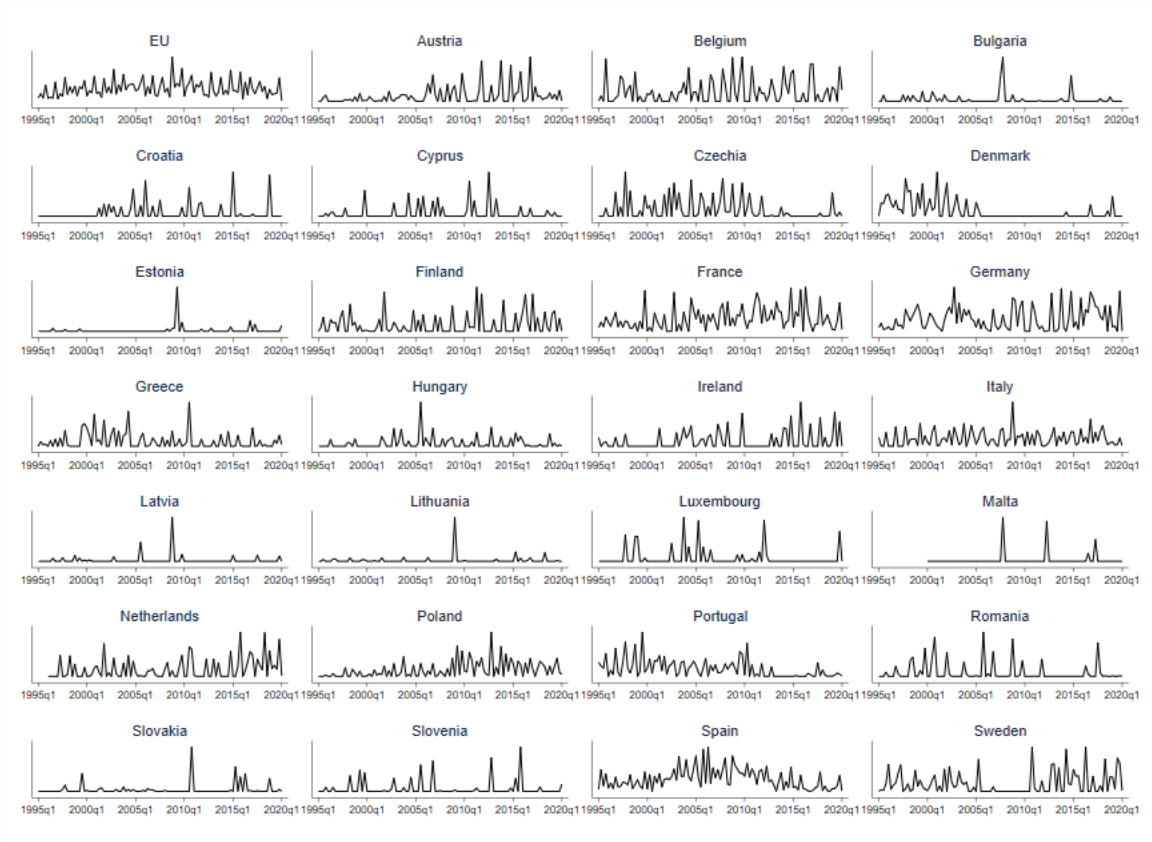


Figure A.3: Evolution of infrastructural projects in different EU countries for 1995Q1-2020Q1

B Additional results

B.1 Estimated weights for different countries

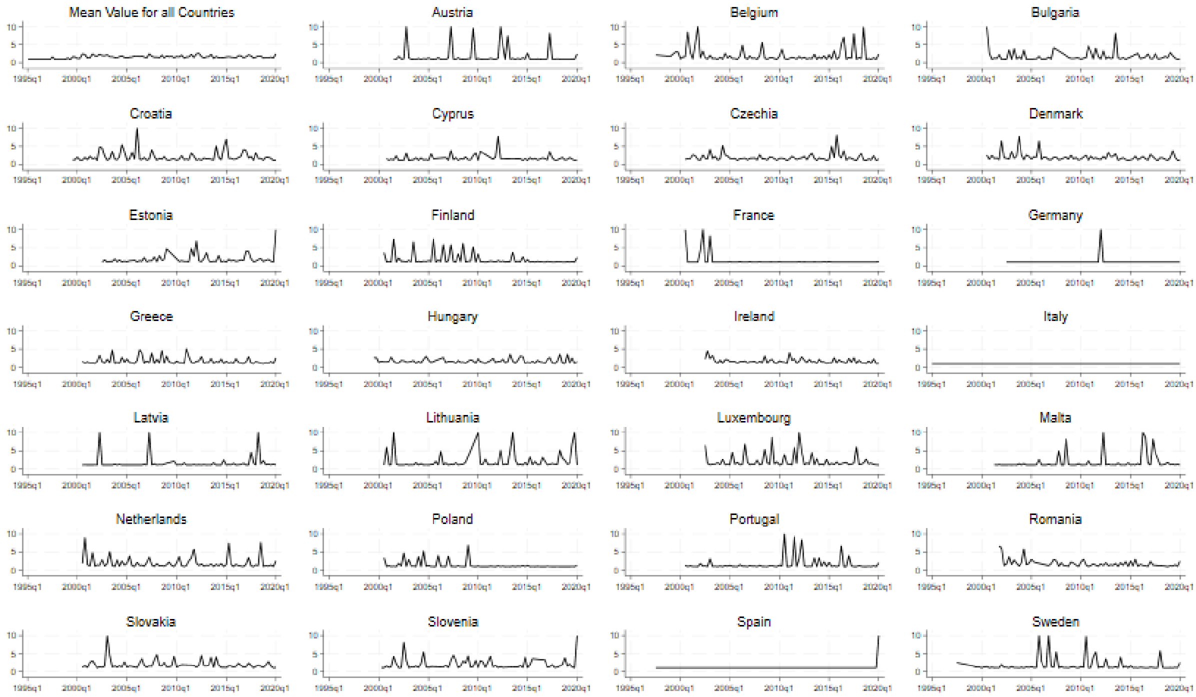
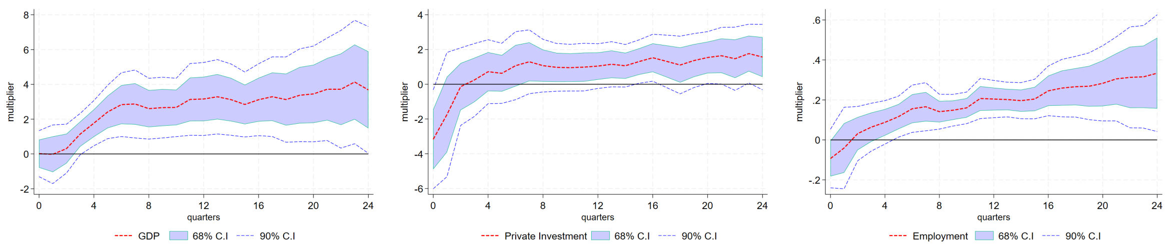


Figure B.1: The figure reports regression weights constructed as the inverse of the estimated probability of receiving EIB loans for EU countries over the period 2000Q1–2020Q1. To preserve scale and avoid distortion from extreme observations, weights exceeding 10 are top-coded at 10.

B.2 Two-way clustering of standard errors



(a) GDP **(b)** Private investment **(c)** Employment

Figure B.2: Each panel depicts the cumulative multiplier of public investment, instrumented with EIB-financed infrastructure loans, for a different macroeconomic variable. The figures also display 68% confidence intervals (shaded blue areas) and 90% confidence intervals (dashed blue lines). The estimation is based on an unbalanced panel of EU countries over the period 1995Q1–2020Q1, with standard errors clustered at the country and time levels.

B.3 Persistence of EIB infrastructure loan shocks

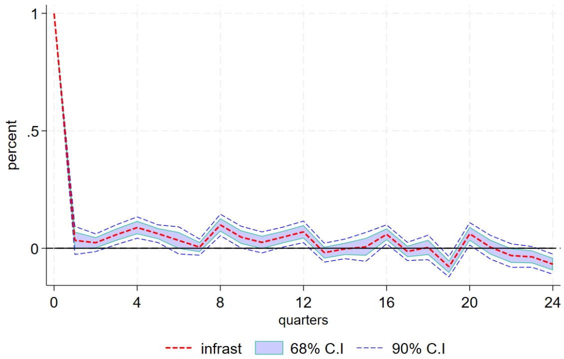
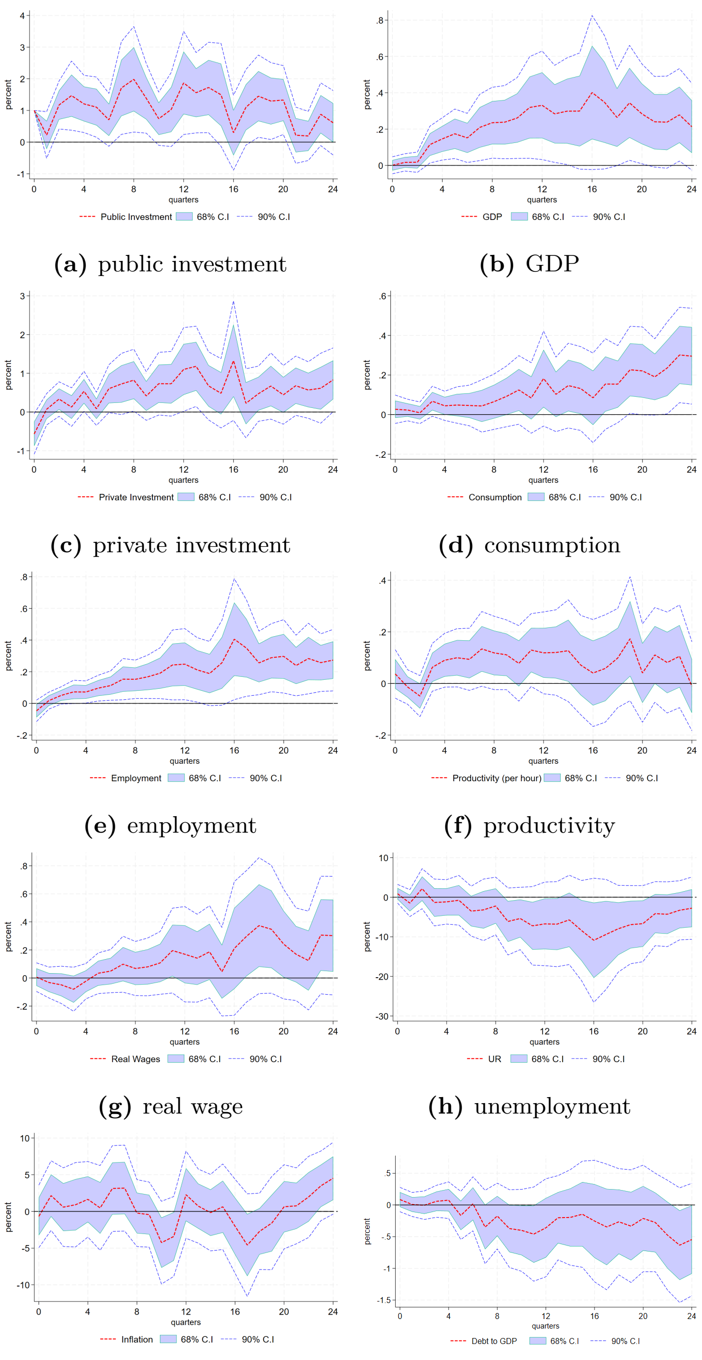


Figure B.3: Effect of a one percent increase in EIB-financed infrastructure loans estimated from equation (1), together with 68% (shaded blue area) and 90% (dashed blue lines) confidence intervals.

B.4 Non-smoothed responses

In local projections, we estimate the dynamic response of each variable separately at each horizon h (the β_h in equation (1)). Unlike VAR impulse responses—where the path is implied by the model's transition dynamics—LP responses are estimated horizon by horizon and can display non-monotonic patterns. Figure B.4 shows the raw, unsmoothed responses. To present smoother response functions, we apply a centered five-quarter moving average to the estimated coefficients throughout the paper.



(a) public investment **(b)** GDP

(c) private investment **(d)** consumption

(e) employment **(f)** productivity

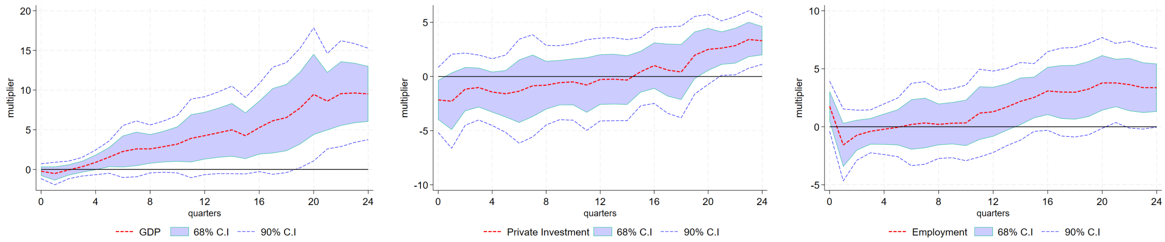
(g) real wage **(h)** unemployment

(i) inflation **(j)** debt-to-GDP

Figure B.4: Effect of a one-percent increase in public investment, instrumented with EIB-financed infrastructure loans, on selected macroeconomic variables. Each panel plots the estimated β_h from equation (1), together with 68% (shaded) and 90% (dashed) confidence intervals. The estimates are obtained from an unbalanced panel of EU countries over 1995Q1–2020Q1, with standard errors clustered at the country and time levels. Response functions are not smoothed.

B.5 Alternative data transformation

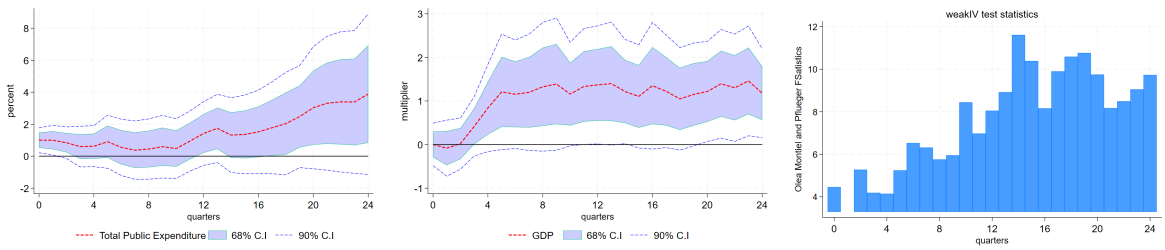
In this exercise, instead of first estimating elasticities and then converting them into multipliers by multiplying by the inverse of the average GDP-to-public-investment ratio, we directly scale the cumulative responses of national account variables by lagged real GDP (and, for employment, by lagged employment). This approach allows us to estimate cumulative fiscal multipliers in a more direct manner and avoid possible biases arising from log transformation.



(a) GDP **(b)** Private investment **(c)** Employment

Figure B.5: Cumulative multipliers of public investment for GDP, private investment, and employment instrumented with EIB-financed infrastructure loans. The figures also display 68% confidence intervals (shaded blue areas) and 90% confidence intervals (dashed blue lines). The estimation is based on an unbalanced panel of EU countries over the period 1995Q1–2020Q1, with standard errors clustered at the country and time levels. To compute multipliers, we have scaled all cumulative values by lagged value of GDP.

B.6 EIB loans as an instrument for total public expenditure

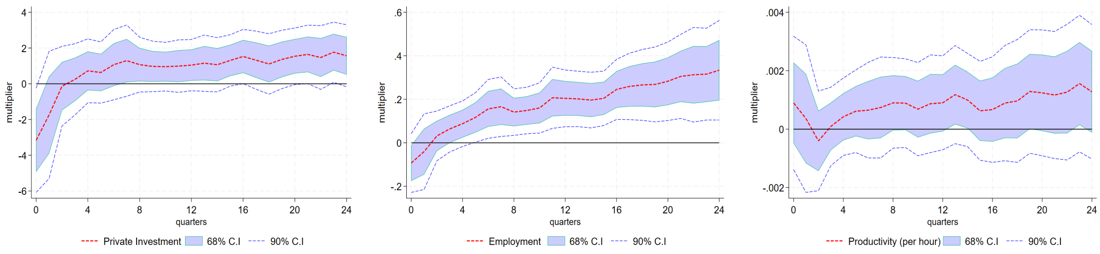


(a) IRF- Public Expenditure **(b)** Cumulative GDP multiplier **(c)** F statistics

Figure B.6: Public expenditure response and GDP cumulative multiplier at different horizons. Panel (a) plots the estimated β_h from equation (1), and panel (b) plots the GDP multiplier estimated from equation (2), where EIB infrastructure loans are used as an instrument for total public expenditure, together with 68% (shaded blue area) and 90% (dashed blue lines) confidence intervals. Panel (c) reports the first-stage weak-IV test F-statistics for equation (2) as developed by Olea and Pflueger (2013).

B.7 Cumulative effect on private investment, employment, and labor productivity

Figure B.7 reports cumulative multipliers for private investment, employment, and labor productivity across all horizons. We first estimate elasticities using equation (2) and then convert them to multipliers using the average ratio of each variable to public investment. Summary results appear in Table 3, which reports the implied cumulative elasticities and multipliers at selected horizons



(a) private investment **(b)** employment **(c)** productivity

Figure B.7: Cumulative multiplier of public investment on private investment, employment, and labor productivity, instrumented with EIB-financed infrastructure loans. The figures report 68% confidence intervals (shaded blue areas) and 90% confidence intervals (dashed blue lines). The estimation is based on an unbalanced panel of EU countries over 1995Q1–2020Q1, with standard errors clustered at the country and time levels.

B.8 Cumulative multiplier; controlling for regional effects

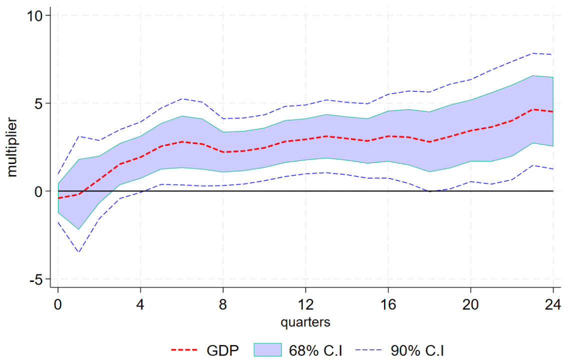
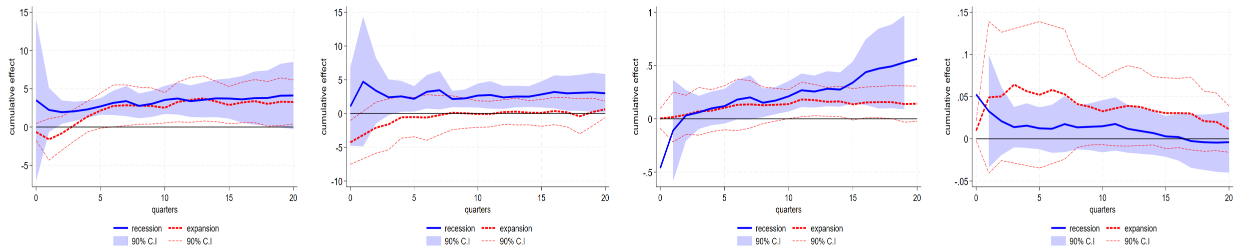


Figure B.8: The graph depicts the cumulative output multiplier of public investment, instrumented with EIB-financed infrastructure loans and 68% confidence intervals (shaded blue areas) and 90% confidence intervals (dashed blue lines). The estimation is based on an unbalanced panel of EU countries over the period 1995Q1–2020Q1, with standard errors clustered at the country and time levels.

B.9 State-dependent results

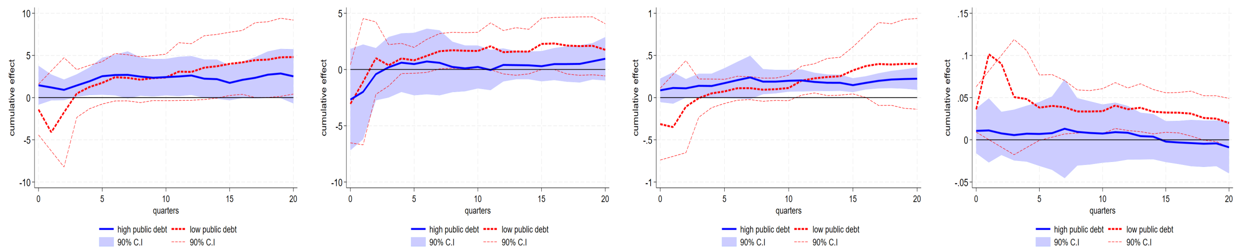
Figure B.9 reports state-dependent local projections from equation (3) for different variables when we interact the shock with regime indicators for the business-cycle phase (recession vs. expansion). Each panel displays horizon-by-horizon coefficients with 90% confidence bands, allowing a direct comparison of dynamics across states. Clearly the state of the business cycle does not affect significantly the size of the multiplier.



(a) GDP **(b)** private investment **(c)** employment **(d)** share prices

Figure B.9: Public investment cumulative effect for recessionary vs. expansionary periods. Each panel plots the estimated $\beta_{A,h}$ and $\beta_{B,h}$ from equation (3), together with 90% confidence intervals. States are defined as explained in the text.

We next look on state dependencies in Figure B.10 regarding the fiscal position (high vs. low public debt-to-GDP) according to the regime indicators and thresholds in section 4.7 of the paper we again find no significant state dependencies.



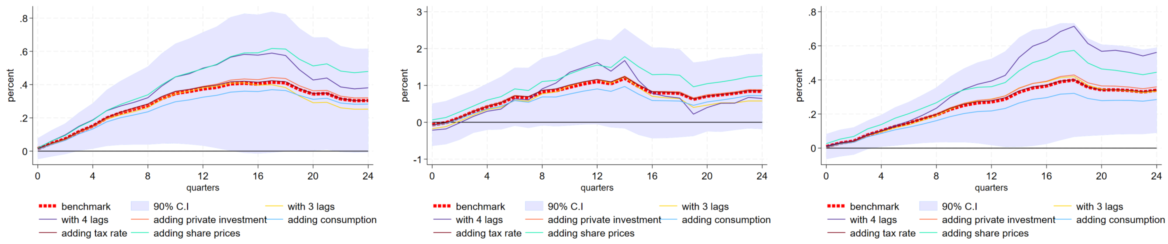
(a) GDP **(b)** private investment **(c)** employment **(d)** share prices

Figure B.10: Public investment cumulative effect for high vs. low public debt ratios. Each panel plots the estimated $\beta_{A,h}$ and $\beta_{B,h}$ from equation (3), together with 90% confidence intervals. States are defined as explained in the text. For readability, we omit wide low-debt confidence bands at a few horizons due to small sample size.

C Robustness Exercises

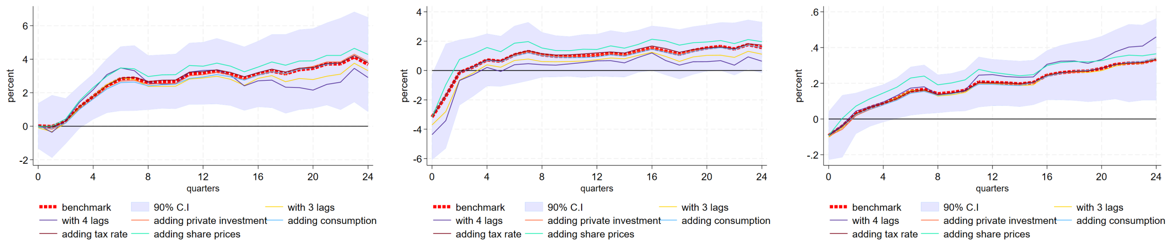
C.1 Alternative specifications

As a robustness check, we re-estimate equations (1) and (2) using alternative specifications of the local projections. In particular, we vary the lag length (considering 3 and 4 lags for all control variables), augment the baseline specification with additional controls (two lags of private investment, consumption, tax rate, and share price index), and re-estimate the responses. Figures C.1 and C.2 show that the resulting impulse responses and cumulative multipliers are close to the benchmark. The dynamic patterns are stable across specifications, with differences well within the confidence bands.



(a) GDP **(b)** private investment **(c)** employment

Figure C.1: Effect of a one percent increase in public investment, instrumented with EIB-financed infrastructure loans, on different macroeconomic variables. The dashed red line in each panel plots the estimated β_h from equation (1), together with its 90% (shaded blue area) confidence interval. Solid lines show re-estimates using alternative specifications of equation 1. Response functions are smoothed using a centered moving average.

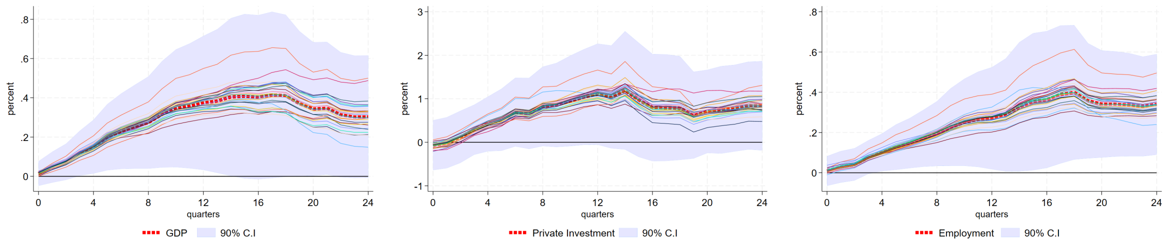


(a) GDP **(b)** Private investment **(c)** Employment

Figure C.2: Cumulative multiplier of public investment, instrumented with EIB-financed infrastructure loans, on different macroeconomic variables. The dashed red line in each panel plots the corresponding multipliers constructed from the estimated β_h^m from equation (2), together with its 90% (shaded blue area) confidence interval. Solid lines show re-estimates using alternative specifications of equation 2.

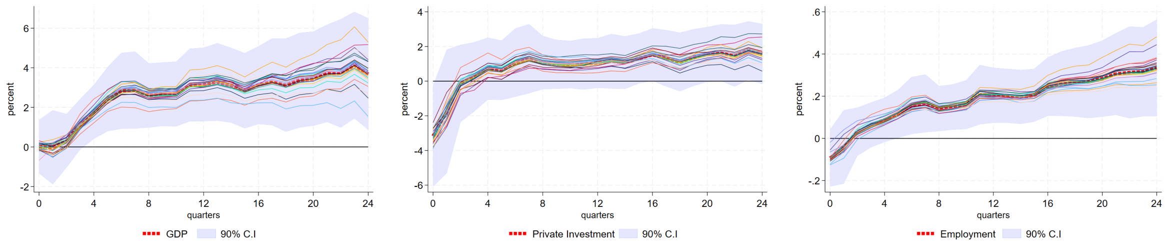
C.2 Excluding countries in turn

We further assess whether our results are driven by any single country. To this end, we re-estimate equations (1) and (2) excluding one country at a time. Figures C.3 and C.4 show that the estimated impulse responses and cumulative multipliers remain close to the benchmark. Differences across leave-one-out specifications are small and remain well within the confidence bands.



(a) GDP **(b)** private investment **(c)** employment

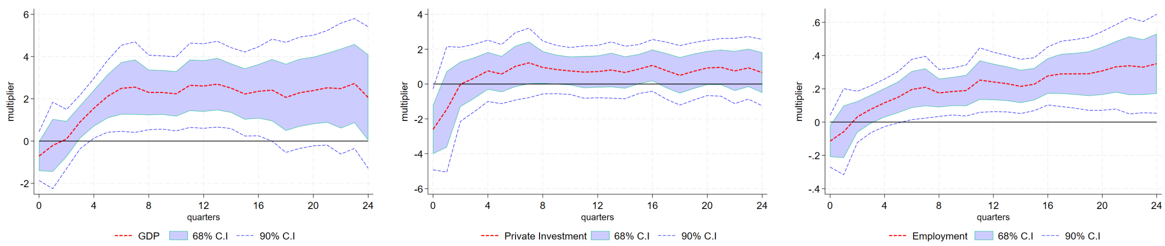
Figure C.3: Effect of a one percent increase in public investment, instrumented with EIB-financed infrastructure loans, on different macroeconomic variables. The dashed red line in each panel plots the estimated β_h from equation (1), together with its 90% (shaded blue area) confidence interval. Solid lines show re-estimates excluding one country at a time. Response functions are smoothed using a centered moving average.



(a) GDP **(b)** Private investment **(c)** Employment

Figure C.4: Cumulative effect of public investment, instrumented with EIB-financed infrastructure loans, on different macroeconomic variables. The dashed red line in each panel plots the corresponding multipliers constructed from the estimated β_h^m from equation (2), together with its 90% (shaded blue area) confidence interval. Solid lines show re-estimates excluding one country at a time.

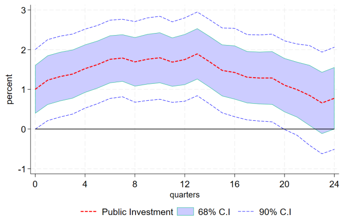
C.3 Excluding Germany, France, Italy, and Spain



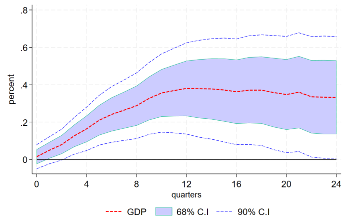
(a) GDP **(b)** Private investment **(c)** Employment

Figure C.5: Cumulative effect of public investment, instrumented with EIB-financed infrastructure loans, on different macroeconomic variables. The dashed red line in each panel plots the corresponding multipliers constructed from the estimated β_h^m from equation (2), together with its 90% (shaded blue area) confidence interval. The estimation is based on an unbalanced panel of EU countries (excluding Germany, France, Italy, and Spain) over 1995Q1–2020Q1, with standard errors clustered at the country and time levels.

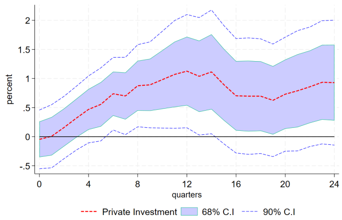
C.4 Reduced form OLS local projections



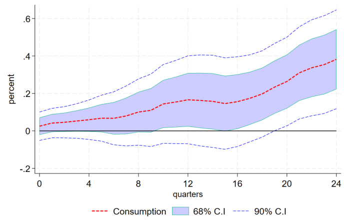
(a) public investment



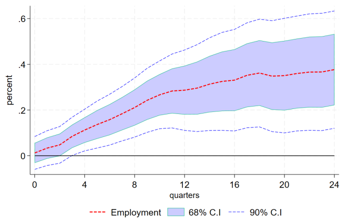
(b) GDP



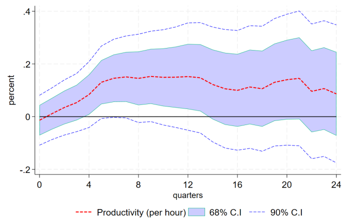
(c) private investment



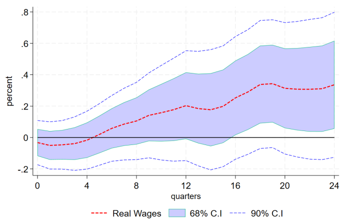
(d) consumption



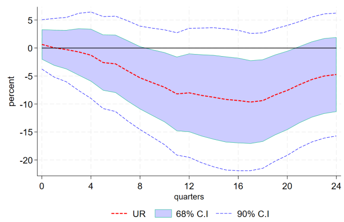
(e) employment



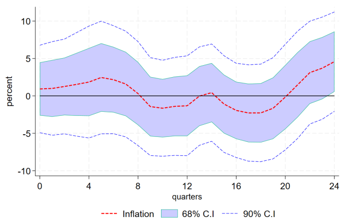
(f) productivity



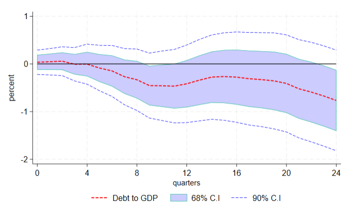
(g) real wage



(h) unemployment



(i) inflation



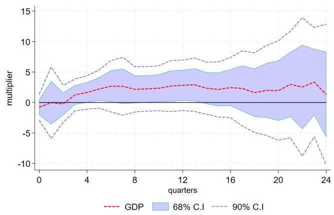
(j) debt-to-GDP

Figure C.6: Effect of a one-percent increase in EIB infrastructure loans on selected macroeconomic variables. Each panel plots the estimated β_h from equation (1), together with 68% (shaded) and 90% (dashed) confidence intervals. The estimates are obtained from an unbalanced panel of EU countries over 1995Q1–2020Q1, with standard errors clustered at the country and time levels. Response functions are smoothed using a centered moving average.

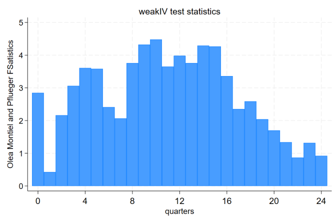
Figure C.6 reports reduced-form OLS local projections based on equation (1). For each horizon h, the cumulative growth of the outcome is regressed on the common set of controls and the log of total EIB infrastructure loans as a direct regressor.

C.5 Unweighted regressions

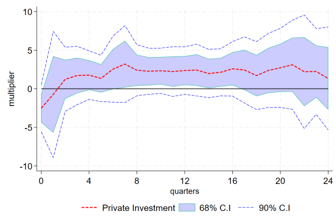
As detailed in Section 2.3, we use an augmented inverse-probability weighting (AIPW) scheme to account for predictable components of treatment. Equations (1) and (2) are estimated by weighted regressions, where weights are the inverse estimated probability that country i receives an EIB loan in quarter t. Reweighting balances observables between treated and untreated observations and reduces bias in the dynamic effects of EIB-financed investment. For comparison, Figures C.7 and C.8 show unweighted estimates: standard errors are larger, consumption exhibits a persistent crowding-out, on-impact crowding-in of private investment, labor productivity falls, and the implied output multiplier is smaller. Moreover, as shown in panel (b) of Figure C.8, the first stage F statistics of the unweighted estimations are significantly lower, indicating weak-instrument concerns when using the original loans data.



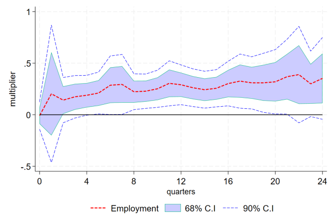
(a) GDP



(b) F-Statistics

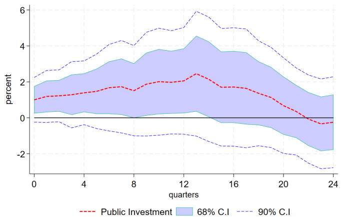


(c) private investment

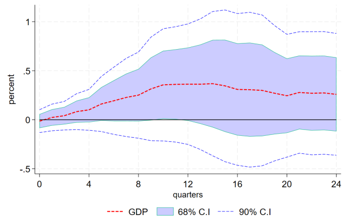


(d) employment

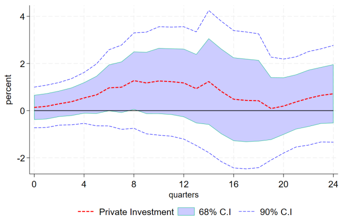
Figure C.8: Cumulative effect of public investment on output, private investment, and employment (non-weighted regressions). Each panel plots the corresponding multipliers constructed from the estimated β_h^m from equation (2) for a different variable, together with 68% (shaded blue area) and 90% (dashed blue lines) confidence intervals. Panel (b) reports the first-stage weak-IV test F-statistics for equation (2) as developed by Olea and Pflueger (2013).



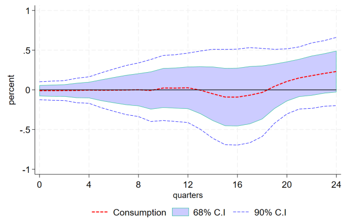
(a) public investment



(b) GDP

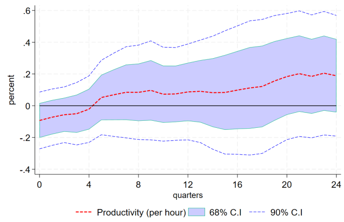


(c) private investment

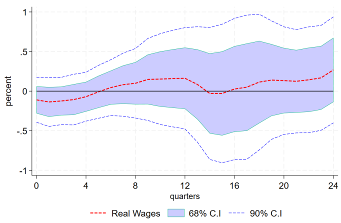


(d) consumption

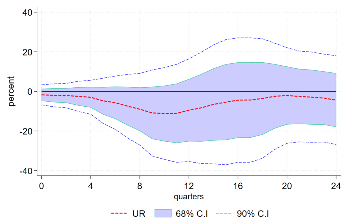
(e) employment



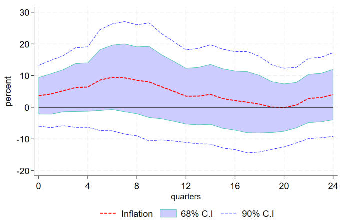
(f) productivity



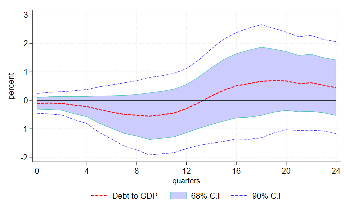
(g) real wage



(h) unemployment



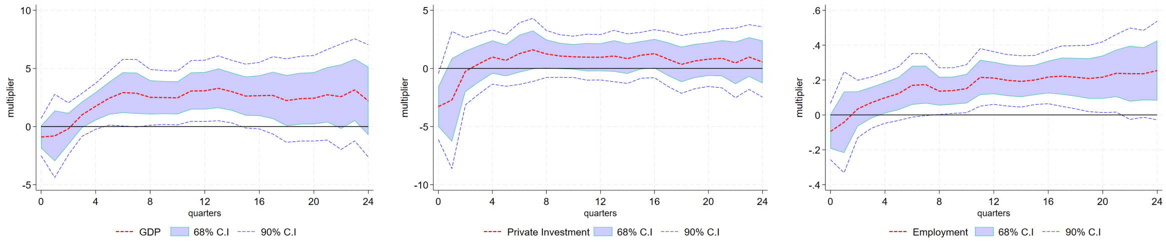
(i) inflation



(j) debt-to-GDP

Figure C.7: Non-weighted regressions: Effect of a one-percent increase in public investment, instrumented with EIB-financed infrastructure loans, on selected macroeconomic variables. Each panel plots the estimated β_h from equation (1), together with 68% (shaded) and 90% (dashed) confidence intervals. The estimates are obtained from an unbalanced panel of EU countries over 1995Q1–2020Q1, with standard errors clustered at the country and time levels. Response functions are smoothed using a centered moving average.

C.6 Winsorizing extreme values of regression weights

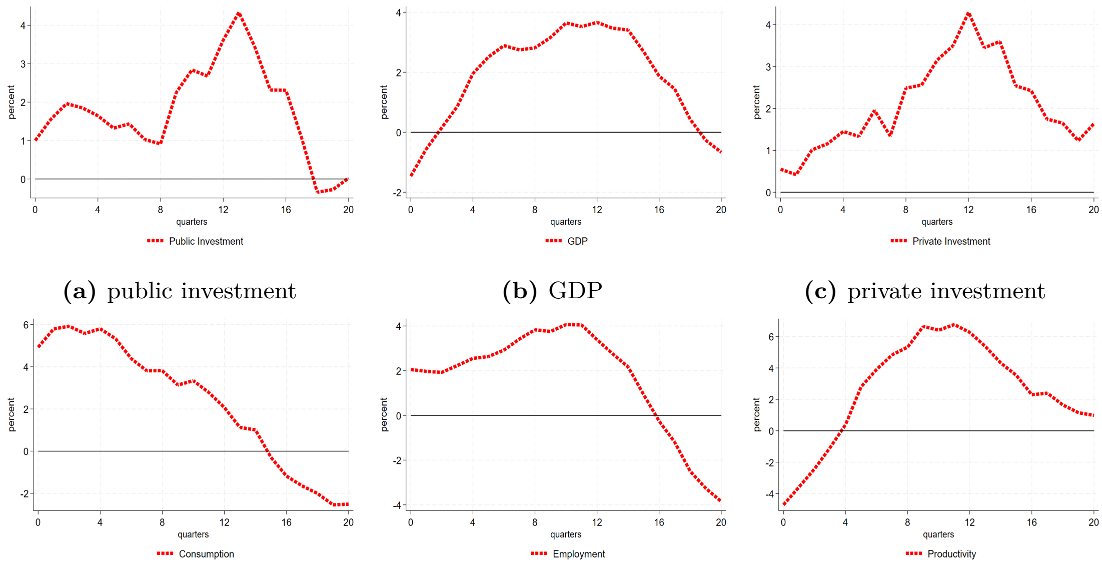


(a) GDP **(b)** Private investment **(c)** Employment

Figure C.9: Winsorizing extreme vales of regression weights: Cumulative multiplier of public investment on GDP, private investment, and employment, instrumented with EIB-financed infrastructure loans. The figures report 68% confidence intervals (shaded blue areas) and 90% confidence intervals (dashed blue lines). The estimation is based on an unbalanced panel of EU countries over 1995Q1–2020Q1, with standard errors clustered at the country and time levels.

C.7 Dynamic Heterogeneity

To assess whether dynamic heterogeneity affects our results, we estimate local projections separately for each country and then average the responses across units. The average is computed using inverse–standard-error weights to give more precision to estimates with lower sampling uncertainty. Because the time series available for each country is short (about 80 observations at $h = 0$, declining with the horizon), we implement reduced-form OLS rather than IV at the unit level. As shown in Figure C.6, OLS and IV deliver very similar dynamics in the panel, which supports using OLS at the unit level. Figure C.10 plots the resulting weighted-average responses. The dynamic patterns closely resemble the panel estimates reported in the main text, especially at earlier horizons, indicating that our baseline results are not driven by dynamic heterogeneity across countries.



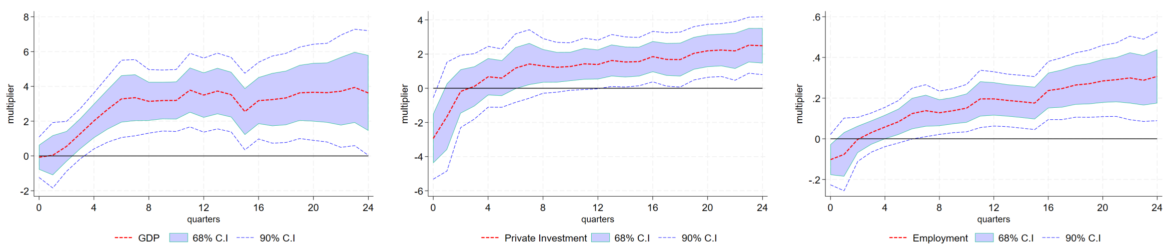
(a) public investment **(b)** GDP **(c)** private investment

(d) consumption **(e)** employment **(f)** productivity

Figure C.10: Effect of a one percent increase in EIB-financed infrastructure projects on different macroeconomic variables. Each panel plots the estimated β_h from reduced form regressions with a similar specification to equation (1). The red dashed line plots the weighted average of the estimation results for each EU27 country. Response functions are smoothed using a centered moving average.

C.8 Controlling for EU-level economic trends

In this exercise, we control for EU-wide economic trends. Specifically, we construct the first principal component of GDP growth across all EU countries over the sample period and include its contemporaneous value and lags as control variables. In addition, we incorporate the current value and two lags of total EIB infrastructure loans in the EU. In this specification, time fixed effects are omitted, as common shocks are captured by these aggregate controls.



(a) GDP **(b)** Private investment **(c)** Employment

Figure C.11: Cumulative multiplier of public investment on GDP, private investment, and employment, instrumented with EIB-financed infrastructure loans, controlling for EU trends. The figures report 68% confidence intervals (shaded blue areas) and 90% confidence intervals (dashed blue lines). The estimation is based on an unbalanced panel of EU countries over 1995Q1–2020Q1, with standard errors clustered at the country and time levels.

D Long data from Spain

D.1 Local-projection instrumental-variable estimation for Spain

In our analysis, we estimate public investment multipliers using EIB infrastructure loan announcements as an exogenous instrument in a panel setting. As emphasized by Nakamura and Steinsson (2014) and Wolf (2023), this approach identifies relative effects, that is, the impact of country i receiving one additional euro of loans relative to country j. Consequently, our estimates are not directly informative about the effects of a single country increasing infrastructure investment. To address this criticism, we use a long Spanish quarterly dataset (1980Q1–2020Q1). We use the historical dataset provided by Alloza et al. (2019) to assemble extended national accounts, public debt, and the GDP deflator, and obtain historical series for employment, stock prices, and interest rates from FRED.

Table D.1 reports descriptive statistics for Spain (1980Q1–2020Q1): quarterly national accounts, employment and labor productivity, financial variables, and EIB infrastructure loans. Eurostat provides quarterly macro series from 1995 onward; for earlier years, we extend the national accounts and public debt data back to 1980 using growth rates from the historical dataset in Alloza et al. (2019). Historical series for employment, stock prices, and interest rates are obtained from FRED dataset. The credit spread is defined as the 10-year sovereign yield difference between Spain and Germany. Labor productivity growth is defined as the quarterly growth rate of output per worker. All transformations follow the conventions used in the baseline panel dataset.

The extended time series facilitates the estimation of the effects of a public investment spending shock in Spain financed with external loans using the EIB loans as an instrument for changes in public investment.

D.2 Alternative identification strategies

To benchmark our results, we next apply alternative identification strategies proposed in the literature to recover public investment shocks and compare the corresponding estimates. This comparison helps clarify the specific transmission mechanisms of our EIB-based shock and highlights its advantages relative to other approaches.

Blanchard–Perotti shocks One of the most widely used measures of exogenous fiscal policy innovations in the literature is that proposed by Blanchard and Perotti (2002) (henceforth BP). BP shocks are identified within a structural VAR using timing restrictions that

	mean	sd	min	max	N
GDP (million euros)	211150	57408	124065	299494	161
total consumption	165521	40760	105628	230702	161
total investment	48255	15463	25593	83292	161
public expenditure	87552	27947	36057	140234	161
public investment	7875	2735	2503	14219	161
exports	52466	29032	12561	107143	161
imports	52839	29888	10317	96825	161
trade to GDP (%)	46	16	19	68	161
debt to GDP (%)	58	25	16	105	161
employment (thousands)	16201	3149	11322	21415	161
CPI inflation	4	4	-2	13	161
labor productivity growth	1	3	-17	13	160
credit spread	290	272	1	925	161
stock market index	67	36	7	155	141
EIB infrastructure loans	510	526	0	2303	161

Table D.1: Descriptive Statistics for macro variables, Spain from 1980Q1 to 2020Q1

exploit the sluggish within-period response of fiscal variables to output. This approach isolates the unanticipated component of fiscal policy from its endogenous response to economic conditions.

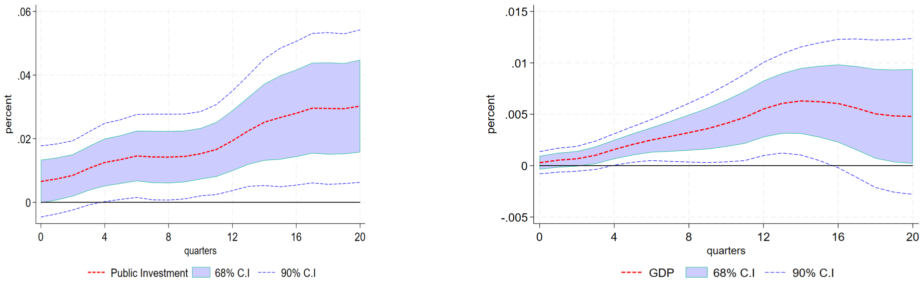
MFEV-based shocks We also adopt an alternative identification strategy based on the methodology proposed by Uhlig (2004) and extended to defense news shocks by Ben Zeev and Pappa (2017). This approach identifies exogenous disturbances that maximize the share of the forecast error variance (MFEV) of a target variable that is assumed to be exogenous to the macroeconomic environment over subsequent periods[15].

Given the results in Table 2, we regress EIB loans on debt-to-GDP, openness, GDP growth, previous EIB loans, stock market performance, and productivity growth, and use the residuals from this regression as instruments for changes in public investment to capture the unpredictable component of EIB loan allocation [16].

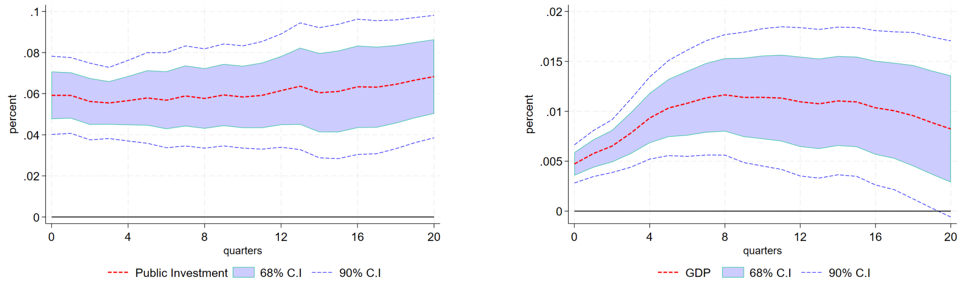
Figure D.1 displays the estimated responses of public investment (left panel) to each of the three identified shocks. The first row reports the effects of EIB infrastructure loans, which exhibit a persistent increase in public investment over time. The second and third rows

[15]We acknowledge that the MFEV approach has limitations when applied to public investment, as this variable is not fully exogenous. However, we mitigate potential predictability concerns by including both macroeconomic and financial variables in the SVAR specification, ensuring that the identified shocks capture innovations that are as exogenous as possible to broader economic conditions.

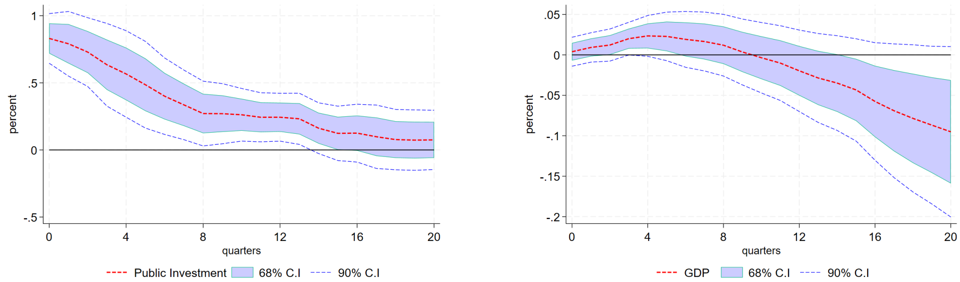
[16]Because Spain receives EIB loans in most quarters in our sample, we regress loan values directly on relevant macroeconomic and financial variables rather than defining a loan-allocation dummy as in the panel analysis.



(a) EIB



(b) MFEV



(c) BP

Figure D.1: Dynamic responses of public investment and output to identified shocks. The first row reports the reduced form estimated effect of a 1% shock on public investment (left) and output (right) using similar controls as equation (1), with 68% (shaded) and 90% (dashed) confidence intervals. The second row shows results from a SVAR where public investment shocks are identified using the MFEV approach, and the third row uses the BP identification. Estimates are based on Spanish data from 1980Q1 to 2020Q1, with responses smoothed using a centered moving average.

show the responses to the MFEV and BP shocks, respectively. Consistent with the panel estimation, the BP shock generates a short-lived increase in public investment that dissipates completely after four years, whereas the MFEV shock produces a more persistent effect, remaining positive over the full horizon. This persistence contributes to a more pronounced GDP response (right panel of Figure D.1) and, as a result, higher multipliers in the medium term. These patterns suggest important similarities between the EIB loan shock and the MFEV shock. Both appear to signal information about sustained increases in future public investment and the trajectory of economic growth.

We next estimate the cumulative output multipliers using the three different shocks as instruments for public investment. The results are presented in Figure D.2. The dynamics of the cumulative multiplier obtained from the EIB and MFEV shocks are very similar: the multiplier is negligible on impact, rises steadily over time, and reaches its peak after roughly four years. Both shocks produce large estimated cumulative multipliers. In contrast, the BP shock yields an output multiplier that never exceeds unity, peaks within two years, and converges to zero by year four, reflecting the short-lived nature of the public investment response it captures.

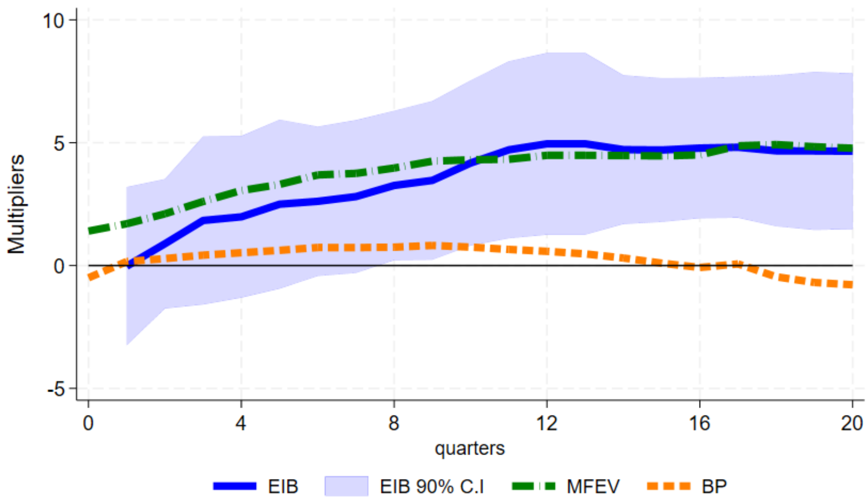


Figure D.2: Public investment cumulative multiplier at different horizons, using different shocks as instruments in equation (2). The solid blue line uses EIB loans as the instrument; the long-dashed green line uses the MFEV shock; and the short-dashed orange line uses the BP residual shock. Shaded blue areas show 90% confidence bands for the EIB specification. For readability, we omit the wide confidence band at horizon zero. The estimation is based on Spanish data over the period 1980Q1–2020Q1.