Anti-Corruption Enforcement and Macroeconomic Fragility: Evidence from Brazil's Lava Jato Shock

Área 3. Método, Teorias Econômicas Heterodoxas e História Econômica

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Abstract
Anti-corruption enforcement is often viewed as improving institutions, but its short-run macroeconomic costs remain unclear. This paper studies Brazil's post-2014 downturn through Operation Lava Jato, combining synthetic control with quarterly local projections based on new informational salience indices. Synthetic-control estimates indicate real GDP per capita losses of 5-7 percent relative to an external counterfactual. Local-projection results imply smaller but meaningful losses of 2-3 percent under an investment-augmented specification. The evidence suggests that Lava Jato was a relevant, though not exclusive, contributor to Brazil's recession, operating through disrupted capital formation, delayed projects, tighter credit, and weak reallocation mechanisms of productive capacity.

Resumo
A fiscalização anticorrupção é geralmente vista como um mecanismo de fortalecimento institucional, mas seus custos macroeconômicos de curto prazo ainda são pouco compreendidos. Este artigo analisa a recessão brasileira pós-2014 a partir da Operação Lava Jato, combinando controle sintético e projeções locais trimestrais baseadas em novos índices de saliência informacional. As estimativas por controle sintético indicam perdas de 5-7% no PIB per capita em relação ao contrafactual. As projeções locais sugerem perdas menores, de 2-3%, sob especificação com investimento. A evidência indica que a Lava Jato contribuiu para a recessão, via investimento menor, projetos atrasados, crédito restrito e realocação frágil.

Palavras-chave: Fiscalização anticorrupção; Lava Jato; Fragilidade macroeconômica; Canal do investimento; Controle sintético; Projeções locais; Brasil.

1. Introduction

Anti-corruption enforcement is commonly viewed as a central component of long-run institutional development. By strengthening accountability, improving the allocation of public resources, and reducing rent-seeking, enforcement may contribute to higher institutional quality and better development outcomes over time. Yet its short-run macroeconomic consequences remain less well understood. When anti-corruption investigations disrupt investment-intensive sectors, firms dependent on public procurement, long-gestation infrastructure projects, and politically mediated finance, they may generate immediate output costs through delayed investment, tighter credit

conditions, and heightened uncertainty (Góes, 2016; Wang, 2016; Marrazzo and Terzi, 2017; Ghazanchyan et al., 2018). More broadly, the macroeconomics of uncertainty suggests that shocks which raise uncertainty can induce firms to postpone investment and hiring, amplifying short-run contractions in economic activity (Bloom, 2009).

This tension is particularly relevant for developing and emerging economies, where large firms, public banks, infrastructure projects, state-owned enterprises, and government procurement often play a central role in capital formation. In such settings, enforcement shocks may operate not only through legal or political channels, but also through investment, credit allocation, and productive capacity. Recent micro-level evidence reinforces this interpretation. Claudio Ferraz et al. (2025) document large contractions in employment, wage bills, and bank credit for investigated firms, as well as spillovers to non-investigated firms through the bank-credit channel. These findings suggest that anti-corruption enforcement can generate substantial short-run macroeconomic costs when it disrupts large, interconnected firms and financial networks.

Brazil's post-2014 recession provides a particularly important setting in which to examine these mechanisms. The downturn coincided with Operation Lava Jato, a sharp collapse in investment, worsening political conditions, and a persistent rise in uncertainty. Lava Jato was not simply a legal or political event. It was also a large institutional and informational shock affecting sectors with high macroeconomic multiplier potential, especially construction, infrastructure, oil and gas, and firms linked to public procurement. The relevant empirical question is therefore not whether Lava Jato mattered in isolation, but whether and to what extent it contributed to Brazil's post-2014 recessionary divergence, and through which macroeconomic channels.

A central difficulty is that two related but distinct empirical objects are often conflated. The first is Brazil's aggregate post-2014 divergence from a plausible external counterfactual. The second is the component of that divergence associated with Lava Jato-related shocks within Brazil. The aggregate divergence captures Brazil's overall underperformance relative to comparable economies after 2014, including the combined effects of policy errors, political instability, external shocks, investment collapse, and institutional disruptions. The Lava Jato-related component, by contrast, requires a within-country strategy capable of tracing the dynamic effects of changes in the informational salience of the operation.

This paper addresses this challenge by combining two complementary empirical strategies. First, we use the synthetic control method, following Abadie, Diamond, and Hainmueller (2010), to estimate Brazil's aggregate post-2014 deviation from an external counterfactual. Second, we estimate quarterly local projections, following Jordà (2005), using newly constructed corruption-related informational salience indices based on news coverage, structured events, online searches, and information demand. This two-step design does not attribute the entire post-2014 downturn to Lava

Jato. Rather, it separates Brazil's broader recessionary divergence from the component empirically consistent with the timing, intensity, and propagation of Lava Jato-related informational shocks.

The results suggest that the two empirical strategies provide complementary evidence. Synthetic-control estimates indicate that Brazil's real GDP per capita remained persistently below its external counterfactual after 2014, with average post-treatment gaps between 5 and 7 percent depending on the donor pool and sample window. Local-projection estimates point to smaller, but economically meaningful, losses of about 2 to 3 percent over 2014-2019 under the preferred investment-augmented specification. These estimates suggest that Lava Jato was quantitatively relevant, although not sufficient to explain Brazil's full recessionary divergence.The evidence is also consistent with an investment-channel interpretation. Parsimonious macro-financial specifications produce modest effects and weak statistical support. Once lagged investment is introduced, the estimated losses become larger, more persistent, and more statistically informative. This pattern suggests that Lava Jato-related shocks propagated through delayed infrastructure projects, weaker capital formation, disruptions in investment-intensive sectors, and tighter financial conditions affecting firms linked directly or indirectly to the investigation. Related evidence from China points in the same direction, with anti-corruption campaigns reducing growth partly by depressing physical investment (Wang, 2016; Qu, Sylwester, and Wang, 2018).

This paper contributes to the literature in three ways. First, it separates Brazil's aggregate post-2014 macroeconomic divergence from the component more plausibly associated with a major anti-corruption enforcement shock. Second, it combines an external counterfactual approach with a domestic dynamic framework, allowing the broader recessionary divergence to be compared with the estimated contribution of Lava Jato-related shocks. Third, it highlights the investment channel as a key mechanism through which institutional and informational shocks may translate into short-run macroeconomic costs in developing economies.

2. Historical Context and Related Literature

2.1 Competing Interpretations of Brazil's Post-2014 Downturn

Brazil's post-2014 recession emerged from the interaction of external shocks, domestic policy choices, structural fragilities, and institutional disruptions. This multiplicity of causes is central to the empirical challenge addressed in this paper. If the downturn reflected several overlapping forces, the relevant question is not whether any single factor explains the recession in isolation, but how much each component contributed to Brazil's deviation from a plausible counterfactual trajectory.

One strand of the literature emphasizes the interaction between deteriorating external conditions and pre-existing structural vulnerabilities. The reversal of the commodity supercycle, weaker global growth, and changing international financial conditions reduced the support that had sustained Brazil's previous expansion. Fernández, González, and Rodríguez (2017) show that global shocks account for a substantial share of macroeconomic fluctuations in emerging economies,

especially in Latin America. In Brazil, these external forces interacted with weaker productivity growth, declining industrial dynamism, lower investment capacity, and growing macroeconomic imbalances. Oreiro and D'Agostini (2016) argue that the end of favorable terms of trade exposed deeper structural weaknesses, including exchange-rate overvaluation, premature deindustrialization, and a squeeze on profitability. Similarly, Ferreira-Filho and Fraga (2020) stress the combined role of structural regression, declining economic complexity (Hidalgo et al., 2007), weakening industrial competitiveness (Ferreira-Filho et al., 2017), growing financial fragility in the spirit of Minsky (1986), and adverse external shocks and capital-flow reversals (Cavallo et al., 2016).

A second strand gives greater weight to domestic policy choices and the deterioration of macroeconomic governance. Lisboa and Pessoa (2016), Pessoa (2016), Barbosa-Filho and Pessoa (2014), Schymura (2017), and Fraga Neto (2018) argue that excessive interventionism, fiscal deterioration, policy inconsistency, and distortions associated with the so-called Nova Matriz Econômica eroded confidence, reduced investment efficiency, and amplified the downturn. Matos (2016), using a panel of emerging economies, also concludes that domestic factors were more important than external ones in explaining Brazil's underperformance relative to comparable countries.

A third interpretation adopts a more synthetic view. Borges (2016, 2017a) argues that explanations centered exclusively on policy errors tend to overstate their role, since part of the slowdown reflected international shocks, sector-specific disturbances, energy constraints, and measurement issues. Barbosa-Filho (2020), in turn, emphasizes a combination of worsening terms of trade, policy reversals, weakening credibility, and the contractionary effects of Lava Jato on Petrobras-linked investment and government-related construction contracts. This interpretation is particularly relevant here because it treats Lava Jato not as an isolated cause of the recession, but as one element within a broader configuration of adverse macroeconomic and institutional shocks.

Taken together, these interpretations point to two conclusions. First, Brazil's post-2014 recession was clearly multi-causal: external conditions, domestic policy choices, structural weaknesses, political instability, and institutional shocks all contributed to the downturn. Second, the relative contribution of each component remains an open empirical question. This is why a simple before-and-after comparison is insufficient. A credible assessment requires distinguishing Brazil's aggregate post-2014 underperformance from the component more plausibly associated with Lava Jato-related shocks.

2.2 Why Lava Jato May Have Had Macroeconomic Effects

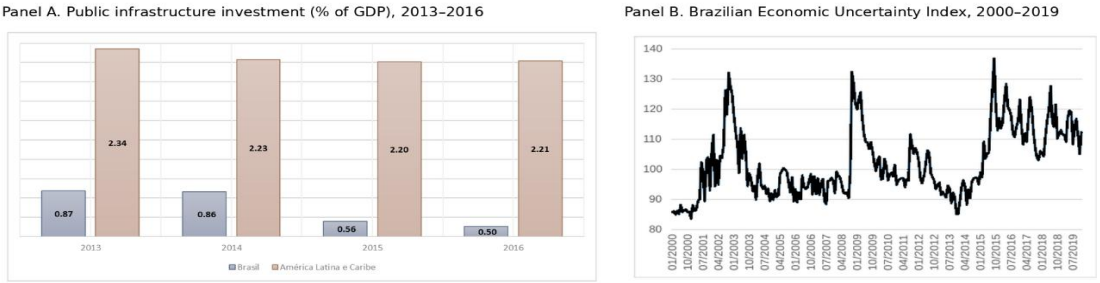
Within this broader debate, Operation Lava Jato stands out as a relevant domestic shock not only because of its political and legal salience, but because of the sectors and investment networks it affected. The operation reached large construction companies, Petrobras-linked projects,

infrastructure contracts, public procurement arrangements, and firms dependent on politically mediated finance. These activities were closely connected to Brazil's investment cycle and had high multiplier potential, making Lava Jato a potential institutional and informational shock with aggregate consequences.

The main transmission mechanism runs through investment. Large-scale enforcement actions can affect aggregate activity when they interrupt long-gestation projects, weaken the balance sheets of major contractors, restrict access to credit, and delay public or quasi-public investment decisions. This mechanism is particularly relevant in economies where infrastructure, regulated sectors, state-owned enterprises, public banks, and large domestic firms play a central role in capital formation.

This channel is plausible in Brazil after 2014. Public infrastructure investment declined from 0.86 percent of GDP in 2014 to 0.50 percent in 2016, while construction activity fell sharply, with sectoral growth moving from 4.49 percent in 2013 to -2.14 percent, -9.0 percent, and -9.98 percent in 2014, 2015, and 2016, respectively (Ipea, 2022). Gross fixed capital formation also dropped markedly. These patterns do not prove that Lava Jato caused the investment collapse, but they show that the operation unfolded in sectors through which a large enforcement shock could have generated macroeconomic effects.

Figure 1 – Investment disruption and uncertainty around the Lava Jato period in Brazil



Notes: Panel A reports public infrastructure investment in Brazil and Latin America and the Caribbean. Panel B reports the Brazilian Economic Uncertainty Index.
Sources: Infralatam; FGV.

A second mechanism operates through uncertainty, credit, and network propagation. The Brazilian economic uncertainty indicator rose sharply after 2014 and remained elevated, consistent with interpretations linking Lava Jato to uncertainty and weaker investment (Oreiro and D'Agostini, 2016; Ferreira-Filho and Fraga, 2020) and with the broader literature on uncertainty shocks and irreversible investment (Bloom, 2009; Baker, Bloom, and Davis, 2016). When enforcement affects large firms connected to suppliers, banks, workers, and public contracts, the effects may extend beyond investigated firms through credit restrictions, reputational risk, contract suspensions, and supply-chain disruptions. The point is not that anti-corruption efforts are undesirable in net terms, but that enforcement may entail non-trivial short-run macroeconomic costs when it interacts with fragile investment conditions and weak mechanisms for reallocating capital.

2.3 Related Empirical Literature and This Paper's Contribution

The international empirical literature supports the distinction between long-run institutional gains and short-run macroeconomic costs. Marrazzo and Terzi (2017) show that reform waves may depress growth in the years immediately following implementation before longer-term gains materialize. Wang (2016) finds that China's anti-corruption campaign reduced provincial investment and growth in the short run, while Qu, Sylwester, and Wang (2018) provide related evidence at the provincial level. Ghazanchyan et al. (2018), using a news-based corruption index, show that corruption-related shocks can reduce GDP per capita, with stronger effects in emerging and developing economies.

This literature is directly relevant to Brazil, but it leaves an important gap. Less is known about how enforcement shocks operate in economies where public investment, state-owned enterprises, regulated sectors, large contractors, and government procurement are central to capital formation. In such settings, the macroeconomic consequences of enforcement depend not only on punishing corrupt practices, but also on the economy's capacity to reorganize suspended projects, preserve credit flows, substitute firms, and reallocate productive capacity.

The Brazilian empirical literature has examined the post-2014 downturn using counterfactual approaches. Balassiano (2018), Barbosa-Filho (2018), and Pessoa (2017) show that Brazil's recession cannot be fully explained by external conditions, but leave open how much of the divergence can be associated with Lava Jato-related shocks. This paper addresses that question by combining synthetic control, which estimates Brazil's aggregate post-2014 divergence, with local projections based on Lava Jato salience indices, which assess the dynamic component associated with the operation. The article therefore contributes by distinguishing total underperformance from the Lava Jato-related component, linking Brazil's recession to the international literature on corruption-related shocks, and highlighting the investment channel as a mechanism through which enforcement may generate short-run macroeconomic costs.

3. Empirical Strategy

3.1 Two Estimands and Two Complementary Designs

The empirical strategy distinguishes between two related but conceptually different objects. The first is Brazil's aggregate post-2014 divergence from a plausible external counterfactual. The second is the component of that divergence associated with Lava Jato-related shocks within Brazil. These quantities need not coincide: the aggregate divergence captures Brazil's overall underperformance relative to comparable economies, while the Lava Jato-related component refers to the dynamic output response associated with changes in the informational salience of the operation.

Because these objects are different, they require complementary empirical designs. Synthetic control is used to estimate the scale of Brazil's post-2014 deviation from an external counterfactual. This estimate should not be interpreted as the effect of Lava Jato alone, since it may also reflect policy

choices, political instability, fiscal adjustment, confidence effects, and other shocks that differentiated Brazil from the donor pool. Local projections are then used to assess whether Lava Jato-related informational shocks were followed by contractionary output dynamics within Brazil, conditional on broader macroeconomic and financial controls.

The purpose of combining these methods is not to produce two estimates of the same parameter, but to discipline the interpretation of the evidence. Synthetic control establishes the magnitude of the broader recessionary divergence, while local projections evaluate whether a meaningful component of that divergence is consistent with the timing and propagation of Lava Jato-related shocks.

3.2 Synthetic Control and the External Counterfactual

We use the synthetic control method to estimate Brazil's aggregate post-2014 deviation from an external counterfactual. Let Y_{it}^{N} denote the potential outcome for country i at time t in the absence of treatment, and let Y_{it}^{I} denote the potential outcome under treatment. The observed outcome is

$$Y_{it} = Y_{it}^{N} + \tau_{it} D_{it},$$

where $D_{it} = 1$ if country i is exposed to treatment at time t, and $D_{it} = 0$ otherwise. Brazil is the treated unit, indexed by $i = 1$. The treatment period begins in 2014, so T_0 denotes the last pre-treatment period and $t > T_0$ corresponds to the post-2014 period. The treatment effect of interest is

$$\tau_{1t} = Y_{1t}^{I} - Y_{1t}^{N}, t > T_0.$$

Because Y_{1t}^{N} is unobserved after treatment, synthetic control approximates it through a weighted average of countries in the donor pool. Following the standard formulation, the untreated potential outcome can be represented as

$$Y_{it}^{N} = \alpha_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it},$$

where α_t is a common time effect, Z_i is a vector of observed covariates, λ_t is a vector of unobserved common factors, μ_i is a vector of factor loadings, and ε_{it} is an idiosyncratic error term.

Let $W = (w_2, \dots, w_{J+1})'$ be a vector of donor-pool weights satisfying $w_j \geq 0$ and $\sum_{j=2}^{J+1} w_j = 1$. The synthetic counterfactual for Brazil is

$$\hat{Y}_{1t}^{N}(W) = \sum_{j=2}^{J+1} w_j Y_{jt}.$$

The optimal weights W^* are chosen to minimize the pre-treatment discrepancy between Brazil and its synthetic counterpart. The estimated post-treatment gap is therefore

$$\hat{\tau}_{1t} = Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt}, t > T_0.$$

In this paper, the synthetic-control exercise recovers Brazil's overall post-2014 divergence relative to an external benchmark. This gap should not be interpreted as the effect of Lava Jato alone, since it may also reflect domestic policy choices, political instability, fiscal adjustment, confidence effects, and other shocks that differentiated Brazil from the donor pool.

We also implement placebo reassignments within the donor pool to assess whether Brazil's post-2014 divergence is unusually large relative to countries not exposed to the same domestic institutional event. Thus, synthetic control establishes the magnitude and distinctiveness of Brazil's aggregate divergence, but it does not by itself allocate that divergence across domestic mechanisms.

3.3 Local Projections and the Dynamic Effect of Lava Jato-Related Shocks

To assess the component of Brazil's post-2014 divergence associated with Lava Jato-related shocks, we estimate quarterly local projections. This framework is appropriate because corruption-related shocks are not directly observable and because Lava Jato is better represented as a sequence of time-varying informational shocks than as a single one-off intervention. The intensity of these shocks is proxied by quarterly salience indices constructed from multiple information sources, as described in Section 4.

Let $y_t$denote log real GDP per capita, and let $Shock_t$denote one of the Lava Jato salience indices. For each horizon $h = 0,1, \dots, H$, we estimate:

$$y_{t+h} - y_{t-1} = \alpha_h + \beta_h Shock_t + \Gamma_h' X_{t-1} + \sum_{k=1}^{p} \Phi_{h,k} \Delta y_{t-k} + \sum_{k=1}^{p} \Psi_{h,k} Shock_{t-k} + \varepsilon_{t+h}.$$

Here, $X_{t-1}$is a vector of lagged macroeconomic controls, $p$is the lag order, and $\varepsilon_{t+h}$is the horizon-specific regression error. The coefficient $\beta_h$traces the response of log real GDP per capita at horizon $h$to a Lava Jato-related informational shock. Because the dependent variable is specified as a long difference, the estimates are aligned with the paper's focus on cumulative medium-run losses rather than contemporaneous effects alone.

The control structure is designed to reduce the risk that Lava Jato-related shocks proxy for broader macroeconomic fluctuations. Lagged output terms capture persistence in GDP dynamics, while lagged shocks absorb serial dependence in the salience indices. Additional macro-financial controls account for global financial conditions, commodity prices, monetary policy, inflation, fiscal stance, energy prices, credit conditions, and domestic financial conditions. In the investment-augmented specifications, lagged gross fixed capital formation is included to assess whether the estimated response is consistent with the investment-channel mechanism discussed in Section 2.

Inference is based on Newey-West heteroskedasticity-and-autocorrelation-consistent standard errors, since local projections with overlapping horizons induce serial correlation in the regression residuals.

3.4 Cumulative Responses and Historical Decomposition

The main object of interest in the local-projection block is the medium-run output loss associated with the realized sequence of Lava Jato-related shocks. Because the dependent variable is specified as a long difference, the estimated coefficient $\hat{\beta}_h$captures the response of log real GDP per capita up to horizon h. This allows the impulse-response profile to be translated into a historical decomposition and an implied counterfactual path for output.

Let $Shock_t$denote the realized Lava Jato salience shock at time t. The estimated contribution of past Lava Jato-related shocks to output at time $t$is computed as

$$\widehat{HD}_t = \sum_{h=0}^{H} \hat{\beta}_h \, Shock_{t-h}.$$

The counterfactual output path that removes this estimated contribution is then given by

$$\tilde{y}_t = y_t - \widehat{HD}_t.$$

This yields an internal dynamic counterfactual: observed output is compared with a path that retains the same macroeconomic environment and control structure, but removes the estimated contribution of Lava Jato-related informational shocks. To express this counterfactual in percentage terms, we define the implied output gap as

$$\widehat{gap}_t = 100[\exp\,(y_t - \tilde{y}_t) - 1].$$

Negative values indicate that observed GDP per capita lies below the counterfactual path without the estimated contribution of Lava Jato-related shocks. This mapping provides the bridge between the local-projection estimates and the average output losses reported in the results section.

3.5 Measurement Robustness and the Investment Channel

The local-projection design uses three alternative Lava Jato salience indices: two PCA-based measures that recover common variation across standardized informational indicators, and one direct index centered on Lava Jato-specific content. This multi-index strategy reduces dependence on a single proxy and allows the analysis to assess whether the estimated responses are preserved across different representations of the underlying informational shock. We also compare a parsimonious macro-financial benchmark with an investment-augmented specification that includes lagged gross fixed capital formation. This comparison is motivated by the paper's central mechanism: if Lava Jato-related shocks propagated through delayed projects, weaker capital formation, tighter credit conditions, and disruptions in investment-intensive sectors, then accounting for investment dynamics should yield more coherent response profiles. The investment-augmented specification is therefore interpreted as evidence of consistency with the proposed mechanism, not as definitive proof of mediation.

3.6 Model Selection and Interpretation

Local-projection estimates may be sensitive to choices regarding the shock proxy, lag structure, control set, and treatment of seasonality. For this reason, the empirical strategy does not

rely on a single arbitrary specification, nor does it select models by maximizing the estimated effect. Instead, admissible specifications are evaluated through a structured validation procedure based on statistical informativeness, dynamic stability, parsimony, and economic coherence.

The validation procedure considers a broad specification space, including alternative shock indices, control blocks, identification schemes, lag orders, and specifications with and without seasonal controls. The preferred specifications reported in the main text are selected because they provide stable, interpretable, and economically meaningful response profiles, not because they generate the largest point estimates. Historical decompositions are then used to translate the estimated sequence of Lava Jato-related shocks into an implied counterfactual path for output, placing the local-projection evidence on a scale comparable to the synthetic-control estimates while preserving the distinction between the two empirical objects.

4. Data and Construction of the Lava Jato Salience Indices

4.1 Data for the Synthetic-Control Exercise

The synthetic-control exercise uses annual cross-country data to estimate Brazil's aggregate post-2014 divergence from an external counterfactual. The outcome variable is real GDP per capita in constant 2017 U.S. dollars. The donor pool is defined by data availability and by the exclusion of countries exposed to the same domestic institutional shock.

The predictor set includes variables capturing productive capacity, demographic structure, external exposure, and macroeconomic conditions: physical capital stock per capita, human capital, population growth, trade openness, terms of trade, urban population, elderly population, inflation, and the real interest rate. These variables are used to construct a weighted combination of countries that closely reproduces Brazil's pre-2014 trajectory, rather than to estimate structural relationships between covariates and output.

The annual panel combines information mainly from the World Bank and the Penn World Table. Table 1 summarizes the variables, transformations, and sources used in the synthetic-control exercise.

Table 1 – Variables used in the synthetic-control exercise

Variables	Notation	Source
GDP per capita, constant 2017 U.S. dollars	level (constant 2017 US$)	World Bank (2022)
Physical capital stock per capita	log-level	Penn World Table (2022)
Trade (sum of exports and imports of goods and services)	percent of GDP	World Bank (2022)
Terms of trade	level	World Bank (2022)
Human capital	index	Penn World Table (2022)
Population growth	%	World Bank (2022)
Elderly population	%	World Bank (2022)
Urban population	%	World Bank (2022)
Inflation rate	%	World Bank (2022)
Real interest rate	%	World Bank (2022)

Source: Authors' elaboration.

4.2 Quarterly Macroeconomic Data for Brazil

The local-projection analysis uses quarterly macroeconomic data for Brazil over the period 1996Q4-2019Q4. The dependent variable is log real GDP per capita, denoted $lgdp_pc$, constructed from Brazil's quarterly national accounts and expressed in constant-price terms. The sample provides a sufficiently long pre-2014 window to estimate output dynamics and covers the Lava Jato period through 2019, while avoiding contamination from the Covid-19 period.

The control set captures the main external and domestic macro-financial conditions that may affect Brazilian output independently of Lava Jato-related shocks. External controls include the VIX, the U.S. 10-year Treasury yield, and a broad commodity-price index, which proxy global uncertainty, international financial conditions, and commodity-market fluctuations. Domestic controls include the SELIC policy rate, IPCA inflation, credit aggregates, real electricity prices, fiscal variables, and gross fixed capital formation. All controls enter the regressions with lags to reduce simultaneity and reverse-causality concerns and to reflect the delayed transmission of macroeconomic shocks.

Table 2 – Quarterly macroeconomic variables used in the local-projection specification

Variable	Description	Source
$\mathbf{GDPpc}_{t-1}$	Lagged log real GDP per capita	IBGE
VIX	Global financial uncertainty and risk aversion (S&P 500 implied volatility index)	FRED
US10Y	Yield on the 10-year U.S. Treasury bond, proxy for global long-term interest rates	FRED
COMM	Global commodity price index capturing fluctuations in commodity markets and Brazil's terms of trade	IMF / FRED
SELIC	Quarterly average of Brazil's policy interest rate	Central Bank of Brazil
IPCA	Quarterly inflation based on Brazil's official consumer price index	IBGE
FBKF	Log of gross fixed capital formation (FBCF), proxy for the investment cycle	IBGE
CRED	Log of credit aggregates capturing domestic financial conditions	Central Bank of Brazil
PLD	Real electricity price (PLD) deflated by IPCA	CCEE / IBGE
SP	Consolidated public-sector fiscal balance: Fiscal balance of the consolidated public sector, including the central government, regional governments, and state-owned enterprises; included to capture domestic fiscal conditions.	Brazilian Treasury
PFI	Public sector fiscal impulse indicator capturing discretionary fiscal policy changes	Brazilian Treasury

Source: Authors' elaboration.

4.3 Lava Jato Salience Indices

A central challenge in estimating the macroeconomic effects of anti-corruption enforcement is that corruption-related shocks are not directly observable. We address this problem by constructing quarterly indices that proxy the informational salience of Operation Lava Jato in Brazil. These indices do not measure corruption itself. Rather, they capture the intensity with which Lava Jato entered the public, political, and economic information environment, potentially affecting expectations, credit conditions, investment decisions, and perceived institutional risk.

The indices are constructed from five complementary data sources: GDELT Global Knowledge Graph, GDELT document counts, GDELT structured events, Google Trends for Brazil, and Wikipedia pageviews. These sources capture different dimensions of information flow, including

news intensity, structured political and judicial events, public search behavior, and online demand for information. Relevant content is identified using a structured dictionary of terms related to corruption practices, judicial investigations, Operation Lava Jato, and the main organizations and actors involved in the scandal. Table 3 summarizes the sources used in the construction of the indices.

For GDELT-based sources, informational intensity is measured as the share of corruption- or Lava Jato-related records in total Brazil-related coverage within each period. Let $num_{i,t}$ denote the number of relevant records in source i during period t, and let $den_{i,t}$ denote the total number of Brazil-related records in the same source and period. The raw source-specific measure is defined as

$$X_{i,t} = \frac{num_{i,t}}{den_{i,t}}.$$

For Google Trends and Wikipedia pageviews, $X_{i,t}$ is constructed as the average value of daily or weekly observations within each period. These sources are interpreted as direct indicators of public attention and information demand rather than as shares of overall Brazil-related coverage. All raw series are initially constructed at monthly frequency and then aggregated to quarterly frequency using simple averages, aligning the salience indices with the quarterly macroeconomic dataset used in the local-projection analysis.

Because the sources differ in scale and variance, each component is standardized before aggregation:

$$Z_{i,t} = \frac{X_{i,t} - \mu_i}{\sigma_i},$$

where μ_i and σ_i denote the mean and standard deviation of source i over the index-construction sample. The baseline Lava Jato salience index is then constructed as the simple average of the standardized components:

$$Index_t = \frac{1}{N}\sum_{i=1}^{N} Z_{i,t},$$

where N is the number of data sources. This equal-weight aggregation prioritizes transparency, replicability, and robustness over sample-specific statistical optimization, in line with the logic of the economic policy uncertainty and geopolitical risk literatures. Higher values indicate greater Lava Jato-related informational salience.

To assess the validity of the indices, we conduct leave-one-source-out exercises, compare alternative aggregation strategies, examine the temporal alignment between the indices and major Lava Jato events, and evaluate the correlation structure across components. Alternative PCA-based indices, weighted PCA variants, and narrower Lava Jato-specific measures are used as robustness checks in the empirical analysis.

Table 3 – Data sources used in the construction of the Lava Jato salience indices

Data source	Type of signal	Keywords / pages used	Interpretation
GDELT GKG	Global news coverage	corruption, bribery, fraud, embezzlement, Petrobras, Odebrecht, Lava Jato, Operation Car Wash	Share of corruption-related mentions in news about Brazil
GDELT DOC	News document counts	corruption, Lava Jato, Petrobras, Odebrecht, bribery, fraud	Volume of corruption-related news coverage
GDELT Events	Structured political events	corruption, investigation, bribery, judicial actions	Frequency of corruption-related events occurring in Brazil
Google Trends (Brazil)	Public search behavior	lava jato, corrupção, propina, Odebrecht, Petrobras, delação premiada, Sergio Moro	Public attention toward corruption investigations
Wikipedia Pageviews	Information demand	Operação Lava Jato, Operation Car Wash, Sergio Moro, Petrobras, Odebrecht, Corruption	Public demand for information on corruption-related topics

Notes: Google Trends queries are rescaled using an anchor-based normalization procedure with the term "lava jato" as a common reference across query groups. Wikipedia pageviews correspond to the total number of daily views across selected pages in Portuguese and English.

4.4 Composite Lava Jato Indices

Using the standardized source-level indicators, we construct three quarterly measures of Lava Jato-related informational salience. The purpose of this multi-index strategy is to assess whether the empirical results are sensitive to alternative representations of the underlying informational shock.

The first measure, PCA-common, is the first principal component of the standardized source-level indicators. It is designed to capture the common informational signal shared across sources, filtering out idiosyncratic movements specific to individual datasets. The second measure, PCA-2014, is a weighted principal-component index that assigns greater importance to observations from 2014, the year in which Lava Jato emerged as a major institutional event. This index emphasizes the initial informational disruption associated with the operation. The third measure, Lava Jato-direct, is a narrower dictionary-based index centered specifically on Operation Lava Jato and its core actors. Unlike the PCA-based indices, it tracks the narrative salience of the operation itself rather than a broader common factor.

Taken together, these indices provide complementary measurement strategies: a broad latent-factor measure, a shock-focused PCA variant, and a narrower Lava Jato-specific narrative measure. This structure allows the empirical analysis to evaluate whether the estimated macroeconomic responses are robust to alternative measures of Lava Jato-related informational salience. Table 4 summarizes the indices used in the empirical analysis.

Table 4 - Lava Jato salience indices used in the empirical analysis

Index	Variable	Construction method	Interpretation
PCA-common	PCA-common	First principal component of standardized indicators	Common informational signal across sources
PCA-2014	PCA-2014	Weighted principal component, with higher weight on 2014	Shock-focused index emphasizing the initial Lava Jato disruption
Lava Jato-direct	LJ-direct	Dictionary-based measure focused on Lava Jato	Narrative salience of the operation itself

Source: Authors' elaboration.

4.5 Control Variables and Transformations

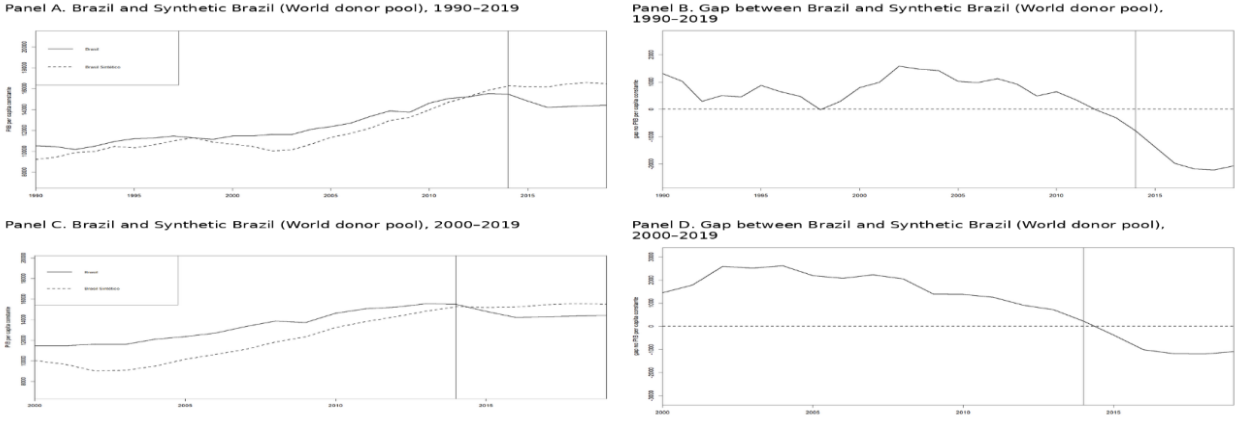
The quarterly control variables account for broader domestic and external macroeconomic conditions that may affect Brazilian output independently of Lava Jato-related shocks. External controls include the VIX, the U.S. 10-year Treasury yield, and a broad commodity-price index; domestic controls include the SELIC policy rate, IPCA inflation, credit aggregates, real electricity prices, fiscal variables, and gross fixed capital formation. All controls enter the regressions with lags to reduce simultaneity concerns and reflect the delayed transmission of macroeconomic shocks. Investment and credit variables are expressed in logarithms when appropriate, nominal variables are converted to real terms, and quarterly averages are used for higher-frequency series. Since the dependent variable is log real GDP per capita, impulse responses can be interpreted approximately as percentage changes.

5. Synthetic-Control Results

We begin by estimating Brazil's aggregate post-2014 divergence from an external counterfactual using alternative donor pools and pre-treatment windows. Four synthetic-control exercises are reported: two using the full global donor pool and two using a more restrictive Latin American donor pool. The global specifications assess whether Brazil's post-2014 underperformance emerges in a broad international comparison, while the regional specifications provide a more demanding benchmark based on economies that are closer to Brazil in terms of external exposure, development characteristics, and commodity-cycle sensitivity.

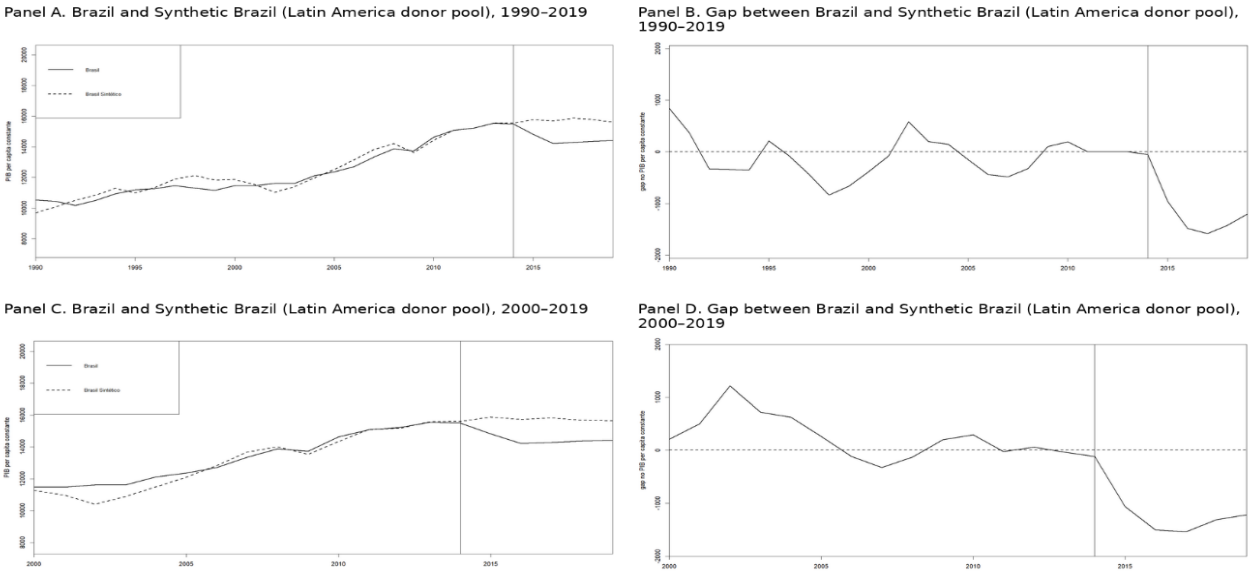
Across all specifications, the results point to a clear and persistent divergence. Brazil's real GDP per capita closely tracks its synthetic counterpart before treatment and then falls below the counterfactual path after 2014. In the global donor-pool exercises, the average post-2014 gap is approximately 7 percent in the 1990-2019 specification and about 6 percent in the 2000-2019 specification. The Latin American exercises yield slightly smaller but still substantial gaps, of approximately 5 percent and 5.5 percent, respectively. This pattern indicates that Brazil's post-2014 underperformance is not driven by a single donor pool or pre-treatment window; it also appears when the counterfactual is constructed from regionally closer economies.

Figure 2 – Synthetic-control results for Brazil: global donor-pool specifications



Notes: Panels A and C report the trajectories of Brazil and Synthetic Brazil under the global donor-pool specifications for 1990-2019 and 2000-2019, respectively. Panels B and D report the corresponding gaps between Brazil and Synthetic Brazil. The vertical line marks 2014, the beginning of the treatment period.

Figure 3 – Synthetic-control results for Brazil: Latin American donor-pool specifications



Notes: Panels A and C report the trajectories of Brazil and Synthetic Brazil under the Latin American donor-pool specifications for 1990-2019 and 2000-2019, respectively. Panels B and D report the corresponding gaps between Brazil and Synthetic Brazil. The vertical line marks 2014, the beginning of the treatment period.

Placebo exercises provide additional support for this interpretation. Reassigning the synthetic-control procedure to selected non-treated countries, including Chile, Mexico, and Paraguay, does not produce post-treatment gaps comparable in magnitude or persistence to the Brazilian case. Although these exercises cannot eliminate all concerns related to idiosyncratic shocks or donor-pool composition, they indicate that Brazil's divergence is not a mechanical feature of the synthetic-control procedure. Detailed placebo results are reported in Appendix Figure A3[1].

These estimates should be interpreted as Brazil's aggregate post-2014 underperformance relative to an external counterfactual, not as the isolated effect of Lava Jato. The next section therefore assesses whether a meaningful component of this divergence is consistent with Lava Jato-related informational shocks operating through investment, credit, and uncertainty channels.

Table 5 – Summary of synthetic-control estimates for Brazil's post-2014 divergence

Exercise	Period	Donor pool	Main synthetic-control weights	Average GDP per capita gap, 2014-2019	Interpretation
World 1	1990-2019	133 countries	Ecuador (0.45); Uruguay (0.55)	-7.0%	Clear post-2014 divergence
World 2	2000-2019	133 countries	Uruguay (0.69); Congo (0.24); others	-6.0%	Persistent negative gap
LA 1	1990-2019	Latin America	Argentina (0.25); Mexico (0.17); others	-5.0%	Strong pre-treatment fit

[1] Due to space limitations, only the main robustness exercises are reported. Additional placebo, specification, and inference checks are available from the authors upon request.

LA 2	2000-2019	Latin America	Colombia (0.61); Argentina (0.30); others	-5.5%	Consistent regional divergence

Notes: The table reports the main synthetic-control exercises. The average post-2014 gap is the mean percentage deviation of Brazil's real GDP per capita from its synthetic counterpart over 2014-2019. Only the main donor-pool weights are reported.

6. Local-Projection Evidence

6.1 Baseline Results and the Investment-Channel Specification

We begin the local-projection analysis by comparing a parsimonious macro-financial benchmark with an investment-augmented specification. The objective is to assess whether Lava Jato-related informational shocks are followed by contractionary output dynamics and whether these dynamics become more coherent once investment persistence is taken into account.

Table 6 reports the baseline comparison. The parsimonious benchmark, denoted block B, includes the lagged dependent variable and core macro-financial controls. The investment-augmented specification, denoted C2, extends this benchmark by adding lagged gross fixed capital formation. Both specifications use the PCA-common shock index, cumulative innovation identification, lag order one, and no seasonal controls.

Under the parsimonious benchmark, the mean GDP per capita gap over 2014-2019 is close to zero, and no horizon displays statistically significant negative responses at the 90 percent confidence level. Once lagged investment is introduced, the investment-augmented specification yields a mean output gap of approximately -2.6 percent over 2014-2019, with statistically significant negative responses across five horizons and a trough of -9.7 percent in 2019Q3. This contrast does not prove mediation in a strict causal sense, but it is consistent with the interpretation that investment dynamics were central to the propagation of Lava Jato-related shocks.

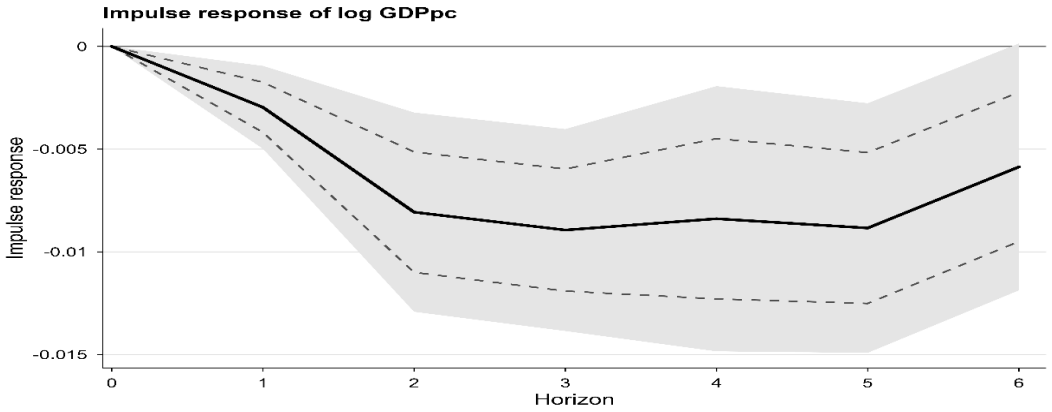
Table 6 – Benchmark versus investment-augmented specification

Specification	Shock index	Block	Lag	Mean gap 2014-2016 (%)	Mean gap 2016-2018 (%)	Mean gap 2014-2019 (%)	Minimum quarterly gap (%)	Trough	Negative significant horizons, 90%
Parsimonious benchmark	PCA-common	B	1	-0.00	0.48	-0.54	-5.77	2019Q3	0
Investment-augmented benchmark	PCA-common	C2	1	-1.24	-2.39	-2.56	-9.70	2019Q3	5

Notes: Block B includes the lagged dependent variable and core macro-financial controls. Block C2 extends B by adding lagged gross fixed capital formation. Both specifications use cumulative innovation identification, no seasonal controls, lag order one, and the PCA-common shock index.

Figure 4 illustrates the dynamic impulse-response profile underlying the investment-augmented specification. The contraction peaks around horizons 2-3 and remains negative over several periods before gradually dissipating. This timing is consistent with investment-driven propagation, in which delays in project execution and capital accumulation generate effects that unfold over time rather than only on impact.

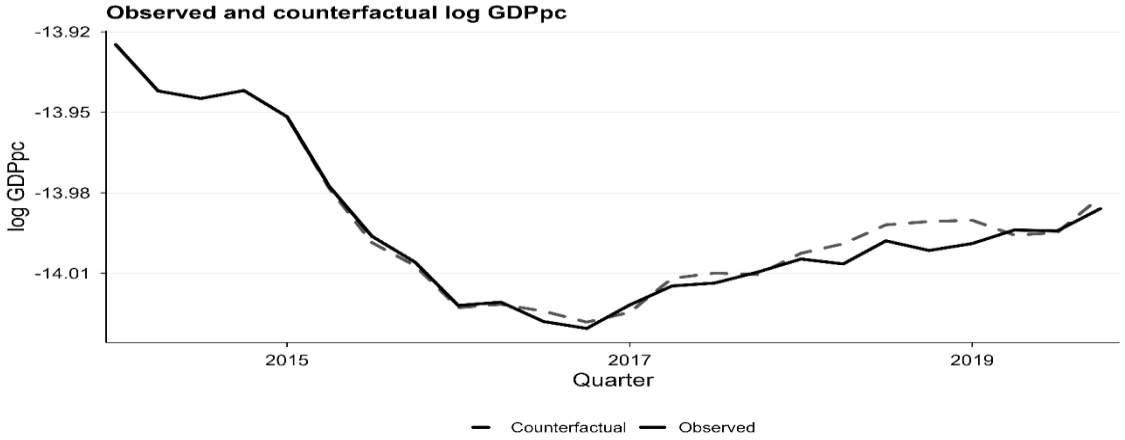
Figure 4 – Main impulse-response function: C2, PCA-common



Source: Authors' elaboration.

The economic significance of these dynamics becomes clearer when the impulse-response estimates are translated into a historical counterfactual. Figure 5 compares observed log real GDP per capita with a counterfactual path that removes the estimated contribution of Lava Jato-related informational shocks under the preferred investment-augmented specification. The counterfactual path lies above observed output during much of the post-2016 period, indicating a persistent output shortfall associated with the estimated sequence of shocks.

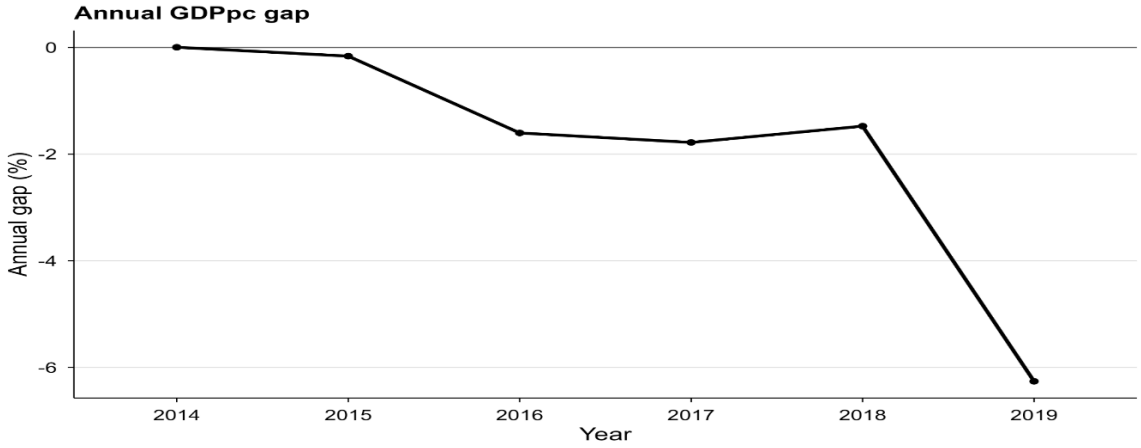
Figure 5 – Observed and LP-based counterfactual log GDP per capita



Notes: The figure reports observed and counterfactual log real GDP per capita under the preferred investment-augmented specification.

Figure 6 expresses the same historical decomposition in percentage terms. The annual GDP per capita gap widens gradually after 2014 and reaches approximately -6 percent by 2019. This trajectory places the local-projection evidence on a scale comparable to the synthetic-control estimates: while synthetic control points to a broader post-2014 divergence of approximately 5-7 percent, the local-projection results suggest that a smaller but economically meaningful component of that divergence is consistent with Lava Jato-related shocks operating through the investment channel.

Figure 6 – Annual GDP per capita gap relative to the LP-based counterfactual, 2014-2019



Note: The figure reports the annual GDP per capita gap, in percentage terms, between observed output and the local-projection-based counterfactual trajectory.

These magnitudes are consistent with related international evidence. Ghazanchyan et al. (2018) show that corruption-related shocks can reduce GDP per capita, especially in emerging and developing economies. Evidence from China also suggests that anti-corruption campaigns may reduce short-run growth partly through weaker investment dynamics (Wang, 2016; Qu, Sylwester, and Wang, 2018). The Lava Jato-related losses therefore fall within a plausible range for major institutional shocks affecting investment-intensive economies.

6.2 Measurement Robustness across Shock Indices

Having shown that the investment-augmented specification produces a more coherent contractionary profile, we next assess whether the results depend on the measurement of Lava Jato-related shocks. This step is important because the salience indices are constructed from distinct informational sources and capture different dimensions of the underlying institutional shock.

Table 7 reports the main measurement-robustness exercise. It compares estimates obtained using three alternative shock indices: PCA-common, PCA-2014, and LJ-direct. All specifications use the investment-augmented model, lag order $p = 1$, and cumulative innovation identification. The results are broadly stable across measures. The estimated mean output gap over 2014-2019 ranges from approximately -1.9 percent to -2.7 percent without seasonal controls and from -2.6 percent to -2.7 percent with seasonal controls.

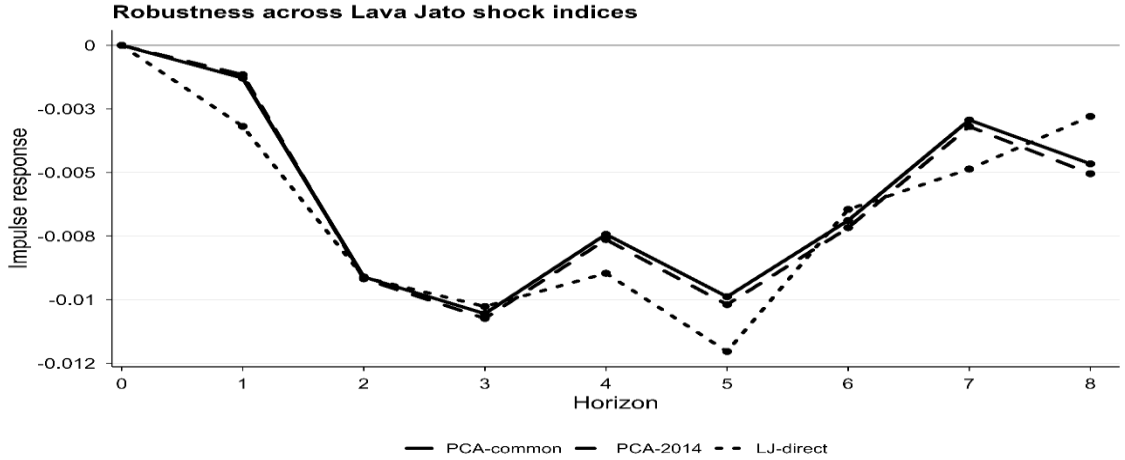
Table 7 – Measurement robustness under the investment-channel specification

Shock index	Mean gap 2014-2019, no seasonal controls (%)	Mean gap 2014-2019, seasonal controls (%)	Absolute difference	Negative significant horizons (90%), no seasonal	Negative significant horizons (90%), seasonal
PCA-common	-2.56	-2.57	0.02	5	5
PCA-2014	-2.67	-2.68	0.01	5	5
LJ-direct	-1.93	-2.62	0.69	5	4

Notes: All specifications use the investment-augmented model (C2), lag order $p = 1$, and cumulative innovation identification.

The PCA-based indices are highly stable across seasonal treatments, while the LJ-direct index is somewhat more sensitive, consistent with its narrower and more event-driven construction. Figure 7 confirms that the dynamic profiles are similar across indices, with differences mainly in amplitude and precision.

Figure 7 – Robustness across Lava Jato shock indices.



Notes: The figure reports impulse responses using PCA-common, PCA-2014, and LJ-direct under the common C2 specification, with cumulative innovation identification and no seasonal controls.

6.3 Timing, Persistence, and Trough Dynamics

We next examine the timing and persistence of the estimated effects. If Lava Jato-related shocks propagated through investment dynamics, their macroeconomic effects would be expected to unfold gradually as projects were delayed, capital accumulation slowed, and credit relationships weakened.

Table 8 reports mean output gaps across subperiods, the minimum quarterly gap, the timing of the trough, and the number of statistically significant negative horizons under the investment-augmented specification. Output losses are relatively modest in 2014-2016, with mean gaps ranging from approximately -0.6 percent to -1.1 percent, but become larger in 2016-2018, reaching approximately -2.3 percent to -2.6 percent. Across all indices, the output gap reaches its trough in 2019Q3, and the number of statistically significant negative horizons remains high, ranging from four to five. This pattern is consistent with a delayed and persistent transmission mechanism.

Table 8 – Timing and persistence under the investment-channel specification

Shock index	Mean gap 2014-2016 (%)	Mean gap 2016-2018 (%)	Mean gap 2014-2019 (%)	Minimum quarterly gap (%)	Trough	Negative significant horizons (90%)
PCA-common	-1.03	-2.32	-2.56	-10.52	2019Q3	5
PCA-2014	-1.08	-2.42	-2.68	-10.78	2019Q3	5
LJ-direct	-0.56	-2.57	-2.62	-10.87	2019Q3	4

Notes: All specifications use the investment-augmented model (C2), lag order $p = 1$, cumulative innovation identification, and seasonal controls.

6.4 Seasonal Robustness and Specification Stability

We next examine whether the estimated effects depend on seasonal adjustment or broader specification choices. In quarterly data, seasonal patterns may affect dynamic responses, but comparisons with and without seasonal controls indicate limited changes in the magnitude, timing, and persistence of the estimated output response. Table 9 summarizes the broader validation protocol, which considers alternative shock measures, lag structures, seasonal treatments, control blocks, and inference procedures. The objective is not to select the specification with the largest estimated effect, but to verify whether the main findings are preserved across reasonable empirical alternatives.

Table 9 – Validation and robustness protocol for the local-projection results

Validation exercise	Implementation	Main conclusion
Alternative shock indices	PCA-common, PCA-2014, LJ-direct	Results remain negative across measures
Investment-channel comparison	B versus C2	Effects strengthen with lagged investment
Seasonal controls	With and without seasonal dummies	PCA-based results are stable
Lag robustness	Alternative lag orders	Results are not driven only by (p=1)
Leave-one-source-out	Rebuild index excluding each source	Index is not driven by one component
Rolling-window checks	Re-estimate across windows	Negative response remains broadly stable
Alternative inference	Confidence levels / HAC variants	Main inference is preserved
Credit-augmented specifications	Add credit controls	Does not improve upon the investment benchmark

Notes: The table summarizes the main validation exercises for the local-projection results.

Overall, the validation exercises indicate that the contractionary pattern is not driven by a single shock index, specification choice, lag order, data source, seasonal treatment, or inference procedure.[2]

6.5 Interpretation

Taken together, the local-projection evidence points to a consistent interpretation. Lava Jato-related informational shocks are associated with economically meaningful output losses, on the order of 2 to 3 percent of real GDP per capita over 2014-2019. This pattern is preserved across alternative shock measures, seasonal treatments, and specification choices, suggesting that the estimated contractionary response is not driven by a single proxy for Lava Jato-related salience. The local-projection results therefore complement the synthetic-control evidence: while synthetic control captures Brazil's broader post-2014 underperformance, local projections identify a meaningful component of this divergence consistent with the timing and propagation of Lava Jato-related shocks.

The results are most consistent with an investment-channel interpretation. Under the parsimonious macro-financial benchmark, the estimated effects are small and imprecise; once gross fixed capital formation is included, the responses become larger, more persistent, and statistically

[2] Due to space limitations, only the main robustness exercises are reported. Additional placebo, specification, and inference checks are available from the authors upon request.

more informative. This does not prove mediation in a strict causal sense, but it suggests that investment dynamics are central to the propagation of the shock. Substantively, the evidence is consistent with delayed infrastructure projects, weaker capital formation, heightened uncertainty, tighter credit conditions, and disruptions in investment-intensive sectors, in line with firm-level evidence on credit, employment, wage bills, and spillovers beyond directly investigated firms (Claudio Ferraz et al., 2025).

7. Reconciling the Two Sets of Estimates

The difference between the two sets of estimates reflects the distinct empirical objects they measure. Synthetic control estimates Brazil's aggregate post-2014 divergence relative to an external counterfactual, whereas local projections assess the dynamic component associated with Lava Jato-related informational shocks within Brazil. The larger synthetic-control losses, roughly 5 to 7 percent, and the smaller local-projection losses, approximately 2 to 3 percent, should therefore be interpreted as complementary estimates rather than competing measures of the same effect.

This distinction implies that Lava Jato was neither peripheral nor exhaustive in explaining Brazil's recessionary divergence. Brazil's downturn remains inherently multi-causal, reflecting external deterioration, domestic policy reversals, political instability, fiscal adjustment, macro-financial imbalances, and institutional disruptions. A disciplined interpretation is that Lava Jato-related shocks account for a meaningful, but partial, component of the observed deviation.

The investment channel helps connect the two empirical blocks. In the local-projection estimates, the effects are weak under the parsimonious benchmark but become larger, more persistent, and statistically more informative once lagged gross fixed capital formation is introduced. This does not prove mediation in a strict causal sense, but it suggests that investment dynamics are central to interpreting the propagation of the shock. The paper's contribution is therefore to provide a disciplined decomposition of magnitude and mechanisms: Lava Jato was quantitatively relevant and economically interpretable, although not sufficient to explain the full recessionary divergence.

8. Conclusion

This paper examined the contribution of Operation Lava Jato to Brazil's post-2014 recessionary divergence by distinguishing Brazil's aggregate underperformance relative to an external counterfactual from the component associated with Lava Jato-related informational shocks. To do so, it combined synthetic control with quarterly local projections based on newly constructed salience indices derived from news coverage, structured events, online searches, and information demand.

The results indicate two complementary margins. Synthetic-control estimates suggest that Brazil's real GDP per capita remained persistently below its external counterfactual after 2014, with average losses of approximately 5 to 7 percent. Local-projection estimates point to smaller, but economically meaningful, losses of about 2 to 3 percent under the preferred investment-augmented

specification. These magnitudes should not be interpreted as competing estimates of the same effect: the former captures Brazil's aggregate post-2014 divergence, while the latter assesses the dynamic component associated with Lava Jato-related shocks. Taken together, the evidence suggests that Lava Jato was quantitatively relevant, though not sufficient to explain the full recessionary divergence.

The investment channel is central to this interpretation. Lava Jato-related shocks are associated with modest and imprecise responses under the parsimonious benchmark, but the estimated responses become larger, more persistent, and statistically more informative once lagged gross fixed capital formation is included. This pattern is preserved across alternative shock measures and is consistent with micro-level evidence showing that Lava Jato affected employment, wage bills, credit, and firm activity, with spillovers beyond directly investigated firms (Claudio Ferraz et al., 2025). The results point to a mechanism in which enforcement shocks propagate through delayed projects, weaker capital formation, tighter credit conditions, and disruptions in investment-intensive sectors.

These findings refine the interpretation of Brazil's post-2014 recession. The downturn was not monocausal: external deterioration, domestic policy choices, fiscal adjustment, weakening credibility, political instability, and broader macro-financial imbalances all mattered. More broadly, the Brazilian case shows that anti-corruption enforcement may generate long-run institutional gains while also entailing short-run macroeconomic costs when it interacts with fragile investment structures, politically connected sectors, and weak mechanisms for reallocating capital and productive capacity. Recognizing these costs strengthens the case for enforcement strategies that preserve economic continuity, facilitate the reallocation of projects and credit, and reduce unnecessary destruction of productive capacity.

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