Great Expectations: Electoral Accountability After Economic Shocks*

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Abstract

This paper examines how exogenous economic shocks shape electoral accountability in local elections. We develop a theoretical framework in which sudden income gains temporarily boosts support for incumbents, even when the underlying shock is unrelated to their actions. As voters gradually update their expectations, however, the political advantage fades. We test these theoretical predictions using Brazil's 2003 legalization of genetically engineered soybean seeds, a policy that triggered uneven productivity gains across municipalities due to variation in climate and soil. Leveraging this quasi-natural experiment over the 2000–2020 period, we show that incumbent mayors were more likely to be reelected in municipalities with larger gains in soy productivity — but this advantage was short-lived. Our findings highlight how misattribution and voter learning jointly shape the political consequences of economic change in developing countries, where structural reliance on commodity exports increases vulnerability to external shocks.

Keywords: exogenous shocks, economic voting, electoral accountability, local politics
JEL Codes: D72; O13; O17; O54

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1 Introduction

Between 1980 and 2003, in presidential elections across 13 Latin American countries, a one percentage point decline in GDP per capita was associated with a 1.7 percentage point drop in the incumbent's vote share (Benton, 2005). Such regularities underscore that economic performance is a central benchmark for evaluating elected officials (Duch & Stevenson, 2008). Yet the salience of economic considerations varies over time. Early in a term, voters form prospective expectations about future success; as performance information accumulates, their judgments become increasingly retrospective (Singer & Carlin, 2013). Even well-informed citizens may struggle to assign responsibility accurately. When economic shifts originate in global rather than domestic forces, voters can reward or punish governments for outcomes beyond their control (Duch, 2001; Gomez & Wilson, 2001; Valdini & Lewis-Beck, 2018; Wolfers, 2007). The strength of this economic voting mechanism thus depends on the clarity of responsibility — whether voters can discern the government's true role in shaping economic conditions — a requirement often unmet in practice (Achen & Bartels, 2017). External disturbances such as commodity-price swings, global financial shocks, or even seemingly irrelevant events can obscure that link, blurring accountability and distorting electoral responses (Fowler & Hall, 2018; Fowler & Montagnes, 2015; Healy et al., 2010).

This challenge is particularly acute in developing countries, whose economies are heavily exposed to external forces such as commodity prices, exchange rates, international policy shifts, and U.S. interest rates (Campello & Zucco, 2016). In commodity-dependent democracies, volatility amplifies the scope for misattribution: voters may credit favorable terms of trade as domestic competence and blame downturns on local mismanagement, or redirect responsibility to international actors such as the IMF or WTO (Alcañiz & Hellwig, 2011; Hellwig & Samuels, 2007). Dependence on volatile exports also constrains governments' ability to respond, narrowing the range of electorally salient policy choices (Ezrow & Hellwig, 2014). Whereas diversified, fiscally capacious economies can buffer turbulence through financial access and social insurance (Wibbels, 2006), undiversified exporters reliant on a narrow set of primary commodities face income swings that weaken the link between performance and electoral reward (Novaes & Schiumerini, 2022). Weak institutional frameworks further amplify these distortions. In many developing democracies, limited party discipline, fragmented coalitions, and short time horizons reduce policy credibility and obscure responsibility for outcomes (Duch & Stevenson, 2008; Klašnja & Titiunik, 2017). These blurred lines are evident where nationally designed programs are implemented locally, leading voters to credit municipal incumbents for centrally funded initiatives (De La O, 2013; Labonne, 2013). Combined with economic volatility, such institutional fragilities compound voters' difficulty in distinguishing policy-driven performance from external shocks, further weakening electoral accountability.

Much of the literature on economic voting and clarity of responsibility focuses on national-level outcomes, examining how voters attribute macroeconomic performance to presidents, prime ministers, or ruling parties (e.g. Campello & Zucco, 2020; Lewis-Beck &

Stegmaier, 2000; Lewis-Beck et al., 2008; Nadeau et al., 2013; Remmer, 2014). Yet many of the policies that shape citizens' economic well-being are implemented locally, and external shocks can reshape local conditions even when local governments have little control over underlying fundamentals. This question is especially relevant in developing economies, where external exposure and institutional weakness blur accountability and make subnational settings a sharp test of how voters interpret economic change. Recent work suggests that exogenous shocks can shape subnational elections (Gélineau et al., 2025; Novaes & Schiumerini, 2022), indicating that local incumbents may benefit from conditions beyond their control. Yet the nature and persistence of these effects remain unclear: do voters treat windfalls as lasting signals of competence, or do they recalibrate their expectations as the source of growth becomes clearer? Building on this insight, we ask: how do exogenous shocks affect electoral accountability at the local level — and, crucially, how persistent are their political effects in commodity-dependent democracies?

We develop a simple framework linking exogenous income shocks to voter behavior through adaptive expectations. Voters use changes in their own income to infer incumbent performance but update their expectations only gradually. A sudden improvement in local economic conditions thus raises perceived performance relative to expectations, generating a temporary incumbency advantage as voters initially misattribute these gains to local policymakers. As expectations adjust, however, the political payoff fades — even when prosperity endures.

We test these implications in Brazil, where the 2003 legalization of genetically engineered (GE) soybean seeds generated a large, positive productivity shock in a key export sector. Because the benefits from GE soy adoption depended on agronomic suitability — determined by soil and climate — the policy created uneven gains across municipalities that were unrelated to local political factors. The reform increased productivity, reduced labor intensity, and spurred manufacturing employment in some areas but not others (Bustos et al., 2016, 2020). Using public opinion data from *Latinobarómetro*, we show that voters in municipalities with larger productivity gains perceived these improvements as local rather than national, reinforcing the scope for misattribution. We then combine agricultural and electoral data from 2000–2020 in a difference-in-differences framework that leverages both the timing of the reform and cross-municipality variation in agronomic suitability. We find that incumbents in high-productivity-gain municipalities were significantly more likely to win reelection in the years following the shock, consistent with voters misattributing externally driven gains to local performance. Yet this electoral bonus proved fleeting: it peaked in 2008 — when the benefits of GE soy adoption were most visible — and dissipated in subsequent cycles as voters' expectations adjusted.

Our findings contribute to understanding how exogenous economic shocks shape electoral accountability in three main ways. First, we conceptualize and test voter misattribution as a temporary rather than persistent phenomenon, showing how externally driven gains generate short-lived incumbency advantages that fade as expectations adjust. Voters respond to perceived changes rather than absolute levels of economic performance, gradually recalibrating their evaluations over time. This dynamic perspective moves beyond static models of economic voting to reveal how accountability evolves.

Second, we expand the scope of existing analyses of local accountability. Prior studies such as Novaes and Schiumerini (2022) provide valuable evidence that external shocks can affect subnational elections, but their regression-discontinuity design identifies effects only at the margin of victory. By exploiting geographic variation in agronomic suitability, we estimate average treatment effects across all 5,570 Brazilian municipalities — capturing the full distribution of electoral outcomes and improving external validity.

Finally, our findings reveal a broader tension in commodity-dependent developing economies: external volatility shapes not only economic outcomes but also the functioning of electoral accountability itself. When recurrent shocks blur the line between policy-driven growth and externally induced booms, voters face greater uncertainty about who deserves credit or blame. In such settings — where volatility is high and democratic institutions are still consolidating — citizens' capacity to assign responsibility is constrained, limiting the scope for stable and informed accountability.

The remainder of the paper proceeds as follows. Section 2 presents a simple theoretical framework linking exogenous income shocks to incumbents' electoral fortunes through adaptive expectations. Section 3 introduces the Brazilian case, showing how variation in agronomic suitability shaped municipalities' exposure to the productivity shock and how this variation affected voters' economic conditions and perceptions. Section 4 details the empirical strategy and reports the main results. Section 5 concludes by discussing the broader implications for accountability in commodity-dependent democracies.

2 Theoretical Framework

We develop a simple theoretical framework of local elections in commodity-dependent economies, where external windfalls affect household income independently of government action. The framework captures how voters update retrospective evaluations after such shocks and how incumbents may temporarily benefit from misattribution. Municipalities r hold local elections at discrete periods $t \in \{-1, 0, 1, 2, \dots\}$, each populated by a unit continuum of risk-neutral voters indexed by $i \in [0, 1]$. Politicians are *ex ante* identical, so elections serve purely as a mechanism for retrospective accountability rather than selection among heterogeneous types (Ashworth, 2012).

At $t = 0$, each municipality r experiences an exogenous positive income windfall $\Delta A_r > 0$, assumed permanent for analytical convenience though long-lasting in practice. Such shocks may arise from new extraction technologies, expanded arable land, high-yield crop varieties, or natural resource discoveries. The windfall is realized before the $t = 0$ election, so voters' observed income already embeds the gain — creating scope for misattribution when the source of prosperity lies outside local control.

2.1 Income, Exposure, and Expectations

Voters do not directly observe policy effort or quality. Instead, following the logic of retrospective voting (Fearon, 1999; Wolfers, 2007), they use their own material outcomes — particularly income — as a proxy for performance. Two dimensions of household-level heterogeneity shape how income responds to shocks.

First, individuals differ in their exposure to the regional windfall. Let $\theta_{i,r} \in [\eta, 1]$ denote the exposure of voter i in municipality r, where $0 < \eta < 1$ represents the lowest spillover any resident receives. Exposure may arise through different channels — such as employment, investment, or production linkages — but it need not be greatest among those directly tied to the expanding sector. Broader general-equilibrium effects can transmit gains to other parts of the economy, for instance through labor reallocation, rising local demand, or downstream industrialization. This formulation allows that the main beneficiaries of an external income shock may lie outside the directly affected sector, consistent with labor-saving technological change, structural transformation, or diffusion through supply chains. Exposure is taken as exogenous and time-invariant, with its cumulative distribution $F_r(\theta)$ as common knowledge.

Second, voters differ in their baseline income levels. Let $\mu_{i,r}$ denote the pre-shock income of individual i in municipality r, capturing heterogeneity unrelated to the commodity windfall. Each period, income is further affected by an idiosyncratic zero-mean shock $\varepsilon_{i,r,t} \sim \mathcal{N}(0, \sigma_\varepsilon^2)$, which we assume is independent across individuals, municipalities, and time. The variables $\mu_{i,r}$, $\theta_{i,r}$, and $\varepsilon_{i,r,t}$ are mutually independent; $\theta_{i,r}$ is drawn once — prior to $t = -1$ — and remains fixed thereafter. Consequently, the observed income of voter i in municipality r at date t is given by:

$$y_{i,r,t} = \mu_{i,r} + \theta_{i,r}\mathbb{I}_{\{t\geq 0\}}\Delta A_r + \varepsilon_{i,r,t} \tag{1}$$

where $\mathbb{I}_{\{t\geq 0\}}$ is an indicator function that equals 1 from $t = 0$ onward and 0 beforehand.

In line with models of gradual learning and bounded rational updating, voters compare their current income with a moving reference point that adjusts gradually. Let $\lambda \in (0, 1)$ denote the speed of adjustment. The reference income evolves according to:

$$\bar{y}_{i,r,t} = (1-\lambda)\,\bar{y}_{i,r,t-1} + \lambda\, y_{i,r,t-1} \tag{2}$$

with each voter's initial benchmark given by $\bar{y}_{i,r,-1} = \mu_{i,r}$.

From Equation (2), voters are initially surprised by the windfall, but as new income realizations arrive, their benchmark gradually converges toward the post-shock level. Substituting Equation (1) into (2) and iterating forward yields a closed-form expression for the reference income:

$$\bar{y}_{i,r,t} = \mu_{i,r} + \left[1-(1-\lambda)^{t+1}\right]\theta_{i,r}\,\mathbb{I}_{\{t\geq 0\}}\,\Delta A_r + \sum_{s=-1}^{t-1}(1-\lambda)^{t-1-s}\,\varepsilon_{i,r,s} \tag{3}$$

where the first term represents the pre-shock baseline, the second captures the gradually internalized income windfall, and the third aggregates past idiosyncratic shocks with geometrically declining weights. Note that, as $t \to \infty$, the reference income converges to its post-shock steady state, i.e. $\bar{y}_{i,r,t} \to \mu_{i,r} + \theta_{i,r}\Delta A_r$.

2.2 Sanctioning Behavior and Support for the Incumbent

Voters sanction the incumbent by comparing their *current* income with the *reference* income formed in the previous period. The resulting satisfaction gap for voter i in municipality r at election t is defined as:

$$G_{i,r,t} \equiv y_{i,r,t} - \bar{y}_{i,r,t} \tag{4}$$

Using (1) and (3), and focusing on the post-shock years $t \geq 0$, we obtain

$$G_{i,r,t} = \theta_{i,r} \Delta A_r \gamma(t) + \varepsilon_{i,r,t} - \sum_{s=-1}^{t-1} (1-\lambda)^{t-1-s} \varepsilon_{i,r,s} \tag{5}$$

where the decay factor $\gamma(t) = (1-\lambda)^{t+1}$ captures the diminishing surprise from the income windfall as voters' expectations adjust.

Importantly, baseline income heterogeneity $\mu_{i,r}$ does not affect the satisfaction gap, which depends solely on exposure to the regional windfall and idiosyncratic shocks.

A voter retains the incumbent if, and only if, their satisfaction gap is non-negative. From Equation (5) we know that $G_{i,r,t}$ is the sum of independent normal shocks; conditional on exposure $\theta_{i,r}$, the satisfaction gap is therefore normally distributed with mean $\theta_{i,r}\,\Delta A_r\,\gamma(t)$ and variance σ_ε^2. Hence the probability that voter i supports the incumbent at date t is given by:

$$\Pr\left[G_{i,r,t} \geq 0 \mid \theta_{i,r}\right] \;=\; \Phi\!\left(\frac{\theta_{i,r}\,\Delta A_r\,\gamma(t)}{\sigma_\varepsilon}\right) \tag{6}$$

where $\Phi(\cdot)$ denotes the cumulative distribution function of the standard normal.

Aggregating over the continuum of voters with exposure distribution $F_r(\theta)$ yields the share of municipality r's electorate that supports the incumbent in election t:

$$S_r(t) \;=\; \int_\eta^1 \Phi\!\left(\frac{\theta\,\Delta A_r\,\gamma(t)}{\sigma_\varepsilon}\right) dF_r(\theta) \tag{7}$$

For expositional clarity, it is useful to consider a particularly transparent case in which individual exposure within a region takes only two values. Suppose a fraction $p \in (0,1)$ of voters are fully exposed ($\theta = 1$), while the remaining $1-p$ receive only the baseline spillover ($\theta = \eta$). Equation (7) then simplifies to:

$$S_r(t) \;=\; p\,\Phi\!\left(\frac{\Delta A_r\,\gamma(t)}{\sigma_\varepsilon}\right) \;+\; (1-p)\,\Phi\!\left(\frac{\eta\,\Delta A_r\,\gamma(t)}{\sigma_\varepsilon}\right) \tag{8}$$

a weighted average of the approval probabilities of the two voter groups. We employ this two-type specification in Proposition 3 to derive closed-form comparative statics while retaining the intuition of the general case.

Elections are decided by simple majority rule: the incumbent is reelected in period t if and only if $S_r(t) > \frac{1}{2}$. Following Alesina and Rodrik (1994), we abstract from vote margins and strategic turnout, focusing instead on aggregate support as the key determinant of electoral outcomes. This assumption isolates the mechanism of interest — how exogenous income shocks translate into incumbency advantage — without introducing additional layers of political competition or coordination.

2.3 Income Windfall and Incumbency

Let $V_r(t) = \Pr\left(S_r(t) > \frac{1}{2}\right)$ denote the likelihood of reelection for the incumbent in region r at election t, as governed by model parameters. We now derive three comparative-static results linking the magnitude, timing, and diffusion of income shocks to incumbents' electoral fortunes.

First, we establish how the size of the income shock influences the incumbent's probability of reelection.

Proposition 1 (Windfall Magnitude and Reelection)**.** *For every post-shock electoral period, the probability of reelection is strictly increasing in the magnitude of the regional income windfall.*

Proof. Differentiating Equation (7) with respect to ΔA_r gives

$$\frac{\partial S_r(t)}{\partial \Delta A_r} \;=\; \int_{\eta}^{1} \phi\Big(\tfrac{\theta\,\Delta A_r\,\gamma(t)}{\sigma_\varepsilon}\Big)\,\frac{\theta\,\gamma(t)}{\sigma_\varepsilon}\,dF_r(\theta) \;>\; 0$$

because the standard-normal density $\phi(\cdot)$ is strictly positive and all other factors are non-negative. Under simple majority rule, the incumbent wins whenever $S_r(t) > \frac{1}{2}$. Thus $V_r(t) \equiv \Pr[S_r(t) > \frac{1}{2}]$ is a non-decreasing transformation of $S_r(t)$ that is strictly increasing on the interior of $(0,1)$. Consequently

$$\frac{\partial V_r(t)}{\partial \Delta A_r} \;>\; 0, \qquad \forall\, t \geq 0 \qquad \square$$

Second, we show that the electoral benefit of a windfall diminishes as voters' expectations adjust over time.

Proposition 2 (Decay of Windfall Advantage)**.** *The marginal electoral benefit of the regional income windfall diminishes over time.*

Proof. For any $t \geq 0$, the windfall enters each voter's satisfaction gap through the term $\theta_{i,r}\,\Delta A_r\,\gamma(t)$, with $\gamma(t) = (1-\lambda)^{t+1}$ and $\gamma'(t) < 0$. From Proposition 1 we have:

$$\frac{\partial S_r(t)}{\partial \Delta A_r} \;=\; \int_{\eta}^{1} \phi\Big(\tfrac{\theta\,\Delta A_r\,\gamma(t)}{\sigma_\varepsilon}\Big)\,\frac{\theta\,\gamma(t)}{\sigma_\varepsilon}\,dF_r(\theta) \;>\; 0$$

Differentiating this expression with respect to t multiplies the integrand by $\gamma'(t) < 0$, yielding:

$$\frac{\partial^2 S_r(t)}{\partial \Delta A_r\,\partial t} \;<\; 0$$

Because the reelection probability $V_r(t) = \Pr[S_r(t) > \frac{1}{2}]$ is monotonically increasing in $S_r(t)$, the same sign carries over:

$$\frac{\partial^2 V_r(t)}{\partial \Delta A_r\,\partial t} \;<\; 0 \qquad \square$$

Finally, we examine how heterogeneity in exposure and spillovers shapes aggregate electoral support.

Proposition 3 (Exposure and Spillover)**.** *In the two-type case, the probability of reelection is strictly increasing in both the fraction of fully exposed individuals and the magnitude of spillovers given an exposure level.*

Proof. With two exposure types, aggregate support is given by:

$$S_r(t) \; = \; p\,\Phi\big(k\big) + (1-p)\,\Phi\big(\eta\,k\big)$$

with $k \;\equiv\; \frac{\Delta A_r\,\gamma(t)}{\sigma_\varepsilon} \;>\; 0$. Because $S_r(t)$ is linear in p, it follows that:

$$\frac{\partial S_r(t)}{\partial p} \;=\; \Phi\big(k\big) - \Phi\big(\eta\,k\big)$$

Since $0 < \eta < 1$ and the standard-normal c.d.f. Φ is strictly increasing, the difference is positive. That is, $\frac{\partial S_r(t)}{\partial p} > 0$. Again, as the reelection probability is monotonically increasing in $S_r(t)$, we have:

$$\frac{\partial V_r(t)}{\partial p} > 0$$

Furthermore, only the second term of the $S_r(t)$ depends on η, so we have:

$$\frac{\partial S_r(t)}{\partial \eta} \;=\; (1-p)\,\phi\big(\eta\,k\big)\,k$$

Because $k > 0,\ 1-p > 0$, and $\phi(\cdot) > 0$, the derivative is strictly positive. Thus:

$$\frac{\partial V_r(t)}{\partial \eta} > 0$$

□

2.4 Discussion

This theoretical framework builds on prior work showing that voters shift from prospective to retrospective evaluations over an incumbent's term (Singer & Carlin, 2013). We formalize a fully retrospective mechanism linking long-lasting exogenous income shocks — such as those arising from commodity windfalls — to temporary electoral rewards. When a positive shock raises household income, expectations remain anchored in pre-shock conditions, creating a short-lived satisfaction gap that increases incumbent support. As voters gradually adjust their benchmarks over time, the perceived benefit of the shock fades even though income remains permanently higher. The resulting incumbency advantage decays geometrically at a rate determined by the speed of expectation adjustment, λ. This pattern mirrors evidence that, in periods of economic stability, economic performance becomes less salient relative to issues such as corruption, crime, or foreign policy (Singer, 2013).

A key implication of the framework, illustrated by simulations in Appendix Figures A.1, A.2, A.3, and A.4, is that it isolates the mechanism through which exposure conditions electoral responses. Baseline income heterogeneity, $\mu_{i,r}$, is absorbed by the adaptive benchmark and does not affect the satisfaction gap. Instead, what drives incumbent support is the interaction between individual exposure, $\theta_{i,r}$, and the magnitude of the regional windfall, ΔA_r. This combination produces a temporary surge in support that peaks in the first post-shock election and fades over time, despite lasting economic gains.

Together, these dynamics yield a clear empirical prediction: exogenous income shocks should produce a temporary increase in incumbent support. The next section tests this prediction using data from a large-scale agricultural transformation that generated uneven windfalls across municipalities in a commodity-dependent economy.

3 Agricultural Transformation in Brazil

3.1 Case Selection

Brazil provides an ideal setting to test the relationship between exogenous income shocks and electoral accountability. The country combines deep global integration with substantial local heterogeneity in commodity dependence, allowing for a sharp comparison across municipalities differentially affected by external booms. In June 2003, the federal government authorized the cultivation and sale of genetically engineered (GE) soybean seeds for the 2003/2004 harvest season.[1] Six months later, this temporary authorization was renewed for the following season,[2] and in March 2005 a permanent biosafety framework was established, creating the National Technical Commission on Biosafety and legalizing GE crops on a lasting basis.[3]

GE soy seeds offered clear technological advantages: they were more resistant to pests and herbicides, reduced input costs, and simplified weed control. These gains increased profitability in traditional soy regions and expanded the crop's geographic frontier into areas where conventional seeds had been less competitive. As Appendix Figure A.5 shows, the area devoted to soy production and total output rose sharply after 2003, coinciding with the legalization of GE seeds. Appendix Figure A.6 further illustrates that land per worker and output per worker — a proxy for labor productivity — increased markedly in the same period.

By 2023, Brazil had become the world's largest soybean producer (FAOSTAT), both in cultivated area and total output. The productivity surge translated into higher revenues, job creation, and infrastructure improvements, spurring capital investment in soy-linked municipalities (Bustos et al., 2020). Although local officials had no role in triggering these

[1] Lei 10.688, https://www.planalto.gov.br/ccivil_03/leis/2003/l10.688.htm

[2] Lei 10.814, https://www.planalto.gov.br/ccivil_03/leis/2003/l10.814.htm

[3] Lei 11.105, https://www.planalto.gov.br/ccivil_03/_ato2004-2006/2005/lei/l11105.htm

gains, many nonetheless claimed credit for them. The legalization of GE soy seeds thus provides a plausible quasi-natural experiment: a large, exogenous, and geographically uneven economic shock with plausible political repercussions, potentially enhancing incumbent mayors' reelection prospects.

3.2 Productivity Shock

Building on Bustos et al. (2016, 2020), we exploit the 2003 legalization of GE soy seeds as a large, exogenous productivity shock whose local impact varied systematically across municipalities. Although the policy applied nationally, its benefits were highly uneven: municipalities with soil and climatic conditions more favorable to GE soy experienced substantially larger productivity gains. This heterogeneity in potential yield provides the core source of identification for our empirical analysis.

A possible concern is that areas poised to benefit most from GE adoption might have exerted greater lobbying pressure on federal decision-makers, introducing endogeneity. However, a municipality's potential yield from GE soy is determined by long-run agronomic factors —soil quality, rainfall, and temperature — that are unrelated to political influence or actual production patterns (Bustos et al., 2016). This feature allows us to isolate exogenous differences in exposure to the productivity shock.

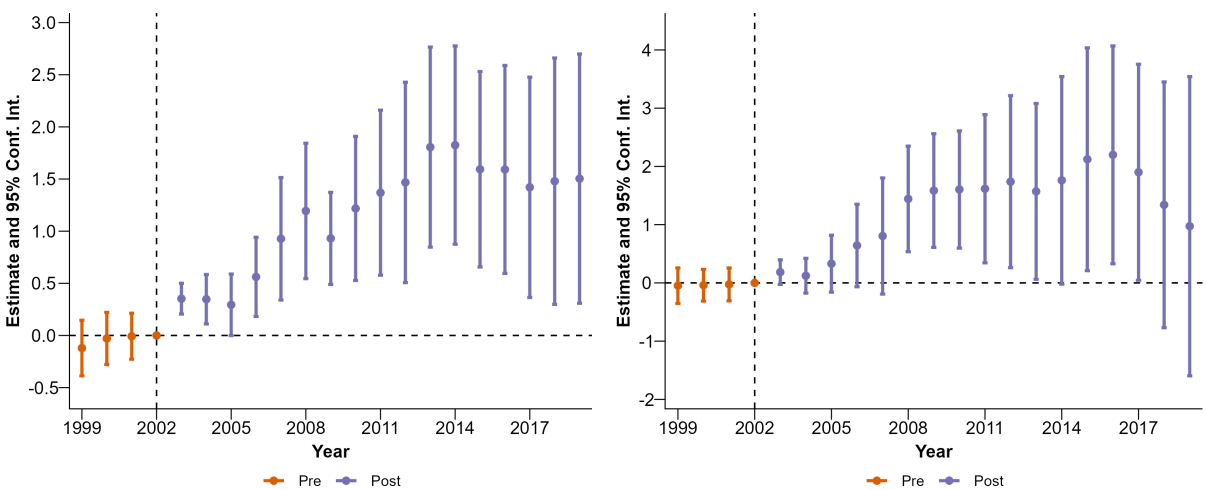
To measure local suitability for GE soy adoption, we use data from the Food and Agriculture Organization's Global Agro-Ecological Zones (FAO-GAEZ) project, which estimates potential crop yields based on historical climate data (1961–2010), local soil characteristics, and terrain constraints. The model reports potential yields under two regimes: a low-input scenario, reflecting traditional practices with minimal mechanization, and a high-input scenario, corresponding to modern techniques with improved seeds, fertilizers, and full mechanization.

We define each municipality's exposure to the productivity shock as ΔA_r^{soy}, the difference between its potential yield under high- and low-input conditions. This measure captures the magnitude of productivity gains from moving from traditional to modern agriculture. Appendix Figure A.8 maps this measure, aggregated into deciles, showing stark spatial variation across Brazil. Even in regions that were highly productive *ex ante*, potential yields under the new technology are three to five times higher. If GE soy adoption enhanced incumbent reelection prospects, it should have done so disproportionately in municipalities with larger potential yield gaps — those most exposed to the exogenous income windfall and thus to the transient satisfaction gap highlighted in our theoretical framework.

3.3 Economic Outcomes and Voter Perceptions

Before turning to the political consequences of the productivity shock, we first verify that the legalization of GE soy produced heterogeneous economic effects across municipalities. Consistent with our theoretical mechanism, regions with larger potential yield gains should have experienced stronger income growth. To test this, we estimate an event-study specification that interacts the change in potential soy yield, ΔA_r^{soy}, with year indicators, using 2002 — the year immediately preceding GE soy legalization — as the reference period.[4] Annual municipal GDP per capita data (in thousands of current Brazilian reais) come from the Brazilian Institute of Geography and Statistics (IBGE). Standard errors are clustered at the microregion level (geographically contiguous groups of municipalities defined by IBGE) to account for spatial and temporal correlation in residuals.

Figure 1: Dynamic Effects of the Soy Shock on Municipality Income per Capita



(a) Unweighted Estimates

(b) Population-Weighted Estimates

This figure shows the dynamic effects of ΔA_r^{soy} on GDP per capita. Vertical bars represent 95% confidence intervals. The dotted vertical line indicates 2002, the year preceding the legalization of GE soybean seeds. The specification includes municipality and year fixed effects, microregion–year interactions, and standard errors clustered at the microregion level (555 clusters). Panel (a) presents unweighted estimates, whereas Panel (b) applies population weights.

Figure 1 presents the estimated dynamic effects, showing that the introduction of GE soy seeds was associated with pronounced local income gains. Municipalities more exposed to the productivity shock — those with higher increases in soy potential yield — experienced long-lasting and statistically significant rises in GDP per capita relative to less exposed areas. To gauge the magnitude of this effect, focusing on the weighted results in Panel (b), a one–standard-deviation increase in exposure corresponds to relative income gains of roughly 1,200 to 2,000 reais per capita, depending on the year (2008 marks the onset of significance, 2016 the peak effect following the US–China trade conflict). These gains emerge gradually and become pronounced only several years after legalization,

[4] Appendix Table A.1 reports complementary long-difference estimates under varying model specifications. Results consistently show that municipalities with greater potential yield gains experienced significantly faster growth in GDP per capita between 2000 and 2010.

consistent with delays in technology adoption, planting cycles, and harvest timing.[5]

Admittedly, not every change to the local economy affects voting behavior, as voters have limited attention spans and do not always care about economic issues (Singer, 2011, 2013). For local context to matter, it must be salient in the minds of citizens, through what Larsen et al. (2019) call "context priming." The sharp increase in soy production (Appendix Figure A.6) and associated rise in household income (Figure 1) suggest a shock large enough to affect individuals' lived experience. To confirm that this transformation registered in public attitudes (and that perceptions varied with individual exposure), we turn to public opinion data from Latinobarómetro, focusing on a question about personal economic well-being: "In general, how would you describe your present economic situation and that of your family? Would you say that it is very good, good, about average, bad, or very bad?"[6]

In Figure 2, Panel (a) plots the share of respondents who answered "very good" or "good," disaggregated by tertiles of ΔA_r^{soy}, the municipal-level change in potential soy yield. While all respondents expressed greater optimism about their economic situation in the 2004-2010 period (reflecting a general improvement in living conditions among Brazilians), those in areas most affected by the productivity shock (third tertile) were more likely to report favorable personal economic evaluations. While the limited sample size (around 1,000 Brazilians per wave) constrains statistical inference, a one-way ANOVA comparing the mean share of respondents who answered "very good" or "good" reveals a statistically significant difference across tertiles ($p < 0.001$), and Tukey's post-hoc tests confirm that this difference is driven by respondents in the highest tertile (see the Appendix for full results). Households with more exposure to the productivity shock not only experienced improved economic conditions but also perceived such improvement.

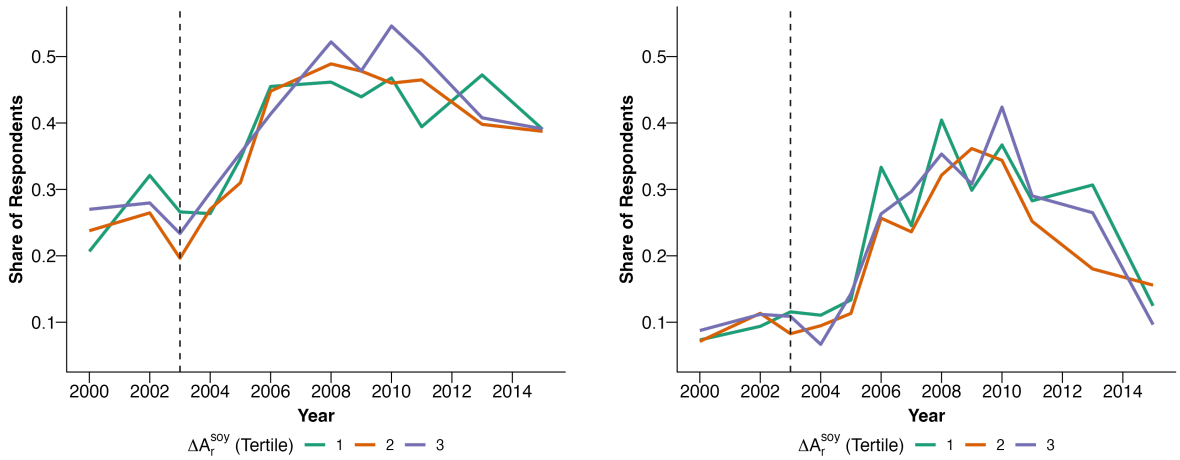
Importantly, this relationship holds for individual, not national economic evaluations. Latinobarómetro also asks respondents: "In general, how would you describe the present economic situation of the country? Would you say that it is very good, good, about average, bad, or very bad?"[7] In Figure 2, Panel (b) shows the relationship between soy productivity and national economic evaluations. While a one-way ANOVA indicates significant differences around tertiles ($p < 0.001$), Tukey's post-hoc tests (see the Appendix) reveal that respondents in the third tertile are significantly less optimistic than those in the first tertile. Although not a smoking gun, this pattern is consistent with our expectation of local attribution and context priming: voters directly exposed to the productivity shock

[5] In the Appendix, we show that more exposed municipalities also experienced income gains using alternative data. Drawing on employer–employee records from RAIS, we construct two indicators: (i) the average formal wage and (ii) the per capita formal wage bill. Because RAIS covers only formal employment, these results likely understate the broader income effects of the shock. We therefore report them as complementary evidence and retain GDP per capita as our main outcome, given its broader coverage of local income.

[6] We include the following Latinobarómetro waves: 1998, 2000, 2002–2006, 2008–2011, 2013, and 2015. Other years are excluded either because the question was not asked (2007, 2016–2018, 2020), municipality identifiers were unavailable (1996, 1997, 2001), or no survey was conducted (1999, 2012, 2014, 2019).

[7] While this question (unlike the previous one) was asked in the 2016, 2017, 2018, and 2020 waves, these years are not included to render both panels in Figure 2 comparable.

Figure 2: Share of Latinobarómetro Respondents Who Report Favorable Economic Evaluations, by Potential Soy Yield



(a) Personal Economic Evaluation

(b) National Economic Evaluation

For every Latinobarómetro wave, Panel (a) shows the share of respondents who answered the question "In general, how would you describe your present economic situation and that of your family?" with "very good" or "good," disaggregated by tertiles of ΔA_r^{soy}, the municipal-level difference in potential soy yield. Panel (b) does the same for respondents who answered the question "In general, how would you describe the present economic situation of the country?" with "very good" or "good." The dotted vertical line indicates the legalization of GE soybean seeds in 2003. The 3rd tertile indicates municipalities most affected by the productivity shock.

perceive the resulting economic gains as *localized*. This sets the stage for a political response: voters should reward local — rather than national — incumbents, at least in the short term.

4 The Political Consequences of a Productivity Shock

4.1 Electoral Context

Brazil elects national and state leaders every four years and municipal leaders in midterm elections.[8] Since 1997, mayors, governors, and the president can serve up to two consecutive four-year terms. Most municipalities elect mayors through a simple majority, except for those with over 200,000 registered voters, where a runoff election is held if no candidate secures an absolute majority in the first round. All municipalities follow a mayor-council form of government and have significant autonomy to manage their own budgets and provide key public services, including education, healthcare, and sanitation. This means

[8]The following discussion does not apply to Brasília and Fernando de Noronha, the only two of Brazil's 5,570 municipalities not to hold municipal elections.

that Brazilian mayors are powerful figures; their elections are politically consequential and have been widely studied (Brollo & Nannicini, 2012; Bueno, 2018; De Magalhães, 2015; Johannessen, 2020; Novaes & Schiumerini, 2022).

Following De Magalhães (2015), our unit of analysis is the individual candidate, and our main outcome of interest is a candidate's unconditional *Probability of Winning* (not conditional on the incumbent's probability of rerunning). We retrieve this information, along with each candidate's *Incumbency* status (that is, whether the candidate won the previous mayoral election), from the Superior Electoral Court (*Tribunal Superior Eleitoral*, or TSE) for the 1996, 2000, 2004, 2008, 2012, 2016, and 2020 municipal elections. Because *Incumbency* refers to the previous election, $t-1$, we use 1996 data to construct the lagged independent variable, but restrict our analysis to elections beginning in 2000.

4.2 Empirical Strategy

To quantify the variable impact of GE seed adoption across municipalities, we employ a difference-in-differences (DiD) framework across multiple electoral cycles using the measure ΔA_r^{soy}, the difference in potential soy yields between high-input and low-input conditions. The first election included in our analysis, 2000, provides a pre-treatment baseline preceding both the legalization of GE soy seeds in 2003 and the initial smuggling of such seeds from Argentina since 2001, two factors that could otherwise complicate identification.[9] The 2004 election — the first after legalization — serves as our baseline treatment year. Our identification strategy exploits this nationwide policy change, combined with exogenous cross-municipality variation in productivity gains, to estimate the differential incumbency advantage induced by the productivity shock.

To test the first proposition that productivity shocks increase the incumbency advantage, our DiD model is given by:

$$\begin{aligned} V_{j,r,t} = \beta_1 \text{Incumbency}_{j,r,t-1} + \beta_2 \left(\text{Incumbency}_{j,r,t-1} \times \text{D}_{r,t}\right) + \beta_3 \left(\text{Incumbency}_{j,r,t-1} \times \Delta A_r^{soy}\right) \\ + \beta_4 \left(\text{D}_{r,t} \times \Delta A_r^{soy}\right) + \beta_5 \left(\text{Incumbency}_{j,r,t-1} \times \text{D}_{r,t} \times \Delta A_r^{soy}\right) + \rho X_{j,r,t} \\ + \mu_r + \gamma_t + \delta_{s,t} + \varepsilon_{j,r,t} \end{aligned} \quad (9)$$

where $V_{j,r,t}$ denotes the probability of electoral victory for candidate j in municipality r during election year t. Here, $\Delta A_r{}^{soy}$ captures the productivity shock, and $D_{r,t}$ is an indicator set to 1 for elections from 2004 onward (post-shock) and 0 otherwise. The terms μ_r and γ_t represent municipality and election-year fixed effects, respectively, while $\delta_{s,t}$ captures region-by-election-year fixed effects, addressing potential regional temporal heterogeneity. These fixed effects control for systematic variations due to policy changes or broader socioeconomic shifts across regions. The triple interaction term β_5 captures how incumbents' electoral advantage varied with exposure to productivity gains after GE soy legalization. To adjust for observable differences, additional specifications incorporate

[9] We only have one pre-treatment period because mayors could not run for reelection before 1997.

candidate-level covariates ($X_{j,r,t}$): gender, age, education, and party affiliation, all retrieved from TSE. As before, we cluster standard errors at the microregion level.

Even when the underlying economic transformation is persistent, its political consequences — particularly the incumbency advantage — may dissipate as voters update their beliefs or as initial gains become less politically salient over time. To assess this second proposition and further validate our identification assumptions, particularly the parallel pre-trends condition, an event-study model evaluates whether electoral outcomes followed similar trajectories in high- and low-exposure municipalities before the policy intervention:

$$V_{j,r,t} = \sum_{t \neq 2004}^{t} \mathbb{I}\left\{\tau = t\right\} \left[\alpha_t Incumbency_{j,r,t-1} + \beta_t \left(Incumbency_{j,r,t-1} \times \Delta A_r{}^{soy}\right)\right] + \rho X_{j,r,t} + \mu_r + \gamma_t + \delta_{s,t} + \varepsilon_{j,r,t} \quad (10)$$

This specification introduces a flexible set of year-specific interaction coefficients β_t, assessing the evolution of incumbency advantages relative to the productivity shock over time. Under the parallel trends assumption, the coefficient for 2000 (pre-treatment) should not differ significantly from zero.

Finally, we evaluate the third proposition: the political return to an income shock should be larger where a greater share of the population is directly exposed to the gains or benefits indirectly from local spillovers. Following Bustos et al. (2016), we note that municipalities with higher potential soy yields experienced a decline in agricultural employment and an increase in manufacturing employment between 2000 and 2010. These changes, reflecting the labor-saving nature of GE soy adoption, suggest that the income gains primarily benefited workers in non-agricultural sectors, particularly manufacturing.

Building on this insight, we use data from the 2000 Census to construct two employment-based proxies for local exposure, disaggregated by the Brazilian National Classification of Economic Activities (CNAE), following crosswalks from Cícero (2025). The first measure indicates the share of municipal employment in soy-related activities (soy cultivation, agricultural services, and vegetable oil processing), reflecting the most immediate points of contact with the technological change — though not necessarily its main beneficiaries. The second measure indicates the share of employment in manufacturing, which proxies for the sectors most positively affected by the shock and broader economic spillovers, as manufacturing-intensive municipalities tend to have more diversified and structurally responsive local economies. For each measure, we estimate:

$$\begin{aligned} V_{j,r,t} = {} & \beta_1 \, \text{Incumbency}_{j,r,t-1} + \beta_2 \left(\text{Incumbency}_{j,r,t-1} \times \text{D}_{r,t}\right) + \beta_3 \left(\text{Incumbency}_{j,r,t-1} \times \Delta A_r^{soy}\right) \\ & + \beta_4 \left(\text{D}_{r,t} \times \Delta A_r^{soy}\right) + \beta_5 \left(\text{Incumbency}_{j,r,t-1} \times \text{D}_{r,t} \times \Delta A_r^{soy}\right) \\ & + \beta_6 \left(\text{Incumbency}_{j,r,t-1} \times \text{D}_{r,t} \times \Delta A_r^{soy} \times \text{Employment}_r\right) + \rho X_{j,r,t} \\ & + \mu_r + \gamma_t + \delta_{s,t} + \varepsilon_{j,r,t} \quad (11) \end{aligned}$$

This approach assesses whether the political impact of the shock varies systematically with local labor market composition, holding overall exposure constant.

4.3 Results

Table 1 reports estimates of Equation (9) across increasingly saturated specifications. Column (1) includes only municipality and election-year fixed effects. Columns (2) and (3) introduce region-year fixed effects, at the state and then microregion levels, to account for regional electoral dynamics and unobserved time-varying shocks. Column (4) adds party-year fixed effects to absorb national partisan dynamics, such as the influence of gubernatorial or presidential coattails. Column (5), our preferred specification, includes candidate-level controls to account for individual heterogeneity in electoral appeal (with a modest reduction in sample size due to missing data).

All specifications identify a sizable incumbency advantage: all else equal, incumbents are about 30 percentage points more likely to win reelection. Consistent with the first proposition of our formal framework, the interaction between incumbency and exposure to potential soy yield is statistically significant *after the legalization of GE soy* (post-shock). Incumbents in municipalities with greater agronomic suitability for the new technology — measured by potential yield gains — gained disproportionate electoral benefits after 2003.

Table 1: Potential Soy Yield and Electoral Victory DiD

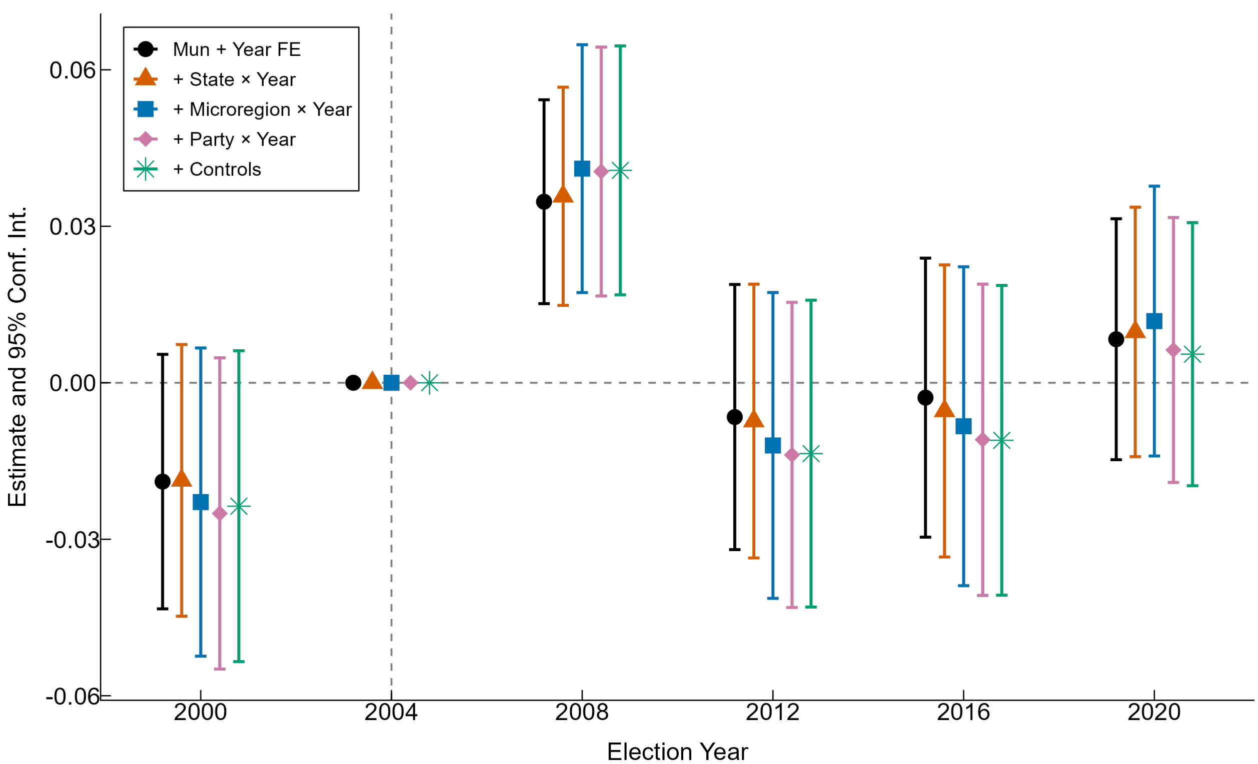
Dependent variable:	**Prob. Victory**				
	(1)	(2)	(3)	(4)	(5)
Incumbency	0.2981***	0.2991***	0.3019***	0.2617***	0.2601***
	(0.0306)	(0.0307)	(0.0313)	(0.0317)	(0.0317)
Incumbency × Post-shock	-0.0386	-0.0401	-0.0405	0.0318	-0.0304
	(0.0309)	(0.0309)	(0.0315)	(0.0317)	(0.0317)
Incumbency × ΔA_r^{soy}	-0.0221	-0.0226	-0.0232	-0.0244	-0.0236
	(0.0155)	(0.0155)	(0.0158)	(0.0160)	(0.0160)
Post-shock × ΔA_r^{soy}	-0.0043	-0.0067	-0.0024	-0.0024	0.0024
	(0.0044)	(0.0044)	(0.0055)	(0.0052)	(0.0053)
Incumbency × Post-shock × ΔA_r^{soy}	0.0331**	0.0338**	0.0344**	0.0328**	0.0319**
	(0.0158)	(0.0158)	(0.0161)	(0.0163)	(0.0162)
Municipality fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓
State-Year fixed effects		✓	✓	✓	✓
Microregion-Year fixed effects			✓	✓	✓
Party-Year fixed effects				✓	✓
Controls					✓
Observations	90,926	90,926	90,926	90,926	90,334
R^2	0.087	0.088	0.092	0.122	0.125

Notes: Unit of analysis is a candidate j in municipality r and election t. Standard errors (in parentheses) are adjusted for 555 microregion clusters. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In our preferred specification, a one standard deviation increase in ΔA_r^{soy} is associated with a 2.7 percentage point increase in the probability of reelection ($\approx 0.85 \times 0.032$). Alternatively, moving a municipality from the 25th to the 75th percentile of the distribution of soy potential yield corresponds to a 4.15 percentage point increase in reelection probability ($\approx (2.46 - 1.16) \times 0.032$). These magnitudes are similar to those reported by Novaes and Schiumerini (2022), who find a 3–5 percentage point incumbency boost in response to one standard deviation commodity price shocks in Brazil. Our results also align with evidence from other Latin American contexts that local economic fluctuations meaningfully affect incumbent support (Murillo & Visconti, 2017).

To assess the second proposition of our framework and test the parallel trends assumption underlying our identification strategy, we estimate Equation (10) and report the dynamic treatment effects in Figure 3. These event-study specifications follow the structure of Table 1, with progressively saturated models incorporating various combinations of fixed effects and covariates.

Figure 3: Dynamic Effects of Potential Soy Yield on Incumbent Reelection Probability



This figure provides a visual representation of the five models in Table 1. Each point represents a regression coefficient ($\hat{\beta}$) from estimating Equation (10). The dependent variable is the probability of victory of candidate j in municipality r in each election $t = 2000, \ldots, 2020$. All regressions include municipality and year fixed effects. Standard errors are clustered at the microregion level (555 clusters).

The results offer two key insights. First, the pre-treatment coefficients (from the 2000 election) are close to zero and statistically insignificant across all specifications. This supports the validity of the parallel trends assumption: absent the GE soy shock, municipalities with differing exposure to productivity gains would have followed comparable electoral trajectories.

Second, the dynamic effects are temporally concentrated. All specifications identify a statistically significant increase in the incumbency advantage in 2008, the first election when the GE soy shock could plausibly have translated into visible local economic improvements. A one standard deviation increase in ΔA_r^{soy} raised the probability of reelection by about 3.5 percentage points. However, this electoral gain did not persist: the estimated effects in 2012, 2016, and 2020 are small and statistically indistinguishable from zero.

Although Dilma Rousseff's presidency (2011–2016) was marked by a national political and economic crisis, its uniform impact across municipalities allows us to isolate the transient effect of local economic gains on reelection probabilities. This transience is consistent with the mechanism emphasized by our argument: as voters internalize sustained income gains, earlier improvements lose political salience. What initially registered as an economic windfall is soon internalized as the new norm, eroding the incumbent's perceived credit over time.

Finally, we test whether incumbency effects were stronger in municipalities with greater direct exposure or higher spillover potential (Proposition 3) by extending our preferred specification and interacting the triple-difference term with sectoral employment share, following Equation 11. In Table 2, column (1) presents the baseline result without additional interactions, equivalent to column (5) in Table 1. Column (2) tests variation by soy-related employment share. The interaction term is statistically insignificant: incumbents did not benefit more in municipalities with more employment in soy-related sectors. Consistent with Bustos et al. (2016), we interpret this result as a consequence of the labor-saving nature of GE soy technology: although these sectors were closely tied to the shock, they did not transmit substantial income gains to local workers.

By contrast, column (3) shows a significantly stronger post-shock incumbency advantage in municipalities with higher preexisting manufacturing employment. This finding supports the prediction: incumbents were more likely to be rewarded in municipalities where downstream gains reached a broader electorate or where the local economy was better positioned to absorb and diffuse the shock.

4.4 Robustness Checks

We further assess the robustness of our findings in the Appendix. First, we re-estimate all models weighted by the number of valid municipal votes, addressing potential heteroskedasticity from population size disparities. Second, we estimate cross-sectional models by election year (2000–2020), using both linear probability and Probit specifications. Third, following Novaes and Schiumerini (2022), we exclude municipalities where incumbents were term-limited at $t + 1$. In all cases, the main results remain stable in both

Table 2: Potential Soy Yield and Electoral Victory DiD — Employment Shares

Dependent variable:	**Prob. Victory**		
	(1)	(2)	(3)
Incumbency	0.2601***	0.2601***	0.2602***
	(0.0317)	(0.0317)	(0.0317)
Incumbency × Post-shock	-0.0304	-0.0307	-0.0243
	(0.0317)	(0.0317)	(0.0319)
Incumbency × ΔA_r^{soy}	-0.0236	-0.0236	-0.0236
	(0.0160)	(0.0160)	(0.0160)
Post -shock × ΔA_r^{soy}	0.0000	0.0000	0.0002
	(0.0053)	(0.0053)	(0.0053)
Incumbency × Post-shock × ΔA_r^{soy}	0.0319**	0.0344**	0.0128
	(0.0162)	(0.0163)	(0.0172)
Incumbency × Post-shock × ΔA_r^{soy} × Share of Soy		-0.0241	
		(0.0292)	
Incumbency × Post-shock × ΔA_r^{soy} × Share of Manufacture			0.1484***
			(0.0294)
Municipality fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
State-Year fixed effects	✓	✓	✓
Microregion-Year fixed effects	✓	✓	✓
Party-Year fixed effects	✓	✓	✓
Controls	✓	✓	✓
Observations	90,334	90,334	90,334
R^2	0.125	0.125	0.126

Notes: Unit of analysis is a candidate j in municipality r and election t. Standard errors (in parentheses) are adjusted for 555 microregion clusters. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

magnitude and statistical significance. Finally, we test for a *party* incumbency advantage — that is, whether another candidate of the same party won an election at $t - 1$. Like De Magalhães (2015), we identify a disconnect between individual and party estimates, consistent with Brazil's weakly institutionalized party system and widespread party switching (Desposato, 2006). Together, these results indicate that the GE soy shock benefited individual incumbents rather than parties.

Lastly, we explore additional proximate mechanisms underlying our main results. Income gains remain the most plausible channel, as suggested by Figure 1 and consistent with the theoretical framework. Municipalities with larger soy productivity gains experienced sustained increases in income per capita, corroborated by formal wage data. Testing alternative channels, we find no relative changes in per capita municipal revenues or expenditures, and long-difference estimates of the Human Development Index (HDI) reveal no systematic improvements in education or longevity components in more exposed municipalities compared to less exposed ones. Although we cannot identify this as the sole mechanism, the evidence suggests that the electoral response was primarily driven by perceived improvements in private economic well-being rather than by enhanced public service delivery or broader human development. The incumbency boost was short-lived and spatially concentrated, reflecting the political salience of immediate income gains rather than enduring institutional or policy achievements.

5 Conclusion

This study contributes to debates on economic voting by showing how gradual expectation adjustment mediates the political returns to exogenous income shocks. When local economies improve due to external factors, incumbents are more likely to receive credit for prosperity — even when the gains are unrelated to their actions. The theoretical framework explains how this misattribution arises: voters anchor expectations in pre-shock conditions and update them slowly, generating a temporary satisfaction gap that inflates incumbent support. As expectations converge to the new income level, the political advantage fades, even though material circumstances remain improved.

We test these predictions by examining how an agricultural productivity shock shaped mayoral reelection outcomes in Brazil between 2000 and 2020. Exploiting the timing of GE soy legalization and geographic variation in agronomic potential, we show that incumbents were significantly more likely to win reelection in municipalities with larger gains in soy productivity. A one–standard-deviation increase in soy potential yield raised the probability of reelection by 2.7 percentage points, peaking at 3.5 percentage points in 2008 before declining to zero in subsequent elections. This pattern underscores the political salience of recent economic gains and the fleeting nature of attribution errors.

While our empirical analysis focuses on Brazil, the dynamics we document are likely to characterize many low- and middle-income democracies. Undiversified economies, weak institutions, and high exposure to global markets make them particularly vulnerable to misattribution. When external shocks blur the line between competence and coincidence, electoral accountability suffers. Future research could explore *who benefits* from such exogenous gains. For instance, male and conservative candidates may be better positioned to claim credit for an agricultural boom and thus derive larger electoral advantages. Likewise, not all voters are equally prone to misattribution: political knowledge, media exposure, and social networks likely shape how citizens perceive and assign credit for economic change. Understanding these heterogeneities is essential both to identifying when exogenous shocks distort, rather than reinforce, democratic accountability and to designing interventions that strengthen it.

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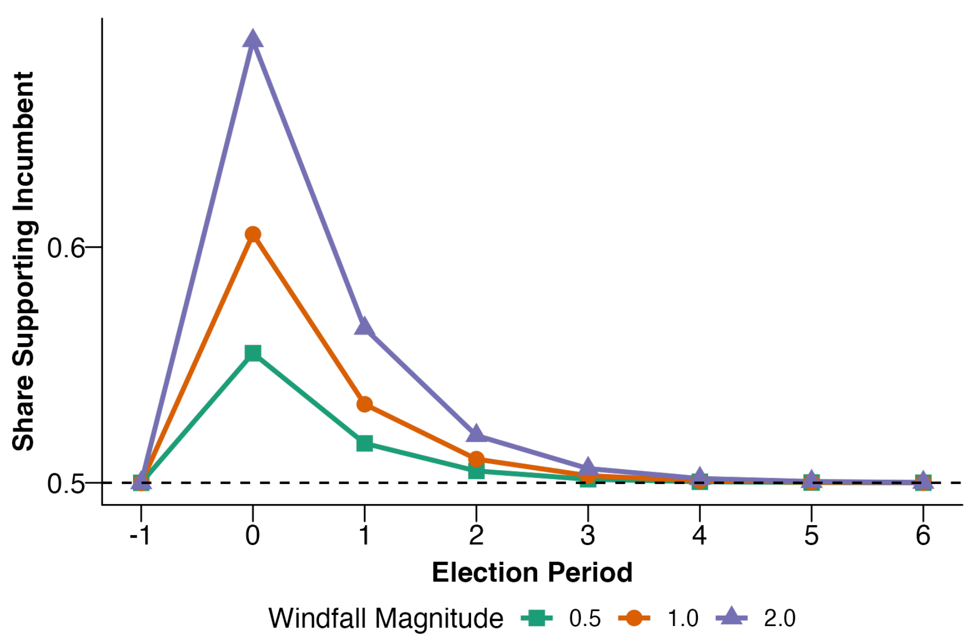
A Appendix

A.1 Simulations

To visualize the dynamic logic of the theoretical-formal framework presented in Section 3, we simulate the aggregate support function $S_r(t)$ under varying parameter configurations. Each exercise isolates a key mechanism: (i) the magnitude of the windfall ΔA_r, (ii) the speed of expectation adjustment λ, and (iii) the structure of exposure — namely, the share of voters fully exposed to the shock p and the intensity of spillovers η.

We begin by illustrating the result in Proposition 1. Holding the speed of adjustment fixed at $\lambda = 0.7$, we assume that 10% of voters are fully exposed to the income windfall, while the remaining 90% receive a spillover of 20%. Figure A.1 plots support dynamics across different windfall magnitudes. As expected, larger shocks generate sharper initial gains in support, reflecting a greater satisfaction gap. However, these gains diminish over time as expectations adjust, even though incomes remain permanently higher.[10]

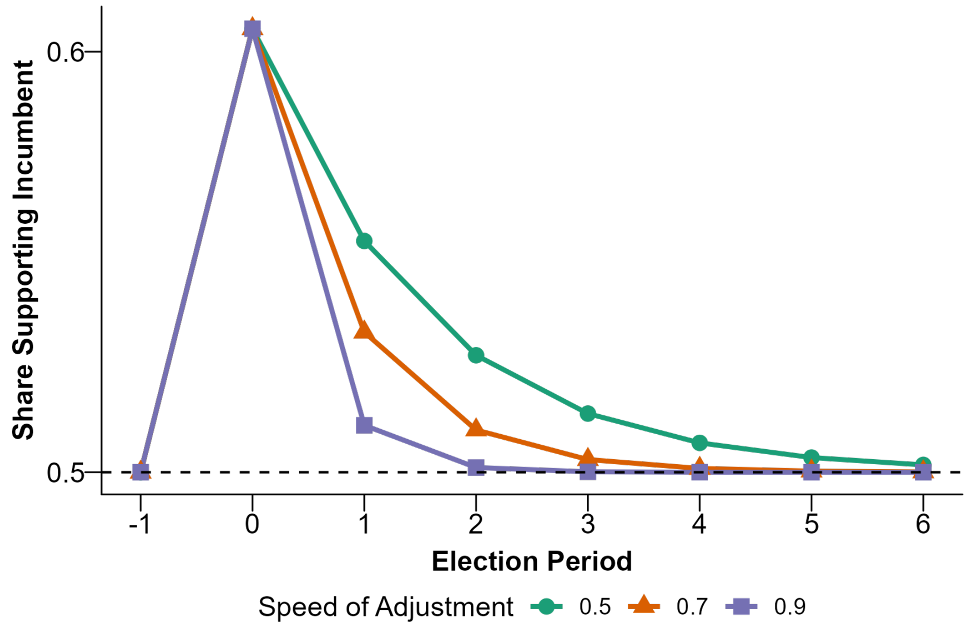
Figure A.1: Windfall Effects on Share Supporting the Incumbent



Next, we turn to the role of expectation adjustment, following Proposition 2. Using the same exposure structure and an intermediate windfall level, Figure A.2 shows how the speed of learning affects the persistence of political gains. When adaptation is slower ($\lambda = 0.5$), the satisfaction gap — and thus support — remains elevated for longer. Faster adaptation compresses this window, causing support to revert more quickly toward baseline levels.

[10]While the model focuses on positive shocks, the logic plausibly holds for negative income shocks that incumbents might be punished for (Murillo & Visconti, 2017).

Figure A.2: Adjustment Speed and the Persistence of Support



We then explore the role of exposure heterogeneity, in line with Proposition 3. Figure A.3 examines how aggregate support varies with the share of voters fully exposed to the shock. Holding other parameters constant, a larger value of p strengthens and extends the boost in support, while a lower value (i.e., more indirect exposure) dampens the aggregate response due to weaker income gains.

Finally, Figure A.4 highlights the role of spillover intensity η, again holding other parameters fixed. When indirect exposure is low, the benefits — and thus support — are narrowly concentrated among the directly exposed minority. As η increases, the windfall reaches a broader segment of the population, amplifying and prolonging political support.

Figure A.3: Share of Fully Exposed Population and Incumbent Support

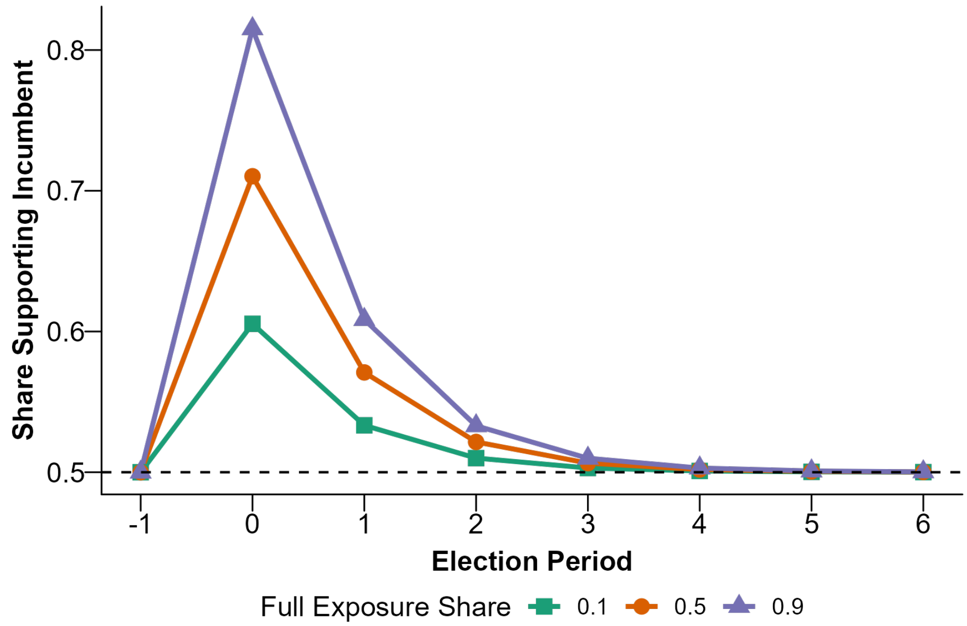
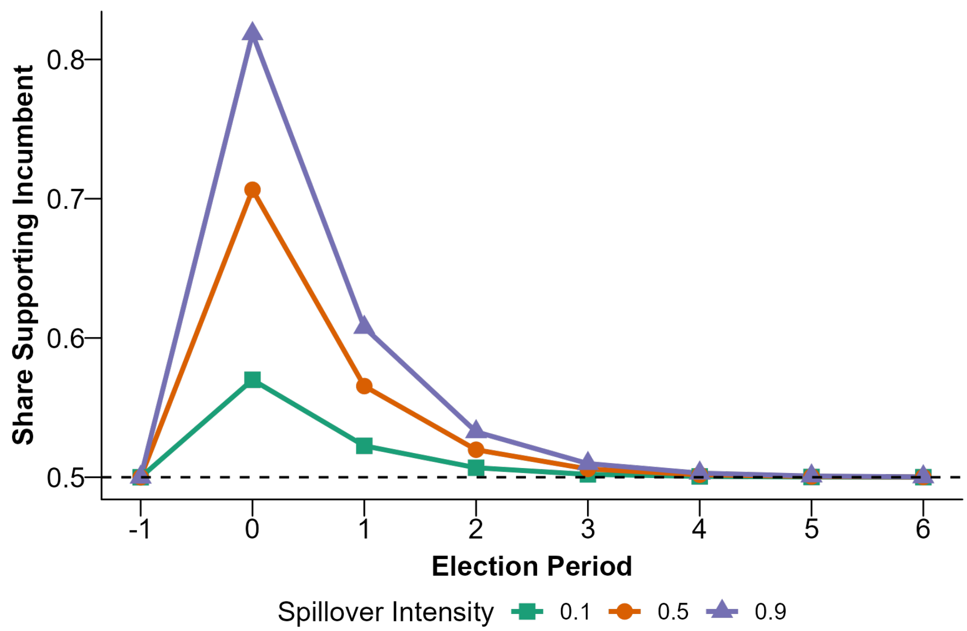


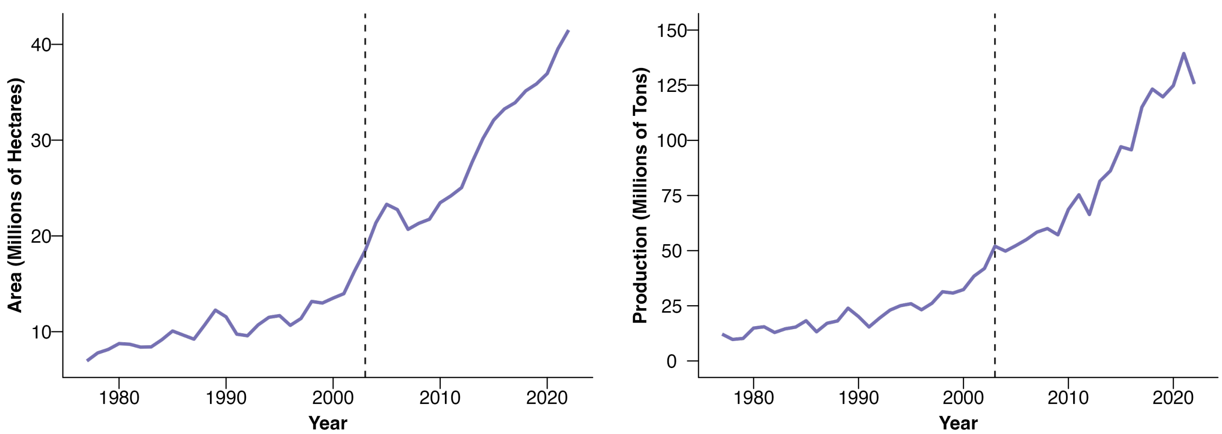
Figure A.4: Spillover Intensity and the Breadth of Political Gains



A.2 Agricultural Transformation in Brazil: Additional Descriptive Information

As Figure A.5 shows, there was a pronounced increase in the area devoted to soy production — and, as a consequence, in total production — after 2003, coinciding with the legalization of GE seeds (as the dotted vertical lines indicate). In addition, Figure A.6 shows that there was a pronounced increase in the area planted per worker and output per worker (or labor productivity).

Figure A.5: Soybean Productivity: 1976-2022

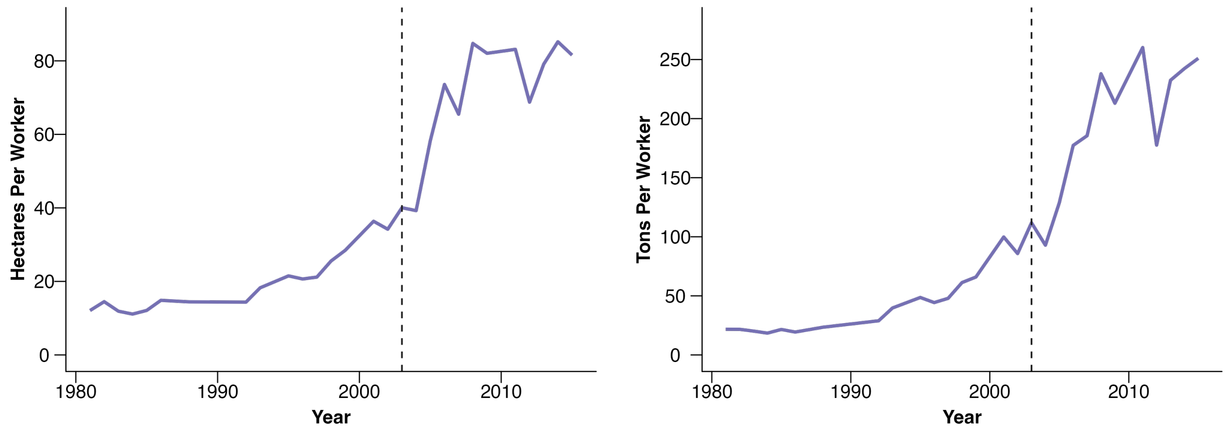


(a) Area Planted (b) Total Production

This figure shows Brazil's soybean productivity, in area planted (millions of hectares, left) and output (millions of tons, right). The dotted vertical line indicates the legalization of GE soybean seeds in 2003. From December 2011 to February 2012, a drought associated with La Niña reduced soybean yields, leading to a temporary dip in labor productivity. Source: Brazilian Ministry of Agriculture, computed by *Companhia Nacional de Abastecimento* (CONAB). Adapted from Bustos et al. (2016).

Figure A.7 compares low-input conditions (which reflect traditional practices with minimal mechanization and no chemical inputs) to high-input conditions (which include improved seeds, fertilizers, pest and weed control, and full mechanization) for soy in Brazil, using data from the Food and Agriculture Organization's Global Agro-Ecological Zones project (FAO-GAEZ). We use these data to construct a measure of local exposure to productivity gains from adopting GE soy seeds in municipality r as ΔA_r^{soy}, the municipal-level *difference* in potential yield in the high- and low-input scenarios. Figure A.8 illustrates the resulting measure of technical change in soy production across municipalities, aggregated into deciles. Since municipality borders change over time, this measure is reported in Áreas Mínimas Comparáveis (AMC), or "smallest comparable areas," as defined by the Brazilian Institute of Geography and Statistics (IBGE). In Figure A.8 and subsequent empirical tests, we convert this unit of analysis to municipalities.

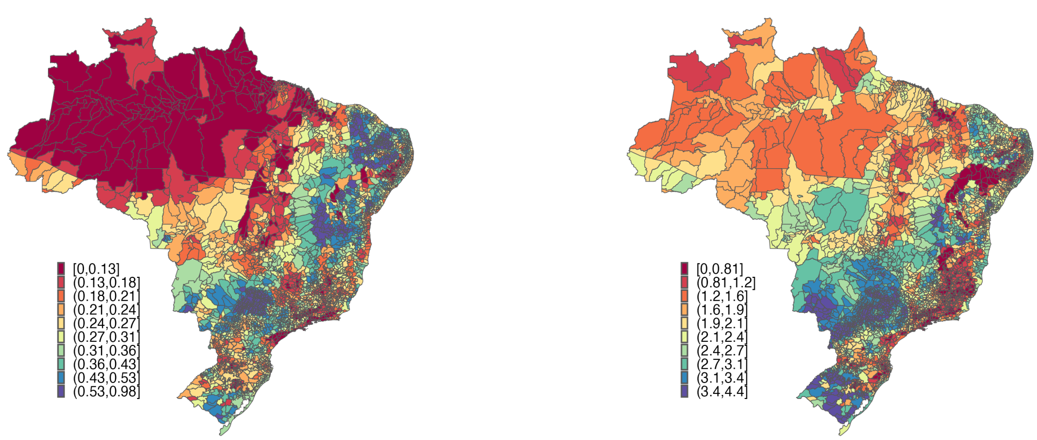
Figure A.6: Soybean Productivity Per Worker: 1980-2015



(a) Area Planted Per Worker (b) Output Per Worker

This figure shows the soybean productivity per worker, in area planted (hectares per worker, left) and output (tons per worker, right). The dotted vertical line indicates the adoption of GE soybean seeds in 2003. From December 2011 to February 2012, a drought associated with La Niña reduced soybean yields, leading to a temporary dip in labor productivity. Source: Brazilian Ministry of Agriculture, computed by *Companhia Nacional de Abastecimento* (CONAB); *Pesquisa Nacional por Amostra de Domicílios* (PNAD), implemented by the Brazilian Institute of Geography and Statistics. Adapted from Bustos et al. (2016).

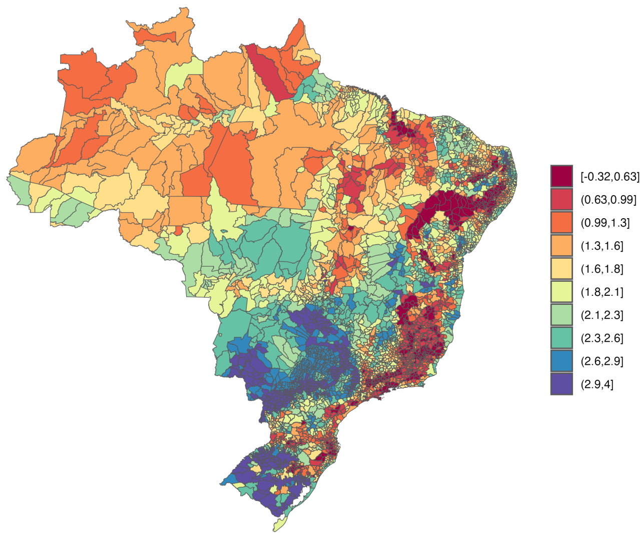
Figure A.7: Potential Soy Yield at the Municipality Level, in Tons Per Hectare (Deciles), by Input Condition



(a) Low (b) High

This figure shows each municipality's potential soy yield (in tons per hectare, aggregated into deciles), using low- and high-input conditions. Source: FAO-GAEZ.

Figure A.8: Difference in Potential Soy Yield at the Municipality Level, in Tons Per Hectare (Deciles)



This figure shows each municipality's potential soy yield under the high-input condition minus its potential soy yield under the low-input conditions. Source: FAO-GAEZ. Adapted from Bustos et al. (2016).

A.3 Additional Income Regression

For clarity, the results shown in Figure 1 come from estimating the following dynamic event-study specification:

$$GDPpc_{r,t} = \sum_{t \neq 2002}^{t} \mathbb{I}\left\{\tau = t\right\} \beta_t \Delta A_r^{soy} + \mu_r + \gamma_t + \delta_{s,t} + \varepsilon_{r,t} \tag{12}$$

Complementing these dynamic estimates, Table A.1 presents long-difference models that summarize income growth between 2000 and 2010. Consistent with the event-study results, municipalities experiencing larger productivity gains also saw significantly greater income increases. Formally, we estimate:

$$\Delta GDPpc_{r,2010-2000} = \beta \Delta A_r^{soy} + \mu_r + \delta_{s,t} + \varepsilon_{r,t} \tag{13}$$

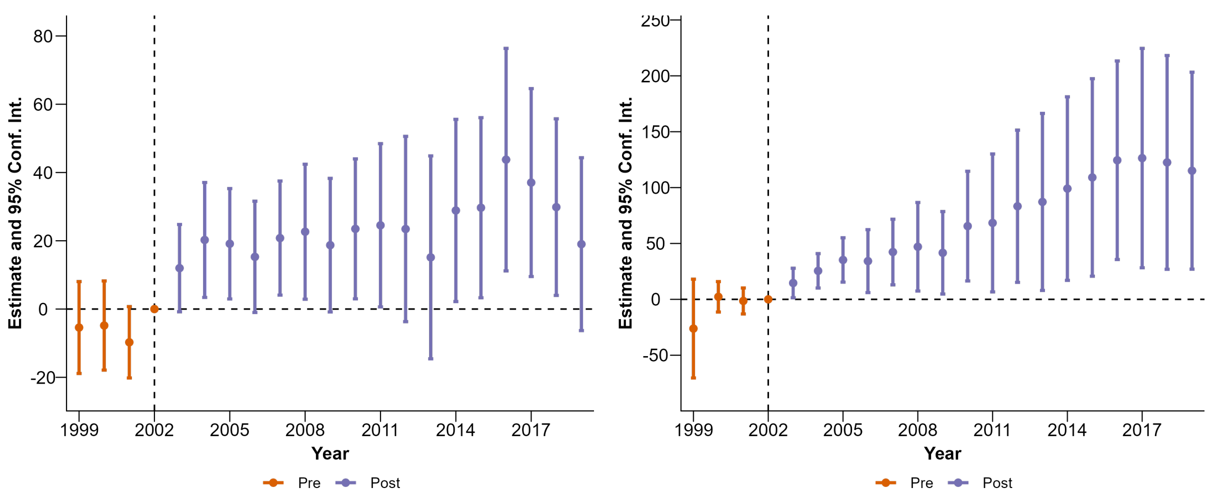
Finally, we extend the analysis by estimating dynamic event-study specifications for two municipality-level outcomes constructed from RAIS: (i) the average formal wage and (ii) the per capita formal wage bill. Figure A.9 indicates that municipalities more affected by the soy shock experienced higher average formal wages relative to less affected areas. Figure A.10 shows that this effect also appears in broader income measures, with significant increases in the per capita formal wage bill. Because RAIS only captures formal employment relationships and firm activity, these results likely represent a lower bound on the overall income effects of the shock.

Table A.1: Soy and Income Per Capita

Dependent variable:	Δ GDPpc				Δ log(GDPpc)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔA_r^{soy}	1.069***	0.9278***	0.3287	1.093**	0.2405***	0.2417***	0.1130***	0.1694**
	(0.1668)	(0.2719)	(0.3510)	(0.4953)	(0.0235)	(0.0335)	(0.0359)	(0.0825)
Weighted		✓	✓	✓		✓	✓	✓
State-year fixed effects			✓	✓			✓	✓
Microregion-year fixed effects				✓				✓
Observations	4,255	4,255	4,255	4,255	4,150	4,150	4,150	4,150
R^2	0.013	0.009	0.098	0.386	0.063	0.051	0.267	0.553

Notes: Unit of analysis r is a municipality. Standard errors (in parentheses) are adjusted for 555 microregion clusters. In columns 2 and 5, observations are weighted by the population; columns 3 and 5 adds state-year fixed effects; and columns 4 and 6 adds microregion-year fixed effects. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

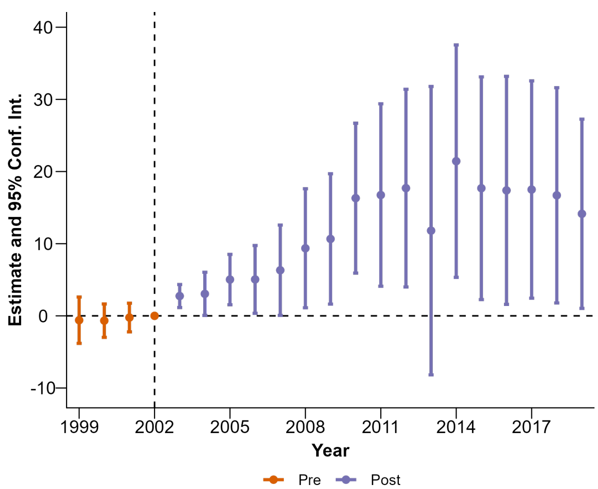
Figure A.9: Dynamic Effects of the Soy Shock on Municipality Average Formal Wage



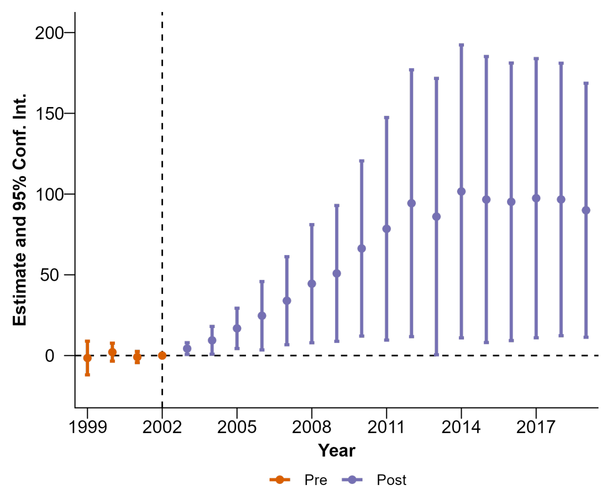
(a) Unweighted Estimates (b) Population-Weighted Estimates

This figure shows the dynamic effects of ΔA_r^{soy} on the average formal wage. Vertical bars represent 95% confidence intervals. The dotted vertical line indicates 2002, the year preceding the legalization of GE soybean seeds. Specifications include municipality and year fixed effects, microregion–year interactions, and standard errors clustered at the microregion level (555 clusters). Panel (a) presents unweighted estimates, whereas Panel (b) applies population weights.

Figure A.10: Dynamic Effects of the Soy Shock on Municipality Per Capita Formal Wage Bill



(a) Unweighted Estimates



(b) Population-Weighted Estimates

This figure shows the dynamic effects of ΔA_r^{soy} on the per capita formal wage bill. Vertical bars represent 95% confidence intervals. The dotted vertical line indicates 2002, the year preceding the legalization of GE soybean seeds. Specifications include municipality and year fixed effects, microregion–year interactions, and standard errors clustered at the microregion level (555 clusters). Panel (a) presents unweighted estimates, whereas Panel (b) applies population weights.

A.4 ANOVA and Tukey's Tests of Voter Perceptions

First, we examine whether increases in soy productivity have a significant effect on *personal* economic evaluations among Latinobarómetro respondents. To do so, we use a one-way ANOVA to test whether the mean share of optimistic respondents — those who answered the question "In general, how would you describe your present economic situation and that of your family?" with "very good" or "good" — differs across tertiles of municipal-level changes in potential soy yield (ΔA_r^{soy}). As Table A.2 shows, the significant F-statistic ($p < 0.001$) indicates that at least one group differs. We then estimate Tukey's honestly significant difference (HSD) post-hoc tests to compare all possible pairs of means, finding that the difference in means is driven by respondents in the top tertile: individuals in municipalities most affected by the productivity shock (third tertile) report significantly higher optimism compared to those in the first and second tertiles. No statistically significant difference is observed between the first and second tertiles.

Table A.2: ANOVA and Tukey's HSD Test Results for Optimistic Personal Economic Evaluation Across Tertiles of ΔA_r^{soy}

(a) One-Way ANOVA					
Source	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Tertiles of ΔA_r^{soy}	2	3.00	1.50	7.41	0.0006
Residuals	19,877	4024.00	0.20		
(b) Tukey's HSD Post-Hoc Tests					
Comparison	Diff	95% CI Lower	95% CI Upper	p adj	
2 – 1	-0.010	-0.029	0.008	0.388	
3 – 1	0.019	0.001	0.038	0.035	
3 – 2	0.030	0.011	0.048	0.000	

Second, we examine whether increases in soy productivity have a significant effect on *national* economic evaluations among Latinobarómetro respondents. Now, the one-way ANOVA tests whether the mean share of optimistic respondents — those who answered the question "In general, how would you describe the present economic situation of the country?" with "very good" or "good" — differs across tertiles of municipal-level changes in potential soy yield (ΔA_r^{soy}). Table A.3 presents the results. As before, the significant F-statistic ($p < 0.001$) indicates that at least one group differs; Tukey's HSD post-hoc tests suggest that respondents in the third tertile are significantly *less* optimistic than those in the first tertile. Put together, the results of Tables A.2 and A.3 suggest that the perceptions of economic improvement applied to the local/individual (not national) level.

Table A.3: ANOVA and Tukey's HSD Test Results for Optimistic National Economic Evaluation Across Tertiles of ΔA_r^{soy}

(a) One-Way ANOVA

Source	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Tertiles of ΔA_r^{soy}	2	5.20	2.5796	18.52	0.000
Residuals	19,877	2769.00	0.1393		

(b) Tukey's HSD Post-Hoc Tests

Comparison	Diff	95% CI Lower	95% CI Upper	p adj
2 – 1	-0.039	-0.054	-0.024	0.000
3 – 1	-0.016	-0.031	-0.001	0.037
3 – 2	0.023	0.008	0.038	0.001

A.5 DiD Robustness

To probe the robustness of Table 1, we re-estimate these models in several ways. First, in Table A.4, we weight them by valid municipal votes, addressing potential heteroskedasticity arising from population disparities. Second, in Table A.5, we replace the linear DiD with a Probit specification. Finally, in Table A.6, we do both: we present the results of Probit specifications weighted by valid municipal votes. Our results are largely robust to these changes.

Table A.4: Potential Soy Yield and Electoral Victory DiD (Weighted)

Dependent variable:	**Prob. Victory**				
	(1)	(2)	(3)	(4)	(5)
Incumbency	0.3712***	0.3722***	0.3749***	0.3169***	0.3097***
	(0.0643)	(0.0642)	(0.0657)	(0.0661)	(0.0668)
Incumbency × Post-shock	-0.0217	-0.0230	-0.0216	-0.0238	-0.0183
	(0.0608)	(0.0609)	(0.0630)	(0.0634)	(0.0642)
Incumbency × ΔA_r^{soy}	-0.0134	-0.0133	-0.0110	-0.0059	-0.0040
	(0.0311)	(0.0311)	(0.0318)	(0.0326)	(0.0328)
Post-shock × ΔA_r^{soy}	-0.0034	-0.0061	0.0008	0.0090	0.0017
	(0.0081)	(0.0076)	(0.0098)	(0.0102)	(0.0103)
Incumbency × Post-shock × ΔA_r^{soy}	0.0533*	0.0536*	0.0530*	0.0427	0.0413
	(0.0300)	(0.0300)	(0.0311)	(0.0315)	(0.0315)
Municipality fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓
State-Year fixed effects		✓	✓	✓	✓
Microregion-Year fixed effects			✓	✓	✓
Party-Year fixed effects				✓	✓
Controls					✓
Observations	90,926	90,926	90,926	90,926	90,334
R^2	0.162	0.163	0.169	0.229	0.232

Notes: Unit of analysis is a candidate j in municipality r and election t. Standard errors (in parentheses) are adjusted for 555 microregion clusters. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: Potential Soy Yield and Electoral Victory DiD — Probit

Dependent variable:	**Prob. Victory**				
	(1)	(2)	(3)	(4)	(5)
Incumbency	0.7867***	0.7895***	0.7997***	0.6947***	0.6966***
	(0.0832)	(0.0837)	(0.0858)	(0.0879)	(0.0881)
Incumbency $\times$ Post-shock	-0.0996	-0.1031	-0.1045	-0.0830	-0.0708
	(0.0839)	(0.0841)	(0.0860)	(0.0880)	(0.0881)
Incumbency $\times$ ΔA_r^{soy}	-0.0582	-0.0593	-0.0613	-0.0646	-0.0615
	(0.0421)	(0.0422)	(0.0433)	(0.0445)	(0.0444)
Post-shock $\times$ ΔA_r^{soy}	-0.0122	-0.0183	-0.0083	0.0050	0.0007
	(0.0128)	(0.0129)	(0.0157)	(0.0154)	(0.0161)
Incumbency $\times$ Post-shock $\times$ ΔA_r^{soy}	0.0886**	0.0900**	0.0924**	0.0879*	0.0846*
	(0.0428)	(0.0429)	(0.0439)	(0.0451)	(0.0449)
Municipality fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓
State-Year fixed effects		✓	✓	✓	✓
Microregion-Year fixed effects			✓	✓	✓
Party-Year fixed effects				✓	✓
Controls					✓
Observations	90,926	90,926	90,926	90,242	89,655
Pseudo R^2	0.068	0.068	0.072	0.099	0.103

Notes: Unit of analysis is a candidate j in municipality r and election t. Standard errors (in parentheses) are adjusted for 555 microregion clusters and observations are weighted by valid votes. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.6: Potential Soy Yield and Electoral Victory DiD — Probit (Weighted)

Dependent variable:	**Prob. Victory**				
	(1)	(2)	(3)	(4)	(5)
Incumbency	1.018***	1.021***	1.035***	0.8578***	0.8394***
	(0.1911)	(0.1922)	(0.1992)	(0.2005)	(0.2039)
Incumbency × Post-shock	-0.0284	-0.0289	-0.0208	-0.0394	-0.0221
	(0.1787)	(0.1792)	(0.1886)	(0.1879)	(0.1907)
Incumbency × ΔA_r^{soy}	-0.0379	-0.0369	-0.0269	-0.0085	-0.0025
	(0.0907)	(0.0913)	(0.0943)	(0.0989)	(0.0995)
Post-shock × ΔA_r^{soy}	-0.0145	-0.0226	-0.0077	0.0239	-0.0027
	(0.0289)	(0.0268)	(0.0341)	(0.0358)	(0.0365)
Incumbency × Post-shock × ΔA_r^{soy}	0.1624*	0.1621*	0.1604*	0.1258	0.1221
	(0.0894)	(0.0901)	(0.0950)	(0.0977)	(0.0977)
Municipality fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓
State-Year fixed effects		✓	✓	✓	✓
Microregion-Year fixed effects			✓	✓	✓
Party-Year fixed effects				✓	✓
Controls					✓
Observations	90,926	90,926	90,926	90,242	89,655
Pseudo R^2	0.139	0.140	0.146	0.204	0.207

Notes: Unit of analysis is a candidate j in municipality r and election t. Standard errors (in parentheses) are adjusted for 555 microregion clusters and observations are weighted by valid votes. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A.6 Term Limits

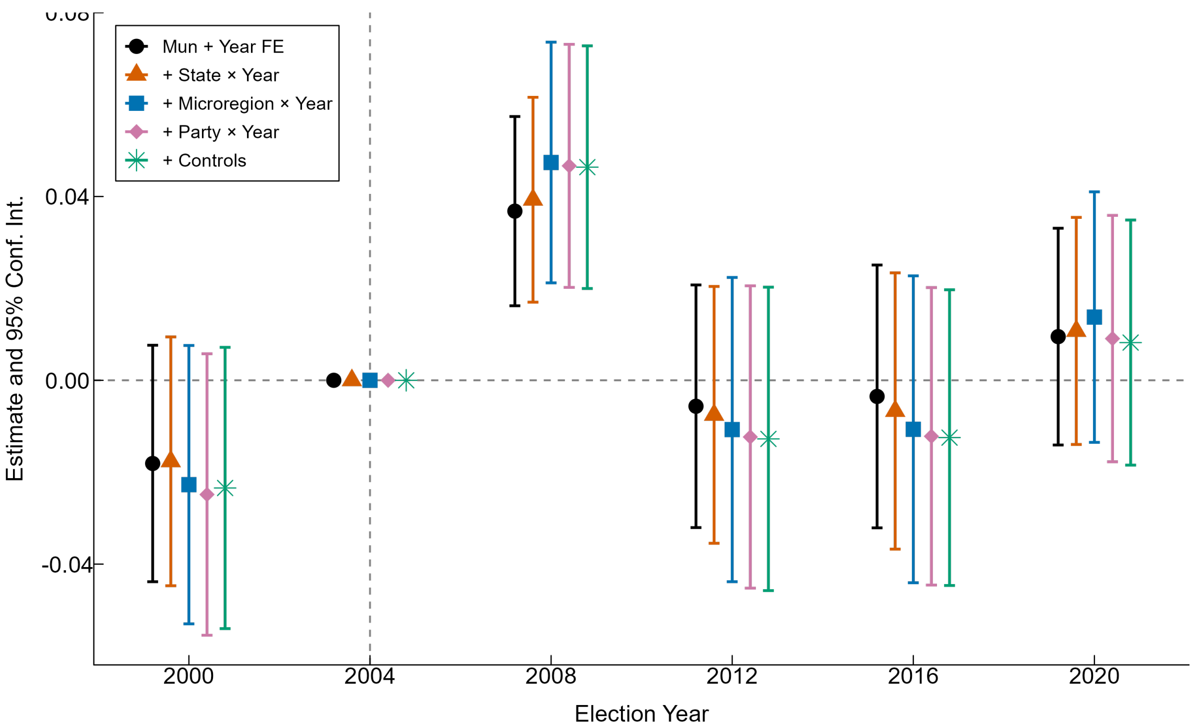
Following Novaes and Schiumerini (2022), Table A.7 excludes municipalities where incumbents cannot run in $t+1$ due to term limits. The results are nearly identical in terms of magnitude and statistical significance. Figure A.11 presents the corresponding dynamic effects. In Table A.8, we present similar results estimating a Probit model.

Table A.7: Potential Soy Yield and Electoral Victory DiD — Excluding Municipalities With Term-Limited Incumbents

Dependent variable:	**Prob. Victory**				
	(1)	(2)	(3)	(4)	(5)
Incumbency	0.3030***	0.3034***	0.3060***	0.2648***	0.2624***
	(0.0311)	(0.0312)	(0.0319)	(0.0322)	(0.0322)
Incumbency × Post-shock	-0.0138	-0.0149	-0.0158	-0.0064	-0.0045
	(0.0313)	(0.0314)	(0.0321)	(0.0323)	(0.0323)
Incumbency × ΔA_r^{soy}	-0.0221	-0.0225	-0.0232	-0.0243	-0.0233
	(0.0158)	(0.0158)	(0.0162)	(0.0163)	(0.0163)
Post-shock × ΔA_r^{soy}	-0.0051	-0.0082*	-0.0031	0.0018	-0.0002
	(0.0044)	(0.0045)	(0.0057)	(0.0054)	(0.0055)
Incumbency × Post-shock × ΔA_r^{soy}	0.0336**	0.0343**	0.0350**	0.0336**	0.0321*
	(0.0160)	(0.0161)	(0.0164)	(0.0166)	(0.0165)
Municipality fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓
State-Year fixed effects		✓	✓	✓	✓
Microregion-Year fixed effects			✓	✓	✓
Party-Year fixed effects				✓	✓
Controls					✓
Observations	68,832	68,832	68,832	68,832	68,361
R^2	0.110	0.111	0.116	0.142	0.146

Notes: Unit of analysis is a candidate j in municipality r and election t. Standard errors (in parentheses) are adjusted for 555 microregion clusters. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure A.11: Dynamic Effects of Soy Potential Yield — Excluding Municipalities With Term-Limited Incumbents



Each point represents a regression coefficient ($\hat{\beta}$) from estimating Equation (10). The dependent variables are the probability of victory of candidate j in municipality r in each election $t = 2000, \ldots, 2020$. All regressions include municipality and year fixed effects. Standard errors are clustered at the microregion level (555 clusters).

Table A.8: Potential Soy Yield and Electoral Victory DiD — Probit, Excluding Municipalities With Term-Limited Incumbents

Dependent variable:	**Prob. Victory**				
	(1)	(2)	(3)	(4)	(5)
Incumbency	0.8001***	0.8016***	0.8124***	0.7046***	0.7057***
	(0.0848)	(0.0853)	(0.0876)	(0.0898)	(0.0899)
Incumbency × Post-shock	-0.0265	-0.0302	-0.0324	-0.0127	-0.0015
	(0.0853)	(0.0858)	(0.0881)	(0.0901)	(0.0902)
Incumbency × ΔA_r^{soy}	-0.0578	-0.0587	-0.0611	-0.0643	-0.0611
	(0.0430)	(0.0432)	(0.0443)	(0.0456)	(0.0455)
Post-shock × ΔA_r^{soy}	-0.0154	-0.0239*	-0.0132	0.0013	-0.0020
	(0.0130)	(0.0133)	(0.0164)	(0.0162)	(0.0168)
Incumbency × Post-shock × ΔA_r^{soy}	0.0906**	0.0924**	0.0954**	0.0914**	0.0870*
	(0.0436)	(0.0437)	(0.0449)	(0.0463)	(0.0461)
Municipality fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓
State-Year fixed effects		✓	✓	✓	✓
Microregion-Year fixed effects			✓	✓	✓
Party-Year fixed effects				✓	✓
Controls					✓
Observations	68,829	68,829	68,826	68,193	67,719
Pseudo R^2	0.086	0.086	0.090	0.114	0.119

Notes: Unit of analysis is a candidate j in municipality r and election t. Standard errors (in parentheses) are adjusted for 555 microregion clusters and observations are weighted by valid votes. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A.7 Party Incumbency

In Table A.9, we evaluate the existence of a *party* incumbency advantage (that is, whether another candidate *of the same party* won an election at $t-1$). As De Magalhães (2015) shows, this measure is not directly comparable to our original (individual) incumbency measure, at least not in a country with weak parties and widespread party switching like Brazil. Unsurprisingly, our results are not robust to the use of this measure, indicating that only individual candidates — not their parties — benefit from the incumbency advantage conferred by the productivity shock.

Table A.9: Potential Soy Yield and Electoral Victory DiD — Party Incumbency

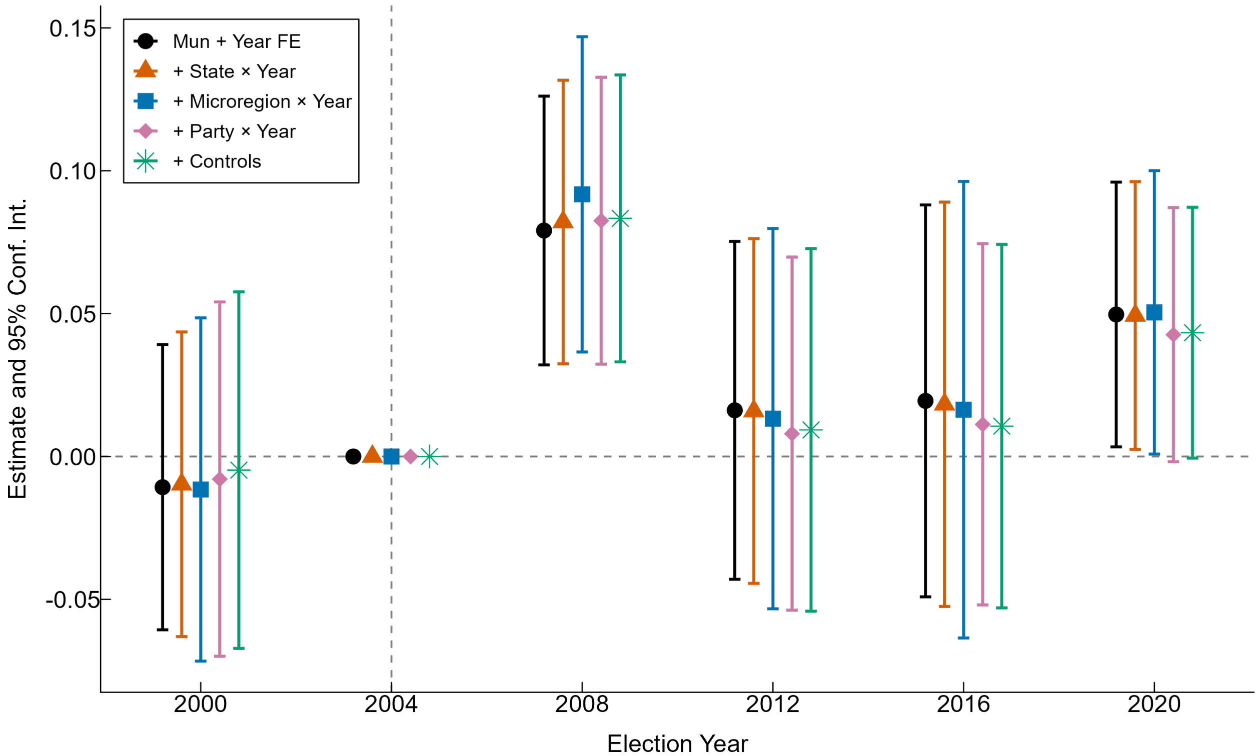
Dependent variable:	**Prob. Victory**				
	(1)	(2)	(3)	(4)	(5)
Party Incumbency	0.2117***	0.2141***	0.2167***	0.1730***	0.1729***
	(0.0285)	(0.0287)	(0.0294)	(0.0299)	(0.0302)
Party Incumbency × Post-shock	-0.0268	-0.0291	-0.0305	-0.0162	-0.0185
	(0.0294)	(0.0296)	(0.0303)	(0.0306)	(0.0307)
Party Incumbency × ΔA_r^{soy}	-0.0037	-0.0035	-0.0039	-0.0047	-0.0052
	(0.0150)	(0.0150)	(0.0154)	(0.0156)	(0.0156)
Post-shock × ΔA_r^{soy}	0.0007	-0.0003	0.0012	0.0062	0.0037
	(0.0045)	(0.0045)	(0.0057)	(0.0055)	(0.0056)
Party Incumbency × Post-shock × ΔA_r^{soy}	0.0108	0.0104	0.0106	0.0107	0.0117
	(0.0157)	(0.0157)	(0.0161)	(0.0163)	(0.0162)
Municipality fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓
State-Year fixed effects		✓	✓	✓	✓
Microregion-Year fixed effects			✓	✓	✓
Party-Year fixed effects				✓	✓
Controls					✓
Observations	90,926	90,926	90,926	90,926	90,334
R^2	0.065	0.06	0.069	0.103	0.107

Notes: Unit of analysis is a candidate j in municipality r and election t. Standard errors (in parentheses) are adjusted for 555 microregion clusters. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A.8 Weighted Event-Study

Figure A.12 re-estimates the original event-study results of Figure 3, weighting them by valid votes.

Figure A.12: Dynamic Effects of Soy Potential Yield (Weighted)



Each point represents a regression coefficient ($\hat{\beta}$) from estimating Equation (10). The dependent variables are the probability of victory of candidate j in municipality r in each election $t = 2000, \ldots, 2020$. All regressions include municipality and year fixed effects. Standard errors are clustered at the microregion level (555 clusters) and observations are weighted by valid votes.

A.9 Mechanism and Interpretation

We present evidence consistent with an income-based channel rather than incumbent policy. Municipalities with higher ΔA_r^{soy} experienced persistent increases in GDP per capita relative to less exposed areas (Figure 1). Parallel event studies using RAIS outcomes — average formal wages and the per capita formal wage bill — display similar dynamics (Appendix Figures A.9 and A.10).

A potential alternative mechanism is that these income gains translated into higher municipal revenues, enabling incumbents to expand public spending and thereby increase their electoral appeal. While Brazilian municipalities manage portions of service provision in education, health, and basic infrastructure, their fiscal autonomy is limited. Own-source revenues are modest, and intergovernmental transfers from state and federal governments account for the bulk of local budgets. Nevertheless, if soy-driven income gains disproportionately increased fiscal capacity in more exposed municipalities, incumbents might have benefited from improved public-good provision rather than from voters' misattribution of income shocks.

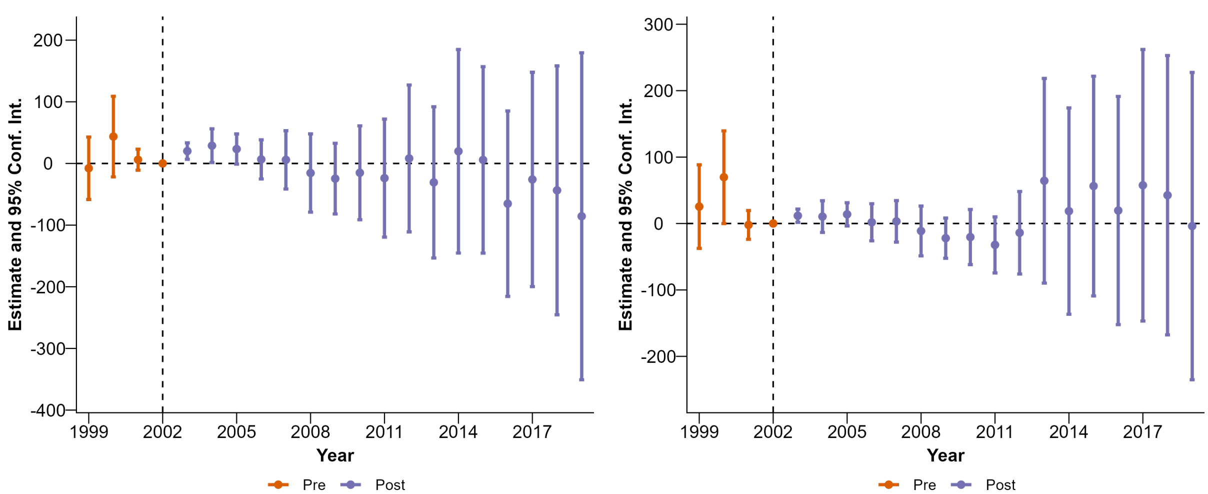
To assess this possibility, we estimate event-study specifications for per capita municipal government *revenues* and *expenditures*, analogous to Equation (12):

$$Revpc_{r,t} = \sum_{t \neq 2002} \mathbb{I}\{\tau = t\}\, \beta_t\, \Delta A_r^{soy} + \mu_r + \gamma_t + \delta_{s,t} + \varepsilon_{r,t} \tag{14}$$

$$Exppc_{r,t} = \sum_{t \neq 2002} \mathbb{I}\{\tau = t\}\, \theta_t\, \Delta A_r^{soy} + \mu_r + \gamma_t + \delta_{s,t} + \varepsilon_{r,t} \tag{15}$$

The results, reported in Figure A.13, show no systematic differences. Across specifications with municipality and year fixed effects, microregion–year interactions, and clustering at the microregion level, the coefficients on ΔA_r^{soy} remain close to zero and statistically indistinguishable from zero. There are minor positive movements up to 2005, but no discernible effects thereafter. The absence of a fiscal response in more exposed municipalities weighs against an incumbent-policy mechanism based on public-good provision or budgetary expansion.

Figure A.13: Dynamic Effects of the Soy Shock on Municipality Revenue and Expenditures per Capita



(a) Government Revenue per Capita

(b) Government Spending per Capita

This figure shows the dynamic effects of ΔA_r^{soy} on municipal revenues and expenditures per capita. Vertical bars represent 95% confidence intervals. The dotted vertical line indicates 2002, the year preceding the legalization of GE soybean seeds. Specifications include municipality and year fixed effects, microregion–year interactions, and standard errors clustered at the microregion level (555 clusters). Panel (a) presents unweighted estimates, whereas Panel (b) applies population weights.

Lastly, we complement the mechanism analysis by examining long differences in the municipal Human Development Index (HDI) between 2000 and 2010. The indexes are drawn from the *Atlas do Desenvolvimento Humano*, which relies on microdata from the

Brazilian decennial population census. Because microdata for the most recent census are not yet available, our analysis is restricted to earlier years and is therefore less informative about subsequent dynamics. Table A.10 reports the estimates. Columns (1) and (2) present the results for overall HDI, with the latter incorporating population weights. The subsequent columns report results for the three HDI components — longevity, education, and income — again showing unweighted and weighted specifications side by side. We find that more exposed areas display a small relative decline in overall HDI compared to less exposed localities. The magnitude is limited, but the decomposition shows no systematic effect on the income component, while the education and longevity components are modestly negative. This pattern is consistent with an income-driven channel operating through temporary gains rather than improvements in public-service outcomes, and it further weighs against an incumbent-policy mechanism based on expanded local provision.

Table A.10: Soy and HDI

Dependent variable.:	**Δ HDI**		**Δ HDI Longevity**		**Δ HDI Education**		**Δ HDI Income**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔA_r^{soy}	-0.0045***	-0.0060***	-0.0017**	-0.0026**	-0.0061***	-0.0078***	-0.0011	-0.0017*
	(0.0009)	(0.0016)	(0.0008)	(0.0010)	(0.0013)	(0.0025)	(0.0009)	(0.0010)
Weighted		✓		✓		✓		✓
State fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Observations	4,255	4,255	4,255	4,255	4,255	4,255	4,255	4,255
R^2	0.564	0.605	0.411	0.502	0.453	0.513	0.200	0.399

Notes: Unit of analysis r is a municipality. Standard errors (in parentheses) are adjusted for 555 microregion clusters. In columns 2, 4, and 6 observations are weighted by the population. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Taken together, these findings point to a clear interpretation: exogenous income gains temporarily boosted support for incumbents, but the effect is not mediated by local government spending or improvements in public-good provision. Instead, the evidence aligns with an income-driven channel consistent with voters' short-term attribution of economic gains.