Institutions Across Domains: Essays on Democracy, Deforestation, and Monetary Policy

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Dedication

To Pilar, Henry, Natalia, Pedro, Alicia, and Stefanie. Without your support and encouragement, this would have never been possible.

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Contents

1. General introduction

This dissertation comprises three essays that examine problems related to deforestation and conflict, monetary policy, and democratic institutions. Each essay is a self-contained study with an independent topic; however, the unifying theme across the dissertation is the analysis of institutions and the ways in which they can influence policy outcomes. Defined as human-devised constraints that structure human behavior—through formal rules embedded in legal frameworks or informal mechanisms such as traditions, customs, and codes of conduct—institutions are the distinctive feature across these three essays, shaping political, economic, and social interactions (North, 1991).

The first essay investigates the effect of Colombia's 2016 peace agreement with FARC on deforestation. The peace agreement resulted in an institutional framework consisting of laws and decrees that specified the commitments of both the government and the FARC to end hostilities. Among these commitments was the relocation of FARC combatants into designated areas to undergo disarmament and reintegration into civilian life. This process led to the withdrawal of FARC forces from municipalities where they had previously exercised influence and control. Using Synthetic Control Methods, the study finds that deforestation increased in these municipalities, particularly when other armed groups—such as paramilitaries and the ELN—were present in nearby areas. In contrast, municipalities where the FARC had been the sole armed group in the vicinity exhibit no significant change in deforestation dynamics. Qualitative evidence indicates that the FARC used forest cover for strategic military purposes, which inadvertently provided protection against deforestation. These results suggest that the FARC's disarmament removed this form of protection and created local power vacuums that were rapidly exploited by nearby armed actors, who mobilized into these municipalities to exert control and engage in deforestation-related economic activities.

The second essay analyzes the effect of inflation targeting on inflation levels. Since the 1990s, inflation targeting has become a popular institutional framework that explicitly identifies price stability as the primary objective of monetary policy. However, existing empirical evidence on its effects on inflation after adoption remains mixed and inconclusive, largely due to differences in samples, time periods, and identification strategies. To provide broader and more systematic

evidence, this study uses the largest possible sample and applies Synthetic Control Methods to estimate the effect of inflation targeting on inflation for each adopting country. The results show some heterogeneity across countries, but inflation targeting most commonly leads to a significant reduction in inflation after adoption. On average, countries experience a 2.8 percentage point decline in annual inflation five years after implementation.

The third essay compares the effectiveness of institutions in Athenian and representative democracies in delivering policies aligned with citizens' preferences. By integrating both democracies into a principal–agent framework, the study shows that the formal institutions of Athens ensured that implemented policies were aligned with the citizenry, whereas in representative democracies policies tend to align with the preferences of elected representatives. To achieve policy outcomes consistent with citizens' preferences, representative democracies must also rely on informal institutions—such as norms, values, and codes of conduct—which encourage elected officials to value the act of representation and to implement policies that more closely reflect citizens' preferences.

Together, the three essays illustrate the central role of institutions—formal and informal, historical and contemporary—in shaping behavior, influencing policy outcomes, and structuring the economic, social, and political landscapes in which individuals and governments operate.

2. Colombia's Peace Process and its Impact on Deforestation: A Synthetic Control Study

Abstract

This study examines the effect of Colombia's peace agreement with FARC guerrillas on deforestation. Using Synthetic Control Methods, I analyze deforestation trends in Colombia and its municipalities relative to other countries in the region from 2000 to 2021. The findings show that deforestation accelerated after the peace agreement, with increases concentrated in former FARC-controlled areas after the 2017 disarmament. The effect is strongest in municipalities where other armed groups, such as the ELN or paramilitaries, were nearby. In contrast, areas controlled solely by FARC or without any armed groups did not show significant changes in deforestation trends. Results suggest that the FARC's disarmament created a power vacuum exploited by nearby armed groups, who initiated deforestation-related economic activities.

2.1 Introduction

Deforestation is a global issue with significant welfare implications. It reduces the capacity of forests to absorb CO_2 and regulate the earth's climate (Pan et al., 2011; Bonan, 2008). It also disrupts hydrologic cycles, threatening ecosystem services and natural capital (Ellison et al., 2017; Costanza et al., 1997). Moreover, deforestation harms human livelihoods, particularly for those in poverty who depend on forests for subsistence and economic activities (Sunderlin et al., 2005). Despite global efforts to reduce deforestation rates, substantial forest cover has still been lost. Globally, between 1990 and 2020, approximately 1.78 million km^2 of forest area—equivalent to the size of Libya—was lost (FAO, 2020).

Colombia, like many other countries, has experienced a similar trend in deforestation. Since 2000, it has lost a gross area of 48,032 km^2, comparable to the size of Slovakia. However, Colombia also faces the unique challenge of complex conflict dynamics, which further contribute to deforestation (The International Crisis Group, 2021).

The country has endured a long-lasting conflict with various armed groups, including the Revolutionary Armed Forces of Colombia (FARC), since the 1960s. This conflict has caused significant human suffering. Between 1958 and 2018, an estimated 450,000 people were killed, around 7 million were displaced, and there were numerous cases of kidnapping and landmine casualties (Comisión de la Verdad, 2022).

A major milestone in Colombia's conflict history was the peace process with FARC. It began with a permanent cease-fire in 2014 and culminated in the signing of peace agreements in the second semester of 2016. As a result, after 2017, around 13,000 FARC combatants were disarmed (UN Verification Mission in Colombia, 2022).

This achievement has positively impacted the welfare of territories previously under FARC control. Studies report improvements in several socio-economic indicators. For example, there has been a slowing of the decline in fertility rates (Guerra-Cujar et al., 2023). Education outcomes have also improved, with reduced dropout rates, lower grade failure rates, higher graduation rates, and better math and reading scores (Prem et al., 2023b). Additionally, there has been higher firm entry and more employment opportunities (Bernal et al., 2024). Finally, landmine explosions and victims have decreased (Perilla et al., 2024).

However, the peace process has also generated unintended consequences. One such consequence is the increase in killings of social leaders (Prem et al., 2022) and the rise in coca crop cultivation (Prem et al., 2023a). Most relevant to this study, the peace agreements have also led to an increase in deforestation in municipalities previously controlled by FARC (Prem et al., 2020).

Building on the observed increase in deforestation, this paper explores the relationship between the Colombian peace agreement and deforestation in greater depth. It estimates the countrywide effects of the peace agreement on deforestation trends and decomposes these effects at the municipal level according to each municipality's exposure to armed groups before the ceasefire. It employs the Synthetic Control Method (SCM) for the period 2000–2021, using the 2014 ceasefire as the treatment date, and deforestation data of counties in South America and Panama (Abadie and Gardeazabal, 2003) [1]

[1]Using Colombian municipalities to estimate the effects risks including treated units in the control group. This could occur if, for instance, peace agreement effects influenced deforestation dynamics across every municipality in the country. By estimating the effects using Panama and South American countries, the study ensures that controls remain

This study finds that after the 2014 ceasefire, a significant nationwide increase in deforestation followed the 2017 FARC disarmament. It then shows that this increase in deforestation stems mainly from municipalities where FARC was present before the peace agreement. In particular, deforestation rose in municipalities where FARC and other groups—such as paramilitaries and the ELN—were present, while no significant changes in deforestation trends were identified for municipalities where FARC was the only armed group.

These findings are in line with qualitative evidence showing that, following the 2017 disarmament of FARC, territories formerly under guerrilla control were rapidly occupied by other armed groups. FARC had typically restricted deforestation in the areas where it operated, using forest cover for strategic purposes, and its disarmament removed this unintended protection (The International Crisis Group, 2021). However, territorial expansion creates additional logistical challenges and costs. Armed groups must allocate more resources to secure these territories, including the mobilization of militants. Consequently, after demobilization, armed groups located near these municipalities were able to establish control and engage in deforestation-related economic activities more easily than in municipalities farther away where only FARC had been present (Mueller et al., 2019).

The relationship between conflict and deforestation dynamics remains inconclusive, as different patterns may emerge depending on the context, institutional settings, and the incentives actors may face when engaging in deforestation-related activities (Shapiro et al., 2021; Butsic et al., 2015; Grima and Singh, 2019; Burgess et al., 2015). This paper makes two distinct contributions to the literature on conflict and deforestation within the Colombian context. First, it provides a broader perspective on conflict–deforestation dynamics by estimating a positive effect of the peace agreement on Colombia's deforestation trends at the national level. This finding complements previous studies that document a positive relationship within the country at the municipal level (Prem et al., 2020; Clerici et al., 2020; Murillo-Sandoval et al., 2020).

Second, by decomposing the nationwide effect into Colombian municipalities, this paper links national and subnational dynamics. It identifies the areas across the country where deforestation has significantly increased, depending on exposure to armed groups. Thus, it complements studies that link deforestation trends to particular armed groups in Colombia— for instance, Vargas et al. (2014) finding increases in deforestation associated with paramilitary activity, or Cantillo and Garza (2022) associating lower deforestation rates with areas where guerrillas are present compared to areas where paramilitaries operate. Moreover, by showing that deforestation increases only in territories exposed to both FARC and other armed groups, with no significant effect in areas controlled solely by FARC, this paper extends the results of Prem et al. (2020).

unaffected by the peace agreement, producing more reliable estimates.

The remainder of this paper is organized as follows. Section 2.2 provides context on Colombia's long-standing conflict and the socio-economic and political factors contributing to deforestation. Section 2.3 describes the data used, including deforestation metrics and exposure to armed groups. Section 2.4 explains the SCM as an identification strategy and details its application in this study. Section 2.5 presents the results, including estimates of deforestation in Colombia and its territories. Finally, Section 2.6 concludes and offers directions for future research.

2.2 Context of the Colombian conflict

Colombia has experienced a 60-year-long conflict where guerrilla movements, including FARC and ELN, were driven by a complex interplay of sociopolitical and economic factors. One primary motivator for these groups was the pervasive socioeconomic disparities, particularly in rural areas. Land inequality, limited access to resources, and inadequate agrarian reforms fueled discontent among marginalized communities. This discontent prompted some to take up arms.

In this complex scenario, during the 1980s and 1990s, paramilitary groups emerged with ties to local elites, landowners, and business interest groups. Their formation was driven by the growing influence and territorial expansion of guerrilla movements and by the Colombian state's limited capacity to exert control. Additionally, drug trafficking became a major source of funding for both guerrilla groups and paramilitary organizations. This created intense competition for control over key regions, which further intensified the conflict among the Colombian government, guerrillas, and paramilitaries (National Center for Historical Memory, 2013).

The Colombian conflict has caused severe humanitarian consequences, with 450,664 deaths between 1985 and 2018—mostly attributed to paramilitaries and guerrillas—along with 121,768 forced disappearances, 50,770 kidnappings, and 16,238 cases of child recruitment. Additionally, 7.7 million people were forcibly displaced, particularly between 1995 and 2002, and widespread human rights violations occurred, including sexual violence, torture, extortion, and attacks on protected property (Comisión de la Verdad, 2022) [2].

To end the conflict, the Colombian government and FARC initiated peace negotiations in 2012. A major milestone was achieved in December 2014 with the establishment of a permanent ceasefire, which significantly de-escalated the violence between both parties (CERAC, 2016). In November 2016, the peace agreement was signed. Beginning in 2017, FARC ex-combatants were relocated to

[2] See: https://web.comisiondelaverdad.co/actualidad/noticias/principales-cifras-comision-de-la-verdad-informe-final

Transitory Zones for Normalization (ZVTN) to undergo disarmament and reintegration into civilian life.

After the peace agreement in Colombia, territories formerly controlled by FARC experienced significant changes in control and increased instability due to the emergence and expansion of various armed groups (Fundación Ideas para la Paz, 2017). The withdrawal of FARC created a power vacuum that was quickly filled by other actors, including the ELN, paramilitary groups, and FARC dissidents who rejected the peace deal. These groups expanded their influence in strategic areas, creating a complex new security landscape. This shift in conflict dynamics has led to increased violence and competition for control over resources and territories, which has affected local communities and, among other things, increased deforestation.

2.3 Data

To explore and evaluate the causal relationship between conflict dynamics and deforestation in Colombian territories, this paper uses two datasets. The first provides data on the presence of armed groups in Colombian municipalities before the 2014 cease-fire. The second contains deforestation data for South America and Panama. These datasets are merged to construct a panel covering the period from 2000 to 2021.

This paper follows other studies that use violent events as indicators of armed group influence or control in Colombian territories (Acemoglu et al., 2013; Ch et al., 2018; Prem et al., 2020, 2022). Assessing the presence and influence of armed groups in a given area is complex, as these organizations may exert influence without the use of violence, or violent acts may not always directly indicate territorial control. Nevertheless, non-violent dominance and presence may result from past acts of violence that established a group's authority.

To identify Colombian municipalities exposed to different armed groups before the ceasefire based on violent events, this paper uses data from Restrepo et al. (2004). The dataset draws on reports from Noche y Niebla, an NGO run by the Centro de Investigación y Educación Popular (CINEP), providing detailed records of violent events. These records include the date, location, perpetrators (FARC, ELN, paramilitaries), type of event (e.g., attack or clash), and outcomes such as deaths and injuries. The original dataset covers 1999–2012, but was updated by the Universidad del Rosario through 2014.

The exposure to armed groups follows Prem et al. (2020) and Prem et al. (2022). A dummy variable equals 1 for municipalities where at least one violent event attributed to FARC occurred

between 2011 and 2014. For exposure to other armed groups, a dummy variable is set to 1 if, during the same period, a violent event involving other armed groups occurred within the municipality or in a neighboring municipality. A value of 0 indicates that neither the municipality nor its neighbors experienced violent attacks from other armed groups.

Using this coding, municipalities are first divided into two main groups: (1) those with FARC presence and (2) those without it. Each group is then subdivided into five categories: (1) municipalities with both ELN and paramilitary presence, (2) municipalities with only ELN presence, (3) municipalities with only paramilitary presence, (4) municipalities with ELN or paramilitary presence, and (5) municipalities without either ELN or paramilitary presence. Table 2.1 shows that, of the 1,122 municipalities, 129 registered at least one FARC attack during the 2011–2014 period. Among these, 19 municipalities experienced attacks exclusively by FARC, while the remaining 110 also registered attacks by either paramilitary groups or the ELN.[3]

Deforestation data is obtained from the Global Forest Change dataset Hansen et al. (2013). This dataset uses satellite imagery to analyze tree cover, forest loss, and forest gain over time. It employs algorithms that distinguish between different types of land cover changes, providing a detailed temporal analysis of global forest dynamics.[4]

The variables of interest extracted from this dataset are: (1) tree canopy cover for the year 2000, measured as the area in km^2 of canopy closure for vegetation over 5 meters tall within a defined area, and (2) the year of forest cover loss, which measures, for each year, the area in km^2 that transitioned from forest to non-forest in locations previously classified as forested in the 2000 canopy cover data.[5]

These variables are conditioned on the geographic area of interest. For Panama and South American countries other than Colombia, both variables are downloaded using national boundary maps, while for Colombia they are obtained at the municipal level. Additionally, for Colombian municipalities, the data is aggregated by summing tree canopy cover for the year 2000 and annual forest cover loss for each year within each of the exposure groups described above.

In this paper, deforestation is measured using three indicators for each area of interest:

- **Percentage Cover Loss in Year** t: This indicator calculates the percentage of forest cover

[3]This paper uses the 2021 municipal coding, which consists of 1,103 municipalities and 18 non-municipal areas. Between 2000 and 2020, the total number of municipalities and non-municipal areas increased from 1,116 to 1,122.

[4]Data was downloaded using the R package *gfcanalysis*. For more information, see https://cran.r-project.org/web/packages/gfcanalysis/gfcanalysis.pdf

[5]A description of the data can be found at https://data.globalforestwatch.org/documents/941f17325a494ed78c4817f9bb20f33a/explore.

Municipal exposure to armed groups
2011-2014

Exposure category	Municipalities
FARC present	
ELN or paramilitaries	110
ELN and paramilitaries	32
ELN	6
Paramilitaries	72
Neither ELN nor paramilitaries (only FARC)	19
Total FARC present	129
No FARC present	
ELN or paramilitaries	454
ELN and paramilitaries	80
ELN	33
Paramilitaries	341
Neither ELN nor paramilitaries (No armed group)	539
Total without FARC	993
Total municipalities	1,122

Table 2.1: This table reports the number of municipalities by armed group exposure. Municipalities are first classified by the presence of FARC and subsequently by exposure to ELN and/or paramilitary groups.

lost in year t by dividing the forest cover loss area in year t by the total tree canopy cover in 2000. It is represented by the following formula:

$$y_{t,\mathrm{p}} = \frac{Cover\ loss_t}{Canopy_{2000}} \times 100$$

- **Cumulative Percentage Cover Loss up to Year** t: This indicator measures the cumulative percentage of forest cover lost up to year t. It sums forest cover loss areas from 2000 to year t and divides by the total tree canopy in 2000. Thus, it is equivalent to adding the percentage cover loss for each year up to year t. It is represented by the following formula:

$$y_{t,\mathrm{c}} = \frac{\sum_{\hat{t}=2000}^{t} Cover\ loss_{\hat{t}}}{Canopy_{2000}} \times 100 = \sum_{\hat{t}=2000}^{t} y_{\hat{t},\mathrm{p}}$$

- **Average Percentage Cover Loss**: This indicator calculates the average yearly percentage cover loss, $Y_{t,\mathrm{p}}$, between periods t_1 and t_2, where $t_1 < t_2$. It is represented by the following formula:

$$\bar{y}_{t_1,t_2} = \frac{\sum_{\hat{t}=t_1}^{t_2} y_{\hat{t},\mathrm{p}}}{t_2 - t_1 + 1}$$

Change in Average Percentage Cover Loss in South America, 2011–2014 to 2015–2021

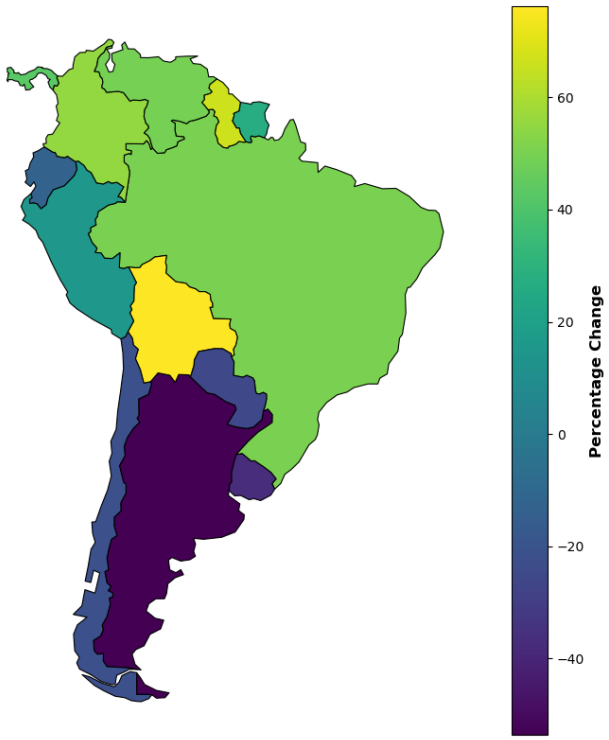
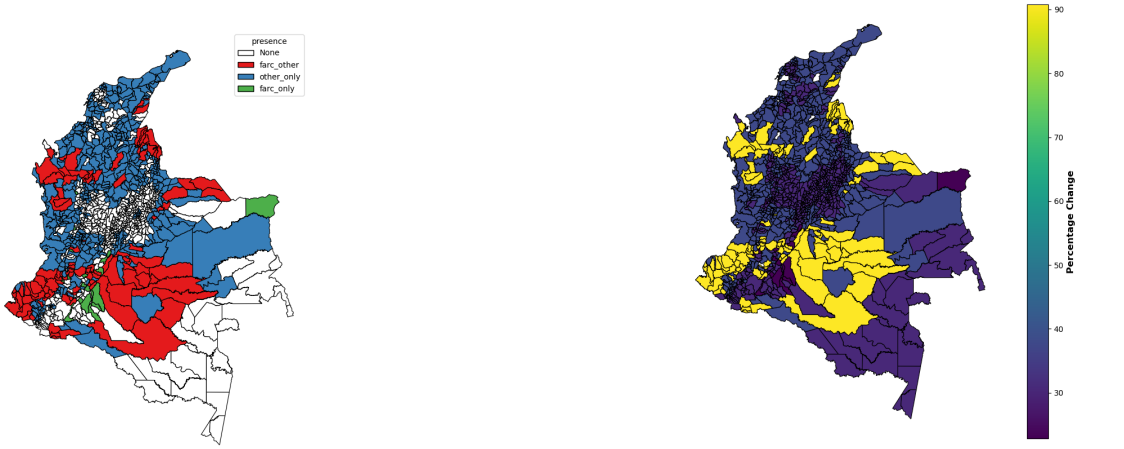


Figure 2.1: The figure shows the relationship between the average percentage cover loss for the pre-ceasefire period (2011–2014) and the post-ceasefire period (2015–2021) for South American countries and Panama. The values are calculated as the percentage difference between $\bar{y}_{2015,2021}$ and $\bar{y}_{2011,2014}$ for each country. This reflects the relative change in deforestation rates across the two periods.

A first glance at the data reveals that deforestation increased in Colombia after the 2014 ceasefire but remained within the range observed in other South American countries, as shown in Figure 2.1. Colombia stands out with one of the largest rises, as average percentage cover loss grew by 55.2% between 2015–2021 and 2011–2014. However, Colombia is not the country with the highest increase. Bolivia leads with a 76.2% rise, followed by Guyana at 66.3%, while Colombia ranks third, slightly ahead of Brazil at 50.1%. On the other hand, non-Amazonian countries such as Argentina saw a 53.6% decrease in average percentage cover loss between 2015–2021 and 2011–2014, followed by Uruguay with a 37.2% reduction and Paraguay with 25.7%. This shows that Colombia is not alone in facing rising cover loss but follows a broader deforestation pattern among forest-rich countries in the region.

Spatial Distribution of Armed Groups and Tree Canopy Cover Loss



(a) Armed groups spatial distribution

(b) 2011-2014 vs 2015-2021 change in average percentage cover loss

Figure 2.2: This figure compares changes in average percentage cover loss between 2011–2014 and 2015–2021 with the spatial distribution of armed groups in Colombian municipalities for 2011–2014. It allows for observing how deforestation trends changed in relation to the presence of armed groups across municipalities.

This increase in average percentage cover loss nationwide is further decomposed within Colombian municipalities and its relationship to armed group distribution during 2011–2014 (Figure 2.2). Panel (a) shows the exposure to armed groups across the country, displaying municipalities without exposure to any armed group, those exposed to both FARC and other armed groups, those exposed only to other armed groups, and those exposed solely to FARC. On the other hand, Panel (b) shows the percentage change in average cover loss for 2015–2021 compared to 2011–2014, based on these armed group distributions.

The rise in deforestation is mainly concentrated in municipalities with both FARC and other armed groups, while areas with only FARC presence show the smallest increases. The figure shows that municipalities with both FARC and other armed groups experienced the highest increase, at 90.8%. Municipalities exposed only to other armed groups saw a 37.8% rise. Those without exposure to armed groups had a 30.3% increase, while municipalities with only FARC presence had the lowest, at 22.8%.

2.4 Identification Strategy

This study uses an identification strategy based on the SCM developed by Abadie and Gardeazabal (2003) and Abadie et al. (2010). It constructs a counterfactual trajectory of deforestation in Colombia under the hypothetical scenario in which no peace agreement with FARC occurred. This counterfactual is constructed as a weighted combination of deforestation data from Panama and other countries in South America, where higher weights are assigned to countries whose deforestation dynamics more closely resemble Colombia's before the 2014 ceasefire.

The analysis covers the period 2000–2021. Formally, consider a sample of $J+1$ units. The treated unit, $j=1$, corresponds to Colombia or its areas grouped by the presence of armed groups. The untreated units—also denoted as control group or donors—$j \neq 1$, correspond to Panama and the other countries in South America. The timeline is divided into two periods, with 2014 marking the ceasefire with FARC. Thus, there are T periods, with the treatment event occurring in period T_0. Pre-intervention periods are $t = 1, \ldots, T_0$, while post-intervention periods are $t = T_0+1, \ldots, T$.

In this paper, the outcome variable is the cumulative percentage cover loss up to year t, $y_{jt,\mathrm{c}}$. A synthetic control is constructed from a vector of positive weights that sum to one, $W^* = (w_2^*, \ldots, w_{J+1}^*)$. These weights satisfy $W^* = \operatorname{argmin}\left(\sum_{m=1}^{k} v_m (Y_{1m} - Y_{0m}W)^2\right)$ for the pre-intervention periods. Here, Y_1 is a $T_0 \times 1$ vector of with the pre-intervention outcome of the treated unit. Y_0 is a $T_0 \times J$ matrix containing the outcome for the control group. The term v_m is a weight that reflects the relative importance of the m-th variable when measuring the discrepancy between Y_1 and $Y_0 W$.

The synthetic control for $y_{1t,\mathrm{c}}$ is computed as $\hat{y}_{1t,\mathrm{c}} = \sum_{j=1}^{J} w_j^* y_{jt,\mathrm{c}}$. The treatment effect is defined as $\alpha_{1t} = y_{1t,\mathrm{c}} - \hat{y}_{1t,\mathrm{c}}, \quad t > T_0$. For confidence in the estimated outcomes, this paper follows Cattaneo et al. (2021). This work addresses uncertainty quantification in the SCM framework, providing conditional prediction intervals for the estimated synthetic control.[6]

Deforestation data is obtained from the Global Forest Change satellite dataset (Hansen et al., 2013). To estimate the effects on deforestation trends in Colombia and its municipalities, the study uses South American countries and Panama as controls. Additionally, it examines municipal-level effects based on exposure to FARC and other armed groups. For this purpose, the paper follows the criteria of Prem et al. (2022), which rely on recorded instances of violent attacks between 2011 and

[6]This paper uses the statistical software described in Cattaneo et al. (2024), which supports Python, R, and Stata implementations. Additional documentation is available at https://nppackages.github.io/scpi/. Prediction intervals are constructed using sub-Gaussian bounds.

2014 as indicators of armed group presence and influence.

2.5 Results

2.5.1 Deforestation in Colombia

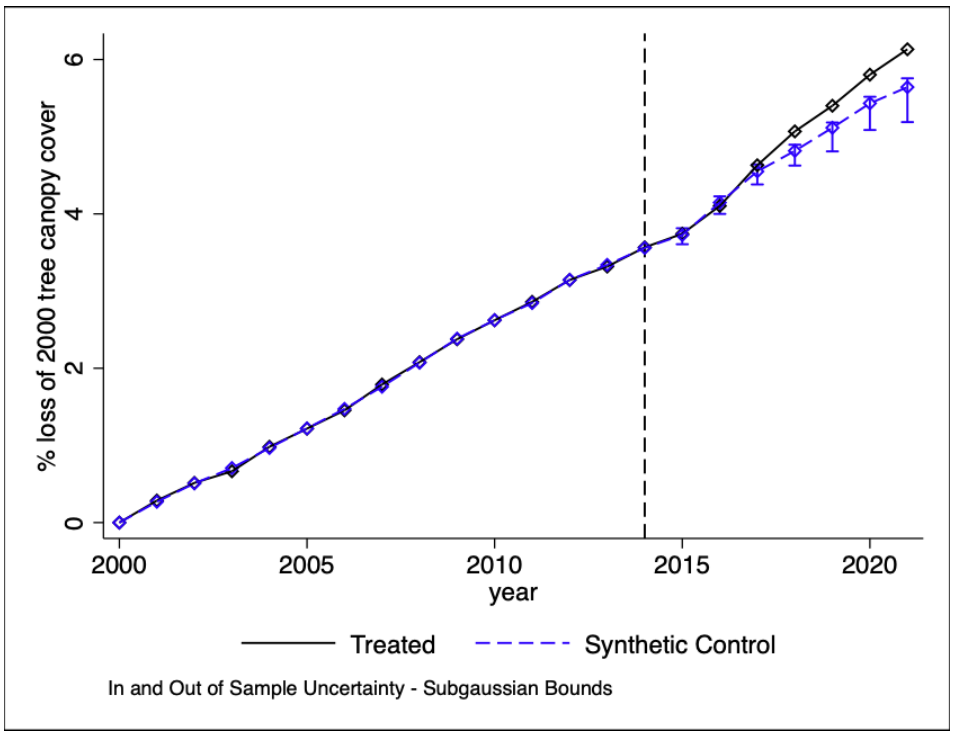


Figure 2.3: The figure shows the impact of the 2014 ceasefire on Colombia's cumulative percentage cover loss, $Y_{t,c}$, across the entire country. The 90% prediction intervals are generated using the approaches of Cattaneo et al. (2021) and Cattaneo et al. (2024). These intervals account for both in-sample and out-of-sample uncertainty. The latter is estimated using sub-Gaussian bounds.

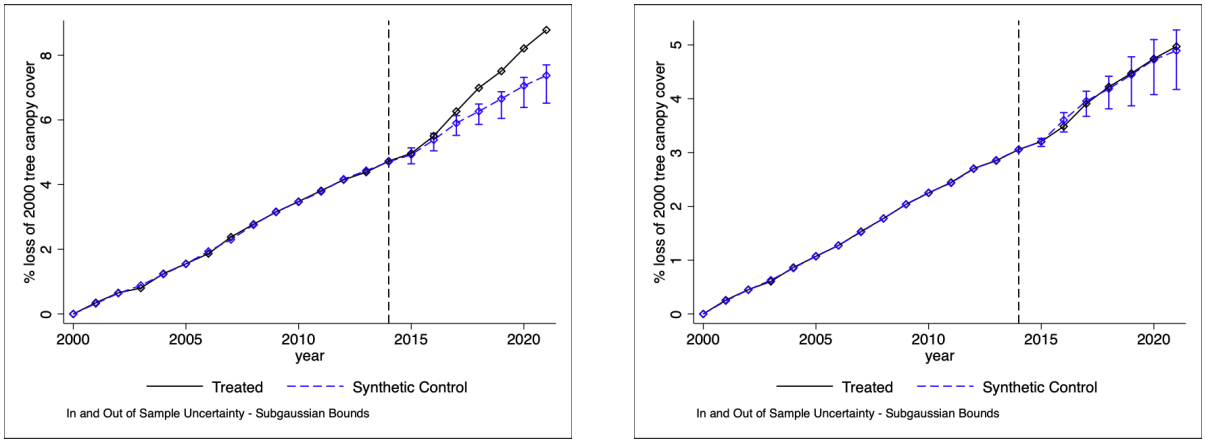
Figure 2.3 shows Colombia's cumulative percentage loss of 2000 tree canopy cover compared to its synthetic control. The plot is divided into pre-treatment years (2000–2014), where weights are assigned to match the treated unit, and post-treatment years (2015–2021). In this latter period, causal effects are estimated as the difference between the treated unit and its synthetic control.

In the pre-treatment period, the synthetic control aligns closely with the treated unit, indicating a strong fit. By 2014, Colombia's cumulative cover loss reached 3.7% and rose to 6.1% by 2021. In

contrast, the synthetic control's cumulative loss was 5.6% in 2021. The prediction intervals do not overlap with the treated outcome, suggesting a statistically significant effect. Importantly, the trends begin to diverge in 2017, the year of FARC's disarmament. This divergence is associated with an estimated effect, α_{1t}, of an additional 0.49% cumulative cover loss by 2021. Thus, deforestation appears to have increased nationwide as a result of the peace process with FARC.

2.5.2 Deforestation in municipalities with and without FARC presence

Deforestation in Colombian municipalities according to FARC exposure



(a) With FARC (b) Without FARC

Figure 2.4: The figures show the impact of the 2014 ceasefire on Colombia's cumulative percentage cover loss, $Y_{t,c}$. They separate municipalities with FARC attacks during 2011–2014 from those without such attacks in the same period.

Given the country-wide effect identified in Colombia, this paper decomposes it between municipalities with FARC presence during 2011–2014 and those without. Figure 2.4 shows the cumulative cover loss for both the treated unit and its synthetic control for these two groups. The figure indicates that deforestation trends increased only in municipalities exposed to FARC before 2014, with no significant effect in those without exposure. Panel (a) presents the synthetic control estimates for the municipalities exposed to FARC. In these areas, deforestation rose significantly compared to the synthetic control after 2016. The estimated effect corresponds to an additional cumulative cover loss of 1.4% by 2021.[7]

[7]This finding is consistent with Prem et al. (2020), who estimated a yearly average cover loss increase of 0.12% between 2015 and 2017. When calculated for the same period, this paper obtains a nearly identical estimate.

On the other hand, Panel (b) shows the effects for the municipalities in the sample where there were no FARC attacks during the period 2011-2014. The figure shows that after the 2014 ceasefire, cumulative cover loss for both treated and synthetic controls follows almost the same trend, with the treated outcome overlapping with the prediction intervals. This indicates that both time series do not significantly differ from each other. This suggests that for municipalities where FARC was not present, deforestation trends did not change as a consequence of the peace agreement.

2.5.3 Deforestation in municipalities with FARC presence

The identified effects on municipalities exposed to FARC during the period 2011–2014 are further decomposed according to exposure to other armed groups, specifically paramilitary groups and ELN guerrillas. These results are illustrated in Figure 2.5.

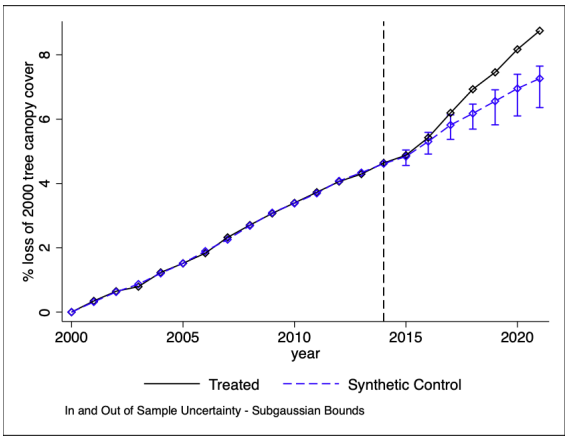
Panel (a) shows the results for municipalities exposed to FARC and at least one other armed group before 2014. These municipalities could have been exposed to ELN, paramilitaries, or both. Overall, exposure to other armed groups is associated with an additional cumulative cover loss of 1.5% by 2021. The effect varies by group. The largest effect occurs in municipalities exposed to FARC and ELN, with 3.6% additional cumulative cover loss by 2021 (panel c). This is followed by municipalities exposed to FARC, paramilitaries, and ELN, with 1.6% (panel b). The smallest effect appears in municipalities exposed only to FARC and paramilitaries, with 1.4% (panel d). In contrast, panel (e) shows that municipalities with only FARC presence before the 2014 ceasefire experienced a non-significant decrease in deforestation trends.

That municipalities exposed to FARC and ELN show the highest effect may partly reflect the limited sample size of only six municipalities, implying a smaller area available for deforestation. Nonetheless, this result is significant. The International Crisis Group (2021) notes ELN's contradictory stance on environmental protection: it publicly opposes environmental destruction while often engaging in activities that contradict this position. In contrast, increases in deforestation linked to paramilitary activity are consistent with previous evidence (Vargas et al., 2014; Cantillo and Garza, 2022).

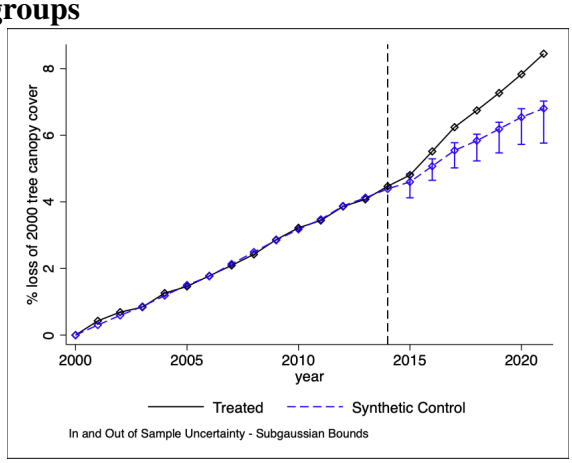
After disaggregating the effect on municipalities exposed to FARC, it becomes clear that the significant rise in deforestation after 2016 is mainly driven by areas where both FARC and other armed groups were present before the 2014 ceasefire. In contrast, municipalities with only FARC presence showed a slight but non-significant decline.

This difference reflects both proximity and timing. Deforestation rose sharply after 2016,

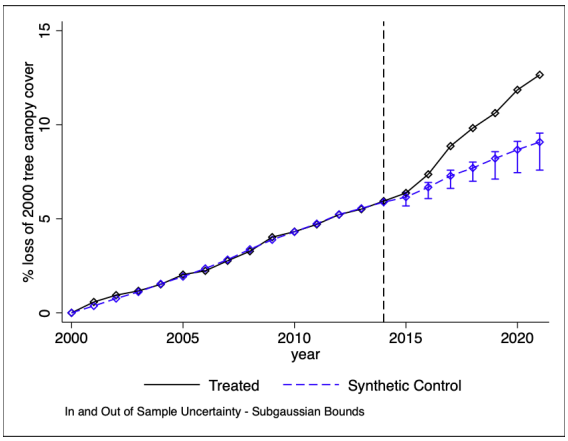
Deforestation in Colombian municipalities exposed to FARC according to the presence of other armed groups



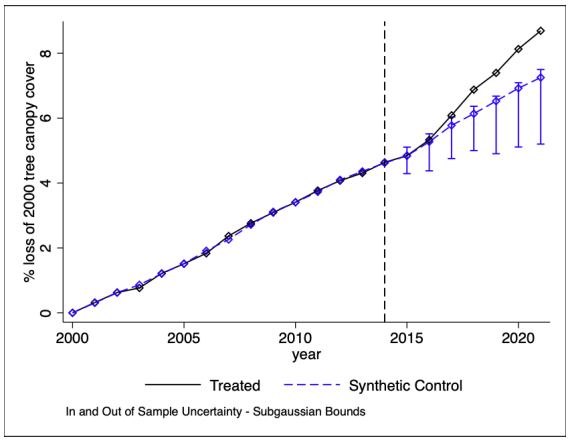
(a) FARC and ELN or paramilitary



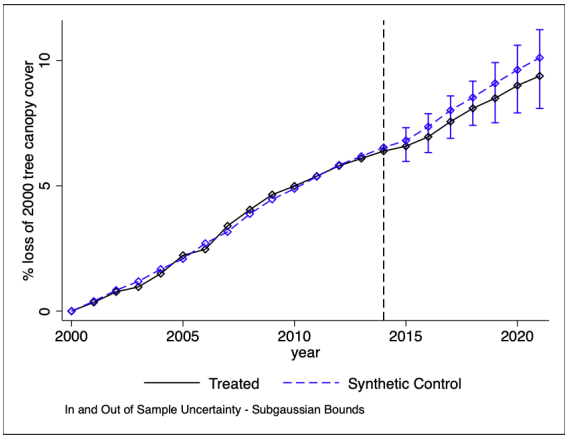
(b) FARC, ELN and paramilitaries



(c) FARC and ELN



(d) FARC and paramilitaries



(e) Only FARC

Figure 2.5: The figures show the impact of the 2014 ceasefire on Colombia's cumulative percentage cover loss, $Y_{t,c}$, for municipalities where FARC attacks occurred during 2011–2014. The results are separated by exposure to other armed groups.

coinciding with FARC disarmament and the relocation of combatants to Transitory Zones for Normalization (ZVTN)[8]. The withdrawal of FARC this year removed an unintended layer of forest protection. With limited state presence in these rural areas, this allowed other armed groups to expand and engage in illegal activities such as mining, logging, cattle ranching, and coca cultivation (The International Crisis Group, 2021).

Proximity lowered the cost of expansion and intensified deforestation where other groups were already present (Mueller et al., 2019). Municipalities that experienced attacks by other armed groups, either within their territory or in neighboring areas, became easier targets for post-2016 territorial expansion, as they were already nearby. In contrast, municipalities with only FARC presence were more isolated, increasing the cost for other groups to establish control. Thus, distance acted as a deterrent to deforestation by increasing the effort required for other armed groups to access these areas, explaining why deforestation trends increased only in municipalities exposed to both FARC and other armed groups.

2.5.4 Deforestation in municipalities without FARC presence

Although municipalities without FARC presence prior to 2014 did not show changes in deforestation trends after the peace agreements, they were still analyzed to explore the role of other armed groups. These municipalities were further disaggregated by exposure to other groups, as shown in Figure 2.6.

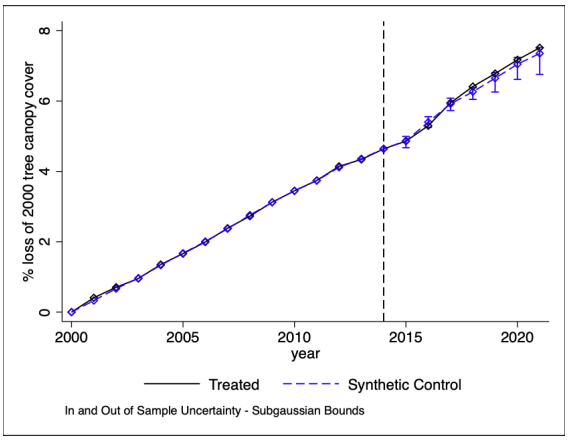
Panels (a) to (d) show that, regardless of the type of armed group present, the 2014 ceasefire and peace agreement did not significantly affect deforestation patterns. The synthetic control closely follows the observed cumulative cover loss after 2014. The only significant effect appears in municipalities exposed only to paramilitaries, with an additional 0.2% cumulative cover loss by 2021. In comparison, municipalities exposed to both FARC and paramilitaries show an effect more than eight times larger.[9] Panel (e) shows a similar pattern for municipalities without attacks during 2011–2014. Their cumulative forest cover loss matches the synthetic control, indicating no significant effect from the 2014 ceasefire. Thus, for all these municipalities, regardless of the presence of armed groups other than FARC, the peace process did not affect deforestation dynamics.

The combination of FARC exposure, disarmament, and distance to other armed groups helps

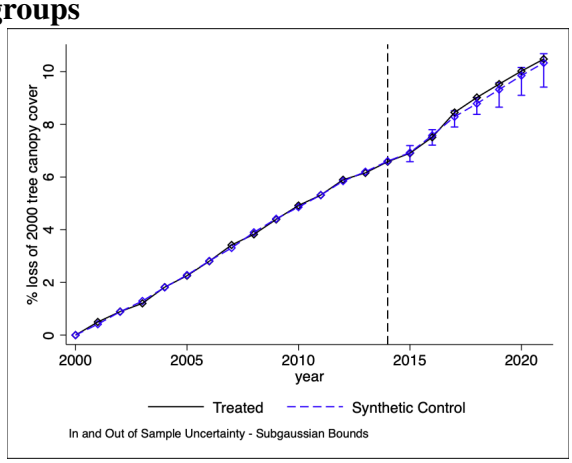
[8]See: https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=84596

[9]Municipalities exposed to paramilitaries or ELN also show small significant estimates. However, since the estimates for municipalities exposed only to ELN are small and insignificant, it can be concluded that effects come from municipalities exposed only to paramilitaries.

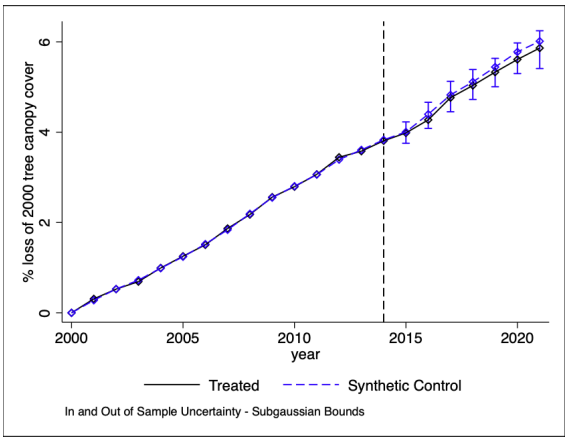
Deforestation in Colombian municipalities not exposed to FARC according to the presence of other armed groups



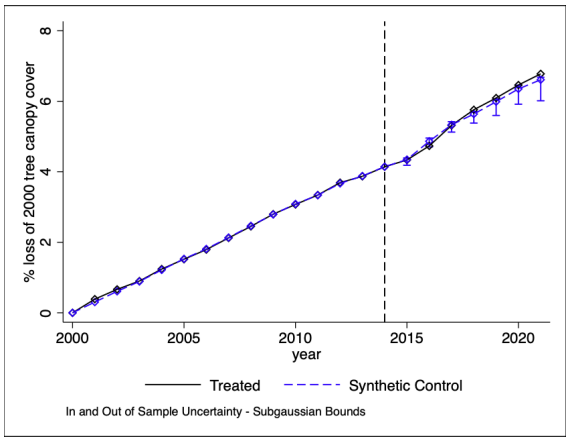
(a) ELN or paramilitary



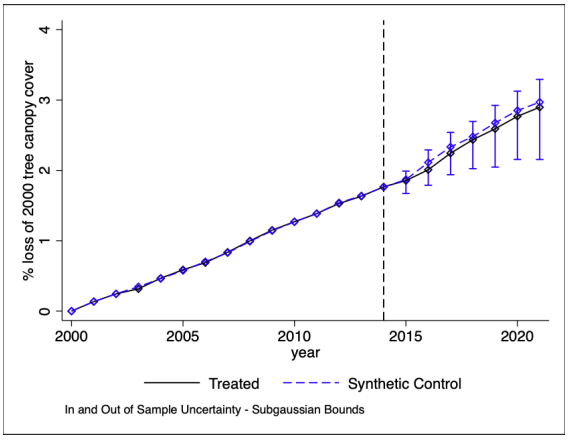
(b) ELN and paramilitaries



(c) ELN



(d) Paramilitaries



(e) No armed group

Figure 2.6: The figures show the impact of the 2014 ceasefire on Colombia's cumulative percentage cover loss, $Y_{t,c}$, for municipalities without FARC attacks during 2011–2014. Results are further separated by exposure to other armed groups.

Estimated effects over cumulative cover loss and exposure to armed groups (Values in %)

Territory	2015	2016	2017	2018	2019	2020	2021	$\Delta\bar{Y}_{2015,2021}$
Country-wide								
α_{COL}	0.0	-0.0	0.1	0.3*	0.3*	0.4*	0.5*	0.1
With FARC								
α_{farc}	0.0	0.1	0.4*	0.7*	0.9*	1.2*	1.4*	0.2
$\alpha_{farc\&other}$	0.0	0.1	0.4*	0.8*	0.9*	1.2*	1.5*	0.2
$\alpha_{farc\&paras\&eln}$	0.2	0.4*	0.7*	0.9*	1.1*	1.3*	1.6*	0.2
$\alpha_{farc\&eln}$	0.2	0.7*	1.6*	2.1*	2.4*	3.2*	3.6*	0.5
$\alpha_{farc\&paras}$	0.0	0.1	0.3*	0.7*	0.9*	1.2*	1.4*	0.2
$\alpha_{farc\,only}$	-0.2	-0.4	-0.4	-0.4	-0.6	-0.6	-0.7	-0.1
Without FARC								
$\alpha_{no\,farc}$	0.0	-0.1	-0.0	0.0	0.0	0.0	0.1	0.0
$\alpha_{paras\&eln}$	-0.0	-0.1	0.2	0.2	0.2	0.2	0.1	0.0
$\alpha_{other\,only}$	-0.0	-0.1	0.0	0.2*	0.1	0.1	0.2	0.0
$\alpha_{eln\,only}$	-0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.0
$\alpha_{paras\,only}$	-0.0	-0.1	-0.0	0.1*	0.1*	0.1*	0.2*	0.0
α_{none}	-0.0	-0.1	-0.1	-0.0	-0.1	-0.1	-0.1	-0.0

Table 2.2: The table summarizes the estimated effects and their significance for all estimations using the synthetic control method. The estimated effects on cumulative cover loss, $\alpha_{1t} = Y_{1t,c} - \hat{Y}_{1t,c}$, are reported for each post-treatment year and grouped by the presence of armed groups. The change in average percentage cover loss, $\Delta\bar{Y}_{2015,2021}$, is computed as $\Delta\bar{Y}_{2015,2021} = \bar{Y}_{2015,2021} - \bar{\hat{Y}}_{2015,2021}$. Here, $\bar{\hat{Y}}_{2015,2021}$ represents the average percentage cover loss using the synthetic control trend. An asterisk (*) is added whenever the treated outcome $Y_{1t,c}$ lies outside the 90% prediction intervals computed with the method of Cattaneo et al. (2021).

explain the effects described in the previous section. However, this mechanism does not apply to municipalities without FARC presence before 2014. Since FARC was absent during 2011–2014, reintegration did not alter power dynamics between armed groups and the State. Without a power vacuum, armed groups had no incentive to expand, and illegal activities linked to deforestation were not expected to change.

2.5.5 Summary of the Effects of the 2014 Cease-Fire on Deforestation Trends

The effects of the ceasefire on deforestation in Colombia and its municipalities, based on exposure to different armed groups, are summarized in Table 2.2. The table separates effects for the country as a whole, municipalities exposed to FARC, and those without FARC presence. For the latter two categories, results are further disaggregated by exposure to other armed groups. The results indicate that the peace agreement significantly increased deforestation at the national level. This effect is driven entirely by municipalities where FARC was present before the ceasefire.

Among municipalities exposed to FARC, those with FARC presence alone did not experience significant increases in deforestation. In contrast, municipalities exposed to both FARC and other armed groups saw clear and significant increases. Municipalities without FARC presence before the ceasefire did not show meaningful changes in deforestation trends. Overall, the results indicate that rising deforestation in Colombia is concentrated in areas where FARC and other armed groups overlapped before 2014.

2.5.6 Synthetic control weights

Synthetic control weights (Values in %)

Outcome var	VEN	ECU	PAN	BRA	GUY	PRY	ARG	URY	SUR	BOL	CHL	PER
Country-wide												
$Y_{COL,c}$	56.4	22.3	8.1	12.2	0.0	0.0	1.0	0.1	0.0	0.0	0.0	0.0
With FARC												
$Y_{farc,c}$	20.1	30.5	27.6	19.7	0.0	0.0	1.4	0.7	0.0	0.0	0.0	0.0
$Y_{farc\,only}$	0.0	0.0	63.7	28.8	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0
$Y_{farc\,other}$	26.0	28.5	24.4	19.0	0.0	0.0	0.1	1.9	0.0	0.0	0.0	0.0
$Y_{farc\&eln}$	13.9	25.5	31.3	22.1	0.0	7.2	0.0	0.0	0.0	0.0	0.0	0.0
$Y_{farc\&paras}$	1.6	25.7	32.2	21.6	16.4	0.0	2.5	0.0	0.0	0.0	0.0	0.0
$Y_{farc\&paras\&eln}$	45.6	30.8	2.7	16.1	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0
Without FARC												
$Y_{no\,farc,c}$	67.0	17.8	1.0	9.6	4.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
$Y_{none,c}$	18.3	6.6	6.0	4.8	63.8	0.0	0.5	0.0	0.0	0.0	0.0	0.0
$Y_{other\,only,c}$	41.0	17.8	12.7	26.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0
$Y_{eln\,only,c}$	41.4	31.9	15.8	9.5	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0
$Y_{paras\,only,c}$	58.3	11.2	5.7	22.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
$Y_{paras\&eln\,only,c}$	0.0	18.6	34.9	40.3	0.0	3.4	0.0	2.8	0.0	0.0	0.0	0.0
Mean weights	30.0	20.6	20.5	19.4	6.5	1.6	1.0	0.4	0.0	0.0	0.0	0.0

Table 2.3: The table shows the weights w_j^* for each donor country used to construct the cumulative percentage cover loss $Y_{t,c}$ for each area of interest. For each synthetic control, the weights w_j^* sum to 1. In the bottom row, the table also reports the mean weights w_j^* for each country across all areas of interest.

Table 2.3 presents the optimal weights used in the synthetic controls to construct the cumulative percentage cover loss trajectory. At the same time, Figure 2.7 displays the trajectories of the cumulative percentage cover loss, $Y_{t,c}$, for both Colombia and the donor pool countries.

From the table, it is clear that Venezuela, Ecuador, Panama, and Brazil are the main donors in constructing the cumulative percentage cover loss, with weights $w_j^* > 0$ and the highest mean weights. Since these weights are calculated in the pre-treatment period (2000–2014), it follows that deforestation dynamics in Colombia and its municipalities were similar to those in these countries

before the ceasefire. Figure 2.7 highlights this result. Colombia's cumulative percentage cover loss trajectory (red line) closely matched those of Venezuela, Ecuador, Panama, and Brazil (blue tones) during the pre-treatment period. This similarity may be explained by their shared borders and contiguous forest areas. Colombia shares the Amazon rainforest with Venezuela, Ecuador, and Brazil, and the Darién forest with Panama. In contrast, Guyana, Paraguay, Argentina, and Uruguay contributed only marginally to the synthetic controls, with very small mean weights. Suriname, Bolivia, Chile, and Peru did not contribute at all.

Cumulative percentage cover loss for Colombia and countries in the donor pool

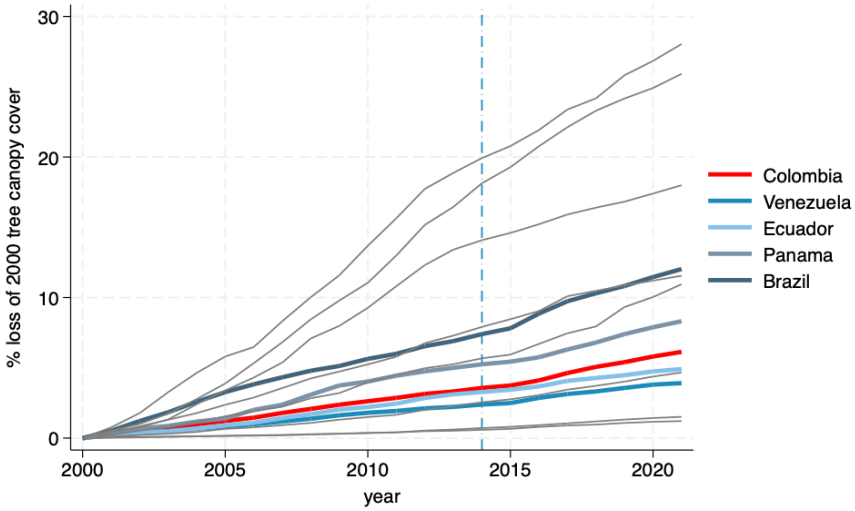


Figure 2.7: This figure shows the trajectories of cumulative percentage cover loss for Colombia and the donor pool countries. It separates the pre-treatment period (2000–2014) from the post-treatment period (2015–2021). Colombia is highlighted in red. The main donor countries—Venezuela, Ecuador, Panama, and Brazil—are shown in blue tones. Countries contributing marginally or not at all to the synthetic controls are displayed in gray.

2.6 Conclusions

This article examines the relationship between the Colombian conflict and deforestation dynamics. It focuses on the links between the peace process, the presence of armed groups in municipalities during 2011–2014, and the subsequent rise in deforestation trends.

Using the synthetic control method, this study finds: 1) Colombia as a whole experienced an increase in deforestation trends following the peace agreement. 2) This effect originates exclusively from municipalities exposed to FARC during 2011–2014. Municipalities without FARC presence showed no significant changes in deforestation trends, regardless of other armed groups. 3) Within

FARC-exposed municipalities, the effect is concentrated in those where other armed groups were also present. Municipalities with only FARC presence did not exhibit significant effects. 4) Positive effects on deforestation were found regardless of which additional group was present with FARC. These effects appeared in municipalities with FARC and ELN, FARC and paramilitaries, and in those where all three groups were present.

The findings suggest that deforestation dynamics after 2016 are shaped by two main factors: FARC's disarmament and the distance to other armed groups. FARC's withdrawal in 2017 removed an unintended layer of forest protection and created a power vacuum, which, combined with weak state presence, allowed other armed groups to expand and engage in illicit activities such as cattle ranching, logging, mining, and coca cultivation. Expansion was easier and cheaper in municipalities already near other armed groups, leading to higher deforestation pressures there. By contrast, municipalities with only FARC presence or those farther from other groups faced higher entry costs, making expansion and related deforestation less likely. Similarly, municipalities without FARC presence before 2014 did not experience power shifts, reducing incentives for armed group expansion and leaving deforestation trends largely unchanged.

Appendix

A.1 Robustness tests

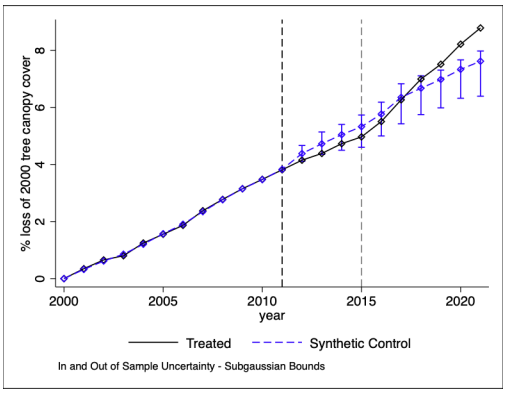
A.1.1 Out-of-Sample test

The Out-of-Sample Validation Test, as suggested by Abadie and Vives-i Bastida (2022), consists of moving the treatment date backward. Synthetic controls estimate the path of the outcome variable for the treated unit as if the intervention had not occurred. Their validity can be tested by checking how well they predict outcomes in pre-intervention periods not used to compute the weights.

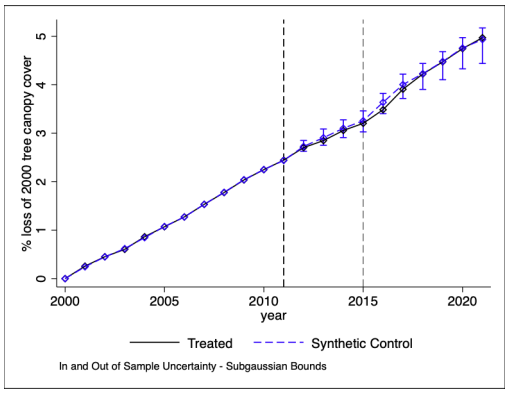
Here, the pre-treatment period is shifted from 2014 to 2011, recalculating the synthetic control for cumulative percentage cover loss over 2000–2011. If the original results are reliable, this adjustment should not change the findings. The synthetic control should still predict deforestation trajectories for 2012–2014 and produce similar effect estimates for 2015–2021.

Figure 8 presents the recalculated results. Panel (a) shows municipalities exposed to FARC prior to the 2014 ceasefire. The synthetic control slightly exceeds the observed trajectory for 2012–2014,

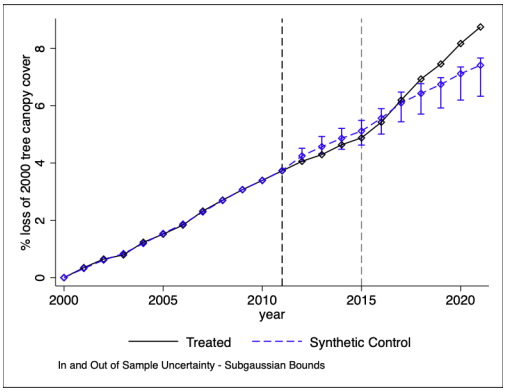
Out-of-Sample test: pre-treatment period between 2000-2011



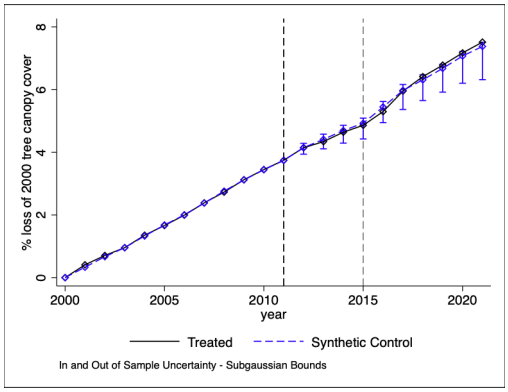
(a) With FARC



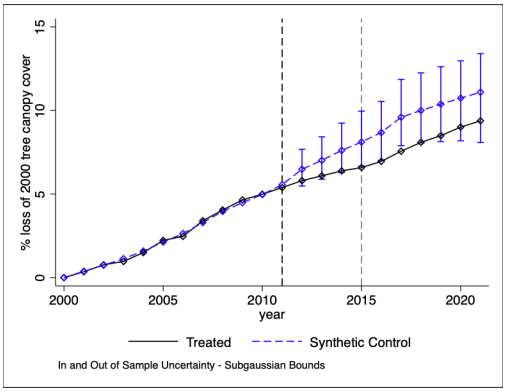
(b) Without FARC



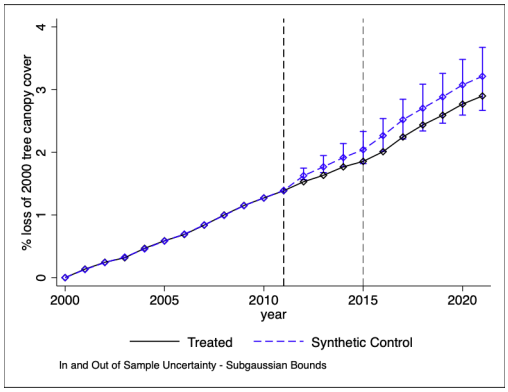
(c) FARC and other armed groups



(d) Other armed groups only



(e) Only FARC



(f) No armed groups

Figure 8: The figure presents the out-of-sample test, shifting the treatment date back by three years and re-estimating the effects. The left column shows municipalities exposed to FARC, distinguishing those with other armed groups from those with only FARC presence. The right column shows municipalities without FARC. The black dotted line marks two years before adoption, and the gray dotted line marks the actual treatment period.

but remains within prediction intervals. After 2015, the paths diverge, and from 2018 onward the observed trajectory rises significantly above the synthetic control. Panel (c) shows a similar pattern for municipalities exposed to both FARC and other armed groups.

Panel (e) shows municipalities exposed only to FARC. The observed trajectory remains below the synthetic control after 2015, with differences not statistically significant. This confirms that municipalities with only FARC presence did not experience an increase in deforestation after the ceasefire.

Panels (b), (d), and (f) show municipalities without FARC presence, disaggregated by exposure to other armed groups. In all cases, observed trajectories and synthetic controls move together before and after 2015, indicating no impact of the peace agreements.

Overall, shifting the treatment date confirms that deforestation increases occurred mainly in municipalities where FARC and other armed groups were present before 2014. No significant changes are observed in municipalities without FARC or those with only FARC presence.

A.1.2 Permutation test

To confirm that the identified effects are unique to Colombia and not driven by donor pool countries, a permutation test is conducted Abadie et al. (2015). This involves excluding Colombia, assigning treatment to each donor country in turn, and using the remaining countries to construct synthetic controls. The outcome variables, synthetic controls, and prediction intervals are then averaged across all donor countries.

Since donor countries did not experience a peace process or ceasefire in 2014, their deforestation patterns are expected to remain unchanged. Thus, the trajectories of cumulative percentage cover loss and their synthetic controls should not differ significantly.

Figure 9 displays the average trajectory of cumulative cover loss and synthetic controls for donor countries during 2000–2021, including confidence intervals. The observed and synthetic trajectories closely match, and post-treatment values remain within the prediction intervals, indicating no significant effects. Therefore, the increase in deforestation identified for Colombia after the 2014 ceasefire can be attributed solely to Colombia and not to donor pool countries.

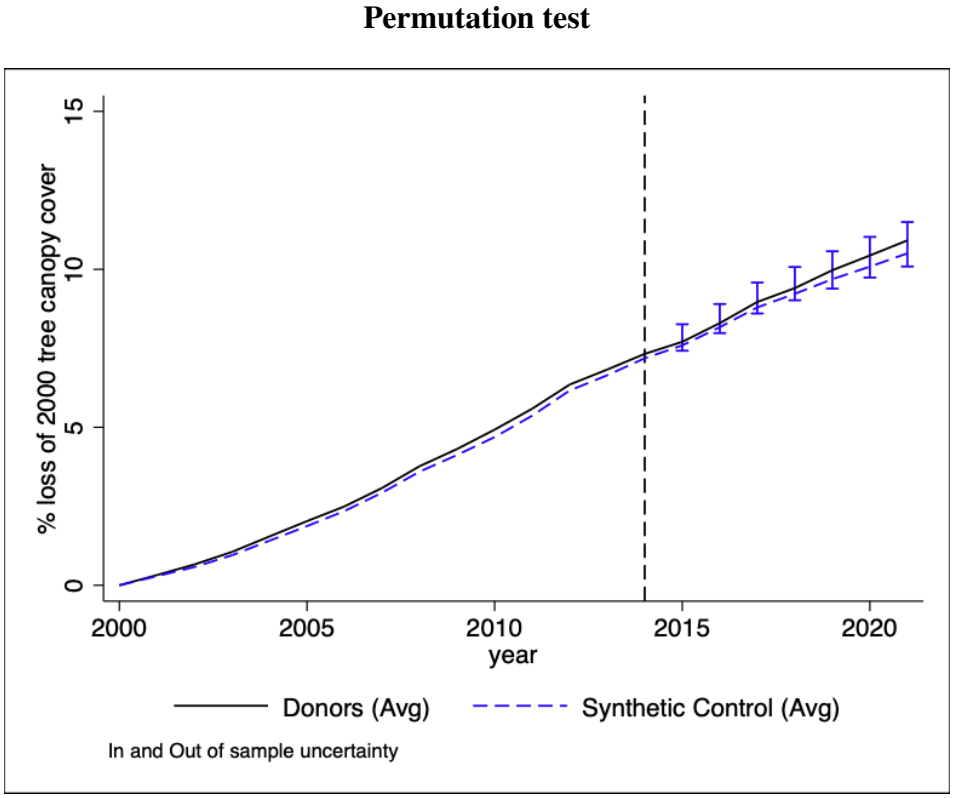
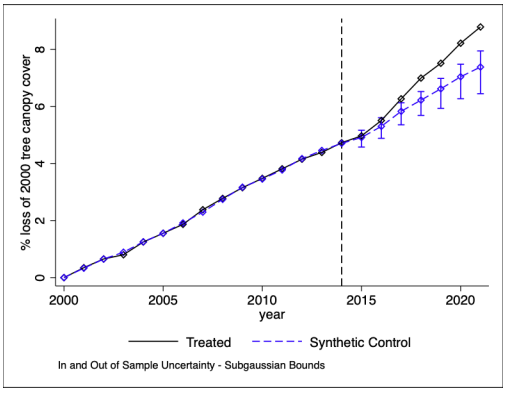
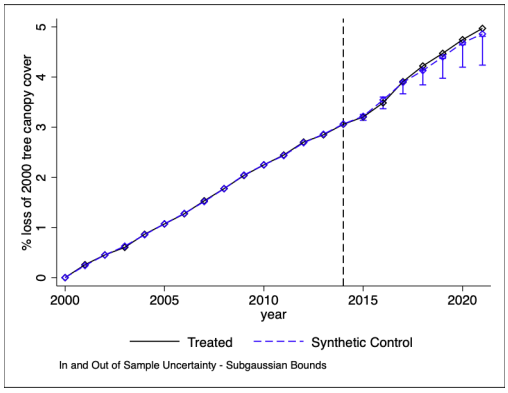


Figure 9: The figure displays the permutation test, which involves assigning the treatment to each country in the donor pool and re-estimating the effects. The cumulative percentage covered loss for both the treated unit and the synthetic control, along with the prediction intervals, are then averaged.

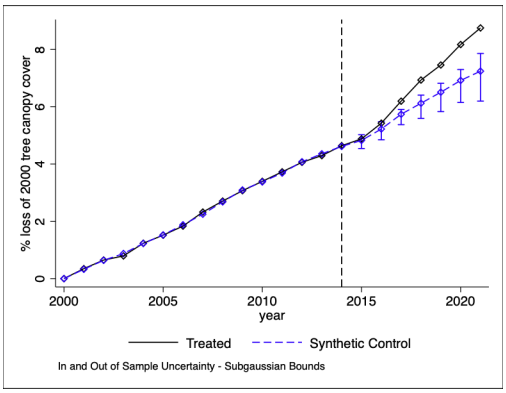
Exclusion of adjacent states of boundary countries



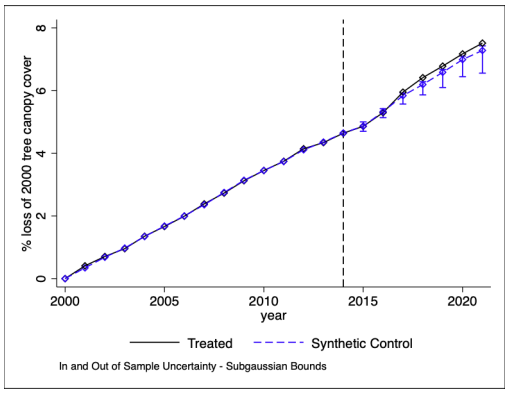
(a) With FARC



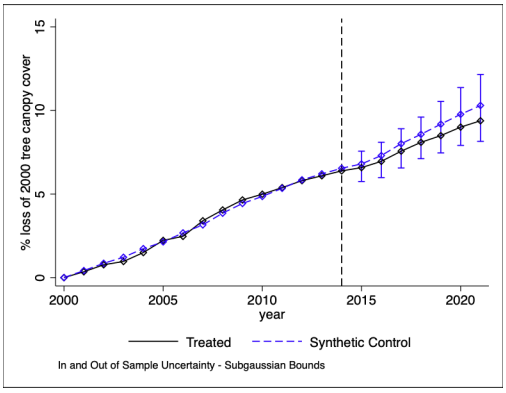
(b) Without FARC



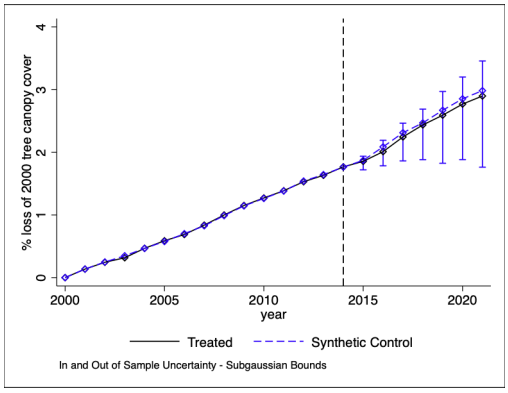
(c) FARC and other armed groups



(d) Other armed groups only



(e) Only FARC



(f) No armed groups

Figure 10: This figure shows the recalculated results, excluding Darién province from Panama; the provinces of Carchi, Esmeraldas, and Sucumbíos from Ecuador; the department of Loreto from Peru; the states of Zulia, Táchira, Apure, and Amazonas from Venezuela; and the state of Amazonas from Brazil.

A.1.3 Exclusion of areas adjacent to Colombia in neighboring countries.

Since the conflict in Colombia is concentrated in border areas, municipalities with higher deforestation levels also tend to be near the border. Because the donor countries for the synthetic control—Panama, Ecuador, Brazil, and Venezuela—share borders with Colombia, there is a risk that border regions in these countries were indirectly affected by the Colombian conflict and its 2014 ceasefire.

To address this, synthetic controls for cumulative percentage cover loss were recalculated excluding regions adjacent to Colombia: Darién province in Panama; the provinces of Carchi, Esmeraldas, and Sucumbíos in Ecuador; the department of Loreto in Peru; the states of Zulia, Táchira, Apure, and Amazonas in Venezuela; and the state of Amazonas in Brazil.

Figure 10 summarizes these recalculated results. Panel (a) confirms that municipalities exposed to FARC experienced a sharp increase in cumulative cover loss after 2016. Panel (c) shows similar results for municipalities exposed to both FARC and other armed groups, indicating significant post-2016 deforestation. Panel (e) shows a non-significant decline in deforestation for municipalities with only FARC presence. By contrast, panels (b), (d), and (f) show no significant differences for municipalities without FARC exposure, whether or not other armed groups were present.

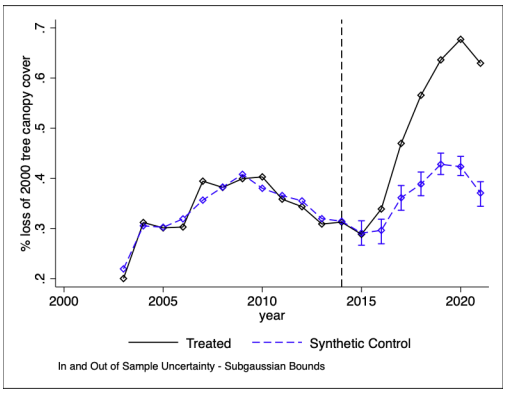
Overall, excluding border regions from the donor pool does not change the main conclusions: deforestation increases are concentrated in municipalities where FARC and other armed groups were present before 2014, while municipalities with only FARC or no FARC presence show no significant post-ceasefire changes.

A.1.4 Results using average percentage cover loss

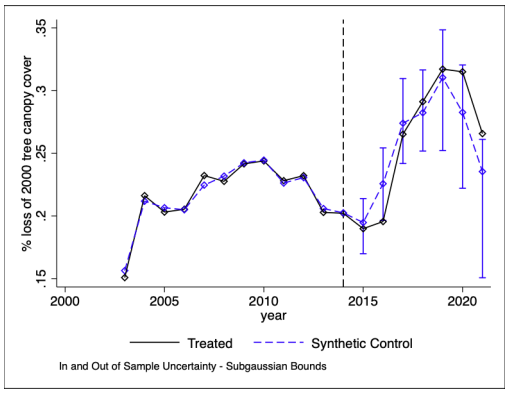
The synthetic control method estimates treatment effects by ensuring that the outcome variable and its synthetic control closely align in the pre-treatment period. A good pre-treatment fit increases confidence that post-treatment differences can be attributed to the treatment. However, when the fit is poor—often the case with highly volatile outcome variables—post-treatment conclusions become less reliable Abadie and Vives-i Bastida (2022).

For this study, synthetic controls are based on cumulative percentage cover loss, $Y_{t,c}$, a low-volatility series that provides a good fit. To confirm that results are not driven solely by this measure, they are recalculated using the average percentage cover loss over the last four periods, $\bar{Y}_{t-3,t}$, which smooths volatility and improves comparability.

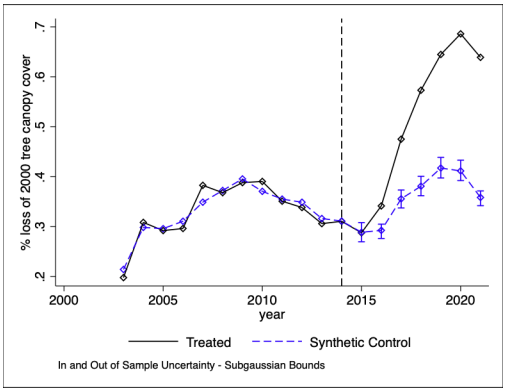
Results using average percentage cover loss



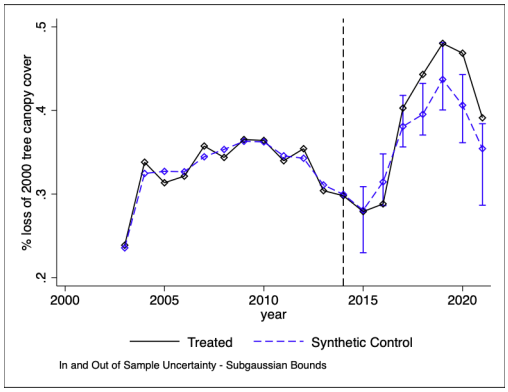
(a) With FARC



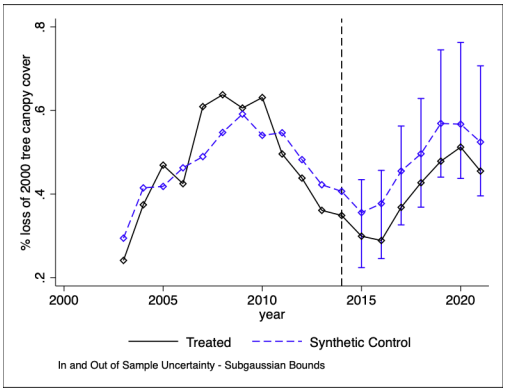
(b) Without FARC



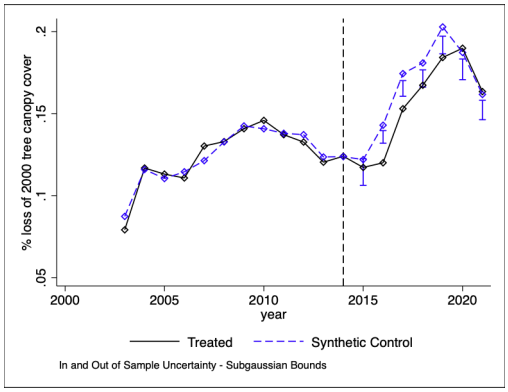
(c) FARC and other armed groups



(d) Other armed groups only



(e) Only FARC



(f) No armed groups

Figure 11: The figure shows the recalculated results using the average percentage cover loss for the last four periods, $\bar{Y}_{t-3,t}$, for Colombian municipalities according to their type of exposure to armed groups.

Figure 11 presents these recalculations. Panels (a) and (c) show that municipalities exposed to FARC, and those exposed to FARC and other armed groups, continue to experience significant post-2015 increases in deforestation, despite a poorer pre-treatment fit. Panel (e) shows that municipalities exposed only to FARC remain below the synthetic control, with no significant differences.

Panels (b), (d), and (f) show results for municipalities without FARC presence. Trends remain statistically similar to their synthetic controls, except for a slight post-treatment rise in panel (d), where municipalities with only other armed groups show small but significant increases in deforestation.

Overall, using average percentage cover loss yields conclusions consistent with those from cumulative cover loss, though the weaker pre-treatment fit makes these results less reliable. This limitation would be even stronger if using unsmoothed percentage cover loss, $Y_{t,p}$.

3. What is the effect of Inflation Targeting? A Synthetic Control Method Approach

Abstract

This paper examines the causal effects of inflation targeting on inflation levels using the synthetic control method. It provides a comprehensive analysis by estimating the impact of inflation targeting on the consumer price index for each country that adopted the policy since its inception in New Zealand in 1989. The study focuses on individual country cases and calculates average treatment effects, offering both aggregate and country-specific insights into inflation trajectories. The findings show that, on average, inflation targeting reduces average annual inflation rates by 2.8 percentage points, compared to synthetic controls. When disaggregating the results, developed economies show a reduction of 1.8 percentage points, while developing economies show a 3.0 point decrease. At the country level, most economies experienced decreases in inflation after adopting inflation targeting.

3.1 Introduction

Inflation targeting (IT) is an institutional framework that explicitly identifies price stability as its primary goal. It involves publicly announcing a quantitative inflation target to ensure transparency and accountability. Often described as "constrained discretion," IT combines rule-like elements that anchor expectations with the flexibility needed for central banks to respond to economic shocks (Hammond, 2012).

Since New Zealand pioneered IT in 1990, the framework has gained widespread adoption, with

45 countries having adopted IT by 2023 (IMF, 2024). By 2017, about 70% of global GDP was produced in countries using this framework, as many adopters are developed economies (Cobham, 2023).

Empirical evidence shows that most countries adopting IT had high inflation before introducing the framework and that inflation rates generally declined after adoption (Figure 3.1). This meant that most countries met their targets (Corbo et al., 2001; Roger and Stone, 2005; Mishkin and Schmidt-Hebbel, 2007). This suggests that the effect of adopting IT is a reduction in inflation levels.

Inflation Rate Before vs. After Adopting Inflation Targeting

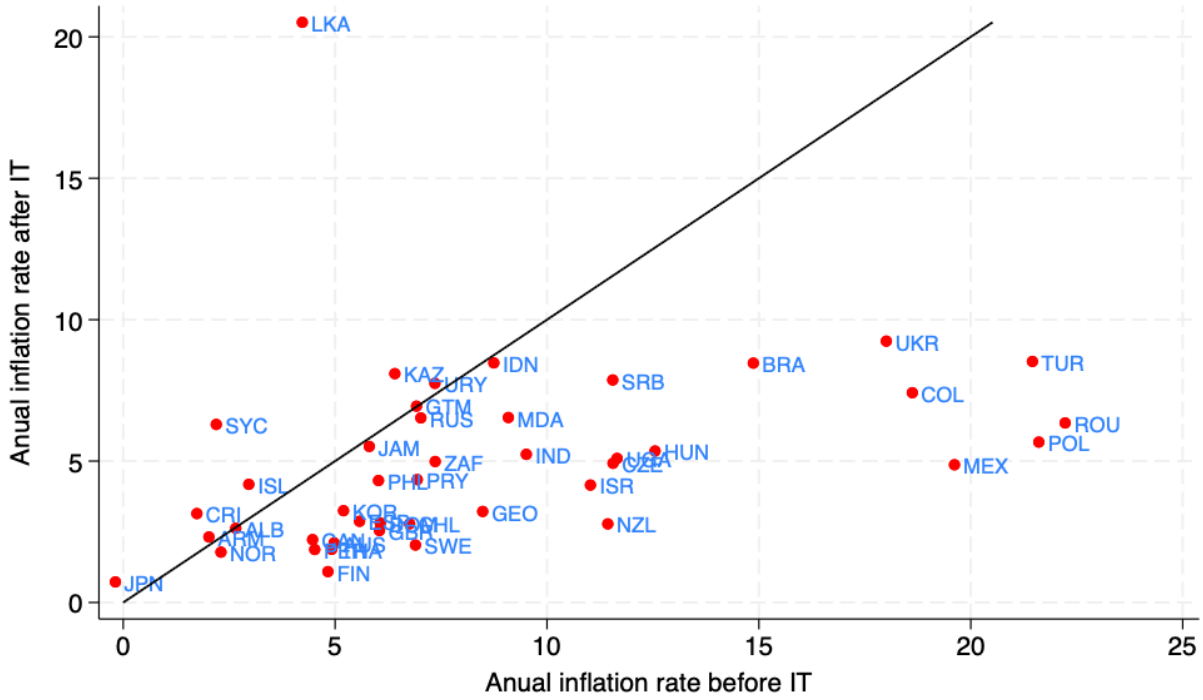


Figure 3.1: The graph compares the average annual inflation rate five years before and after adopting IT. The black line represents the 45-degree line. Points below the line indicate a reduction in inflation after adoption. Each country is labeled with its three-digit ISO code.

However, the causal evidence on whether IT leads to lower inflation remains mixed and inconclusive (Petrevski, 2023; Svensson, 2010). This conflicting evidence arises because some studies find no significant effect, others report clear reductions in inflation, and a few studies find significant increases after its adoption (Walsh, 2009). The mixed evidence in the literature stems from differences in the periods analyzed, the countries studied—often distinguishing between developed and developing economies—and the identification strategies employed. These strategies frequently include difference-in-differences, panel data techniques, matching estimators, and synthetic control

methods.

To address this challenge, this paper employs the Synthetic Control Method (SCM) to estimate the average treatment effect (ATE) of adopting IT using the Consumer Price Index (CPI) and computing its corresponding effect on inflation rates.[1] To achieve this, a synthetic control is estimated for 44 countries that adopted this framework using a 10- and 5-year window around the year of adoption.[2] This study uses a comprehensive dataset covering 171 nations for the period 1980–2023 Ha et al. (2023). These effects are then aggregated into the ATE by averaging across country estimates (Funke et al., 2023). To explore heterogeneity, country estimates are also aggregated for developed and developing economies separately, as well as for different regions of the world (Europe, the Middle East, Latin America, Africa, Asia, and the Caribbean).[3]

The results show that adopting IT leads to an ATE corresponding to a reduction of 2.8 percentage points in the average annual inflation rate five years after adoption. The estimated effects are 1.8 percentage points for developed economies and 3.0 percentage points for developing economies. Additionally, the results indicate that, for developed economies, IT adoption reduced core and food inflation, with no significant effects on energy prices. Regional results show significant declines in Europe, the Middle East, and Latin America, non-significant effects in Africa and Asia, and a slight increase in the Caribbean.

At the country level, results show some heterogeneity, as not every IT adopter experienced a significant decrease in inflation, but this is still the most common outcome. Of the 44 nations analyzed, 5 were excluded from ATE calculations due to poor pre-treatment fit and 2 for lacking five years of post-adoption data, leaving 37 in the sample. Among them, 29 (78.4%) recorded lower inflation rates, with 18 showing significant reductions. Conversely, 8 (21.6%) experienced increases, 5 of which were significant. Thus, inflation targeting most often leads to lower inflation, as reflected in the average treatment effect and the prevalence of significant reductions across countries.

By linking the ATE to country-specific estimates and analyzing economies by development level and region, the main contribution of this paper is to provide both the broadest and most detailed analysis of the effects of inflation targeting on inflation levels. This paper shows that while inflation

[1] Using CPI, a smoother and less volatile series, improves the pre-treatment fit and leads to more reliable estimates. This is ideal for SCM, as volatile series often yield poor estimates because the treated unit and its synthetic control do not align well in the pre-intervention period (Abadie and Vives-i Bastida, 2022). Since inflation rates are derived from CPI, this approach still captures the effects of inflation targeting while enhancing estimation accuracy.

[2] Of the 45 countries adopting inflation targeting, only Kenya lacks sufficient data to estimate its effects.

[3] Not all country estimates were used to calculate the ATE. The fit remained inadequate for some countries, which were excluded from these calculations. Additionally, countries that adopted inflation targeting after 2018 were removed, as they lacked five years of post-adoption data needed to estimate effects.

targeting generally reduces inflation, there is heterogeneity across regions and countries. This finding helps explain apparently contradictory results in the literature, where different methods and samples yield mixed conclusions—some studies report significant decreases in inflation using difference-in-differences, panel estimates, or matching estimators (Gonçalves and Salles, 2008; Lin and Ye, 2009; Yamada, 2013; Arsić et al., 2022; Ayres et al., 2014; Abo-Zaid and Tuzemen, 2012; Alpanda and Honig, 2014; Vega and Winkelried, 2005; de Mendonça and de Guimarães e Souza, 2012), while others find non-significant or negligible effects using the same approaches (Thornton, 2016; Naqvi and Rizvi, 2009; Brito and Bystedt, 2010; Stojanovikj and Petrevski, 2021; Kose et al., 2018; Ardakani et al., 2018).

An additional contribution of this paper is the identification of an ATE showing a significant decrease in inflation for developed economies.[4] The literature generally reports negative but non-significant effects for these economies when using difference-in-differences (Ball and Sheridan, 2005; Ball, 2010), matching estimators (Lin and Ye, 2007; Ball and Sheridan, 2005; Ginindza and Maasoumi, 2013), or instrumental variables (Willard, 2012), possibly because both IT adopters and non-adopters experienced declines in inflation levels during the period analyzed, making estimation more challenging (Ball and Sheridan, 2005). Moreover, this paper decomposes the ATE, showing that developed economies adopting IT at the beginning of the 1990s experienced larger declines in inflation levels compared to late adopters. It further decomposes the ATE into effects on core, food, and energy price indexes, showing that the reduction in CPI inflation is driven mainly by core and food price indexes, while no significant effect is found for energy prices.

The final contribution relates to studies employing the synthetic control method (SCM) (Barbosa et al., 2018; Lee, 2011; Duncan et al., 2022). By estimating the effect using the CPI rather than the inflation rate, this paper provides more reliable estimates, as treated units and their synthetic controls exhibit a better pre-intervention fit. Additionally, these studies provide estimates only at the country level and do not report ATE.

This article is structured as follows. Section 3.2 describes the data sources used in the analysis. Section 3.3 explains the identification strategy. Section 3.4 presents the findings, beginning with the ATE and then disaggregating the results. Finally, Section 3.5 concludes.

[4]Developed economies in this paper are defined as OECD members up to 1990. This criterion is similar to that used in most studies estimating IT effects on developed economies.

3.2 Data

The CPI data used comes from Ha et al. (2023). A comprehensive global database of inflation measures. The dataset spans 1970 to 2023 and includes up to 209 countries, covering 38 advanced and 171 emerging or developing economies. It provides six inflation measures: headline CPI, core CPI, food price index, energy price index, producer price index, and the GDP deflator. Data are available at monthly, quarterly, and annual frequencies. This study analyzes a sample of 171 countries, including 44 that adopted IT. The dataset spans 1980 to 2023 and uses quarterly observations.[5]

Determining the exact timing of IT adoption is not always straightforward. Conventionally, countries adopting this framework must meet several criteria. Price stability must be explicitly stated as the primary goal of monetary policy, a quantitative inflation target must be publicly announced, and the process must be transparent with clear accountability mechanisms (Hammond, 2012). Nevertheless, it is not always clear whether all these criteria are fully met. To address this, the study uses adoption dates for IT countries up to 2009 from Hammond (2012). For countries adopting after 2009, dates are obtained from the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) database (IMF, 2022) and central bank websites[6].

3.3 Identification strategy

This study uses an identification strategy based on the SCM developed by Abadie and Gardeazabal (2003) and Abadie et al. (2010). It constructs a counterfactual trajectory of CPI for IT adopters under the hypothetical scenario in which they did not adopt IT. This counterfactual is constructed as a weighted combination of CPI data from non-adopters, where higher weights are assigned to countries whose CPI trajectories more closely resemble those of IT countries before adoption.

Let the outcome of interest be y_{it} for I treated units in periods $t = 1, 2, \ldots$. For each i, consider a sample of $J + 1$ units. The treated unit, $j = i$, represents the IT country, while the $j \neq i$ units are non-treated countries—denoted also as the control group or donors. The total number of periods T is split into two segments, where the split point is the period when the treated country adopted IT. Thus, $T = T_0 + T_1$, with T_0 as the number of pre-treatment periods and T_1 as the number of

[5]Quarterly data is used because pioneer adopters, such as New Zealand and Australia, do not publish monthly data, which reduces the number of treated countries. Nevertheless, robustness checks are performed using monthly data.

[6]Data available at https://www.elibrary-areaer.imf.org/Pages/Home.aspx

post-treatment periods. [7]

A synthetic control is constructed using a vector of weights that sum to 1, $W^* = (w_2^*, \ldots, w_{J+1}^*)$, which satisfies $W^* = argmin\{\sum_{m=1}^{k} v_m(Y_{im} - Y_{0m}W)^2\}$ for periods $t \leq T_0$. Here, Y_i is a $T_0 \times 1$ vector containing the pre-intervention outcome y_{it} for the treated unit, Y_0 is a $T_0 \times J$ matrix with the same variable for the control group, and v_m is a weight that reflects the relative importance of the m-th variable when measuring the discrepancy between Y_i and Y_0W. Thus, the synthetic control for y_{it} is $\hat{y}_{it} = \sum_{j=1}^{J} w_j^* y_{jt}$. The treatment effect is then $\alpha_{it} = y_{it} - \hat{y}_{it}$ for $t > T_0$. Here, y_{it} represents the CPI, normalized to 1 in the first pre-treatment period.

To calculate the ATE, both the synthetic control and the CPI for each treated unit are divided by their value in the intervention period, normalizing them to y_{it} with $t = T_0$. Then, the average CPI for adopters in period t is $y_t = \frac{\sum_{i=1}^{I} y_{it}}{I}$, the average synthetic control is $\hat{y}_t = \frac{\sum_{i=1}^{I} \hat{y}_{it}}{I}$ and the average treatment effect is then $\alpha_t = y_t - \hat{y}_t$ for $t > T_0$.

To ensure that average treatment effects are derived under comparable conditions, this paper follows the methodology of Funke et al. (2023). For each country, a synthetic control is estimated using a panel that begins 10 years before and ends 5 years after the adoption of inflation targeting.

Considering quarterly data and panel length, each effect is estimated with $T_0 = 40$ and $T_1 = 20$. Countries adopting inflation targeting after 2018 are excluded, as they lack five years of post-treatment data. If data are unavailable for the full 10-year pre-adoption period, the panel starts when data become available. For countries with poor fit, the starting date is chosen as the quarter before adoption that minimizes the root mean square error (RMSE). The starting quarter must ensure at least 20 quarters (5 years) of pre-treatment periods. If the fit remains inadequate, the estimates are excluded from the average treatment effects.

The main results of this study are not derived from using the entire donor pool to estimate effects for each treated unit. As Abadie and Vives-i Bastida (2022) notes, a larger donor pool is not always better. A large pool raises the risk of overfitting, especially when pre-treatment periods are limited; this might create a perfect pre-treatment fit but generate large post-treatment errors. In contrast, a smaller donor pool of countries similar to the treated unit in the pre-treatment period helps reduce bias and improve synthetic control performance.

Therefore, instead of using all non-treated countries as donors, the sample is separated into seven regions. To estimate the synthetic control of a country within a particular region, only countries

[7] Importantly, donors can include countries that have never adopted IT (never-treated) as well as countries that adopt IT in future periods (not-yet-treated). To be considered a donor, it suffices that the country has not adopted IT during the T periods considered.

in that same region are considered as controls. The first region mirrors samples used in studies on developed economies and includes OECD members up to 1990. These countries share high per capita income levels and similar institutional structures. Countries not included in this group are classified as developing economies and are grouped based on geographical proximity. Using the United Nations M49 classification,[8] the regions are: European countries not in the OECD by 1990; the Middle East (Northern Africa and Western Asia); Latin America; the Caribbean; Sub-Saharan Africa (excluding Western Africa to reduce overfitting); and Asia (Central, Southern, and Eastern Asia).[9]

Table 3.1 presents the total number of countries and the number of inflation-targeting countries in each group. Dividing the sample into these groups keeps the donor pool manageable, ensuring each case has over 20 untreated units rather than a large pool of more than one hundred.

Region	**Number of Countries**	**Number of IT**
Developed	**21**	**8**
Developing	**150**	**36**
Europe	27	10
Middle East	24	4
Latin America	20	9
Caribbean	20	2
Africa	30	3
Asia	29	8
Total	**171**	**44**

Table 3.1: Regions by number of countries and number of inflation-targeting countries

For inference and confidence in the estimated outcomes, this paper applies the methodology of Cattaneo et al. (2021). This approach quantifies uncertainty by computing conditional prediction intervals around the estimated synthetic control.[10] This method separately computes the upper bound $\hat{y}_{it,upper}$ and lower bound $\hat{y}_{it,lower}$ around the synthetic control $\hat{y}_t$ for $t > T_0$. These can also be normalized around the estimated treatment effect α_t, by the formulas $\alpha_{t,upper} = y_t - \hat{y}_{t,upper}$ and $\alpha_{t,lower} = y_t - \hat{y}_{t,lower}$, and averaged into the ATE similarly as exposed above.

[8] Data available at https://unstats.un.org/unsd/methodology/m49/

[9] The analysis is also conducted using all non-treated countries in the sample. Results are presented in Appendix A.3.3.

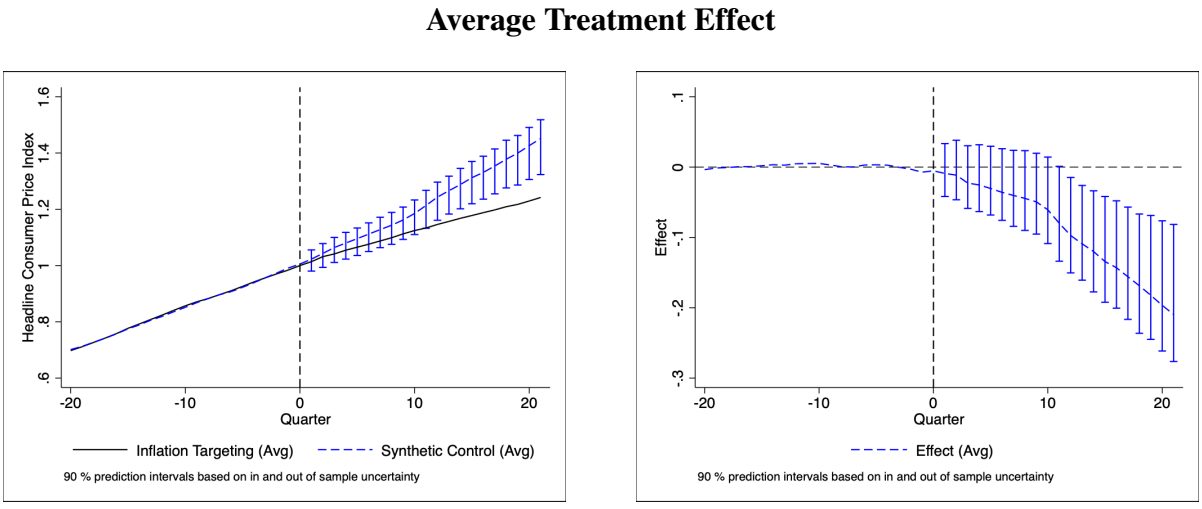
[10] The statistical software described in Cattaneo et al. (2024) is used, with implementations in Python, R, and Stata. Additional documentation is available at https://nppackages.github.io/scpi/. Prediction intervals are constructed using sub-Gaussian bounds.

3.4 Results

This section presents the results on the effect of IT adoption on CPI and inflation rates. Estimates are presented from the most aggregated to the most granular. It begins with the ATE based on the most extensive sample of IT adopters, then presents estimates for developed and developing economies. For developed economies—OECD members in 1990—it also shows estimates at the country level, while for developing economies results are shown at the regional level—European (non-OECD) countries, the Middle East, Latin America, the Caribbean, Africa, and Asia. Finally, results are summarized at the country level for every region analyzed.

3.4.1 Average treatment effect

For calculating the ATE, 37 of the 44 countries were used, and the remaining 7 were excluded. Of these, 2 countries adopted inflation targeting after 2018 and lacked five years of post-adoption data, and 5 were excluded for poor synthetic control fit. The ATE is displayed in Figure 3.2, where both panels are split into the pre-treatment years—when weights are computed—and the post-treatment years—when causal effects and prediction intervals are estimated.



(a) Headline CPI Trayectories

(b) Headline CPI Effect

Figure 3.2: The figures illustrate the effects of inflation targeting on the CPI. The 90% prediction intervals follow the methods of Cattaneo et al. (2021) and Cattaneo et al. (2024). These intervals account for both in-sample and out-of-sample uncertainty, with the latter constructed using sub-Gaussian bounds.

Panel (a) shows the average CPI, y_t, for inflation-targeting countries and the average synthetic

controls. The pre-treatment fit is strong, indicating reliable estimation. After adoption, the CPI diverges downward from the synthetic control, indicating lower inflation levels. The CPI trajectory flattens, while the synthetic control's slope rises. This suggests that IT not only reduces inflation but may also prevent fluctuations similar to those observed in non-adopting countries.

Panel (b) presents the treatment effect, α_t. Before adoption, the effect is near zero; afterward, it becomes negative. Five years after adoption, the CPI is about 20% lower than the synthetic control. Three years post-adoption, the effect falls outside the prediction intervals, becoming statistically significant. The negative effect persists and widens, indicating sustained reductions in inflation throughout the post-treatment period compared to non-adopters.

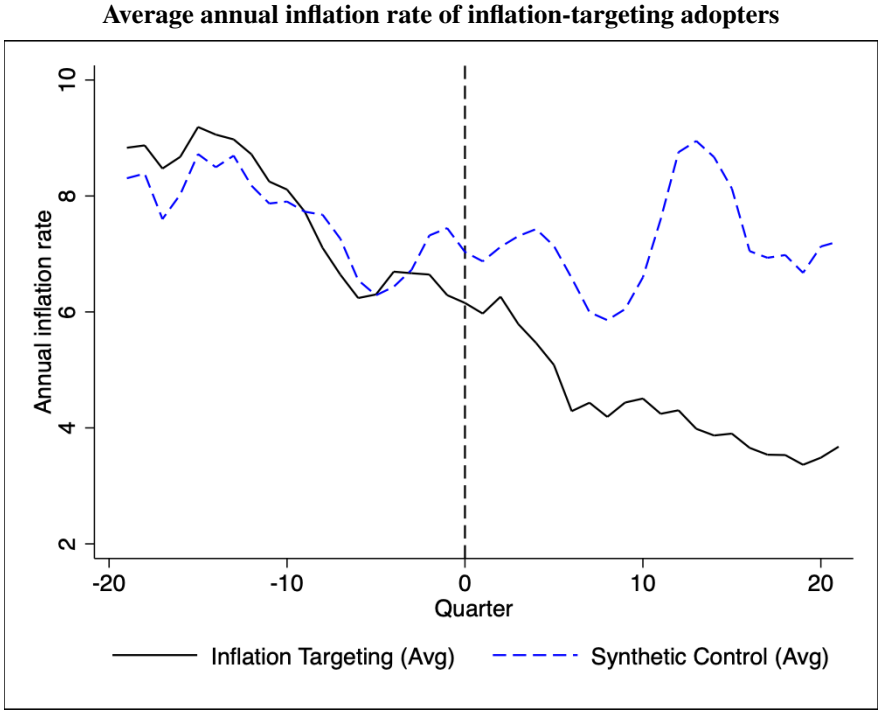


Figure 3.3: This figure shows the annual inflation rates derived from the average CPI trajectory of IT adopters compared to their synthetic controls.

Figure 3.3 shows the annual inflation rates based on the average headline CPI for IT countries and their synthetic controls.[11] During the pre-treatment period, both series follow similar paths, with average annual inflation rates of about 7.7% for inflation-targeting countries and 7.6% for the synthetic control.

In the post-treatment period, inflation-targeting countries record an average annual inflation rate of 4.4%, compared to 7.2% for the synthetic control, a reduction of 2.8 percentage points.

[11] In the pre-treatment period, the match between annual inflation rates is less precise than for the headline CPI. For this reason, effects were calculated using the headline CPI.

One year after adoption, inflation falls and stabilizes below 4%, while the synthetic control shows no significant change and greater fluctuations. In the last 10 quarters, the standard deviation for inflation-targeting countries is 0.3, compared to 0.9 for the synthetic control. These results confirm that inflation targeting reduces inflation and prevents large fluctuations.

3.4.2 Average treatment effects: developed and developing economies

The average treatment effects are disaggregated into developed and developing economies, as shown in Figure 3.4. Panels (a) and (b) show that in both groups, the average CPI closely matches the synthetic control in the pre-treatment period. After adoption, CPI grows more slowly than the synthetic control, indicating that inflation targeting reduces inflation levels.

For developed economies, the CPI shows a sharper decline after adoption, with no significant changes in the trajectory of the synthetic control. For developing economies, the decline in CPI is more gradual, while the synthetic control trajectory increases. This suggests that in developed economies, the main effect is a reduction in inflation. In contrast, in developing economies, inflation targeting both reduces inflation and dampens fluctuations.

Panels (c) and (d) present the treatment effects. Five years after adoption, CPI falls by about 15% and 25% for developed and developing economies, respectively. These results align with the literature, where significant effects are more common in developing economies. However, this analysis also finds significant, though smaller, effects for developed economies.

Panels (e) and (f) display annual inflation rates. For developed economies, in the pre-treatment period the average rates are similar: 5.6% for adopting countries and 5.5% for the synthetic control. Post-treatment, adopting countries average 2.2%, compared to 4.0% for the synthetic control, a difference of 1.8 percentage points. The last 10 quarters show similar volatility, with standard deviations of 0.3 and 0.4 for adopting countries and the synthetic control, respectively. Both adopters and non-adopters experienced a fall in inflation (Ball and Sheridan, 2005), suggesting that adopters would have seen declining inflation even without adopting inflation targeting, though adoption contributed to further reductions.

For developing economies, pre-treatment annual inflation rates are nearly identical: 8.5% for adopters and 8.5% for the synthetic control. Post-treatment, adopters average 5.0% while the synthetic control averages 8.0%, a reduction of 3 percentage points. Volatility also decreases, with standard deviations of 0.4 for adopters and 1.1 for the synthetic control in the last 10 quarters. These results confirm that inflation targeting in developing economies reduced both inflation levels and

volatility.

3.4.3 Developed economies

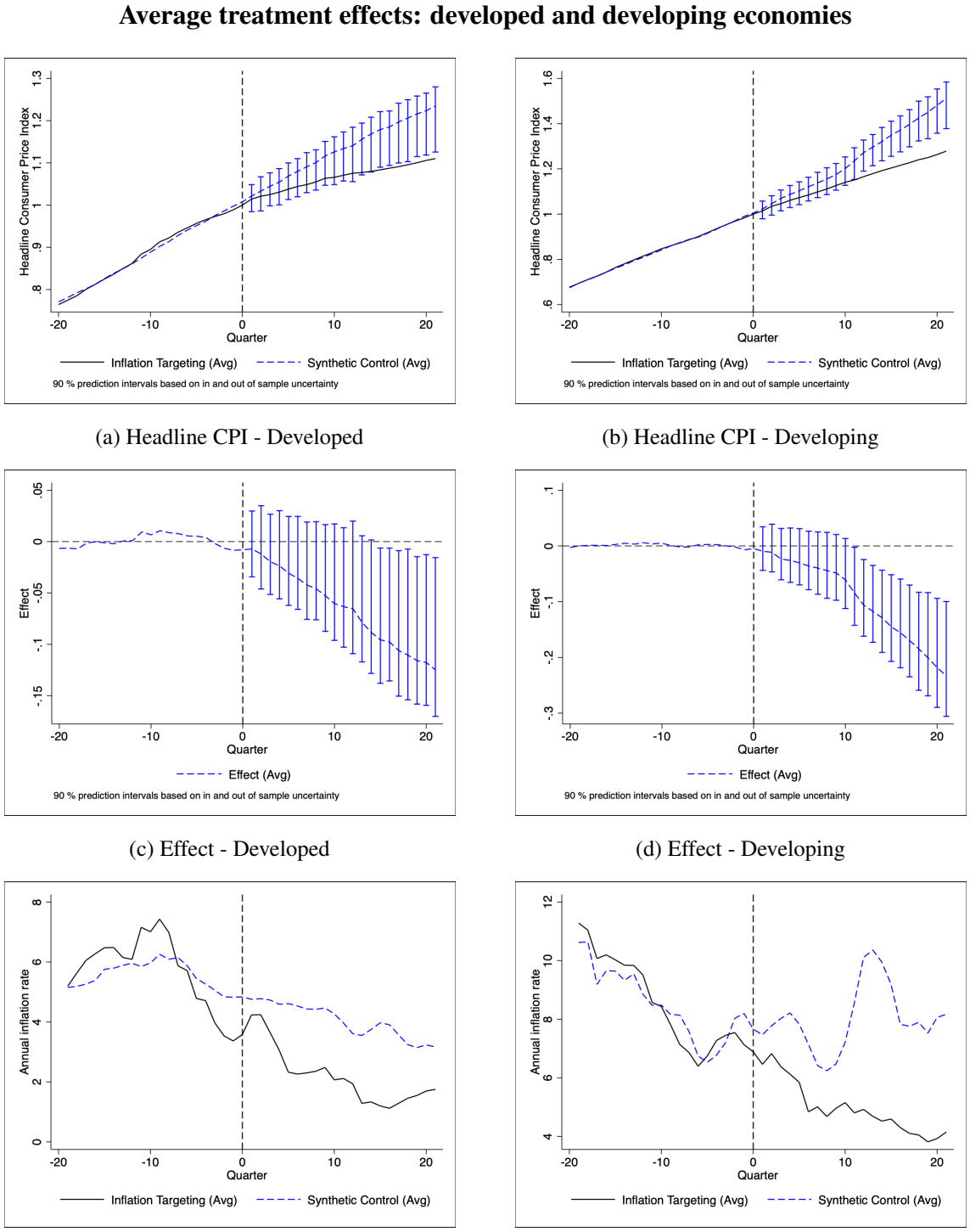
The average treatment effects for developed economies are further disaggregated by country. Figure 3.5 shows the estimated effects, ordered by adoption date, and Table 3.2 reports adoption dates and the percentage point change in the *average annual inflation rate* between pre- and post-treatment periods.

Panel (a) shows New Zealand, the first adopter in 1989Q4, with a 57.2% reduction in the headline CPI five years after adoption, corresponding to a 7.6 percentage point drop in the average annual inflation rate. Panel (b) shows Canada, adopting in 1991Q1, with a non-significant 3.8% CPI reduction, translating to a 0.6 percentage point drop in the average annual inflation rate.

Panel (c) shows the UK, adopting in 1992Q4, with a significant 8.7% CPI decline, corresponding to a 1.4 point drop in the average annual inflation rate. Panel (d) shows Sweden, adopting in 1993Q1, with an 11.5% CPI reduction that is not significant, alongside a 1.5 point drop in the average annual inflation rate. Panel (e) shows Finland, adopting in 1993Q2, with a significant 9.5% reduction five years after adoption, implying a 1.5 point decline in the average annual inflation rate.

Panel (f) shows Australia, adopting in 1993Q2, with a non-significant 7.0% CPI reduction and a 0.7 point drop in the average annual inflation rate. Panel (g) shows Spain, adopting in 1995Q1, with a non-significant 0.9% reduction and a 0.3 point drop in the average annual inflation rate. Finally, Norway, adopting in 2001Q1, shows a significant but small 1.3% CPI reduction and a 0.3 point decline in the average annual inflation rate.

Overall, all economies experienced a drop in inflation, but only New Zealand, the UK, Finland, and Norway show significant CPI reductions. Importantly, the magnitude of the effect declines as the adoption year increases. Countries adopting in the early 1990s experienced larger effects than those adopting later. New Zealand, the UK, Sweden, and Finland recorded drops in the average annual inflation rate above one percentage point, whereas Spain and Norway, which adopted after 1995, saw declines of less than 0.5 percentage points. During the 1990s, developed economies—both IT and non-IT—experienced a fall in inflation rates. For those adopting IT at the beginning of the decade, effects were larger because inflation levels were in general higher, compared to late adopters, when inflation levels were generally much lower.



(a) Headline CPI - Developed

(b) Headline CPI - Developing

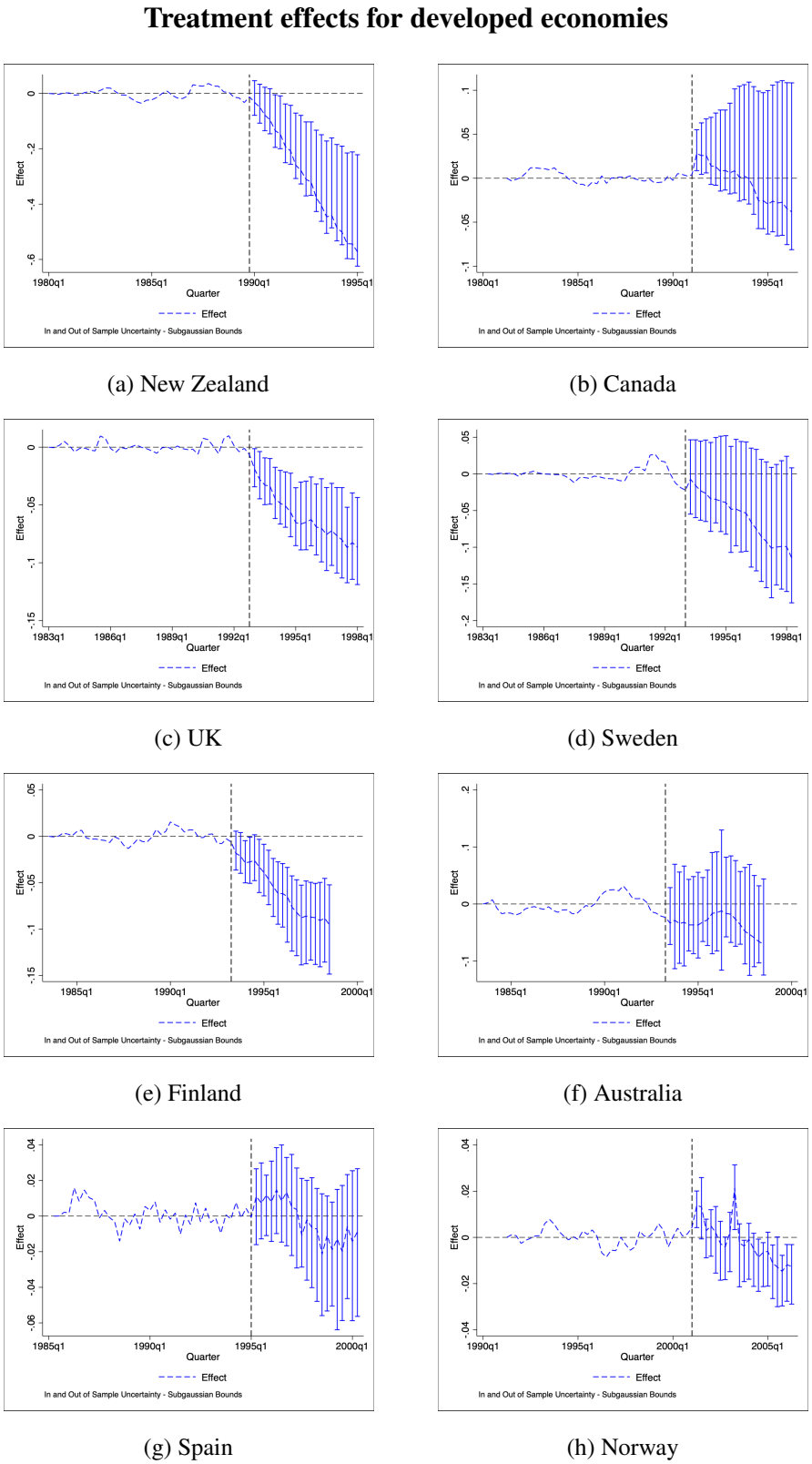
(c) Effect - Developed

(d) Effect - Developing

(e) Annual inflation rate - Developed

(f) Annual inflation rate - Developing

Figure 3.4: This figure shows the average treatment effect for developed and developing countries. The left column presents the trajectories of the average CPI, average effects, and average inflation rate for treated units and their synthetic controls in developed countries. The right column shows the same information for developing countries.



(a) New Zealand

(b) Canada

(c) UK

(d) Sweden

(e) Finland

(f) Australia

(g) Spain

(h) Norway

Figure 3.5: The figure presents the estimated effects and prediction intervals for each country included in the calculation of the average treatment effect for developed economies.

Country	Period of IT adoption	Avg. Inflation Difference to Synthetic Control Post IT (p.p.)
New Zealand	1989q4	-7.6
Canada	1991q1	-0.6
UK	1992q4	-1.4
Sweden	1993q1	-1.5
Finland	1993q2	-1.5
Australia	1993q2	-0.7
Spain	1995q1	-0.3
Norway	2001q1	-0.3

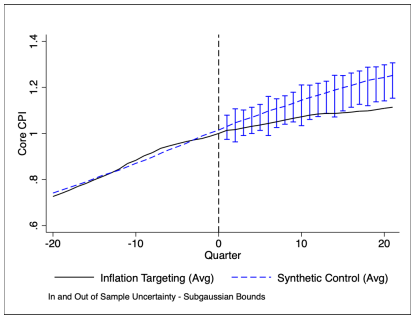
Table 3.2: Quarter of inflation-targeting adoption and average annual inflation rate differences, in percentage points, relative to the synthetic control, five years after adoption.

The data provided by Ha et al. (2023) also include core, food, and energy price index data, which allow the ATE to be decomposed. Figure 3.6 shows the trajectories and ATEs for these indexes in developed economies.[12] The main conclusion from this figure is that the adoption of IT had a significant effect on core CPI and food price indexes, while there is no effect on energy price.

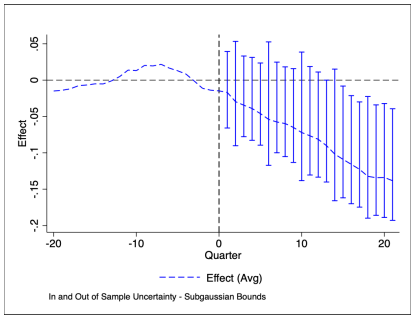
Panels (a) and (c) show the trajectories of the core and food price indexes. In both figures, after IT adoption the trajectories grow below their respective synthetic controls and eventually do not overlap with the prediction intervals. For the energy price index displayed in panel (e), this is not the case, as both the synthetic control and the index evolve alongside each other after IT adoption.

Estimated effects for the core and food price indexes are displayed in panels (b) and (d), respectively. These results show that the core CPI fell by 13.8% five years after adoption, corresponding to a reduction of 2 percentage points in average core inflation. For the food price index, the estimated effect is a decline of 10.6%, associated with a 1.6 percentage point drop in average food inflation. Panel (f) shows no significant effect for the energy price index, which is consistent with energy inflation rates remaining at similar levels for IT adopters and their synthetic controls.

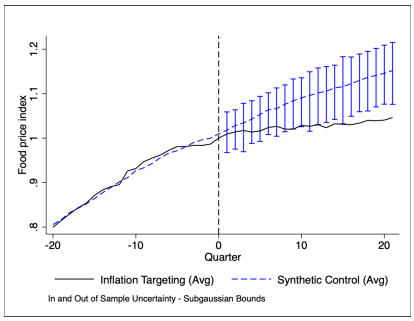
Average treatment effects for core, food, and energy price indexes



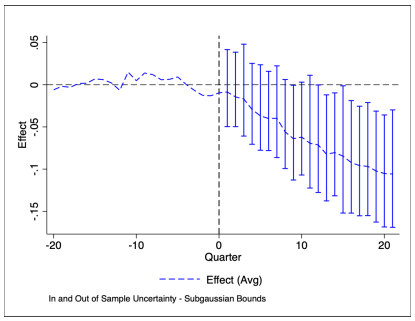
(a) Core Consumer Price Index



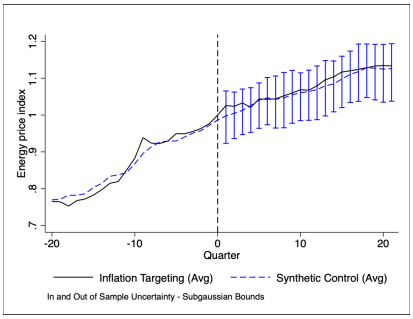
(b) Effect - Core Consumer Price Index



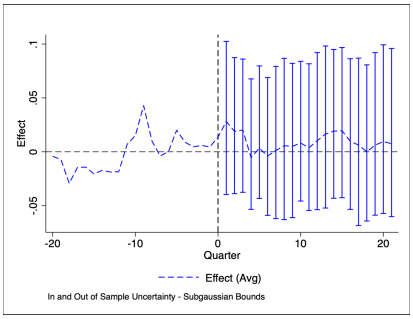
(c) Food Price Index



(d) Effect - Food Price Index

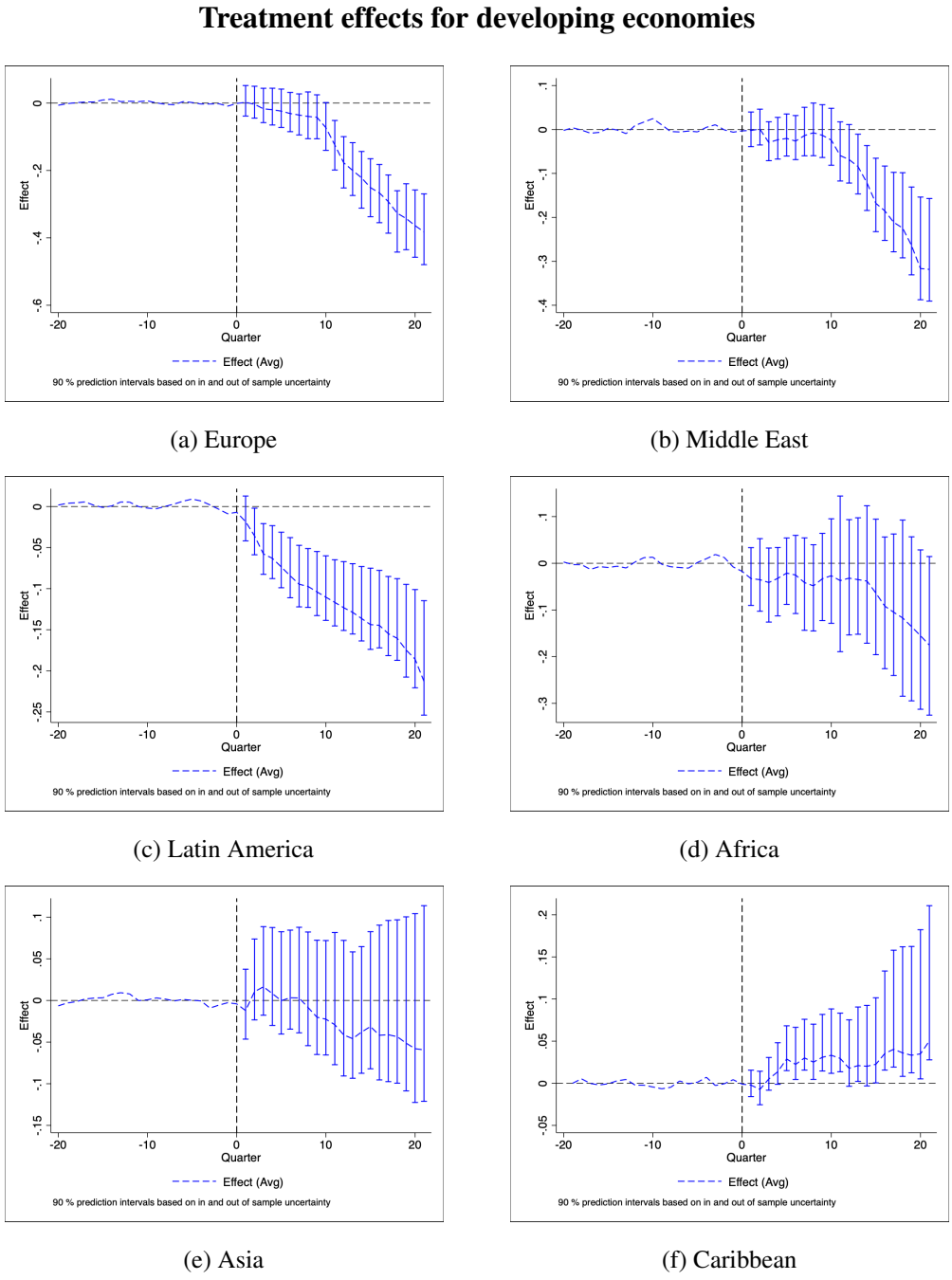


(e) Energy Price Index



(f) Effect - Energy Price Index

Figure 3.6: The figure presents the average estimated effects by decomposing the Consumer Price Index into core, food, and energy price indexes in developed economies.



(a) Europe

(b) Middle East

(c) Latin America

(d) Africa

(e) Asia

(f) Caribbean

Figure 3.7: The figure presents the estimated average treatment effects with prediction intervals for each region of developing economies. Regions are ordered from the largest to the smallest effects.

3.4.4 Developing economies

The average treatment effects for developing economies are disaggregated by region and presented in Figure 3.7, ordered by the magnitude of the effect. The figure supports the conclusion that while IT in developing countries generally reduces inflation by a larger magnitude compared to developed economies, these effects are not uniform across regions.

Panel (a) shows that European countries not classified as developed economies experienced the largest effect, with a 38.2% reduction in the CPI five years after adoption, equivalent to a 4.9 percentage point drop in the average annual inflation rate. Panel (b) shows that in the Middle East, the CPI fell significantly by 31.8%, or 4.3 percentage points. Panel (c) shows that for Latin America, the CPI significantly declined by 21.3%, corresponding to a 2.7 percentage point drop in inflation.

Conversely, Panel (d) shows that in Africa, the effects were not significant, despite a 17.5% reduction in the headline CPI, equivalent to a 2.2 percentage point drop in the average annual inflation rate. Similarly, Panel (e) shows that in Asia, the effects were also not significant, with only a 5.9% reduction, or a 0.7 percentage point decline in inflation. Finally, Panel (f) shows that for the Caribbean, the CPI increased significantly by 5%, or 0.7 percentage points.

3.4.5 Country-level results

The effects are further disaggregated at the country level for developing economies. Not all countries were included in calculating the Average Treatment Effects (ATE). Table 3.3 shows that of the 44 adopters, 7 were excluded. Five were removed due to poor fit between the headline CPI and the synthetic control, and two due to adopting inflation targeting after 2018, having fewer than 5 years of post-adoption data. The table also shows that 10 countries were estimated using less than 10 years of pre-treatment data.

Table 3.4 presents the 37 economies used to calculate the Average Treatment Effects (ATE), divided into developed and developing economies and their regions. It reports if the effects were positive or negative, indicates significance based on the CPI trajectory falling outside the prediction intervals, and shows the change in average annual inflation rates 5 years after adoption.

As mentioned before, among the 8 developed economies, all show negative effects, with 4

[12]Core, food, and energy price indexes are not available for every country in the sample used in this paper. ATEs were therefore estimated only for developed economies, as these data are available for the same countries and time periods as the ATE estimates for headline CPI.

Region	# Countries	# Excluded Total	# Excluded Poor fit	# Excluded After 2018	# Less 10 years Pre IT	# Countries in ATE
Developed	**8**	**0**	**0**	**0**	**0**	**8**
Developing	**36**	**7**	**5**	**2**	**10**	**29**
Europe	10	1	1	0	6	9
Middle east	4	1	1	0	1	3
Latin America	9	1	1	0	2	8
Africa	3	1	0	1	0	2
Asia	8	2	1	1	0	6
Caribbean	2	1	1	0	1	1
Total	**44**	**7**	**5**	**2**	**10**	**37**

Table 3.3: The table reports the number of inflation-targeting countries excluded, distinguishing between poor fit and fewer than 5 years of post-adoption data. It also shows the number of countries used to calculate the Average Treatment Effects and those with less than 10 years of pre-treatment data.

significant, leading to a 1.8 percentage point drop in the average annual inflation rate 5 years after adoption. Among the 29 developing economies, 21 recorded decreases in the CPI, 14 of which were significant, while 8 showed increases, 5 significant. Overall, developing economies saw a 3.0 percentage point reduction in the average annual inflation rate.

Breaking down developing economies by region reveals clear heterogeneity. For instance, in Europe, most countries experienced declines: 6 out of 9 recorded CPI reductions—5 of them significant—while 3 saw increases, only one of which was significant. This produced a substantial regional drop of 4.9 points. In contrast, effects in Asia were smaller: 2 countries recorded increases—1 significant—while 4 experienced decreases—2 significant—resulting in a modest regional decline of 0.7 points.

Overall, 29 of the 37 economies (78.4%) experienced lower inflation rates after adopting inflation targeting, and 18 of these declines (62.1%) were statistically significant. Eight economies (21.6%) saw increases, five of which were significant. Thus, while inflation targeting does not guarantee significant reductions in all cases, its predominant effect is a statistically significant decline in inflation.[13]

[13]For more details, see Table 5, which reports the number of pre-IT years used to construct the synthetic control, the year of IT adoption, whether the country was excluded from the ATE estimation, whether the estimated effects were statistically significant, and the change in annual inflation rates (in percentage points) after adoption.

Region	# Countries in Avg	# Positive Effects	# Positive Effects (Outside PI)	# Negative Effects	# Negative Effects (Outside PI)	Region (Outside PI)	Avg. Inflation Diff. to SC Post IT (p.p.)
Developed	**8**	**0**	**0**	**8**	**4**	**yes**	**-1.8**
Developing	**29**	**8**	**5**	**21**	**14**	**yes**	**-3.0**
Europe	9	3	1	6	5	yes	-4.9
Middle East	3	1	1	2	2	yes	-4.3
Latin America	8	1	1	7	5	yes	-2.7
Africa	2	0	0	2	0	no	-2.2
Asia	6	2	1	4	2	no	-0.7
Caribbean	1	1	1	0	0	yes	0.7
Total	**37**	**8**	**5**	**29**	**18**	**yes**	**-2.8**

Table 3.4: The table summarizes the aggregation of Average Treatment Effects by region. It lists the number of countries used, the count of positive and negative effects, and whether these effects are significant (outside the prediction intervals) five years after adoption. It also reports the percentage point difference in average annual inflation rates between the synthetic control and treated countries after adoption.

3.5 Conclusion

Inflation targeting is a widely used framework. Adopting countries often began with high inflation, which decreased after implementation, enabling them to meet their targets. However, evidence on its impact remains mixed. These mixed results partly reflect differences in methodology, time periods, and country samples across studies. This article applies the SCM to a comprehensive sample of 171 economies from 1980 to 2023. It estimates the average treatment effects of inflation targeting, the effects for developed and developing economies, and the country-level effects for all adopters to date.

This study finds that the Inflation Targeting Framework effectively reduces inflation. The average treatment effects across all adopters show a 2.8 percentage point decline in inflation. Significant reductions are observed in both developing and developed economies, with larger effects in developing economies (3.0%) compared to developed ones (1.8%). In developing economies, of the 6 regions analyzed, 5 showed inflation decreases (3 significant), while 1 showed a significant increase. However, country-level effects vary. Among the 37 countries used to calculate the ATE, eight showed positive effects (five significant), while 29 recorded negative effects (18 significant).

Therefore, it can be concluded that the adoption of the Inflation Targeting Framework effectively reduces inflation. These results hold for both developed and developing economies, at both the regional and country levels. Although not all regions or countries show significant drops in inflation,

this remains the most common outcome.

Appendix

A.1 Results at the country level

Results at the regional and country levels can be found in the supplementary material document. This document provides estimates of the effects of IT adoption on CPI trajectories and the corresponding treatment effects behind the results presented in this document. It also presents regional- and country-level robustness tests similar to those presented in this appendix for the ATE. Additionally, at the country level, it presents the estimated synthetic control weights as well as the estimated effects on inflation rates. Table 5 summarizes the country-level results.

Country	Pre-IT years	Period IT adoption	Excluded	Outside CI (5 yrs)	Avg Infla Diff to SC Post IT (p.p.)
Developed					
New Zealand	10.0	1989q4	no	yes	-7.6
Canada	10.0	1991q1	no	no	-0.6
UK	10.0	1992q4	no	yes	1.4
Sweden	10.0	1993q1	no	no	-1.5
Finland	10.0	1993q2	no	yes	-1.5
Australia	10.0	1993q2	no	no	-0.7
Spain	10.0	1995q1	no	no	-0.3
Norway	10.0	2001q1	no	yes	-0.3
Developing					
Europe					
Czechia	6.75	1997q4	no	yes	-3.0
Poland	5.0	1998q3	no	yes	-7.7
Iceland	5.0	2001q1	no	yes	1.3
Hungary	5.0	2001q2	no	no	-0.8
Romania	10.0	2005q3	no	yes	-3.2
Serbia	10.0	2009q1	no	yes	-19.6
Albania	6.0	2009q1	no	no	0.3
Moldova	10.0	2011q1	no	yes	-7.7
Russia	5.0	2015q1	no	no	1.4
Ukraine	5.0	2016q4	yes	yes	3.2
Middle East					
Israel	10.0	1997q2	no	yes	1.0
Armenia	8.25	2006q2	no	yes	-2.0

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Table 5 continued from previous page

Country	Pre-IT years	Period IT adoption	Excluded	Outside CI (5 yrs)	Avg Infla Diff to SC Post IT (p.p.)
Georgia	10.0	2009q1	no	yes	-10.5
Türkiye	5.0	2006q1	yes	no	-2.5
Latin America					
Chile	10.0	1999q3	no	yes	-1.8
Colombia	10.0	1999q4	no	yes	-7.5
Mexico	10.0	2001q1	no	yes	-3.8
Peru	5.5	2002q1	no	yes	-6.7
Guatemala	10.0	2005q1	no	yes	-0.6
Uruguay	10.0	2008q4	no	no	-0.02
Paraguay	10.0	2011q2	no	no	-1.3
Costa Rica	5.0	2018q1	no	yes	1.3
Brazil	5.0	1999q2	yes	yes	-18.3
Africa					
South Africa	10	2000q1	no	no	-1.7
Uganda	10	2012q3	no	no	-2.8
Seychelles	10	2019q1	yes	no	-63.9
Asia					
Republic of Korea	10	1998q2	no	no	0.3
Thailand	10	2000q2	no	yes	-3.4
Philippines	10	2002q1	no	no	-2.7
Indonesia	10	2005q3	no	yes	-0.7
India	10	2015q1	no	no	-0.7
Kazakhstan	10	2015q3	no	yes	2.6
Japan	6	2012q1	yes	no	0.8
Sri Lanka	10	2020q1	yes	no	14.9
Caribbean					
Dominican Republic	5.0	2012q1	no	yes	0.7
Jamaica	6.25	2017q3	yes	yes	3.8

Table 5: This table reports country-level estimates of inflation targeting effects. It shows the number of years in the pre-treatment period used to compute the synthetic control weights, the year and quarter of adoption, whether the country was excluded from the computation of the ATE, whether the effects were significant by falling outside the prediction intervals during the five years after adoption, and the change in inflation rates, measured in percentage points, after treatment.

A.2 Literature review

The contributions to the literature of this document are based on a review of 23 articles estimating the effects of the adoption of IT on inflation levels, as shown in Table 6. The table shows that the results are mixed. For each method considered, differences in samples—time periods and

treated countries—may result in the identification of substantial decreases in inflation levels or non-significant results after adoption.

Article	Identification Strategy	Evidence	Sample	Findings
Naqvi and Rizvi (2009)	Diff-in-Diff	Against	Period 1987:1–2007:4. Total countries 10, IT 4, non-IT 6. Region, Asia.	Inflation performance improved in all Asian economies in the post-targeting period, but IT did not play a significant role; improved performance is consistent with reversion to the mean.
Thornton (2016)	Diff-in-Diff	Against	Period 1980–2013. Total countries 72, IT 14, non-IT 58. Data from developing economies.	Adopting IT did not significantly reduce inflation or GDP growth volatility relative to other regimes.
Abo-Zaid and Tuzemen (2012)	Diff-in-Diff	Favor	Period 1980–2007. Total countries 50, IT 23, non-IT 27. Data from developed and developing countries.	IT is associated with lower and more stable inflation and higher and more stable GDP growth in developing countries; in developed countries, IT is linked to higher GDP growth and more disciplined fiscal policy.
Alpanda and Honig (2014)	Diff-in-Diff	Favor	Period 1980–2006. Total countries 66. IT 23, non-IT 43. Data from 22 developed and 44 developing economies	IT has no significant effects in advanced economies, but it provides significant benefits in developing economies.
Kose et al. (2018)	Diff-in-Diff	Favor	Period 1996–2015. Total countries 37, IT 16, non-IT 21. Data from developed and developing economies	IT reduced inflation and inflation volatility but was largely neutral for economic growth; it did not stabilize real exchange rates and was sometimes destabilizing.
Gonçalves and Salles (2008)	Diff-in-Diff	Favor	Period 1980–2005. Total countries 36, IT 13, non-IT 23. Data from emerging economies.	IT in emerging economies led to significant reductions in inflation and inflation volatility, without adversely affecting output growth.
Ardakani et al. (2018)	Matching	Against	Period 1990–2013. Total countries 98, IT 27, non-IT 71. Data from developed and developing countries.	No significant differences in inflation levels or volatility between targeters and non-targeters after adoption; however, IT reduced the sacrifice ratio and interest-rate volatility in developed economies and enhanced fiscal discipline in both developed and developing countries.
Vega and Winkelried (2005)	Matching	Favor	Period 1980–2003. Total countries 109, IT 23, non-IT 86. Data from developed and developing economies.	For developing countries, IT significantly reduced the level and volatility of inflation and decreased inflation persistence. For developed countries, effects are lower and less pronounced.
de Mendonça and de Guimarães e Souza (2012)	Matching	Favor	Period 1990–2007. Total countries 180. IT 29, non-IT 151.	IT is an ideal monetary regime for developing economies, significantly reducing inflation and inflation volatility to internationally acceptable levels; for advanced economies, IT does not provide significant advantages.
Lin and Ye (2009)	Matching	Favor	Period 1985–2005. Total countries 52, IT 13, non-IT 39. Data from developing countries.	IT significantly lowered inflation and inflation variability in the thirteen developing countries studied; effectiveness varies with country-specific factors such as fiscal discipline and exchange-rate management.
Yamada (2013)	Matching	Favor	Period 1995–2007. Total countries 121. IT 17, non-IT 104. Data from developing economies.	IT performed better than, or at least as well as, fixed regimes relative to intermediate/flexible regimes; there is no clear difference between fixed and IT regimes in 2000–2007; intermediate and flexible regimes generally deliver higher inflation.
Arsić et al. (2022)	Matching	Favor	Period 1997–2019. Total countries 26, IT 12, non-IT 14. Data from Europe and Central Asia economies.	IT improved macroeconomic performance by reducing inflation, inflation volatility, and GDP volatility, with particularly robust results post-2008; IT did not affect inflation persistence or GDP growth.
Brito and Bystedt (2010)	Panel	Against	Period 1980–2006. Total countries 46. IT 13, non-IT 33. Data from developing countries.	No significant evidence that IT improves economic performance in terms of reducing inflation or stabilizing output growth; IT countries exhibit lower long-run mean inflation but the costs of disinflation are not lower than under other monetary regimes; IT is associated with lower output growth.
Stojanovikj and Petrevski (2021)	Panel	Against	Period 1970–2017. Total countries 44, IT 17, non-IT 27. Data from developing economies.	IT is associated with lower average inflation, but its favorable effects are negligible; there is firm evidence against the proposition that IT lowers inflation volatility; results are robust to alternative specifications and additional controls.
Ayres et al. (2014)	Panel	Favor	Period 1985–2010. Total countries 52, IT 17, non-IT 35. Data from developing countries.	IT is associated with significant reductions in inflation rates and volatility in developing countries, with regional heterogeneity: Europe and Latin America show sizeable disinflation; the Middle East also declines; Asia and Sub-Saharan Africa show slight increases; Oceania shows no clear impact.
Ball and Sheridan (2005)	Diff-in-Diff	Against	Period 1960-2000. Total countries 20, IT 7, non-IT 13. Data from developed countries exclusively.	On average, there is no evidence that IT improves inflation, output, or interest-rate performance; improvements among targeters are consistent with regression to the mean and identification concerns.

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Article	Identification Strategy	Evidence	Sample	Findings
Ball (2010)	Diff-in-Diff	Against	Period 1985-2007. Total countries 20, IT 7, non-IT 13. Data from developed countries exclusively.	On average, there is no evidence that inflation targeting improves performance in terms of inflation, output, or interest rates. Both inflation-targeting and non-targeting countries experienced similar improvements over time, suggesting that other factors contributed to better performance. Regression to the mean explains the apparent benefits of targeting.
Willard (2012)	IV	Against	Period 1985-2002. Total countries 22, IT 8, non-IT 14. Data from developed countries exclusively.	The effect of IT on inflation is generally small and statistically insignificant; IT does not significantly affect inflation variability, uncertainty, or expectations.
Lin and Ye (2007)	Matching	Against	Period 1985–1999. Total countries 22, IT 7, non-IT 15. Data from developed countries exclusively.	IT has no significant effects on inflation or inflation variability in the seven industrial-country cases.
Ginindza and Maasoumi (2013)	Matching	Favor	Period 1980–2007. Total countries 30, IT 12, non-IT 18. Data from developed countries exclusively.	IT helps lower and stabilize inflation, but the numerical quantification is sensitive; there is no evidence of larger gains for late adopters, and reductions in inflation variability are often small and statistically insignificant.
Barbosa et al. (2018)	SCM	Favor	Period 1985-2007. Total countries 20, IT 7, non-IT 13. Data from developed countries exclusively.	IT adopters experienced lower inflation and higher output growth relative to their synthetic controls during the 1990s, with average annual inflation reductions of roughly one percentage point.
Duncan et al. (2022)	SCM	Favor	Period 1980–2018. Total countries 90, IT 23, non-IT 67. Data from 26 advanced economies and 64 emerging and developing economies.	IT effects are heterogeneous and modest on average, with stronger gains in developing economies; IT helps keep inflation closer to target in about half of cases and improves resilience during crises, with effectiveness linked to exchange-rate stability and monetary policy independence.
Lee (2011)	SCM	Mixed	Period 1980–2006. Total countries 60, IT 13, non-IT 47. Data from 60 developing economies.	IT reduced inflation in several cases, while effects were heterogeneous and sensitive to timing.

Table 6: This table lists the articles used in the literature review. For each article, it shows the identification strategy, whether the evidence favors or is against a significant reduction in inflation after IT adoption, the sample, and a brief summary of the findings. The results are organized according to the identification strategy and the type of evidence.

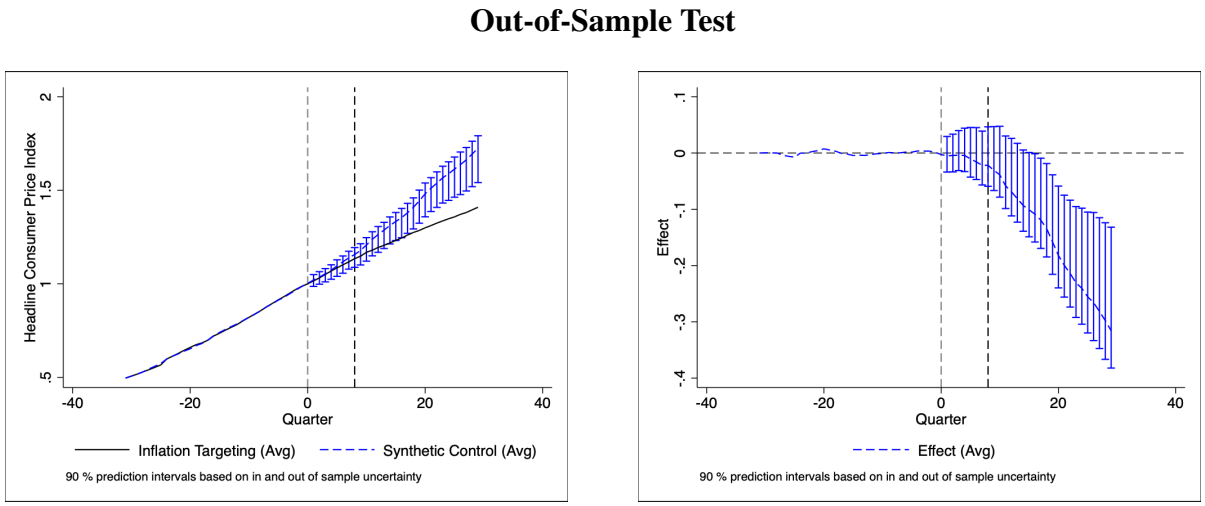
A.3 Robustness tests

To validate the estimated effects, this paper implements three robustness checks: re-estimating the effects using the entire donor pool and monthly frequencies, out-of-sample tests, and permutation tests. Given the regional donor pool and the quarterly frequencies of the main results, the paper also estimates the effects using every donor in the sample with monthly frequencies, expecting similar results. The Out-of-Sample Validation Test, as recommended by Abadie and Vives-i Bastida (2022), involves moving the treatment date backward. In this study, the treatment date is moved backward by two years for each case. If the average treatment effects are correctly estimated, moving the treatment date backward by two years is not expected to result in significant differences compared to estimating the effects at the original treatment date. In other words, moving the treatment date backward should not lead to significant changes in the headline CPI before adopting inflation targeting.

Finally, as recommended by Abadie et al. (2015), the permutation test, also referred to as the placebo test, is applied. This method involves recalculating the results by simulating the treatment

for countries within the donor pool. Specifically, the process excludes the originally treated unit from the analysis, assigns the treatment to a selected country within the donor pool during the same period as the originally treated unit, and uses the remaining countries in the donor pool to construct a synthetic control. This procedure is repeated iteratively for each country in the donor pool. Subsequently, the outcome variables and synthetic controls are averaged. If a country did not implement inflation targeting, assuming it was treated on that specific date would be expected to yield null effects on the headline CPI. Since this procedure is applied across all countries in the donor pool and the effects are averaged, the resulting average effects are also expected to be null.

A.3.1 Out-of-Sample test



(a) Headline CPI Trayectories

(b) Headline CPI Effect

Figure 8: The Out-of-Sample Test involves shifting the treatment date backward by two years and re-estimating the effects. The gray dotted line marks two years before the adoption, while the dotted black line indicates the actual adoption period

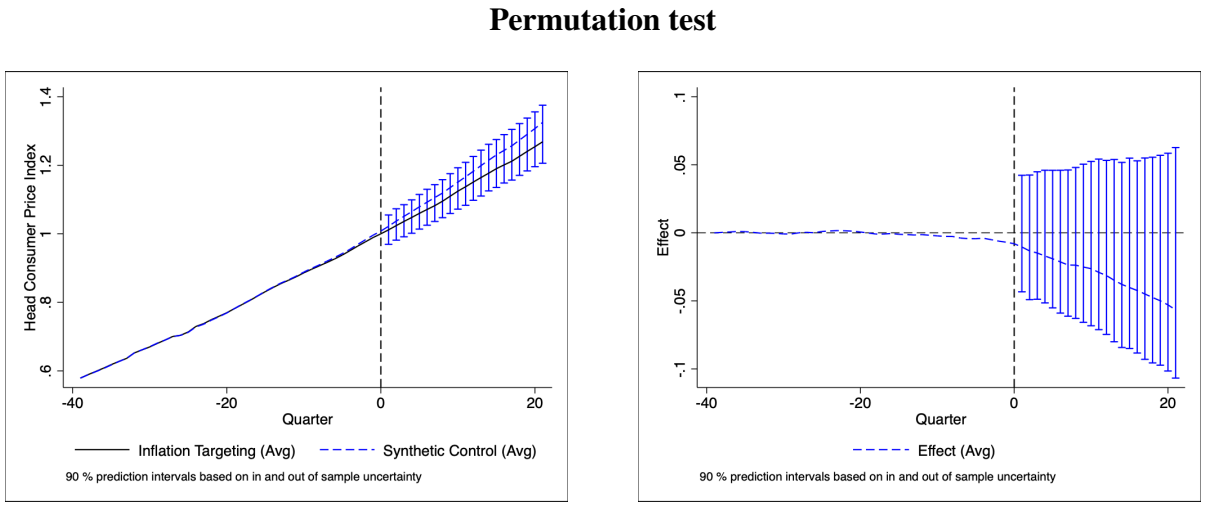
The Out-of-Sample test proposed by Abadie and Vives-i Bastida (2022) advances the treatment date by two years to evaluate the robustness of the results. Synthetic controls approximate the outcome trajectory assuming no intervention. Reliability is assessed by comparing predicted outcomes in the shifted pre-treatment period with actual data. If results are robust, advancing the treatment date should not substantially change the estimated effects.

Figure 8 summarizes the results. Panel (a) shows that moving the treatment date back by two years does not materially change the pre-treatment fit. The average synthetic control continues to closely match the average headline CPI during the shortened pre-treatment period. Both series

follow similar paths between the backward and actual treatment dates. After the actual treatment date, the CPI grows more slowly than the synthetic control, with only a minor divergence appearing about three quarters before treatment.

Panel (b) highlights this small early divergence, which becomes significant seven quarters after the actual treatment date—earlier than the twelve quarters observed in the baseline results. Backdating the treatment date yields a 31.6% reduction in the CPI, equivalent to a 3.6 percentage point drop in the average annual inflation rate five years after treatment, compared to the 2.8 point reduction in the main results.

A.3.2 Permutation test



(a) Headline CPI Trayectories

(b) Headline CPI Effect

Figure 9: The Permutation test involves assigning the treatment of inflation-targeting adoption to every country in the donor pool for each inflation-targeting country and re-estimating the effects. The effects are then averaged for each inflation-targeting country and subsequently averaged across all inflation-targeting countries

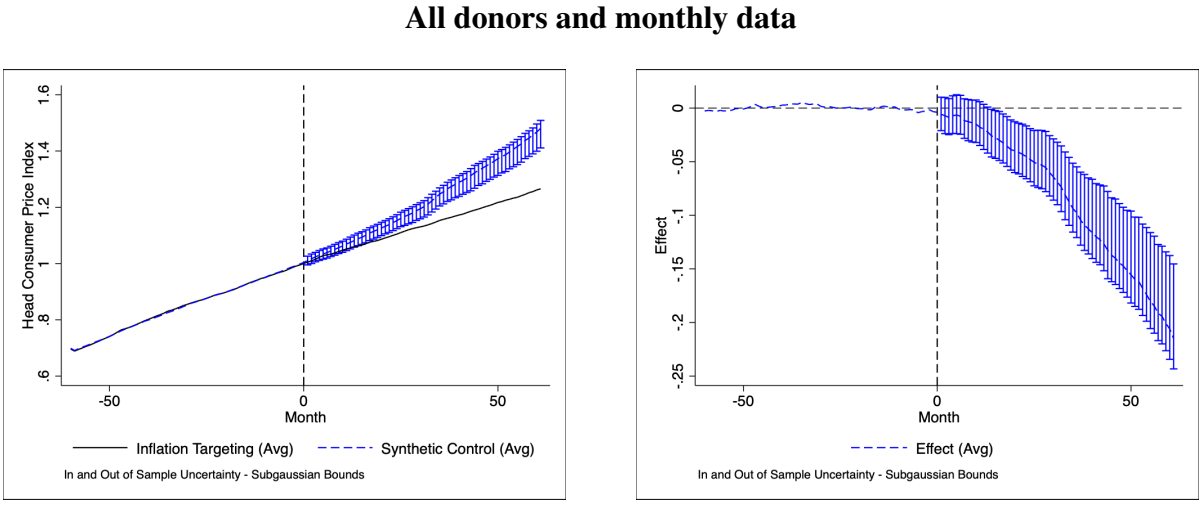
To verify that the estimated effects are attributable only to countries adopting inflation targeting, a permutation test following Abadie et al. (2015) is performed. The procedure assigns placebo treatments to donor pool countries on the same dates as treated countries, excluding the actual treated unit. Synthetic controls are then re-estimated using the remaining donor pool. This process is repeated for all donor countries, and the CPI, synthetic controls, and prediction intervals are averaged.

This approach tests whether CPI trajectories would change if donor countries had hypothetically

adopted inflation targeting. Since they did not adopt, CPI trajectories should remain unaffected, and no significant differences are expected between outcomes and synthetic controls.

Figure 9 shows the results. Panel (a) indicates that the average headline CPI and synthetic control follow nearly identical paths before and after treatment. Minor post-treatment divergences are not statistically significant, as the CPI remains within prediction intervals. Panel (b) confirms that effects stay close to zero and within prediction intervals throughout. The placebo effect is below 5%, compared to nearly 20% for actual adopters, implying only a 0.1 percentage point reduction in annual inflation five years after treatment. These results confirm that the observed effects are driven by inflation targeting.

A.3.3 Estimates using monthly data and all donors in the sample



(a) Headline CPI Trayectories

(b) Headline CPI Effect

Figure 10: The figure shows the average treatment effect computed using all the countries in the sample as donors and monthly data. Having a larger number of pre-treatment periods helps to mitigate overfitting issues, reducing the bias that can arise from using a large donor pool.

The main results were calculated using quarterly and regional data, selecting donors similar to treated countries to reduce overfitting and interpolation bias. As a robustness check, the results were recalculated using all sample countries with monthly data. Extending the donor pool and pre-treatment period improved the model fit. Only 4 of the 44 countries were excluded, compared to 7 in the main results.

Figure 10 shows these results. Panel (a) indicates an excellent pre-treatment fit between the

average headline CPI and the synthetic control. After adoption, the CPI grows more slowly, diverging from the synthetic control. Prediction intervals are narrower than in the regional results. Panel (b) shows that effects fall outside the prediction intervals after the 14th month, compared to the third year when using quarterly data. Five years after adoption, the CPI remains roughly 20% below the synthetic control, consistent with the main results.

Figure 11 presents annual inflation rates estimated with monthly data and all donors. The pre-treatment fit improves compared to the regional results. The average annual inflation rate is 7.8% before treatment and falls to 4.9% after treatment, while the synthetic control remains at 7.7%, implying a 2.8 percentage point decline—almost identical to the 2.8-point result using country groups, differing only by decimals. Volatility also decreases, with a standard deviation of 0.2 in the last 2.5 years compared to 0.6 for the synthetic control. These results confirm that using monthly data and a larger donor pool leads to the same conclusion: inflation drops and becomes less volatile after adopting inflation targeting.

Global average annual inflation rate using monthly data and all donors

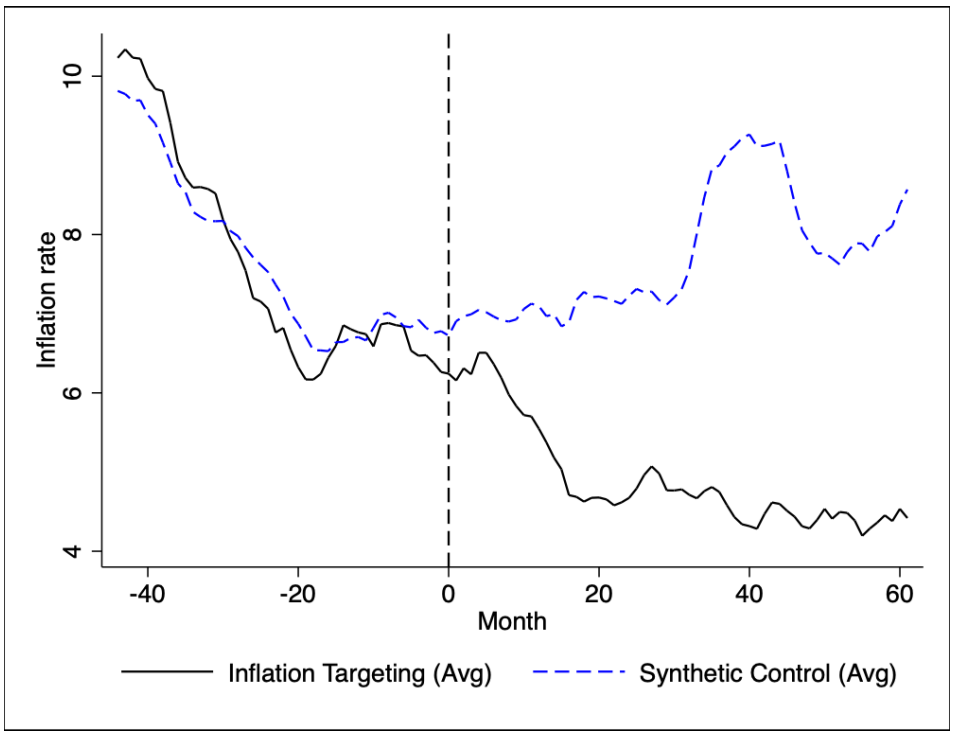


Figure 11: This figure shows the annual inflation rates calculated using the trajectory of the global average headline CPI for countries that adopted inflation targeting, as well as the trajectory of the global average synthetic control using monthly data and all donors in the sample

4. Congruence with Citizens' Preferences in Athenian vs. Representative Democracies

Abstract

This paper addresses the comparative effectiveness of Athenian and representative democracies in implementing policies congruent with citizen preferences. By unifying both forms of democracy within a principal–agent framework, the study shows that the formal institutions of Athenian democracy were highly effective in ensuring policy congruence. This effectiveness resulted from judicial enforcement as well as the frequent citizen examinations and recall votes by the Athenian Assembly, which incentivized public officials to strictly implement the Assembly's decisions. In contrast, representative democracies do not inherently ensure policy congruence. Their effectiveness largely depends on informal institutions, particularly the preferences, values, and codes of conduct of elected representatives, which shape their commitment to representing the citizenry.

4.1 Introduction

Historically, there have been two main forms of democracy: assembly democracy, exemplified in ancient Athens, and representative democracy, which gained prominence through events such as the American and French Revolutions. Although both bear the name "democracy," they differ in methods, institutions, and values. In an assembly democracy, citizens directly choose policies. In a representative democracy, citizens elect representatives who make policy decisions on their behalf. Despite these differences, both systems share the goal of ensuring that policies are congruent with the citizenry by aligning them with citizens' preferences, interests, opinions, goals, or views.

Given the differences and shared purpose of both forms of democracy, a reasonable question arises: how do these two political systems compare in their capacity to make public policy congruent with the citizenry? The main conclusion of this paper is that in an assembly democracy—particularly the Athenian democracy—policy congruence with the citizenry stems primarily from its formal institutions. In contrast, in a representative democracy, formal institutions alone are insufficient. Policies align with the preferences of elected representatives, and unless these representatives value representing the citizenry or have a genuine interest in *making present* citizens' preferences, policies will not be congruent with the citizenry. Thus, policy congruence also relies on informal institutions, especially the codes of conduct of representatives derived from the democratic values that underpin representation.

In Athenian democracy, public positions were filled by magistrates responsible for implementing policies decided by the Athenian Assembly. Similar to representative democracy, both political systems face agency problems whenever representatives or magistrates implement policies not aligned with the citizenry. Hence, this paper builds on the principal–agent dynamic model developed by Banks and Duggan (2008), adapting it to incorporate both representative and Athenian democracy within a unified framework.

In this model, congruence is achieved whenever the agent implements the principal's preferred policy— for the citizenry, this corresponds to the median voter's preferred policy. The model also assumes an adverse selection setting, where the policies implemented by the agent are observable but the agent's preferences are not. The results are driven by the model's parameters. Therefore, in a comparative statics exercise, the analysis compares both forms of democracy based on the parameter values each system may take and examines how the implemented policy may align with or diverge from the principal's preferred policy.

Within the model, this paper compares the congruence of policies in both types of democracies across three formal institutional frameworks. First, it examines the institutions that allow identification of whether implemented policies are congruent with the principal's preferred policy. Second, it considers legal enforcement by the court system. Third, it analyzes the institutions governing the frequency of examinations of agents—which can result in removal from office—and the incentives this creates for officers to implement congruent policies.

The analysis shows that formal institutions ensure that a principal's preferred policy is implemented by communicating it clearly, verifying compliance, and using both court enforcement and frequent examinations to remove subordinates who do not comply. When the principal's decisions are clear and verifiable, they can become part of the legal framework, allowing courts to punish deviations by agents. Similarly, frequent examinations by the principal help assess deviations from

political decisions and enable the removal of agents from public office, punishing them by taking away the benefits of holding these positions.

In Athens, this power rested with the citizens. The Assembly's decrees, which constituted citizens' decisions, were clear and verifiable, as they formed part of the legal system used by the courts to define accusation procedures and punishments. At the same time, every 36 days, the law mandated that the Assembly examine magistrates' performance and vote on whether to recall them from their positions. These formal institutions ensured that policies remained congruent with the citizenry.

In a representative democracy, this power rests with the representatives. Laws and decrees are clear, verifiable, and enforceable by courts. Additionally, executive representatives—presidents or prime ministers—can appoint, evaluate, and remove individuals such as ministers or secretaries from public positions at any time, ensuring that implemented policies remain congruent with their political decisions.

On the other hand, unless a direct democracy mechanism is used, the policies preferred by the citizenry are uncertain and subject to interpretation under representation. They are not part of a legal system that courts can enforce. Moreover, the closest mechanism for citizen examination that threatens representatives' continuity in office is reelection, which, when available, occurs years apart. Representatives can remain in public office for longer periods of time compared to Athenian magistrates, making the punishment from removal less severe. Thus, in a representative democracy, policies are congruent with the citizenry only if representatives prefer to represent them by choosing their preferred policy.

This paper makes three contributions. The first is to unify both political systems within a single principal–agent model. The literature comparing Athenian and representative democracy is extensive and dates back to the emergence of representative democracy, as many features of Athenian democracy inspired its development. Although not formal economic models, notable contributions include Dahl (1989) and Manin (1997). Economic models include contributions focusing exclusively on modeling Athenian democracy (Tangian, 2008; Tridimas, 2015) or on comparing policy outcomes between representative and direct democracy mechanisms (Maskin and Tirole, 2004; Correa-Lopera, 2024).

The second contribution is showing that congruence is achievable in a political system different from representative democracy. Congruence has long been of central interest in the political economy literature. However, most analyses focus exclusively on the attributes of representative democracy, with most results showing that congruence is not attainable under many of its features.

When analyses depart from models that ensure congruence whenever campaign promises are fulfilled in a median voter framework (Hotelling, 1929; Downs, 1957; Calvert, 1985; Wittman, 1977, 1983; Bassetto and Benhabib, 2006)—for example, by incorporating reelection in a principal–agent framework (Barro, 1973; Ferejohn, 1986), adding adverse selection or moral hazard (Duggan, 2000; Banks and Duggan, 2008; Austen-Smith and Banks, 1989; Besley, 2006; Fearon, 1999; Duggan and Martinelli, 2020; Banks and Sundaram, 2002; Duggan and Martinelli, 2017; Duggan, 2017), incorporating uncertainty about voter attributes or preferences (Hinich, 1977; Lindbeck and Weibull, 1993; Roemer, 1997), or allowing for non-commitment to campaign promises (Alesina, 1988)—congruence is generally not achieved. This gap is addressed by drawing on historical evidence from Athenian democracy and showing that congruence was achievable under its formal institutions.

The third contribution is to show that achieving policy congruence with citizens' preferences ultimately depends on representatives' values and preferences, making formal institutions insufficient to guarantee congruence. This point was emphasized by Madison (1788) in the Federalist Papers and reiterated by Besley (2005). In this line, the literature has shown that the quality of public policy depends on individual attributes—such as competence and honesty—of elected leaders (Jones and Olken, 2005; Besley and Reynal-Querol, 2011; Besley et al., 2011; Dal Bo et al., 2017; Pilny and Roesel, 2020; Besley et al., 2005; Caselli and Morelli, 2004). Moreover, research has found that the stronger a society's democratic values, the more stable its democracy tends to be (Besley and Persson, 2019; Welzel, 2007; Alesina and Fuchs-Schundeln, 2007; Neundorf, 2010; Ticchi et al., 2013; Fuchs-Schündeln and Schündeln, 2015; Gulzar and Khan, 2025). This highlights the role of values and informal institutions over formal ones.

This paper is organized as follows. Section 4.2 provides context on Athenian democracy and its institutions. Section 4.3 develops the model and divides its results into five parts: the definition of congruence and the capacity to determine whether policies are congruent with the citizenry; the enforcement role of the court system in both democracies; the relationship between congruence and the frequency of citizens' examinations; the analysis showing that in representative democracy implemented policies are congruent with representatives' political choices; and the relationship between representation values and congruence. Section 4.4 discusses the challenges of both democracies in light of the findings and explains their relevance for contemporary politics. Section 4.5 concludes.

4.2 Athenian democracy main political institutions

Athenian democracy existed from 508 BCE to 322 BCE, and its institutions were not constant but evolved over time as a result of historical events and political reforms. The institutions analyzed in this paper primarily focus on the reforms implemented after the conclusion of the Second Peloponnesian War in 403 BCE, although many of their main attributes are shared with earlier historical periods. In general, the Greek poleis were self-governing territories that encompassed both rural areas and urban centers. The urban areas housed government buildings as well as primary religious, cultural, and educational institutions, such as temples, theaters, and gymnasia. Most Greek poleis were small, covering territories of less than 200 square miles. Sparta and Athens were exceptions, spanning 3,200 and 1,000 square miles, respectively.[1]

In Athens, citizenship was restricted exclusively to men, excluding women, foreign residents (metics), and slaves. Politically, citizenship was organized into ten geographically based demoi. Only citizens had the right to hold public office or participate in the Assembly. The total population is difficult to determine, but estimates place it around 250,000, with approximately 40,000 to 50,000 male citizens by the mid-fifth century.

The Athenians had a well-defined separation between the institutions responsible for citizens' decision-making and those responsible for implementing those decisions. On the one hand, the institutions for citizens' decisions were primarily composed of the Assembly and the Council of Five Hundred.

The Assembly (*Ecclesia*), in which all male citizens over the age of 20 had the right to attend—requiring a quorum of about 6,000 participants—served as the primary decision-making body. It convened at least 40 times per year. Specific plenary sessions (*kyria ecclesiai*) were held 10 times per year—approximately every 36 days—to address major issues such as war, peace, and the accountability of magistrates. Citizens enjoyed equal rights to speak (*isegoria*) and to propose motions. Decisions were typically made through a show of hands, with the majority prevailing.

Before 403 BCE, there was no clear distinction between laws and decrees, with the Assembly holding the power to pass both. After the reforms, a clear distinction was established. Laws were defined as permanent, general rules applicable to all citizens, whereas decrees were temporary measures addressing specific situations and could not override established laws. The powers of the Assembly were limited to passing decrees, while the Council of Five Hundred (*Boule*) prepared the

[1] See Appendix A.1 for a short summary of Athenian history. For a thorough description of Athenian history, see Mitchell (2015); for an account of Athenian institutions, see Hansen (1991).

agenda for Assembly debates and decisions.

Issuing laws involved several steps and actors. Legislative proposals—whether initiated by the Assembly, a magistrate, or a citizen—had to be posted in the Agora for public deliberation. They were then debated and approved for revision by the Assembly in two well-spaced meetings. Afterward, a randomly selected panel of citizens (*nomothetai*), acting as a jury, conducted a trial-like review of the proposed law's merits before its ratification. Importantly, only statutory law could be applied. Customary or unwritten law was explicitly excluded to prevent ambiguity or arbitrary decisions by magistrates.

On the other hand, institutions and procedures for political control were also carried out by the Assembly, the Council of Five Hundred, and the Courts. The Courts (*Dikasteria*), composed of citizen jurors, enforced laws and handled cases of misconduct, malfeasance, or constitutional violations. Citizens could initiate public prosecutions against officials or private individuals who violated public trust.

The Council also served as an administrative and organizational body, overseeing public works, finances, and legislative preparations. It ensured that magistrates were subject to a pre-office scrutiny process (*dokimasia*), verifying the eligibility and qualifications of candidates before they assumed office. It also conducted post-office reviews at the end of their terms (*euthyna*). The *euthyna* process involved auditing magistrates' financial accounts and collecting citizen complaints regarding misconduct. Citizens had three days to file accusations. If these accusations were deemed valid, they were forwarded to the courts. Furthermore, citizens could bring accusations to the Council at any time, which could lead to court proceedings. Such accusations triggered a procedure known as *eisangelia*, covering offenses such as acting outside the law, treason against democracy, conspiracy, and corruption, including embezzlement or bribery. If found guilty, offenders could face severe punishments, including a death sentence.

At the same time, it was obligatory that in every plenary session—held every 36 days or 10 times per year—the Assembly provided citizens with opportunities to evaluate the conduct of magistrates and propose corrective measures. These measures included the *epicheirotonia ton archon*, a process through which officials accused of misconduct could be suspended via a recall vote. This suspension was often followed by a *eisangelia* and a court trial. In this trial, the accused could either be dismissed and punished or reinstated to office.

In Athens, there were approximately 1,100 public offices, including 500 positions within the Council of Five Hundred. Around 100 positions were filled through elections, primarily for roles that required specific qualifications and skills, such as military, public finance, or religious offices.

The remaining positions were filled by lottery, with the only requirements being that candidates were over 30 years old and held full citizenship rights. Public offices typically had a one-year term, and the possibility of holding the same office twice was very limited, depending on the role. This system created a high turnover of public officials. Together with the lottery system, it minimized the concentration of power and promoted broader citizen representation. Finally, to increase citizen participation and achieve greater political equality, measures were gradually introduced to compensate individuals for public service. These measures eventually extended to payments for attending Assembly sessions.

4.3 The model

This section presents the model comparing congruence in both types of democracies. Subsection 4.3.1 defines congruence as the alignment between citizens' decisions and the policy implemented by the agent. It also characterizes the citizens' preferred policy as the median voter's preferred policy. Subsection 4.3.2 analyzes how court enforcement operates to achieve congruent policies in both democracies. Subsection 4.3.3 examines the relationship between the frequency of citizens' examinations—which threaten an agent's continuity in office—and the implemented policy in both systems. Subsection 4.3.4 shows that in a representative democracy, policies are congruent with representatives' preferences. Finally, Subsection 4.3.5 argues that the more representatives value acting in favor of citizens by implementing their preferred policy, the closer the expected policy will be to the median voter's preferred policy.

4.3.1 Citizens' choice and congruence

Definition of Congruence

Both Athenian and representative democracy share a citizenry and individuals responsible for implementing policies—magistrates in Athens and representatives in contemporary political systems. In this model, the concept of congruence is formalized as the "coincidence" between the political choice of a principal—represented by the citizenry—and an agent—represented by either magistrates or representatives. This policy choice is expressed through a choice rule: given a set of policy alternatives X, a choice rule $C(X)$ is defined as a subset of chosen elements, $C(X) \subseteq X$. The choice rule is interpreted as selecting a subset $C(X)$ from the set of alternatives X. Thus, the political choice of the citizenry is given by $C_p(X)$, while the implemented policy by the agent is

denoted $C_a(X)$.

Given that both $C_a(X)$ and $C_p(X)$ are subsets of X, this paper defines implemented policies by the agent as congruent—or aligned—with citizens when every implemented policy $x \in C_a(X)$ is also an element of the citizens' choice rule $C_p(X)$. Conversely, implemented policies are not congruent with the citizens' choice if there exists an element $y \in C_a(X)$ such that $y \notin C_p(X)$. Therefore, the following definition applies:

Definition 4.3.1. *Given a citizen choice $C_p(X)$, implemented policies $C_a(X)$ are congruent with citizens if $C_a(X) \subseteq C_p(X)$.*

Knowledge of citizens' preferred policies

The main difference between Athenian and representative democracy is that Athenians gathered in the Assembly and chose directly from the political alternatives provided by the Council. This gave an unambiguous instruction to the magistrates, which they were required to follow. At the same time, the Council of Five Hundred verified compliance, making it possible to determine whether the policies implemented by magistrates were congruent. In its modern version, representatives are elected by the citizenry to decide and implement political alternatives on their behalf, with only limited opportunities for direct citizen choice through mechanisms of direct democracy.

A first conclusion is that, since direct citizen choice does not exist in representative democracy, it is not possible to determine whether implemented policies are congruent (Rousseau et al., 2002). Formally, this means that $C_p(X) = \{\emptyset\}$ and $C_a(X) \neq \{\emptyset\}$. Thus, by default, implemented policies are not congruent with the citizenry in a representative democracy, i.e., $C_a(X) \nsubseteq C_p(X)$.

An alternative interpretation could be reached based on Pitkin (1967). If citizens do not choose policies directly but elect representatives to make political decisions on their behalf, representatives must interpret citizens' preferences and judge which policy alternatives best align with the citizenry's interests. Representatives can learn about citizens' interests through meetings, surveys, polls, social media analysis, or similar sources. However, citizens hold diverse, sometimes conflicting, and even opposing political positions. This makes the interpretation of citizens' preferences inherently uncertain and subjective. In this scenario, it remains challenging to verify when policies are aligned with the citizenry's interests. Nevertheless, this paper assumes that representatives can infer and interpret citizens' preferences with sufficient precision to determine what would be the citizenry's choice, i.e., $C_p(X) \neq \{\emptyset\}$. It is also assumed that citizens in a representative democracy would make the same decisions as citizens in the Assembly, as well that the policy choices made by representatives are completely observable to the citizenry

The median voter's preferred policy

To provide more structure to citizens' choice, let the set of alternatives $X \subset \mathbb{R}$ be a closed interval. Let $N = [0, 1]$ denote a continuous set of citizens. Individuals' preferences over alternatives are indexed by $\theta \in \Theta$, where Θ is a finite set. Each individual has a probability ρ_θ of being type θ. There are at least two types, and each type has a strictly positive probability of occurrence.

Since the Assembly used majority rule to decide among alternatives, it is appropriate to adopt a version of single-peaked preferences that ensures a clear social choice under majority rule. This choice is represented by the median voter's preferred policy $x_m \in X$ (Arrow, 1951; Black, 1948). This policy will be interpreted as the citizens' choice. To formalize this, the following assumption is stated:

Assumption 1. *For any preference type θ, the utility function u_θ over X is continuous, concave, and strictly quasi-concave, normalized such that $u_\theta \geq 0$, with a unique maximizer x_θ. Furthermore, there are no two types θ', θ'' such that $x_{\theta'} = x_{\theta''}$.*

As previously mentioned, the Assembly typically made decisions on issues that had been discussed and placed on the agenda beforehand by the Council. This process is not explicitly modeled in this paper, but it is assumed that it results in the Assembly choosing the median voter's preferred policy. This policy must win against any other policy in pairwise majority voting. To characterize the median voter's preferred policy, it is first useful to define the set of decisive coalitions, which is composed of sets of citizens forming a majority. More precisely, a decisive coalition, $\mathcal{D}$, is defined as:

$$\mathcal{D} := \left\{ C \subset \Theta \mid \sum_{\theta \in C} \rho_\theta > \frac{1}{2} \right\}$$

Given the definition of a decisive coalition, the assumptions on the utility functions, and the fact that X is a closed interval in $\mathbb{R}$, the median voter's preferred policy x_m has the following properties: 1) m is the unique element in Θ such that all types θ with $x_\theta \leq x_m$ belong to $\mathcal{D}$, and all types with $x_\theta \geq x_m$ also belong to $\mathcal{D}$. 2) For each decisive coalition $C \in \mathcal{D}$ and any policy $y \in X$, there exists a type θ in the coalition who is better off with the median voter's preferred policy, that is, $u_\theta(x_m) > u_\theta(y)$.[2]

[2]To avoid the possibility of ties, an implicit assumption is that no coalition represents exactly half of the population. This assumption is analogous to requiring an odd number of voters when formalizing the median voter in the case of a finite set of citizens.

Given these properties, x_m can be considered the unique policy preferred by citizens. It is ultimately adopted as the Assembly's decision and, by extension, as the citizens' choice in a representative democracy. Hence, $C_p(X) = \{x_m\}$.

4.3.2 The courts

This section shows how court enforcement, depending on whether citizens' choices are codified in norms, can motivate congruent policies. In Athenian democracy, choosing directly from political alternatives meant that Assembly decisions became part of the normative system, making them enforceable by the courts. Additionally, citizens could accuse magistrates both during their term and through end-of-term examinations. Both processes could result in severe punishments, including death sentences. In contrast, in a representative democracy, only decisions made through direct democracy mechanisms are enforceable by courts. Punishments are also generally less severe than those in Athens. Therefore, for most political choices—even assuming knowledge of what citizens would prefer—these choices are not enforceable by courts.

To model this, it is assumed that the agent—either a magistrate or a representative—has two options: implement the citizens' choice or deviate from it. In the first case, their payoff is $u_\theta(x_m)$. In the second, they select their preferred alternative x_θ and face the risk of prosecution with probability c, leading to a penalty P. Their expected payoff in this case is $u_\theta(x_\theta) - cP$.

Therefore, the agent will choose to comply if:

$$cP > u_\theta(x_\theta) - u_\theta(x_m)$$

Let $\bar{u} = \max_{\theta \in \Theta} \{u_\theta(x_\theta) - u_\theta(x_m)\}$ represent the utility gain of the type that benefits the most from deviating by choosing their ideal alternative x_θ instead of x_m. If $cP > \bar{u}$, the cost of deviating exceeds any potential gain. This guarantees that every agent, regardless of type, will select x_m.

In Athens, the possible penalties included the death sentence, implying a high P. The end-of-term examination was mandatory, involving auditing and inviting citizens to report magistrates. Moreover, any magistrate could be accused by any citizen at any moment, making c close to 1. These factors make it highly likely that the expected penalty outweighed any potential utility gain. In contrast, since law enforcement is not possible for any interpretation of citizens' choice in a representative democracy, there is no punishment for deviating from x_m, so $cP = 0$. Therefore, in Athenian democracy, these enforcement mechanisms largely implied congruence, i.e., $C_a(X) = C_p(X) = \{x_m\}$. In a representative democracy, this is not the case unless the representative is of type m, so $C_a(X) \nsubseteq C_p(X)$.

4.3.3 Citizen Examinations

The main conclusion of this section is that more frequent examinations by the citizenry, which could threaten an official's continuity in office, facilitated congruent policies. This occurred in Athenian democracy, where examinations were held 10 times per year; however, this result does not necessarily hold in a representative democracy due to the longer time intervals between examinations. This subsection introduces a strategic model and is organized as follows. First, the model is presented, and the concept of equilibrium is defined. Second, the set of socially acceptable policies that ensure an agent remains in office is characterized. Third, agent types are classified according to whether they choose socially acceptable policies, and the effect of reducing the time between examinations on inducing acceptable choices is analyzed. Finally, the frequency of examinations in both democracies is compared, and the congruence of the resulting policy is evaluated.

An infinite-horizon dynamic model of citizens' examinations

Athenian democracy examined magistrates' performance every 36 days through the recall vote — *epicheirotonia ton archon* — which determined their continuity in office. Whenever dismissed, an accusation process almost always followed in the courts. The vacant position could then be filled by sortition or election. Similarly, reelections, whenever possible, allow citizens to remove a representative from office and replace them with whoever wins the election. However, reelections differ in that they are held years apart, and a trial does not necessarily follow when a representative loses a reelection.[3]

This section introduces the parameter $\tau > 0$, which represents the examination period length, i.e., the number of days between citizens' examinations. For example, in Athenian democracy, recall votes were held every $\tau = 36$ days. In representative democracies, reelections typically occur after about four years, i.e., $\tau = 1460$. This section also introduces the parameter β, which denotes the non-policy benefit received by an agent who implements policies. Although in Athenian democracy the removal of a magistrate from office was followed by an accusation process, the analysis here abstracts from the expected punishment cP. It focuses only on the relationship between congruence with citizens' choices, the examination period length, and the non-policy benefit parameter.

To illustrate how the frequency of citizens' examinations relates to policy congruence, this

[3]Other accountability mechanisms such as demonstrations, protests, or the media are not compared to Athenian democracy, as there is no evidence that these occurred during this historical period.

section introduces an infinite-horizon dynamic setting. Every τ days, given the citizens' choice $C_p(X) = \{x_m\}$, an agent—either a magistrate or a representative—decides which policy in X to implement. This decision is followed by a citizens' examination, where citizens determine whether the agent will continue in office for the next period. If the agent remains, they implement a policy in the subsequent period. Otherwise, they are replaced by another agent, who then implements a policy in the following period. The process then repeats.

Since citizens' examinations determine whether an agent remains in office, let $R = \{\textit{in}, \textit{out}\}$, where *in* denotes retaining the agent and *out* denotes removing them. In Athenian democracy, a recall vote meant that if *in* occurred, the magistrate kept their position. If *out* occurred, they were removed. In representative democracy, elections are assumed to determine whether the incumbent remains *in* office or is replaced by a challenger, i.e., removed *out* of office. Additionally, let $\mathbb{1}_\theta(\textit{in})$ be an indicator function equal to 1 when a citizen of type θ chooses *in*, and 0 otherwise. Since the decision is made from a two-element set, the citizens' majority-rule decision is given by:

$$f = \textit{in} \quad \text{if} \quad \sum_{\theta \in \Theta} \mathbb{1}_\theta(\textit{in})\rho_\theta > \frac{1}{2}, \quad \text{and} \quad f = \textit{out} \quad \text{otherwise.}$$

In this model, the replacing agent is chosen randomly. In Athenian democracy, this occurred through sortition. In a representative democracy, the model follows Banks and Duggan (2008), which assumes a random challenger for elections. Let $K \subset N$ be a finite set representing the candidates for public office, with at least two candidates. Each candidate has a type distribution γ that does not necessarily equal ρ. It is also assumed that whenever an agent is removed from office, they cannot become candidates in future periods. Finally, let s_r be the random device that chooses the replacing agent from the candidate set with uniform probability:

$$s_r \sim \text{Uniform}(K).$$

In this setting, a strategy is defined as a probability measure, for each type, over the alternatives available. Each period, every citizen adopts a examination strategy $\sigma_{if}(\theta) \in \Delta_R$ to decide whether the agent remains in office. If they become an agent filling the public position, they implement a policy using a strategy $\sigma_{ix}(\theta) \in \Delta_X$.[4] Thus, a strategy for an individual i is given by $\sigma_i = (\sigma_{ix}, \sigma_{if})$. A strategy profile $\sigma = (\sigma_i)_{i \in N}$ then specifies a strategy for every individual in each period.

The strategy profile, together with the distribution of types, induces the expected utility for individual i of type θ, given by:

[4]Let Y be a set of alternatives. The set Δ_Y denotes the collection of all possible probability measures on Y. For any $\overline{Y} \subseteq Y$, we define $\Delta_{\overline{Y}} = \{p \in \Delta_Y \mid p(\overline{Y}) = 1\}$.

$$v_\theta(\sigma) = (1 - \delta(\tau))\,(u_\theta(x) + \mathbb{1}_s(i)\beta) + \delta(\tau)\,v_\theta(\sigma).$$

Here, the common discount factor δ is a function of the examination period length τ. As the number of days between citizens' examinations increases, future payoffs receive a smaller weight. For simplicity, let this relationship be captured by $\delta(\tau) = \frac{1}{1+\tau}$. Since $\tau > 0$, it follows that $\delta(\tau) \in (0, 1)$. Finally, if an individual holds office, the indicator function $\mathbb{1}_s(i) = 1$, and they receive a non-policy benefit β.[5]

A simple equilibrium is defined as a strategy profile σ^* that is a best response for every individual. In other words, σ^* ensures that, for any individual i of any type θ, there is no alternative strategy σ_i that satisfies:

$$v_{i\theta}(\sigma^*_{-i}, \sigma_i) > v_{i\theta}(\sigma^*_{-i}, \sigma^*_i),$$

The socially acceptable set of policies

To define the set of socially acceptable policies that ensure an agent remains in office, it is necessary to impose two assumptions on examination and policy implementation strategies. For examination strategies, it is assumed that when citizens decide on an agent's continuity, each individual is non-decisive. This means that, regardless of the examination strategy $\sigma_{if}(\theta)$ they choose, the voting outcome remains unchanged. In other words, an individual i is non-decisive when:

$$f_t(\sigma_{-if}, \sigma'_{if}) = f_t(\sigma_{-if}, \sigma''_{if})$$

for any two strategies σ'_{if}, $\sigma''_{if} \in \Delta_R$. This means that any examination strategy in Δ_R chosen by a citizen is a best response, as the outcome does not change. Considering the concept of non-decisiveness, this paper follows Downs (1957) and Riker and Ordeshook (1968). Citizens' decisions to vote, even when non-decisive, are motivated not only by the chance to influence outcomes but also by the intrinsic value of voting. In this sense, having clear preferences makes it personally meaningful to choose according to those preferences. Therefore, let $v_\theta(in)$ denote the expected utility when the agent remains in office, and let $v_\theta(out)$ denote the expected utility when they are removed. The following assumption is made:

[5]This expected utility function derives from the recursive and stationary version of the payoff function:

$$(1 - \delta(\tau)) \sum_{t=1}^{\infty} \delta(\tau)^{\,t-1} \left[u_\theta(x_t) + \mathbb{1}_{st}(i)\beta\right],$$

where payoffs are normalized using $(1 - \delta(\tau))$.

Assumption 2. *If citizens are non-decisive in an examination voting, then for any individual i of any type θ:*

$$\sigma_{if}(\theta)(\textit{in}) = 1 \quad \textit{if} \quad v_\theta(\textit{in}) \geq v_\theta(\textit{out}),$$

or

$$\sigma_{if}(\theta)(\textit{out}) = 1 \quad \textit{if} \quad v_\theta(\textit{in}) < v_\theta(\textit{out}).$$

Similar to Banks and Duggan (2008), this assumption characterizes citizens' strategies in an examination vote. Each individual assigns probability 1 to retaining the agent when the expected utility of keeping them in office is greater than or equal to that of dismissal. Otherwise, they assign probability 1 to dismissal. In essence, citizens vote according to their preferences, even if their decision does not change the outcome.

Since it is assumed that when an agent is removed from office they are disqualified from becoming a candidate again and replaced by a random agent selected according to the rule s_r, any future set of candidates will consist solely of untested individuals with a type distribution γ. This assumption eliminates any Bayesian updating about the agent's type after dismissal. Consequently, the expected utility of removal depends only on the strategy profile:

$$v_\theta(\textit{out}) = v_\theta(\sigma).$$

For the policy strategy, an additional assumption is introduced following Duggan (2014), which shows that without restrictions, any policy path in X^∞ can be sustained as an equilibrium. A strong but reasonable assumption is that once an agent implements a policy in their first period, they continue implementing the same policy in all subsequent periods. More formally, we assume the following:

Assumption 3. *For any agent i of any type θ, if the implemented policy is x, then for any future periods,*

$$\sigma_{ix}(\theta)(x) = 1.$$

As a result, once an agent adopts a policy x, citizens can predict that the same policy will be implemented in the future. This makes the expected utility of keeping the agent in office $v_\theta(\textit{in}) = u_\theta(x)$. Thus, once an agent assumes a public position, their strategy reduces to selecting the distribution over implemented policies only in their first period.

Given the two previous assumptions, a socially acceptable set is defined as the set of policies in X that allow an agent to remain in public office. This set is built by aggregating the acceptance sets of each type into the acceptance set of the decisive coalitions. Therefore, let the acceptance set for an individual of type θ, given a strategy profile σ, be defined as:

$$A_\theta(\sigma) = \{x \in X \mid u_\theta(x) \geq v_\theta(\sigma)\}$$

For a citizen of type θ, this set contains the policies an agent can choose that provide higher utility than the expected utility of an untested challenger. Any of these alternatives ensures that the citizen would vote to retain the agent. Given the continuity and concavity of utility functions, and the compactness and convexity of X, $A_\theta(\sigma)$ is compact and convex.

Different citizen types may overlap in acceptable implemented policies, forming a coalition. Therefore, for a coalition $C \subset \Theta$, an acceptance set is defined as:

$$A_C(\sigma) = \bigcap_{\theta \in C} A_\theta(\sigma)$$

This set comprises elements in X that encourage the types within a coalition to support the agent. Since it is the intersection of compact and convex sets, it is also compact and convex. Some of these coalitions may be decisive if they hold a majority. Therefore, a socially acceptable set containing the implemented policies with majority support can be defined as follows:

$$A(\sigma) = \bigcup_{C \in \mathcal{D}} A_C(\sigma)$$

In principle, this set is compact but not necessarily convex. Moreover, since $A(\sigma)$ contains alternatives with majority support, x_m is always included in $A(\sigma)$.

Given assumptions 2 and 3 used to define $A(\sigma)$, two key equilibrium propositions are introduced (Banks and Duggan, 2008). The first proposition establishes that an equilibrium exists for any given parameters $\rho, \delta, \beta, \gamma$. The second shows that the equilibrium correspondence $\Sigma^*(\rho, \delta, \beta, \gamma)$ is upper hemicontinuous. In other words, small changes in the parameter values $\rho, \delta, \beta, \gamma$ do not produce significant shifts in the equilibrium set Σ^*. These propositions are particularly valuable because they guarantee equilibrium existence and ensure that minor adjustments in τ will not cause abrupt changes in equilibrium outcomes. Accordingly, the propositions can be stated as follows:

Proposition 1. *There exists an simple equilibrium σ^* (Banks and Duggan, 2008)*

Proposition 2. *The correspondence $\Sigma^*(\rho, \delta, \beta, \gamma)$ of simple equilibria is upper hemicontinuous in the parameters of the model (Banks and Duggan, 2008).*

Winners, losers, and compromising agents.

Congruence occurs when any agent of any type implements the socially acceptable policy $x_m \in A(\sigma)$. For this to hold, the expected utility of choosing an acceptable policy must exceed the expected utility of selecting a policy outside the socially acceptable set. When an agent does not choose an acceptable policy, they are dismissed from office and receive the expected utility given by:

$$(1 - \delta(\tau))[u_\theta(x) + \beta] + \delta(\tau)v_\theta(\sigma),$$

In this case, their optimal strategy is to assign probability 1 to their preferred policy, i.e., $\sigma_x(\theta)(x_\theta) = 1$. If they remain in office, their best strategy is to assign probability 1 to the policy that maximizes their utility within the socially acceptable set $A(\sigma)$, denoted x_θ^A. Formally, $\sigma_{ix}(\theta)(x_\theta^A) = 1$. Their expected utility in this case is $u_\theta(x_\theta^A) + \beta$. Thus, an agent of type θ strictly prefers to stay in office if:

$$u_\theta(x_\theta^A) + \beta > (1 - \delta(\tau))[u_\theta(x_\theta) + \beta] + \delta(\tau)v_\theta(\sigma).$$

Importantly, when the agent's preferred policy is socially acceptable, i.e., $x_\theta^A = x_\theta$, the inequality is always satisfied, and the agent remains in office. If both sides of the equation are equal, the agent's strategy mixes between the socially acceptable policy and their preferred policy. Thus, agent types can be classified into the following sets:

- $W(\sigma) = \{\theta \in \Theta | x_\theta \in A(\sigma)\}$
- $C(\sigma) = \{\theta \in \Theta | x_\theta \notin A(\sigma) \; and \; \sigma_{it}(\theta)(x_\theta^A) = 1\}$
- $L(\sigma) = \{\theta \in \Theta | x_\theta \notin A(\sigma) \; and \; \sigma_{it}(\theta)(x_\theta) > 0\}$

Here, $W(\sigma)$ includes the winner types who secure their position because their preferred policy is acceptable (i.e., $x_\theta \in A(\sigma)$). $C(\sigma)$ represents the compromising types whose preferred policy is not acceptable but who adapt by choosing x_θ^A to remain in office. Finally, $L(\sigma)$ denotes the losing types whose preferred policy is not acceptable and who assign positive probability to their unacceptable policy in their strategy $\sigma_{ix}(\theta)$.

Of particular importance is the set of compromising types, $C(\sigma)$. Members of this set—unlike those in the other sets—respond to citizens' examinations by adjusting their policy choices toward more acceptable alternatives. In contrast, the other types assign positive probability to their own preferred policy. To determine how $C(\sigma)$ changes with variations in examination period length, the previews inequality can be expressed only in terms of τ and β.

Define $x(\sigma)$ as the expected policy if an agent is dismissed. By concavity, for any preference type θ, $u_\theta(x(\sigma)) \geq v_\theta(\sigma)$. This means that citizens, being risk-averse, prefer the certain implementation of $x(\sigma)$ over the expected policy resulting from dismissal. Since this holds for every type, all citizens would vote to retain the agent when they choose $x(\sigma)$, so $x(\sigma) \in A(\sigma)$. Moreover, because x_θ^A is the policy within the socially acceptable set that maximizes the agent's utility, it must satisfy $u_\theta(x_\theta^A) \geq u_\theta(x(\sigma)) \geq v_\theta(\sigma)$. Given that $\delta(\tau) \in (0,1)$, it follows that $u_\theta(x_\theta^A) > \delta(\tau)v_\theta(\sigma)$. Considering that an agent prefers to stay when $u_\theta(x_\theta^A) + \beta > (1-\delta(\tau))[u_\theta(x_\theta) + \beta] + \delta(\tau)v_\theta(\sigma)$, a sufficient condition for this inequality to hold is:

$$\beta > (1-\delta(\tau))[u_\theta(x_\theta) + \beta]$$

This condition can be restated more explicitly in terms of the parameters β and τ. Taking into account that $\delta(\tau) = \frac{1}{1+\tau}$, it becomes:

$$\frac{\beta}{\tau} > u_\theta(x_\theta)$$

This condition states that an agent prefers to remain in office by implementing a socially acceptable policy when either the non-policy benefits of the position are high or the examination period is short. Intuitively, higher non-policy benefits make holding office more attractive, as the agent secures these benefits in future periods. A shorter examination period increases the discount factor, making future payoffs more valuable because they occur sooner.

Now, fix β and define two threshold values for the examination period length τ , $\tau_{c(\sigma)}$ and $\tau_{nc(\sigma)}$:

$$\frac{\beta}{\overline{\overline{u}}} = \tau_{c(\sigma)} \leq \tau_{nc(\sigma)} = \frac{\beta}{\underline{\underline{u}}}.$$

Where $\bar{\bar{u}} = \max_{\theta \in \Theta} \{u_\theta(x_\theta)\}$ is the utility of the agent type with the highest payoff from implementing their preferred policy x_θ. Conversely, $\underline{\underline{u}} = \min_{\theta \in \Theta} \{u_\theta(x_\theta)\}$ represents the utility of the agent type with the lowest payoff.

Since a shorter examination period makes future periods more valuable to the agent—because the discount factor increases—when $\tau < \tau_{c(\sigma^*)}$, all agents except for the median-voter type compromise by selecting a socially acceptable policy, i.e., $C(\sigma^*) = \Theta \setminus \{m\}$. Furthermore, Banks and Duggan (2008) shows that when every agent implements a policy in $A(\sigma^*)$, the only acceptable policy to avoid dismissal is the median voter's preferred policy. Thus, $A(\sigma^*) = \{x_m\}$, meaning that any agent, regardless of type, assigns probability 1 to x_m. This result is formalized in the following proposition.

Proposition 3. *Let assumptions 1 through 3 hold, and let $\tau < \tau_{c(\sigma^*)}$. Then, for any agent i of any type θ, the strategy $\sigma_{ix}(\theta)(x_m) = 1$ constitutes a unique best response.*

As each agent implements the policy $x_m \in A(\sigma^*)$, they ensure their continuity in public office. From the citizens' perspective, the expected utility of keeping the agent in office is $u_\theta(x_m)$. If the agent is removed, they are replaced by another agent whose best decision is also to implement x_m. Thus, the expected utility becomes $v_\theta(\sigma^*) = u_\theta(x_m)$. Therefore, when the examination period length satisfies $\tau < \tau_{c(\sigma^*)}$, the optimal choice for any citizen i of any type θ is to keep the agent in office, i.e., $\sigma_{if}(\theta)(\textit{in}) = 1$. This leads to the following proposition:

Proposition 4. *Let assumptions 1 through 3 hold, and let $\tau < \tau_{c(\sigma^*)}$. Then, there exists a unique simple equilibrium σ^* such that, for every i of any type θ:*

- $\sigma^*_{ix}(\theta)(x_m) = 1$
- $\sigma^*_{if}(\theta)(\textit{in}) = 1$

Given the citizens' choice $C_p(X) = \{x_m\}$, Proposition 4 establishes that, in this unique simple equilibrium, every agent assigns probability 1 to x_m, regardless of type. Consequently, $C_a(X) = \{x_m\}$. Thus, policies are congruent with the citizens' choice whenever $\tau < \tau_{c(\sigma^*)}$:

$$C_a(X) = C_p(X) = \{x_m\}.$$

When $\tau_{c(\sigma^*)} < \tau_{nc(\sigma^*)}$ and the period length satisfies $\tau \in [\tau_{c(\sigma^*)}, \tau_{nc(\sigma^*)}]$, some agent types prefer to remain in office, but not all. Depending on whether their preferred policy is acceptable, they either belong to the winner set or choose to compromise. This implies that $\Theta \setminus L(\sigma^*) \neq \emptyset$. However,

some agents may stop compromising and choose their type-preferred policy x_θ in equilibrium. If policies other than x_m are chosen in equilibrium, the equality $A(\sigma) = \{x_m\}$ no longer holds. In this case, the acceptance set must include at least two distinct policies, $x(\sigma^*)$ and x_m, so $|A(\sigma^*)| > 1$. Therefore, as the period between evaluations increases, citizens must become more flexible and accept that agents may implement policies different from x_m in equilibrium.

Finally, when $\tau > \tau_{nc(\sigma^*)}$ and as τ increases, no agent type chooses to compromise. The benefits of remaining in office are no longer sufficient to outweigh the benefits of implementing their preferred policy. As $\tau \to \infty$, the expected utility from being removed from office converges to $u_\theta(x_\theta) + \beta$. Comparing this with the expected utility of choosing a socially acceptable policy, $u_\theta(x_\theta^A) + \beta$, yields two scenarios.

First, if the type-preferred policy is acceptable, i.e., $x_\theta \in A(\sigma^*)$, the agent selects it and joins the winner set, $\theta \in W(\sigma^*)$. Second, if the type-preferred policy is not acceptable, the utility from choosing the type-preferred policy is greater than that of the socially acceptable policy, i.e., $u_\theta(x_\theta) > u_\theta(x_\theta^A)$. This induces the agent to choose x_θ, be removed from office, and become a loser type, $\theta \in L(\sigma^*)$. In both cases, no type compromises, so $C(\sigma^*) = \emptyset$. Under these conditions, the expected policy is:

$$x(\sigma^*) = \sum_\theta \gamma_\theta x_\theta$$

Moreover, for any acceptable policy $x \in A(\sigma^*)$, there exists a decisive coalition whose members, with type $\hat{\theta} \in C$, find the utility of the implemented policy x at least as large as their expected utility:

$$v_{\hat{\theta}}(\sigma) = \sum_\theta \gamma_\theta u_{\hat{\theta}}(x_\theta)$$

Therefore, in this case, citizen examinations only remove from office agents whose preferred policy is unacceptable. They provide no real incentive to compromise by adopting more socially acceptable policies. This scenario is equivalent to having no examinations at all, a situation commonly referred to as the lame duck effect.[6]

Citizen examinations in Athenian and representative democracy

Parameter values β and τ are determined by formal institutions and may vary between the two types of democracies. In the case of Athenian institutions, the Assembly decided on recall votes every 36 days in plenary sessions. This suggests that τ would take a small value. Regarding the non-policy

[6]Another interpretation is that if τ is seen as the time remaining until citizens' examinations, agents at the beginning of their term will not compromise, choosing their preferred policy—whether acceptable to the citizenry or not. However, as elections approach, agents become more responsive and are more likely to compromise.

benefit β, evidence indicates that magistrates received in-kind compensation (goods and services). Thus, although β was not high enough to generate wealth, it was still sufficiently attractive (Hansen, 1991). The absence of evidence indicating unfilled magistrate positions may also support this point. These parameter values make it reasonable to assume that $\tau < \tau_{c(\sigma^*)}$.[7] Therefore, it can be concluded that every magistrate, regardless of preference type, implemented $C_a(X) = \{x_m\}$. Hence, Athenian democracy assured congruent policies, i.e., $C_a(X) = C_p(X) = \{x_m\}$.

Considering that elections are held every 4 years, the value of τ in a representative democracy could be set at around 1460—about 40 times larger than in Athens. Naturally, if reelections are not possible, it is as if $\tau \to \infty$. Therefore, the value of τ associated with reelections is significantly larger than that of recall voting in Athenian democracy.

It can also be argued that, in a representative democracy, the non-policy benefit β is relatively high. Moreover, theoretical models (Barro, 1973; Ferejohn, 1986; Schultz, 2008) and empirical evidence show that some representatives respond to electoral incentives depending on reelection prospects and examination frequency (Ferraz and Finan, 2011; Leguizamon and Crowley, 2016; Bó and Rossi, 2008).

Thus, the time frame between reelections likely falls between the two theoretical thresholds—i.e., $\tau \in [\tau_{c(\sigma^*)}, \tau_{nc(\sigma^*)}]$. This means that representatives are only partially responsive to electoral accountability mechanisms. Citizens must also become more flexible, accepting policies that do not fully align with their preferences. This grants representatives the ability to implement non-congruent policies without risking their position, $|A(\sigma^*)| > 1$. Furthermore, unless the representative is of type m, there is no guarantee that the implemented policy will be x_m, implying $C_a(X) \nsubseteq C_p(X)$.

4.3.4 Congruence to Representatives' Choice

This subsection shows that if, in a representative democracy, implemented policies are not necessarily aligned with the citizenry, they are instead congruent with the preferences of representatives. This occurs because representatives assume the roles once held by Athenian citizens. Those in legislative and executive positions act as the *nomothetai* and the Assembly, respectively. The randomly selected panel of *nomothetai* functioned as a jury responsible for ratifying law proposals, a role now fulfilled

[7] Although not analyzed explicitly, whenever a magistrate was dismissed, this was followed by an Eisangelia trial in the courts. One could assume a high value of c, especially if the reason for dismissal was implementing a policy x_θ that deviated from the citizens' choice x_m. If convicted, such conduct could result in severe penalties, including death, which implies a significantly high value of P. Thus, this also reinforced the incentives to implement the Assembly's choice.

by representatives in congress or parliament. Meanwhile, the Assembly oversaw executive functions such as issuing decrees, conducting elections, and recalling magistrates. This role is assumed by executive representatives—such as presidents or prime ministers—who issue executive orders or decrees, appoint officials, and remove them from office. Therefore, as in Athenian democracy, both the court enforcement of laws and decrees and the executive's capacity to remove appointed officials ensure that implemented policies align with the political choices of representatives.

For this section, let the legislative representatives' choices in a parliament or congress be denoted by $C_{rl}(X) \subseteq X$. These choices are communicated clearly, and compliance can be verified. They are also enforceable through binding court rulings. While not every ruling results in a penalty, the probability of legal consequences for noncompliance is positive ($cP > 0$). Similarly, let executive choices be denoted by $C_{re}(X)$. Given the hierarchy of decrees relative to laws, these choices must align with legislative ones, i.e., $C_{re}(X) \subseteq C_{rl}(X)$.

Furthermore, executive representatives appoint a wide range of subordinates, including ministers, secretaries, and agency officials, to implement their policy agenda —similar to the Assembly electing magistrates. These political appointees are responsible for translating executive directives into concrete actions while operating within institutional and legal constraints. Let the implemented policies from these positions be denoted as $C_a(X)$. Unlike independent agency heads, judges, or other officials with legal protections, political appointees serve at the discretion of the executive and can be dismissed at any time—similar to the recall vote on magistrates. Since these positions provide non-policy benefits ($\beta > 0$) but can be removed at any moment (implying a low τ), political appointees have strong incentives to align implemented policies with the executive choice, i.e., $C_a(X) \subseteq C_{re}(X)$.

To show this, assume that the legislative representatives' choice is $C_{rl}(X) = X$, where X is the same closed interval in $\mathbb{R}$ as in the previous section. Thus, the law grants the executive representative discretion to choose any policy in X. Given Assumption 1 on preferences, the executive representative i of type θ has a preferred policy x_θ, so their choice is $C_{re}(X) = \{x_\theta\}$. The appointee must also implement a policy in X, while the executive retains the authority to dismiss them at any time. Once dismissed, they are not rehired and are replaced by a random appointee of type γ. The representative's expected utility in the event of dismissal is $v_\theta(\sigma)$. By Assumption 3, when an appointee implements a policy x, the same policy is expected in future periods. Hence, the expected utility of retaining the appointee is $u_\theta(x)$. Importantly, Assumption 2 is no longer required, since the executive representative is completely decisive, making the socially acceptable set defined solely by the executive representative's type.

$$A(\sigma) = A_\theta(\sigma) = \{x \in X | u_\theta(x) \geq v_\theta(\sigma)\}$$

Furthermore, it can be argued that $\tau < \tau_{c(\sigma^*)}$ because non-policy benefits are high (β is large) and appointees can be dismissed at any time (low τ). Therefore, a proposition similar to Proposition 3 can be established in this context:

Proposition 5. *Let assumptions 1 and 3 hold, and let $\tau < \tau_{c(\sigma^*)}$. Then, for any appointee of any type θ', the strategy $\sigma_{i'x}(\theta')(x_\theta) = 1$ constitutes a unique best response.*

Therefore, similar to Proposition 3, in the unique simple equilibrium the appointee chooses the strategy $\sigma_{i'x}(\theta')(x_\theta) = 1$. At the same time, the executive representative retains them in office, i.e., $\sigma_{if}(\theta)(\textit{in}) = 1$.

Importantly, this result shows that the implemented policy is the one preferred by the executive representative, regardless of the appointee's type. Hence, the implemented policy is congruent with the executive choice, i.e., $C_a(X) \subseteq C_{re}(X)$. Moreover, since the executive choice operates within the law and is enforced by the judiciary, it is congruent with the legislative representatives' choice, i.e., $C_{re}(X) \subseteq C_{rl}(X)$. Therefore, the implemented policies are congruent with the representatives' choices, which implies:

$$C_a(X) \subseteq C_{re}(X) \subseteq C_{rl}(X).$$

4.3.5 Values in Representative Democracies

Given that formal institutions in a representative democracy ensure that implemented policies are congruent with representatives' policy choices, this subsection shows that the more representatives value acting on behalf of citizens by implementing their preferred policy, the more the expected policy converges to the median voter's preferred policy.

It was established that for any set of parameters, x_m is always an acceptable policy. Also, if a representative is of type m, they are always a winner type. They do not need to compromise and always choose x_m. A simple interpretation of this result is that a representative of type m happens to have their preferred policy coincide with the socially preferred policy given the preference type distribution ρ. Therefore, this individual chooses x_m solely because it is their own preference, without special consideration for the citizenry.

Another interpretation might be that the utility function u_m of a representative of type m reflects preference relationships based on values, moral judgments, or beliefs. Since utility functions represent preference relations, this could be consistent with the statement: "Given that I interpret the citizens' preferred policy as x_m, I prefer to implement this policy over any alternative." This

interpretation describes a representative who acts as a delegate, prioritizing the views, voices, opinions, and interests of the citizenry in the policy decision-making process.[8]

Thus, in the model, if every representative behaved as a delegate, sharing these preference relationships and interpreting x_m as the citizens' preferred policy, it would imply that everyone is of type m. They would choose x_m, always remain in office, and make the acceptance set $A(\sigma) = \{x_m\}$. Consequently, implemented policies would be congruent with citizens' preferences, i.e., $C_a(X) = C_p(X)$. Despite having the option to choose other policies, their values would still lead them to align with the citizenry.

This would be an extreme situation. However, it can be argued that as the distribution of representative types γ places more weight on type m, the expected policy in equilibrium $x(\sigma^*)$ moves closer to x_m. Similarly, the acceptance set approaches $\{x_m\}$. This relationship can be formalized by the following proposition[9].

Proposition 6. *Let $\hat{\gamma}$ be a representative distribution type such that $\hat{\gamma}_m = 1$. Let $\{\gamma^k\}_{k=1}^{\infty}$ be a sequence converging to $\hat{\gamma}$, and let $\{\sigma^k\}_{k=1}^{\infty}$ be the corresponding sequence of simple equilibria with acceptance sets A^k and expected policies $x(\sigma^k)$. Then, the acceptance sets A^k converge to the singleton $\{x_m\}$ and the expected policies $x(\sigma^k)$ converge to x_m.*

Given that implemented policies depend on the elected representative's preference type, the final result shows the following. When the distribution of representatives' preference types converges toward the median voter's preference, the expected policy also converges to the median voter's preferred policy. Similarly, the set of policies considered acceptable for reelection by the citizenry converges to x_m. Thus, representatives can be reelected by implementing the median voter's preferred policy or policies sufficiently close to it. This result is better interpreted as a convergence in the values and codes of conduct of elected officials, which ultimately leads them to represent the citizenry by implementing congruent policies. It goes beyond a mere coincidence between the representative's preferred policy and that of the median voter.

This result aligns with the view that representation involves valuing and acting in favor of constituents by interpreting their views, opinions, and preferences, incorporating them into the political

[8]The representative may not be of type m but of type θ. Nonetheless, their moral values, beliefs, or normative judgments may lead them to act as trustees. Their preference can be expressed as: "Despite interpreting the citizens' preferred policy as x_m, I prefer to implement another policy x_θ because it is in the best interest of the citizens." In this case, even if the policy is not fully aligned with citizen preferences, the decision still aims to improve the well-being of the citizenry.

[9]This proposition adapts the result on the convergence of the discount rate to 1 in Banks and Duggan (2008), assuming a Euclidean distance between two elements $x, y \in X$, and the Hausdorff distance—defined as $h(Y, x) = \max\{\|y - x\| \mid y \in Y\}$—for a compact set $Y \subseteq X$ and an element $x \in X$.

decision-making process, and exercising judgment to determine which policies are congruent with those preferences (Pitkin, 1967). Moreover, the values held by representatives act as codes of conduct that constrain their behavior when formal institutions cannot (Mansbridge, 2009). This contrasts with the view that every elected official should be understood as an agent who pursues only narrow self-interest (Buchanan, 1989).

4.4 Discussion

This study addresses two different institutional frameworks for the congruence between policies and citizens' preferences. It concludes that in Athenian democracy, formal institutions were sufficient to guarantee congruence. These institutions made citizens' choices clear and explicit through the Assembly, incorporated them into the normative framework, and verified compliance. They also enforced these choices through courts and frequent examinations that determined the continuity of public officers. In contrast, in a representative democracy, congruence depends mainly on informal institutions, particularly the values of representation held by representatives.

If congruence with the citizenry is a goal to be pursued, this analysis presents two alternatives, both with significant challenges. Athenian institutions could, in principle, be replicated in modern times. Technological advancements in recent decades have made direct citizen participation in decision-making more viable. This challenges the conventional argument that assembly-based direct democracies are feasible only in small-scale communities and not at the national level (Dahl, 1989).

However, such an institutional setting would also require a profound transformation in societal values, particularly the belief that citizens are capable of governing themselves. As Palonen and Hansen (2008) notes, the values underpinning Athenian democracy rested on the belief that citizens were intelligent enough to make sound political decisions and participate in public affairs. They were expected to set aside personal interests for the common good and be sufficiently informed and motivated to engage in politics. Citizens also had to listen, understand, and evaluate expert advice, while still applying common sense to choose wisely among alternatives. These values are not necessarily embedded in contemporary societies.

Since the inception of Athenian democracy, the capacity of citizens to make sound decisions and engage in the political process has been questioned (Aristotle, 2013). This skepticism continued in representative democracies, where replicating the Athenian model was never seriously considered (Mitchell, 2015). Institutions were designed so that elected officials often came from higher social ranks. Candidacy for public positions was frequently conditioned on property qualifications.

Elections served mainly to grant legitimacy to rulers through the consent of the citizenry (Manin, 1997). This is understandable, as revolutionary movements that created representative democracies emerged in contexts where hereditary rule was the central issue. Athenian democracy was separated by thousands of years and generations, making its values more distant compared to this revolutionary historical context.

Although many reforms in representative democracies have expanded political rights to vote and hold office, these changes do not necessarily converge toward the Athenian principle of valuing citizens' direct capacity to decide their own affairs—an ideal largely absent in representative systems.

On the other hand, in representative democracies, there are two main challenges to ensure that implemented policies are as close as possible to those preferred by the citizenry: (1) determining what policies citizens actually prefer, and (2) assuring that representatives value representing the citizenry. For the first challenge, ensuring congruence also requires the ability to assess whether implemented policies truly align with citizens' interests. The absence of direct citizen choice makes this task difficult. Nevertheless, efforts can be made to better understand citizens' policy preferences in ways that are less subjective and uncertain, even when these preferences are diverse, conflicting, or opposing.

For the second challenge, this paper concludes that implemented policies reflect the political preferences of representatives. Thus, to ensure congruence, it is crucial that elected representatives genuinely seek to represent the citizenry. Proposition 6 suggests that if more representatives value representing citizens, implemented policies will be more congruent. However, achieving this requires transforming political culture and aligning representatives' values more closely with the ideal of representation, yet it is not clear how this could be accomplished. Moreover, even if such alignment were achieved, it would still require expecting representatives to set aside their own preferences in favor of the citizenry within an institutional framework that does not strongly incentivize compromise with citizens' interests.

In the end, assuring congruence in both systems depends on values. It relies either on citizens valuing their own ability to govern themselves or on elected individuals valuing representation enough to make those decisions on their behalf.

4.5 Conclusions

This paper compares the capacity of Athenian and representative democracies to ensure policy congruence with citizens' preferences within a unified principal–agent framework. In Athenian democracy, formal institutions—such as judicial enforcement of Assembly decisions and frequent examinations of magistrates—were sufficient to guarantee congruence. These mechanisms allowed citizens to verify compliance directly and discipline magistrates if policies diverged. In contrast, representative democracies lack institutional mechanisms that directly translate citizens' preferences into policy. Reelections, when possible, provide only partial incentives due to their long intervals. Moreover, there is no judicial enforcement because no unambiguous criterion exists to determine citizens' preferred policies. As a result, policies in representative democracies tend to reflect the preferences of elected officials rather than the citizenry.

The study also shows that congruence in representative democracies ultimately depends on the values of representation embraced by elected officials. Formal institutions are insufficient to guarantee alignment with citizens' interests. Congruence becomes possible only when representatives intrinsically value their duty to act on behalf of the citizenry and deliberately interpret citizens' preferences as a guiding principle. This highlights a central lesson: sustaining a representative democracy requires not only institutional design but also political values and norms that constrain self-interest and elevate representation. Thus, while Athenian democracy relied on institutional enforcement to secure congruence, representative democracy depends equally on the strength of its formal institutions and the moral commitments of its representatives.

Appendix

A.1 Athenian democracy history

Athenian democracy was a gradual project shaped by historical events and political reforms, rather than a static set of rules.[10] Before Solon's reforms in 594 BCE, Athens functioned as an aristocracy where public offices were held exclusively by noble families, leaving the rest of the population with little influence. Solon's reforms transformed Athens into a timocracy, where public offices were assigned based on wealth, thereby excluding the poor. These reforms also created the Assembly,

[10]For a thorough description of Athenian history, see Mitchell (2015); for an account of Athenian institutions, see Hansen (1991).

which elected certain public officials (magistrates) and exercised limited oversight over them.

However, the most distinctive institution of Athenian democracy—the practice of citizens (the demos) voting on all matters of public relevance in the Assembly—emerged only after Cleisthenes' reforms in 508 BCE. These reforms also created the Council of Five Hundred, tasked with discussing and preparing the agenda for Assembly decisions. Furthermore, they introduced lotteries to assign many public offices and established clear criteria for Athenian citizenship.

Following Cleisthenes' reforms, Athenian democracy faced several wars. These included the Spartan invasion (506 BCE), the first Persian invasion (499–490 BCE), the second Persian invasion (480–479 BCE), and the First Peloponnesian War against Sparta (449–446 BCE). Athens emerged victorious from these conflicts, becoming economically and militarily stronger.

At the same time, to defend the Greek poleis from Persian threats, the Delian League was formed in 476 BCE. This alliance, comprising between 150 and 330 poleis, was heavily influenced by Athens and eventually evolved into the Athenian Empire during the First Peloponnesian War. In this period, the Athenian democracy became a wealthy society, receiving significant resources from member poleis of the Delian League. It also achieved political and military dominance in Greece.

This era witnessed the construction of numerous architectural works, including the Parthenon, which are now considered World Heritage Sites. It also marked a flourishing of literary arts, with the development of theater, and of philosophical and intellectual movements, such as those led by the Sophists.

However, by the end of the 5th century BCE, Athens was militarily defeated, economically bankrupt, and facing internal civil conflicts. The Second Peloponnesian War (431–404 BCE) against the Spartans and their allies, together with the excesses and abuses of the Athenian Empire toward the member poleis of the Delian League, weakened Athens. Impulsive and reckless decisions by the Athenian demos further contributed to a series of military defeats, reducing Athens' military, political, and economic hegemony in the region.

This situation placed significant pressure on the Greek democratic model, which was increasingly viewed as ineffective and inadequate. It created deep divisions within Athenian society, leading to two attempts to establish an oligarchy. The first was the brief coup of the Four Hundred (411 BCE), which restricted the power of the Athenian Assembly. The second was the rise of the Thirty Tyrants in 404 BCE. Both periods were marked by political violence, assassinations, and purges.

After losing the Second Peloponnesian War, the Spartans chose peace and unity with Athens instead of seeking revenge or overthrowing its democracy. During this period, Athenian democracy

entered a phase of reconciliation and reform. Laws were recodified, new processes and checks for lawmaking were created, and mechanisms for participation and access to information for the demos were expanded. These reforms produced the most mature version of Athenian democracy.

Although Athens never regained its former wealth, military power, or political influence over Greece, it improved its finances and strengthened its military capabilities. It also maintained its cultural and intellectual preeminence. Despite various conflicts, Athenian democracy and its institutions grew stronger and lasted nearly eighty years. This period ended with Athens' defeat by the Macedonians in 322 BCE, marking the fall of its democracy and the rise of an oligarchic regime.

A.2 Proofs

Proposition 3. *Let assumptions 1 through 3 hold, and let $\tau < \tau_{c(\sigma^*)}$. Then, for any agent i of any type θ, the strategy $\sigma_{ix}(\theta)(x_m) = 1$ constitutes a unique best response.*

Proof. Given assumptions 1 through 3, all types choose a policy in $A(\sigma)$ and stay in office. Take any agent i, of any type θ and let $S(\sigma)$ denote the support of the policy strategies in the strategy profile (σ), i.e, the smallest closed subset of X with probability one under σ for all θ, and define:

$$\underline{p} = min_{\geq} S(\sigma) \text{ and } \bar{p} = max_{\geq} S(\sigma)$$

There are two cases. Case 1: If $\underline{p} = \bar{p}$, i.e, $|S(\sigma)|= 1$, given that $x_m \in A$, then we know that $S(\sigma) = \{x_m\}$ and so it must be that $\sigma_{ix}(\theta)(x_m) = 1$. Since i, θ are arbitrary, then for any agent i, of any type θ, $\sigma_{ix}(\theta)(x_m) = 1$.

Case 2: If $\underline{p} < \bar{p}$, i.e $|S(\sigma)|> 1$, then by strict quasi-concavity of u_θ, we have that

$$argmin\{u_{\theta'_x}|x \in S(\sigma)\} \subseteq \{\underline{p}, \bar{p}\}$$

For any individual of any type θ'. Define $\underline{\theta} \subseteq \Theta$ as those types for which this minimizer is unique and equal to $\underline{p}$, $\bar{\theta} \subseteq \Theta$ as the types for which this minimizer is unique and equal to $\bar{p}$, and $I \subseteq \Theta$ as the types for which $u_{\theta'}(\underline{p}) = u_{\theta'}(\bar{p})$. Also, by the assumption that $\gamma > 0$ and strict quasi-concavity it follows that

$$v_{\theta'_x}(\sigma) > min\{u_{\theta'_x}|x \in S(\sigma)\}$$

For any individual of any type θ'_x. Thus, we have that $v_{\theta'_x}(\sigma) > u_{\theta'}(\underline{p}) = u_{\theta'}(\bar{p})$ for any i' of any type $\theta \in I$. Hence, individuals whose type belongs to I will vote to fire agents that implement $\underline{p}$ or $\bar{p}$. Also, if the agent implements $\underline{p}$, then individuals that belong to $\underline{\theta}$ will vote to fire them, and if the incumbent implements $\bar{p}$, then individuals that belong to $\bar{\theta}$ will vote against the agent.

Given that $\underline{p} \in S(\sigma)$, then $\underline{p} \in A(\sigma)$, which means that there exits a decisive coalition that favors $\underline{p}$. Since I and $\underline{\theta}$ vote to fire incumbents that implement $\underline{p}$, this coalition must belong to $\bar{\theta}$, let $\overline{D} \subseteq \bar{\theta}$ such a decisive coalition. Since $\overline{D}$ is a decisive coalition, it is the case that $\sum_{\theta \in \overline{D}} \rho_\theta > \frac{1}{2}$. A similar argument is use to show that since $\bar{p} \in S(\sigma)$, then there exists a decisive coalition in $\underline{\theta}$ that favors $\bar{p}$. Let $\underline{D} \subseteq \underline{\theta}$ be such a decisive coalition. It follows that $\sum_{\theta \in \underline{D}} \rho_\theta > \frac{1}{2}$. Since it is the case that $\underline{\theta} \cap \bar{\theta} = \emptyset$, it follows that $\underline{D} \cap \overline{D} = \emptyset$. However, given that $\sum_{\theta \in \underline{D}} \rho_\theta > \frac{1}{2}$ and $\sum_{\theta \in \overline{D}} \rho_\theta > \frac{1}{2}$ we have a contradiction. Therefore, it is not the case that $\underline{p} < \bar{p}$. □

Proposition 4. *Let assumptions 1 through 3 hold, and let $\tau < \tau_{c(\sigma^*)}$. Then, there exists a unique simple equilibrium σ^* such that, for every i of any type θ:*

- $\sigma^*_{ix}(\theta)(x_m) = 1$
- $\sigma^*_{if}(\theta)(in) = 1$

Proof. **(1) Existence**: Let σ^* by an strategy profile such that that for all $\forall i, \forall \theta$, $\sigma^*_{ix}(\theta)(x_m) = 1$ and $\sigma^*_{if}(\theta)(in) = 1$ is a simple equilibrium. Take any i' and any type θ', and any strategy $\hat{\sigma}_{i'}$, such that $\hat{\sigma}_{i'x}(\theta')(x_m) \neq 1$ and $\hat{\sigma}_{i'f}(\theta')(in) \neq 1$.

Agents' strategy: By Proposition 3 and since $\hat{\sigma}_{i'x}(\theta')(x_m) \neq 1$, the expected utility is:

$$\hat{\sigma}_{i'x}(\theta')(x_m)[u_{\theta'}(x_m) + \beta] + \int_{X \setminus x_m} \hat{\sigma}_{i'x}(\theta')(x) \left[(1-\delta)(u_{\theta'}(x) + \beta) + \delta\, u_{\theta'}(x_m)\right] dx.$$

Meanwhile, the expected utility under the strategy $\sigma^*_{i'x}(\theta')(x_m) = 1$ is

$$u_{\theta'}(x_m) + \beta$$

The expected utility under strategy $\hat{\sigma}_{i'x}(\theta')$ is strictly greater than the utility of strategy $\sigma^*_{i'x}(\theta')$ if:

$$\hat{\sigma}_{i'x}(\theta')(x_m)[u_{\theta'}(x_m) + \beta] + \int_{X \setminus x_m} \hat{\sigma}_{i'x}(\theta')(x) \left[(1-\delta)(u_{\theta'}(x) + \beta) + \delta\, u_{\theta'}(x_m)\right] dx$$
$$> u_{\theta'}(x_m) + \beta$$

Express $u_{\theta'}(x_m) + \beta$ as follows:

$$\hat{\sigma}_{i'x}(\theta')(x_m)[u_{\theta'}(x_m) + \beta] + \int_{X \setminus x_m} \hat{\sigma}_{i'x}(\theta')(x) \left[u_{\theta'}(x_m) + \beta\right] dx$$

Then, deviation from $\sigma^*_{i'x}(\theta')$ is profitable if

$$\int_{X \setminus x_m} \hat{\sigma}_{i'x}(\theta')(x) \left[(1-\delta)(u_{\theta'}(x) + \beta) + \delta\, u_{\theta'}(x_m) - (u_{\theta'}(x_m) + \beta)\right] dx > 0$$

Since $\tau < \tau_{c(\sigma^*)}$ and proposition 1 we have that:

$$u_{\theta'}(x_m) + \beta > (1-\delta)(u_{\theta'}(x_{\theta'}) + \beta) + \delta\, u_{\theta'}(x_m)$$

.

By assumption 1, $x_{\theta'}$ is the unique maximizer of $u_{\theta'}$. Thus, for any $x \in X$,

$$(1-\delta)(u_{\theta'}(x_{\theta'}) + \beta) + \delta\, u_{\theta'}(x_m) \geq (1-\delta)(u_{\theta'}(x) + \beta) + \delta\, u_{\theta'}(x_m)$$

Since, $u_{\theta'}(x_m) + \beta > (1-\delta)(u_{\theta'}(x_{\theta'}) + \beta) + \delta\, u_{\theta'}(x_m)$, it is the case that for any $x \in X$,

$$(1-\delta)(u_{\theta'}(x) + \beta) + \delta\, u_{\theta'}(x_m) - (u_{\theta'}(x_m) + \beta) < 0$$

Therefore,

$$\int_{X \setminus x_m} \hat{\sigma}_{i'x}(\theta')(x) \left[(1-\delta)(u_{\theta'}(x) + \beta) + \delta\, u_{\theta'}(x_m) - (u_{\theta'}(x_m) + \beta)\right] dx < 0$$

Since we have that this expression is both strictly greater and strictly smaller than zero, it is a contradiction. Therefore, it is not the case that the expected utility under strategy $\hat{\sigma}_{i'x}(\theta')$ is strictly greater than the utility of strategy $\sigma^*_{i'x}(\theta')$. Since $\hat{\sigma}_{i'x}(\theta')$, i', and θ' are arbitrary, for any i and any θ there is no strategy $\hat{\sigma}_{ix}(\theta)$ such that its expected utility is strictly greater than the expected utility of $\sigma^*_{ix}(\theta)$.

Recall strategy: By proposition 3, for any agent i'' of any type θ'', $\sigma^*_{i''x}(\theta'')(x_m) = 1$. Since it is always the case that $x_m \in A$, then $f = \textit{in}$, implying that the agent is retained and continues implementing x_m in future periods. Therefore, the expected utility for i' of type θ' is $u_{\theta'}(x_m)$. Since i' is non-decisive, it follows that for $\hat{\sigma}_{i'f}(\theta')$ and $\sigma^*_{i'f}(\theta')$:

$$f(\sigma^*_{-i'f}, \sigma^*_{i'f}) = f(\sigma^*_{-i'f}, \hat{\sigma}_{i'f})$$

Therefore, for both strategies $\hat{\sigma}_{i'f}(\theta')$ and $\sigma^*_{i'f}(\theta')$, the expected utility is $u_{\theta'}(x_m)$. Thus, it is not the case that the expected utility under strategy $\hat{\sigma}_{i'f}(\theta')$ is strictly greater than the utility of strategy $\sigma^*_{i'f}(\theta')$. Since $\hat{\sigma}_{i'f}(\theta')$, i', and θ' are arbitrary, for any i and any θ, there is no strategy $\hat{\sigma}_{if}(\theta)$ such that its expected utility is strictly greater than the expected utility of $\sigma^*_{if}(\theta)$.

Finally, since for any i of any type θ, there is no strategy profile $\hat{\sigma}_{ix}(\theta)$ and $\hat{\sigma}_{if}(\theta)$ that constitutes a profitable deviation for either $\sigma^*_{if}(\theta)$ or $\sigma^*_{ix}(\theta)$, the strategy profile σ^* constitutes a simple equilibrium.

(2) Uniqueness: Take any strategy profile $\hat{\sigma}$ and assume it is a simple equilibrium. Also, take any agent i of any type θ with strategy $\hat{\sigma}_{xi}(\theta)$. From Proposition 1, we have that $\hat{\sigma}_{xi}(\theta) = 1$. Since i and θ are arbitrary, it follows that for any i and θ, $\hat{\sigma}_{xi}(\theta) = 1$.

At the same time, take any citizen i' of type θ' with recall strategy $\hat{\sigma}_{fi}(\theta)$. Since for any i and θ, $\hat{\sigma}_{xi}(\theta) = 1$, the expected utility of both retaining and dismissing the agent is $u_{\theta'}(x_m)$. By Assumption 3, the citizen recall strategy is $\hat{\sigma}_{fi}(\theta)(\textit{in}) = 1$. Given that i' and θ' are arbitrary, it follows that for any citizen i' of any type θ', the recall strategy is $\hat{\sigma}_{i'f}(\theta')(\textit{in}) = 1$.

Thus, the strategy profile $\hat{\sigma}$ is a simple equilibrium such that for any i and θ, $\hat{\sigma}_{xi}(\theta) = 1$ and $\hat{\sigma}_{fi}(\theta)(\textit{in}) = 1$. Since σ^* is also a strategy profile such that for any i and θ, $\sigma^*_{xi}(\theta) = 1$ and $\sigma^*_{fi}(\theta)(\textit{in}) = 1$, it follows that $\hat{\sigma} = \sigma^*$. Since $\hat{\sigma}$ is arbitrary, then for any strategy profile $\hat{\sigma}$, if $\hat{\sigma}$ is a simple equilibrium, then $\hat{\sigma} = \sigma^*$. Therefore, σ^* is a unique simple equilibrium.

□

Proposition 5. *Let assumptions 1 and 3 hold, and let $\tau < \tau_{c(\sigma^*)}$. Then, for any appointee of any type θ', the strategy $\sigma_{i'x}(\theta')(x_\theta) = 1$ constitutes a unique best response.*

Proof. Given assumptions 1 and 3, all types choose a policy in $A(\sigma) = A_\theta(\sigma)$ and stay in office. Take any appointee i', of any type θ' and let $S(\sigma)$ denote the support of the policy strategies in the strategy profile (σ), i.e, the smallest closed subset of X with probability one under σ for all θ', and define:

$$\underline{p} = min_{\geq} S(\sigma) \text{ and } \bar{p} = max_{\geq} S(\sigma)$$

There are two cases. Case 1: If $\underline{p} = \bar{p}$, i.e, $|S(\sigma)| = 1$, given that $x_\theta \in A_\theta(\sigma)$ for executive

representative of type θ, then we know that $S(\sigma) = \{x_\theta\}$ and so it must be that $\sigma_{i'x}(\theta')(x_\theta) = 1$. Since i', θ' are arbitrary, then for any appointee i', of any type θ', $\sigma_{i'x}(\theta')(x_\theta) = 1$.

Case 2: If $\underline{p} < \bar{p}$, i.e $|S(\sigma)| > 1$, then by strict quasi-concavity of u_θ, we have that

$$argmin\{u_\theta | x \in S(\sigma)\} \subseteq \{\underline{p}, \bar{p}\}$$

For any executive representative i of any type θ. Define $\underline{\theta} \subseteq \Theta$ as those types for which this minimizer is unique and equal to $\underline{p}$, $\bar{\theta} \subseteq \Theta$ as the types for which this minimizer is unique and equal to $\bar{p}$, and $I \subseteq \Theta$ as the types for which $u_\theta(\underline{p}) = u_\theta(\bar{p})$. Also, by the assumption that $\gamma > 0$ and strict quasi-concavity it follows that

$$v_\theta(\sigma) > min\{u_\theta | x \in S(\sigma)\}$$

For any executive representative of any type θ. Then, we have that $v_\theta(\sigma) > u_\theta(\underline{p}) = u_\theta(\bar{p})$ if $\theta \in I$. In this case, it follows that $\underline{p} \notin A_\theta(\sigma)$ and $\bar{p} \notin A_\theta(\sigma)$, which leads to a contradiction. Similarly, if $v_\theta(\sigma) > u_\theta(\underline{p})$ for $\theta \in \underline{\theta}$, then $\underline{p} \notin A_\theta(\sigma)$, again yielding a contradiction. Finally, if $v_\theta(\sigma) > u_\theta(\bar{p})$ for $\theta \in \bar{\theta}$, it implies that $\bar{p} \notin A_\theta(\sigma)$, which also results in a contradiction. Since in each case—whether θ belongs to I, $\underline{\theta}$, or $\bar{\theta}$—a contradiction arises, it is not the case that $\underline{p} < \bar{p}$.

□

Proposition 6. *Let $\hat{\gamma}$ be a representative distribution type such that $\hat{\gamma}_m = 1$. Let $\{\gamma^k\}_{k=1}^\infty$ be a sequence converging to $\hat{\gamma}$, and let $\{\sigma^k\}_{k=1}^\infty$ be the corresponding sequence of simple equilibria with acceptance sets A^k and expected policies $x(\sigma^k)$. Then, the acceptance sets A^k converge to the singleton $\{x_m\}$ and the expected policies $x(\sigma^k)$ converge to x_m.*

Proof. Given that $\{\gamma^k\} \to \hat{\gamma}$, then $\lim \gamma_m^k = \hat{\gamma}_m = 1$ and $\lim \gamma_\theta^k = \hat{\gamma}_\theta = 1$ for $\theta \neq m$. Take any sequence $\{\sigma^k\}$. Since a representative i of type $m \in W$, then $\sigma_{ix}^k(m)(x_m) = 1$ for any k. So, this implies that $\lim x(\sigma^k) = x_m$

We now show that $\{x^k\}$ converges to x^*. To see why, suppose there exists an open set containing some point $x \in Y$ and a subsequence (also indexed by k) such that $x^k \in Y$ for all k. Because X is compact, we can extract a further subsequence (still indexed by k) and find a policy $x^k \in X^k$ such that $x^k \to x^*$. Since D is finite, we may relabel the subsequence if necessary. Hence, there is some $c \in D$ such that $c \in A(c^0)$ for all k. Thus, for every $c \in C$, we have $c \in A(c^0)$.

On the other hand, assume that A^k does not converge to $\{x_m\}$. Then there exists an open set Y with $x_m \in Y$ and a subsequence (also indexed by k) $\{x^k\}$ such that, for all k, $x^k \in A^k \cap (X \setminus Y)$.

Because $X \setminus Y$ is compact, there exists a subsequence (also indexed by k) and a policy $\tilde{x} \in X \setminus Y$ such that $x^k \to \tilde{x}$. Since D is finite, we may assume there exists some $C \in D$ such that, for all k, $x^k \in A_C(\sigma^k)$. Thus, for all $\theta \in C$, we have $u_{i\theta}(x^k) \geq v_{i\theta}(\sigma^k, \textit{out})$. Now, given that $x(\sigma^k)$ converges to x_m, it follows that $v_{i\theta}(\sigma^k, \textit{out})$ converges to $u_{i\theta}(x_m)$ for every type θ. Then, by continuity, we have $u_{i\theta}(\tilde{x}) \geq u_{i\theta}(x_m)$. But then, strict quasi-concavity implies $u_{i\theta}(\frac{1}{2}\tilde{x} + \frac{1}{2}x_m) > u_{i\theta}(x_m)$ for all $\theta \in C$. Since x_m is always supported by a decisive coalition to any other policy, this leads to a contradiction. Therefore, A^k converges to $\{x_m\}$. □

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