Overlapping Calendars: Colonial Legacies and the Consequences of Misaligned Timing Institutions

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Abstract

This paper studies the economic consequences of conflicts between timing institutions, the rules that govern when schooling, work, and other activities take place, and local economic conditions. We focus on the overlap between school calendars and local agricultural cycles, and document systematic misalignment between the two across countries in southern latitudes. These patterns reflect institutional legacies, as inherited institutions continue to shape the design of school calendars in previously colonized countries. Exploiting this colonial variation as an instrument, our cross-country estimates indicate that greater overlap between school terms and agricultural labor demand increases school dropout rates. To identify the underlying mechanism, we use school-level data to study a calendar reform in Colombia that exogenously increased overlap in two departments. Using a synthetic difference-in-differences approach, we find that calendar misalignment induces a trade-off between schooling and labor, resulting in higher dropout and lower enrollment in rural areas. Our findings highlight the importance of timing institutions as a determinant of human capital accumulation and suggest that aligning social institutions with local economic conditions can generate substantial gains for economic development.

Keywords: Seasonality, school calendar, dropout, colonial legacies, rural, Colombia.
JEL codes: I25, J22, J24, O12, O13, O43.

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1. Introduction

Institutions shape economic outcomes not only by what they prescribe, but by when they prescribe it. A foundational insight in development economics is that institutions are key determinants of long-run economic performance (Acemoglu et al., 2001; Glaeser et al., 2004). Most of this literature studies *what* institutions do. Property rights, legal systems, and political authority have received sustained attention as drivers of economic outcomes. Yet, institutions also shape behavior through a second dimension that remains largely unexplored. They determine *when* economic activity takes place.

Timing institutions are everywhere. School calendars dictate when children attend class. Office and business hours shape when adults work. Tax cycles and electoral schedules govern when major civic obligations occur. Each of these arrangements coordinates millions of people around a common temporal structure. When the timing they impose aligns with the rhythm of local economic activity, they go unnoticed. When it does not, they generate frictions with relevant consequences for individual decisions and aggregate outcomes. Despite how common they are, the economic effects of timing institutions remain understudied. This paper provides systematic evidence that timing institutions are quantitatively important for economic development. We focus on a particularly consequential one, the school calendar, and study how its misalignment with local agricultural cycles shapes human capital accumulation in agrarian economies.

To assess the scope and consequences of this institutional misalignment, we begin by documenting cross-country patterns. We assemble a data set of school calendars around the world and find that countries in southern latitudes mirror northern school calendars despite facing different climatic conditions. We then compare these calendars with local agricultural timing across countries and find that many of them exhibit substantial overlap between periods when schools are in session and local harvest seasons. This overlap is larger among countries in southern latitudes and former colonies, which often retain school calendars inherited from their colonizers even when geographic and seasonal conditions differ substantially. These patterns are consistent with a broader view in which institutional transfers persist and continue to shape economic outcomes long after the colonial period ends (Acemoglu et al., 2001; Glaeser et al., 2004; Bolt and Bezemer, 2009), and suggest that school calendar design in some countries is largely determined by historical institutional factors rather than local economic conditions.

To estimate the causal effect of calendar overlap on school dropout, we instrument using colonial institutional legacies. Specifically, we exploit the interaction between the colonizer's school calendar and the agricultural cycles predicted by a country's geography. We find that a one percentage point increase in overlap raises the share of children out of school by approximately 0.4 percentage points. While these estimates are informative about the global scope of the misalignment, they mask relevant within-country heterogeneity and are subject to potential measurement error.

To address this, we turn to a natural experiment in Colombia that exploits within-country variation. This setting allows us to hold constant country-level factors and exploit granular school-level data to study the mechanism behind the cross-country results directly. The policy reform shifted the academic calendars of public schools in two departments (Nariño and Valle del Cauca) from a September-June schedule, mirroring Northern Hemisphere systems, to a January-November calendar aligned with the rest of the country.[1,2] Importantly, the reform did not alter curricula, assessments, or school resources. It only changed the timing of instruction during the year, increasing the overlap between schooling and periods of peak agricultural labor demand by 2 percentage points, on average, in affected regions.

Using administrative school census data covering the universe of public rural schools in Colombia, and implementing a synthetic difference-in-differences (SDID) design, we estimate the causal effects of this calendar shift. Total enrollment fell by nearly 25 percent in the impacted regions. Dropout rates rose by 1 to 2 percentage points on average, representing about a 50 percent increase relative to the pre-reform baseline. Grade promotion fell by about 2.5 percentage points, an intensive-margin response distinct from dropout. These effects are economically large, persistent over time, and concentrated among primary-school-aged children in rural areas.

The magnitudes implied by the Colombian reform line up with those from our cross-country instrumental variable estimates. The cross-country evidence implies that a 1 percentage point increase in calendar overlap raises school dropout by 0.4 to 0.5 percentage points. The Colombian reform increased the average overlap between school and agricultural calendars by approximately 2 percentage points and raised dropout by 1 to 2 percentage points, which corresponds to a 0.5 to 1 percentage point increase in dropout per percentage point of overlap. Two independent identification strategies thus deliver broadly consistent magnitudes and indicate that calendar alignment is a quantitatively important margin for human capital accumulation.

We provide direct evidence on the mechanism in two steps. First, we construct a measure of calendar overlap at the school level by combining regional school calendars with granular spatial data on crop-specific harvesting cycles. We show that schools experiencing larger increases in overlap exhibit significantly larger increases in dropout and declines in enrollment, whereas those not exposed to an increase in overlap show no detectable effects. Second, we use nationally representative household survey data and a difference-in-differences design to estimate the effect of the reform on child labor. We find that the probability of children engaging in rural work rose by approximately 5 to 10 percentage points in affected municipalities following the reform, with the increase concentrated among primary-school-aged children, closely mirroring the patterns observed in schooling outcomes. These results provide direct causal evidence of a time-allocation mechanism, in which greater overlap between academic calendars and agricultural cycles raises the opportunity cost of schooling, leading households to substitute children's schooling with labor supply during peak agricultural periods.

Our results are robust to several alternative specifications. First, the findings are stable

[1] Departments are like States in the U.S.

[2] De Roux and Riehl (2022) exploit the same reform to study a different question, namely how the resulting academic break between high school and college affected college enrollment and early-career earnings.

across alternative definitions of harvesting intensity, including different thresholds of the annual harvesting distribution. Second, we assess the stable unit treatment value assumption (SUTVA) by examining student transfers and migration patterns. We find no evidence of reform-induced changes in either margin, suggesting that the estimates are not driven by student reallocation across regions. Third, we re-estimate the main effects using a conventional difference-in-differences design with a comparison group of untreated departments selected on agricultural specialization and pre-reform characteristics. The estimates closely match those from our main empirical approach.

Our study contributes to three strands of the economics literature. First, it contributes to the broad literature on the economic effects of institutions. While a long-standing literature has documented how institutions shape economic outcomes through their content (North, 1991; Acemoglu et al., 2001; Glaeser et al., 2004) and how they persist over time (Banerjee and Iyer, 2005; Nunn, 2008; Bolt and Bezemer, 2009; Dell, 2010; Nunn and Wantchekon, 2011; Michalopoulos and Papaioannou, 2013, 2016; Lowes et al., 2017), far less is known about how the timing prescribed by institutions interacts with local economic activity. A small but growing literature has begun to document such effects. Montero and Yang (2022) show that Catholic patron saint day festivals in Mexico reduce long-run economic development when their fixed dates coincide with peak planting or harvest periods. A complementary set of papers documents how school calendars shape labor market outcomes for parents, particularly mothers (Price and Wasserman, 2024; Graves, 2013; Duchini and Van Effenterre, 2022).

We contribute to this nascent literature in two ways. First, we provide systematic evidence that the timing of school calendars is a quantitatively important determinant of children's human capital accumulation. Second, we show that timing institutions can be inherited and persist long after independence, producing more prevalent misalignment in former colonies in southern latitudes. Academic years in many of these countries continue to follow European templates rather than local agrarian cycles, illustrating how colonial institutions shape contemporary outcomes through seemingly minor features. Colonial inheritance explains why this calendar misalignment exists and persists. Our estimates quantify its consequences.

Second, we contribute to the education and child labor literature by showing that school calendars are an important and underexplored determinant of school dropout in agrarian settings (Basu and Van, 1998; Baland and Robinson, 2000; Edmonds and Pavcnik, 2005; Beegle et al., 2006; Edmonds, 2007). Existing work largely treats schooling decisions as driven by income shocks, liquidity constraints, or short-term changes in exam timing, abstracting from the timing of schooling (Watkins, 2000; Dillon, 2021; Merfeld, Merfeld; Allen, 2024; Ito and Shonchoy, 2026). In contrast, we show that the timing of schooling itself can be a first-order determinant of educational outcomes. We document cross-country evidence that greater school-harvest overlap increases dropout and provide causal evidence that shifting Colombia's school year into the harvest season increases both dropout and child labor. Unlike prior studies, we examine a permanent, system-wide change in the school calendar and trace its effects on enrollment, progression, and dropout.

Third, we contribute methodologically by combining cross-country historical variation with within-country quasi-experimental evidence to study both the existence and the mechanism of the effect. More broadly, we connect historical institutional design to contemporary household behavior through a novel timing channel. At the macro level, we exploit variation in colonizer calendars and geography to instrument for school-harvest overlap and estimate its global impact. At the micro level, we leverage a natural experiment in Colombia that isolates the timing mechanism by shifting the academic calendar without altering other aspects of schooling. Although prior work has examined the effects of instructional time and school schedules (Pischke, 2007; Marcotte, 2007; Goodman, 2014; Bostwick et al., 2022; De Roux and Riehl, 2022), we are the first to link inherited calendar design to local economic conditions and to study its consequences using both cross-country and within-country variation. Together, our findings suggest that institutional timing reforms, such as aligning school calendars with local economic conditions, can substantially improve schooling outcomes at low cost.

The remainder of the paper is organized as follows. Section 2 documents systematic misalignment between school and agricultural calendars across countries, links it to colonial institutional legacies, and presents instrumental variable estimates of the effect of calendar overlap on school dropout. Section 3 describes the institutional setting of the Colombian education system, its academic calendars, and introduces the calendar reform studied in this paper. Section 4 presents the data. Section 5 outlines the empirical strategy. Section 6 presents the main school-level results with their corresponding robustness checks, and Section 7 presents causal evidence on how the calendar reform affected child labor market outcomes. Finally, Section 8 concludes.

2. Worldwide Evidence on the Effects of Calendar Overlap

2.1. School Calendars Across Latitudes

School calendars were institutionalized during the 19th century, when European states formalized public primary education through foundational school laws that established centralized, state-regulated systems, including standardized academic calendars.[3] These laws required municipalities to maintain public schools and defined the structure of the school year, limiting the time available for work outside the classroom. Compulsory attendance legislation came later, including the Mundella Act (1880) in the UK and the Jules Ferry Laws (1882) in France, but by then the institutional template of the school calendar had already been established (Lelièvre, 2021; Gold, 2002).

To maximize attendance, school calendars were designed to minimize conflicts with agricultural cycles by scheduling instruction during periods of low-harvesting seasons (Pedersen, 2012). As a result, the academic year typically began after the summer, allowing students and

[3] Particularly, France enacted the Loi Guizot in 1833, Belgium the Loi Nothomb in 1842, Spain the Ley Someruelos in 1838, the Netherlands the Schoolwet in 1806, and the United Kingdom the Forster Act in 1870.

their families to participate in harvest activities.[4] Since then, and until current times, most Northern Hemisphere countries have adopted a school calendar that begins in September or October, following the summer, and ends around May or June.

However, the notion of "summer" does not translate uniformly across latitudes, which implies that school calendars need not follow the same structure everywhere. Equatorial countries lack clearly defined seasons, producing substantial within-country variation in climate and harvest schedules. Countries in the Southern Hemisphere experience summer from November to February, which would naturally imply a school calendar offset relative to northern countries.

Despite these differences, many countries in southern latitudes mirror the northern calendar by scheduling school breaks in July and August, which do not necessarily correspond to their local agricultural cycles. Appendix Figure A.1 illustrates this pattern by plotting current school calendars by country, sorted by latitude.[5] Northern countries align school breaks with the northern summer between June and August. Countries near the Equator, despite experiencing different climatic conditions, tend to follow a similar calendar structure, with school breaks taking place during the same months. In contrast, some countries in the Southern Hemisphere, particularly those with Spanish heritage such as Paraguay, Chile, and Argentina, align school breaks with the southern summer between December and February. Other countries in the South, especially those in Africa with French or British colonial heritage, do not follow this pattern and instead mirror northern calendars.

2.2. Colonial Origins of the School and Agricultural Calendar Overlap

These school calendar patterns in the Global South may be closely linked to colonial institutions, as many countries in equatorial and southern latitudes were historically colonized. In fact, school calendars in former colonies often reflect those of the colonizing country rather than the pattern suggested by latitude. Figure 1 plots the monthly share of school days in former colonies and compares them with those of their colonizers (plotted in the first row of the figures). Colonial calendars frequently persist despite substantial differences in climate and agricultural cycles. Countries colonized by France, the United Kingdom, Belgium, and the Netherlands show a high degree of persistence relative to the school calendar of their colonizer. In contrast, Spanish and Portuguese colonies appear to have adapted their school calendars to local conditions. These patterns suggest that school calendars in some southern countries could have been shaped more by the institutional practices of their colonizers rather than by local agricultural conditions.

The extent to which colonial calendars persisted seems to depend on the degree of institutional autonomy that former colonies had when their school calendars were established.

[4]Additional evidence suggests that the emergence of summer breaks was also influenced by the aristocratic hunting season in France (Lelièvre, 2021), as well as by urban social habits, budgetary constraints, and the preferences of school officials in the United States (Gold, 2002; Weiss and Brown, 2003).

[5]School calendars were hand-collected from the official websites of the ministries of education, or equivalent government bodies, of each country in our sample, using the most recently available academic calendar at the time of data collection. More details are provided in Appendix B.

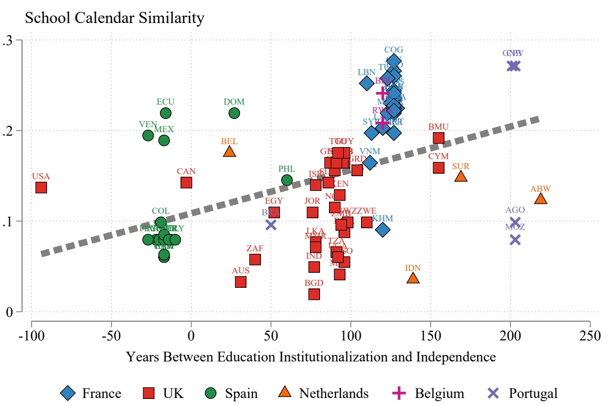
Figure 1: Monthly School-Day Shares by Colony and Colonizer

Notes: The figure shows the share of school days in each month. For each country, the information corresponds to the most recent school calendar data available. Source: Own elaboration based on official sources.

For example, Spanish and Portuguese colonies, which gained independence early, were able to adapt their calendars to local agricultural conditions. In contrast, countries colonized by France, the United Kingdom, or the Netherlands, which achieved independence after school calendars had already been established by colonial authorities, were more likely to retain the inherited structures. This suggests that the timing of independence played a critical role in shaping the alignment between school calendars and local agricultural cycles.

Figure 2 provides empirical evidence for the relationship between independence timing and calendar persistence. It plots the similarity between the school calendars of colonies and their colonizer against the time elapsed between a country's independence and the institutionalization of its colonizer's education system.[6] We observe a strong positive correlation. Countries that gained independence later were more likely to retain colonial calendar structures, while those that gained independence earlier show lower degrees of calendar overlap.

Figure 2: Colonial Legacy and School Calendar Overlap



Notes: The y-axis reports share of vacation days in a year during which students in both the colony and the colonizing country are simultaneously out of school. The x-axis displays an index capturing the difference between the independence date of each colony and the date on which the first educational law was enacted in the corresponding colonizer. The index is normalized to take a value of 1 for the largest observed difference and 0 when the difference is less than or equal to zero. Source: Own elaboration based on official and historical sources.

Two notable examples of this mechanism are Spain and France. Most Spanish colonies, including Colombia which we will emphasize in Section 3, gained independence well before educational systems were formally institutionalized in Spain (in 1838). This early independence allowed these countries to establish their own calendars rather than inherit those of the colonizer. In contrast, former French colonies gained independence only after school systems had already been institutionalized in France and therefore tend to retain calendar structures that closely mirror those of the former colonizer. These examples highlight how the timing of independence shapes the alignment between school calendars and local conditions, driving the broader pattern shown in Figure 2.

2.3. Calendar Overlap and School Dropout

The persistence of colonial school calendars has important consequences for education today. These historical patterns suggest a potential mismatch between school and agricultural

[6]Similarity between both school calendars is computed as the share of vacation days in a year during which students in both the colony and the colonizing country are simultaneously out of school. We use vacation day overlap rather than school day overlap because the number of instructional days is similar across countries by construction, leaving little variation to exploit. Vacation timing, by contrast, reflects specific institutional choices more likely to carry the imprint of colonial educational transfer.

calendars, particularly in formerly colonized countries located at latitudes that differ from those of their colonizers. This mismatch may, in turn, affect present day educational outcomes.

We formally evaluate this by computing the share of days in the year in which the agricultural and school calendars overlap in each country i:

$$O_i = \frac{|\mathbb{S}_i \cap \mathbb{A}_i|}{|\mathbb{D}|},$$

where $\mathbb{D}$ denotes the set of days in a calendar year, $\mathbb{S}_i \subseteq \mathbb{D}$ denotes the set of days when school is in session in country i, and $\mathbb{A}_i$ denotes the set of days corresponding to the harvesting season of country i's main crop. The cardinality in the intersection of these two sets, $|\mathbb{S}_i \cap \mathbb{A}_i|$, captures the number of days in which students are required to attend school during periods of high agricultural activity.[7] On average, both calendars overlap 14% of the year, corresponding to 51 days during the year.[8]

Calendar overlap varies systematically with colonial status and geography. Table 1 reports the results from regressions of calendar overlap on an indicator for former colonial status and country latitude. The estimates show that calendar overlap is significantly higher in former colonies and significantly lower in countries located at higher latitudes. These results are robust to the inclusion of alternative sets of controls. Although descriptive, they point to systematic misalignment between school calendars and local agricultural cycles in countries that were formerly colonized and are located in southern latitudes.

Table 1: School and Agricultural Calendar Overlap by Colonial Status and Latitude

	Dependent variable: Calendar Overlap			
	(1)	(2)	(3)	(4)
Colony	5.433**	6.699***	6.664***	6.786***
	(2.262)	(2.314)	(2.311)	(2.191)
Latitude	-0.107**	-0.116**	-0.116**	-0.092*
	(0.048)	(0.048)	(0.049)	(0.047)
Observations	126	126	126	126
Mean dep. var.	14.20	14.20	14.20	14.20
Macroeconomic controls	No	Yes	Yes	Yes
Demographic controls	No	No	Yes	Yes
Trade controls	No	No	No	Yes

Notes. Macroeconomic controls: GDP (in logs) and consumption share of GDP. Demographic controls: population and employment-to-population ratio. Trade controls: share of trade in GDP and the total trade volume between each country and the set of colonizers, comprising Belgium, France, Portugal, Spain, the Netherlands, and the UK. Source: own elaboration based on administrative records, World Bank Indicators, Penn World Table version 11.0, and Sacks et al. (2010).

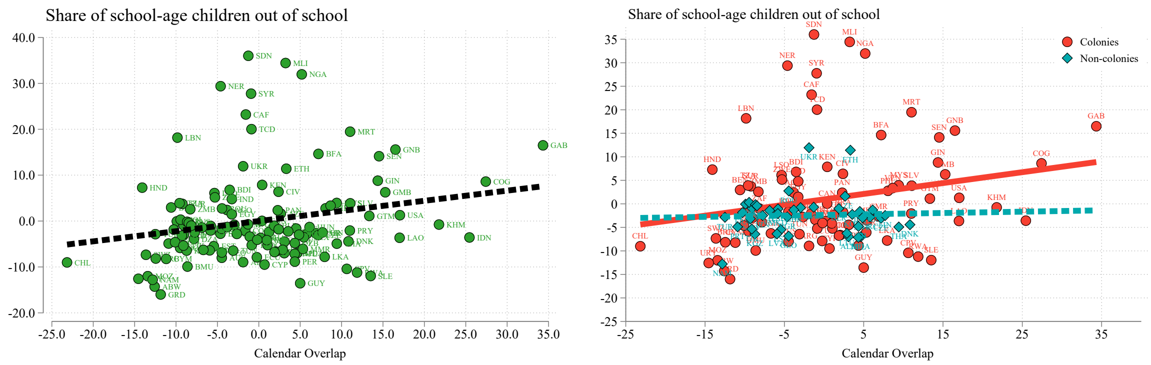
[7] Agricultural calendars are constructed based on data from Sacks et al. (2010), which provides crop-specific harvesting dates at the country level. We use the calendar of the main crop in each country, defined as the crop with the largest harvested area. More details are provided in Appendix B.

[8] Appendix Table A.1 provides descriptive statistics of these measure.

This increased overlap has relevant consequences. It raises the opportunity cost of schooling for rural students, particularly in agrarian economies. When schooling schedules conflict with periods of high labor demand, households may reallocate children's time toward farm work, affecting schooling decisions. To illustrate this relationship, we correlate the measure of calendar overlap with country-level school dropout rates and present the results in Figure 3a.[9] Consistent with this mechanism, countries with greater overlap between school and agricultural calendars exhibit higher school dropout rates.

Figure 3: School Dropout and the Overlap Between School and Agricultural Calendars

(a) All countries (b) Colonies vs Non-Colonies



Notes: The figures shows a scatterplot between the the share of school-age children out of school and the measured overlapping between harvesting and school calendars according to equation 2.3.

This positive relationship, nonetheless, is almost entirely driven by countries with a colonial legacy. Figure 3b separates countries with and without a colonial past, revealing a steeper gradient among former colonies and little to no correlation among countries with no colonial history.[10] Calendar overlap is associated with school dropout primarily in contexts where the school calendar was inherited rather than locally designed.

These correlations should not be interpreted as causal. Unobserved factors may influence both calendar structure and educational outcomes, generating omitted variable bias. In addition, dropout rates could themselves affect the design of school calendars, creating the potential for reverse causality.

To estimate causal effects, we exploit historical colonial legacies and instrument calendar overlap in former colonies using the intersection between the school calendar of the colonizing country and the agricultural calendar predicted by latitude. Let $c(i)$ denote the country that colonized country i and let $\mathbb{L}_i$ denote the set of countries located in the same latitude zone as country i.[11] We construct the following instrument:

[9] We condition on latitude and GDP (in logs) to isolate variation that is not driven by geography and income levels.

[10] Appendix Table A.2 shows this relationship when varying the set of controls used.

[11] Latitude zones are defined as: Equatorial (0–10°), Tropical (10–23.5°), Subtropical (23.5–35°), Temperate (35–50°), and Cool Temperate (50–66.5°).

$$Z_i = \frac{|\mathbb{S}_{c(i)} \cap \mathbb{A}_{\mathbb{L}_i}|}{|\mathbb{D}|},$$

where $\mathbb{S}_{c(i)}$ denotes the set of school days in the colonizing country $c(i)$, and $\mathbb{A}_{\mathbb{L}_i}$ corresponds to the set of days of high agricultural activity predicted by the latitude of country i.[12] For countries that were not colonized the instrument takes the value of zero.[13] On average, both calendars overlap 11% of days in the year (see Appendix Table A.1).

Using this instrument, we estimate the following equations:

$$\begin{aligned} \mathrm{O}_i &= \alpha Z_i + u_i \\ \mathrm{Y}_i &= \beta \hat{\mathrm{O}}_i + \mathbf{X}_i'\gamma + \varepsilon_i, \end{aligned} \tag{1}$$

where Y_i corresponds to the share of primary school age children who are out of school in country i, $\hat{\mathrm{O}}_i$ denotes the predicted overlap between school and agricultural calendars, and $\mathbf{X}_i$ denotes a vector of country level controls.[14] Standard errors are heteroskedasticity-robust.

The coefficient $\hat{\beta}$ in Equation 1 is consistently estimated if the instrument Z_i satisfies the exclusion restriction. This requires that the school calendars of former colonial powers affect school dropout in their former colonies only through the school calendars that these colonies inherited, and not through any other channel. This assumption is plausible because colonial powers originally designed their domestic school calendars to reflect their own climatic and agricultural conditions rather than those of the territories they later administered. As a result, the timing of school terms in the colonizing country is unlikely to be directly related to contemporary educational outcomes in former colonies located at very different latitudes.

The instrument combines this colonial school calendar with agricultural cycles predicted by latitude. By using agricultural calendars derived from countries located at similar latitudes, the instrument captures the agricultural conditions that country i would likely face in the absence of colonial institutional influence. This construction prevents the instrument from being mechanically correlated with country specific agricultural patterns while isolating variation that arises from the interaction between inherited school calendars and local agricultural

[12] $\mathbb{A}_{\mathbb{L}_i}$ is constructed as a leave-one-out estimate of the probability that a country harvests on a given day of the year. For each day d, we estimate the probability that a country growing the same main crop as country i and located in the same latitude zone is actively harvesting on day d, using all countries in that peer group except country i itself. Formally, for each cell combination of country j and day d we compute $\hat{p}_{id} = \sum_{j \in \mathbb{L}_i^c \setminus \{i\}} \mathbf{1}[\text{harvest}_{jd}]/(|\mathbb{L}_i^c| - 1)$, where $\mathbb{L}_i^c \subseteq \mathbb{L}_i$ denotes the set of countries sharing both the same main crop and the same latitude zone as country i. When the peer group contains fewer than two countries, we progressively widen the comparison group first to all countries in the same hemisphere growing the same crop, and then to all countries growing the same crop globally. The resulting daily measure $\hat{p}_{id} \in [0, 1]$ reflects the predicted probability of harvest on each day of the year for a country with similar agroclimatic conditions to country i, purged of country i's own harvest schedule to avoid mechanical correlation.

[13] In Appendix B.2 we consider a second instrument that combines the interaction between the school calendar of the colonizing country, the agricultural calendar predicted by their latitude, and the degree of exposition to colonial education institutions. This second instrument resembles a shift-share design with both the *shift* and the *share* components being arguably orthogonal. Our results are nearly identical using both designs.

[14] Controls include (i) latitude; (ii) GDP (in logs) and the consumption share of GDP; (iii) population and the employment-to-population ratio; and (iv) the share of trade in GDP and the total trade volume between each country and the set of colonizers, comprising Belgium, France, Portugal, Spain, the Netherlands, and the UK.

cycles. Under this interpretation, the instrument reflects the calendar structure that country i would have faced if its school calendar had followed the colonizer's institutional pattern while its agricultural conditions were determined by geography. As such, the instrument should affect school dropout only through its impact on the current overlap between school and agricultural calendars.

Table 2 presents the results of estimating Equation 1.[15] The estimated coefficients are positive and precisely estimated across specifications. The results imply that a one percentage point increase in the overlap between school and agricultural calendars increases school dropout by approximately 0.4 percentage points. The estimates remain stable across different sets of controls, supporting a robust causal relationship between calendar overlap and school dropout.

Under this instrumental variable approach, these estimates should be understood as local average treatment effects. They capture the impact of calendar overlap in countries where school calendars were influenced by colonial institutions and therefore respond to the variation generated by the instrument. In such contexts, where inherited school calendars may not align with local agricultural conditions, students face higher opportunity costs of schooling and are more likely to drop out.

Table 2: Effect of Calendar Overlap on Dropout

	Dependent variable: Dropout rate				
	(1)	(2)	(3)	(4)	(5)
Panel A: Full sample					
Calendar Overlap	0.515***	0.385***	0.406***	0.405***	0.391***
	(0.101)	(0.097)	(0.095)	(0.095)	(0.095)
First-stage F	152.92	106.22	106.64	113.51	115.30
Observations	126	126	126	126	126
Panel B: Former colonies					
Calendar Overlap	0.319***	0.247***	0.320***	0.319***	0.306***
	(0.113)	(0.094)	(0.101)	(0.103)	(0.101)
First-stage F	88.41	85.63	73.31	74.70	76.85
Observations	84	84	84	84	84
Geographic controls	No	Yes	Yes	Yes	Yes
Macroeconomic controls	No	No	Yes	Yes	Yes
Demographic controls	No	No	No	Yes	Yes
Trade controls	No	No	No	No	Yes

Notes. The dropout rate is defined as the share of primary school-age children out of school. For each country, we use the latest available value during the 2010–2019 period. Geographic controls: country latitude. Macroeconomic controls: GDP (in logs) and consumption share of GDP. Demographic controls: population and employment-to-population ratio. Trade controls: share of trade in GDP and the total trade volume between each country and the set of colonizers, comprising Belgium, France, Portugal, Spain, the Netherlands, and the UK. Source: own elaboration based on administrative records, World Bank Indicators, Penn World Table version 11.0, and Sacks et al. (2010).

These results provide strong causal evidence of the relationship between calendar overlap and school dropout, driven by countries with a colonial past. However, while the instrumental variable strategy addresses potential endogeneity in school calendar design, cross-country

[15]The first stage results are presented in Appendix Figure A.2.

estimates remain inherently aggregated and their interpretation might be limited. The analysis relies on national averages that mask substantial within-country heterogeneity in agricultural cycles, school calendars, and schooling decisions. In addition, both agricultural and school calendars might be measured with error at the country level, as harvesting seasons and school schedules often vary across regions within a country. For these reasons, we complement the cross-country results with micro-level evidence in the following sections.

3. A Natural Experiment: Colombia's School Calendar Reform

Colombia is a country near the Equator that provides an ideal historical setting to study the relationship between school and agricultural calendars. The country was colonized by Spain and gained independence in 1819. Spain formally institutionalized its national school calendar only later, which allowed Colombian republican authorities to design their own school schedule after independence.[16] Because of substantial regional variation and political constraints, Colombia adopted a dual school calendar during the twentieth century, in which different areas of the country operated under two opposing school calendars. This system was unified in 2010 under a single national calendar. This reform increased the overlap between the school calendar and local agricultural harvesting periods in some regions of the country. We exploit this institutional change to estimate the effect of school and agricultural calendar overlap on school dropout.

3.1. The Colombian Education System and the Dual School Calendar

Education in Colombia is organized into three levels: (i) primary education (grades 1–5); (ii) lower secondary education (grades 6–9); and (iii) upper secondary education or high school (grades 10–11). Schooling is provided by both public and private institutions. In 2010, approximately 80% of all students were enrolled in public schools, and 31% attended schools located in rural areas.

Unlike countries with centralized and fixed school calendars, the academic year in Colombia can begin either in January and end in November or in September and end in June. The calendar that begins in January and ends in November is known as *Calendar A*, while the calendar that begins in September and ends in June is known as *Calendar B*.[17] Regardless of

[16]We date the institutionalization of Spain's education system to the *Ley de Instrucción Primaria* of 21 July 1838 (*Ley Someruelos*), which established the first functioning liberal primary school system in Spain, requiring municipalities to maintain public schools and introducing teacher certification and provincial supervision of education. This framework was later consolidated by the *Ley de Instrucción Pública* of 9 September 1857 (*Ley Moyano*), which introduced compulsory and free elementary schooling. Since most Spanish colonies, including Colombia, gained independence in the 1810s and 1820s, they did so well before either of these laws was enacted, giving Colombian republican authorities the freedom to design their own school calendar.

[17]School breaks depend on the adopted calendar. Schools following *Calendar A* have a one-month break between June and July and a longer break between November and January. Schools following *Calendar B* have a one-month break between December and January and a longer break between June and September. Both calendars include one-week breaks around April and October.

the calendar, all schools are required to complete 40 weeks of instruction per academic year (Congreso de la República de Colombia, 1994).

Since the early years of the Colombian republic, the academic calendar has undergone substantial transformations. During the colonial period (i.e., before 1810), education in the Spanish colonies was primarily provided by the Church in a decentralized manner and was accessible only to a small elite. In the late eighteenth century, the Spanish Crown introduced the Bourbon reforms to modernize state capacity in the colonies (Chiovelli et al., 2023). As part of these reforms, and influenced by Enlightenment ideas, Carlos III reduced the Church's influence over education and expanded schooling among local and Indigenous populations (Anguita Osuna, 2019). During this period, however, the school calendar played little role in shaping educational access.

Following independence in the 1820s, the Colombian state made efforts to centralize and organize the education system. School calendars, however, were not a central component of these reforms and remained anchored to religious festivities. Archival evidence suggests that throughout the nineteenth century and the first half of the twentieth century, school calendars were not formally institutionalized and varied widely across regions.

The public school calendar in Colombia became explicit and institutionalized in the mid-twentieth century. Decree 75 of 1951 established a fixed academic calendar for public schools and formally introduced two regional calendar regimes. Schools in the Department of Cauca, which at the time included territories that later became the departments of Nariño and Valle del Cauca, were required to begin the school year in October, while schools in the rest of the country started in February. This decree marked the first nationwide recognition of a dual calendar structure and introduced regional differentiation in official school calendars.

Subsequent attempts to standardize class periods nationwide faced substantial opposition and were later revised through Decree 1902 of 1969.[18] The latter decree cited climatic conditions in Valle del Cauca, Nariño, and Cauca that rendered the proposed calendar impractical, as well as requests from principals, teachers, and parents for longer end-of-year vacations and shorter mid-year breaks. This resistance from communities in the southwest suggests that climatic, cultural, and logistical factors played a central role in sustaining regional differentiation in academic calendars. Consequently, since the mid-twentieth century, all public schools in Colombia followed the January–November calendar, except those in the southwest, where public schools traditionally operated under the September–June calendar.[19]

The school calendar reform. Law 715 of 2001 introduced a decentralization reform that assigned local education authorities responsibility for organizing education provision, including defining the academic calendar, while granting certified municipalities autonomy over

[18]Most notably, Decree 1816 of 1967 established uniform academic semesters nationwide, regardless of the calendar followed; the only difference concerned the semester in which schools began. The first semester started on the third Monday of January and lasted 95 instructional days (excluding Saturdays), followed by a mid-year vacation until the Sunday preceding the fourth Monday of July. The second semester began on the fourth Monday of July and also lasted 95 instructional days, with the end-of-year vacation extending until the Sunday preceding the third Monday of January.

[19]Appendix C provides a detailed description of the legal evolution of school calendars since the colonial period.

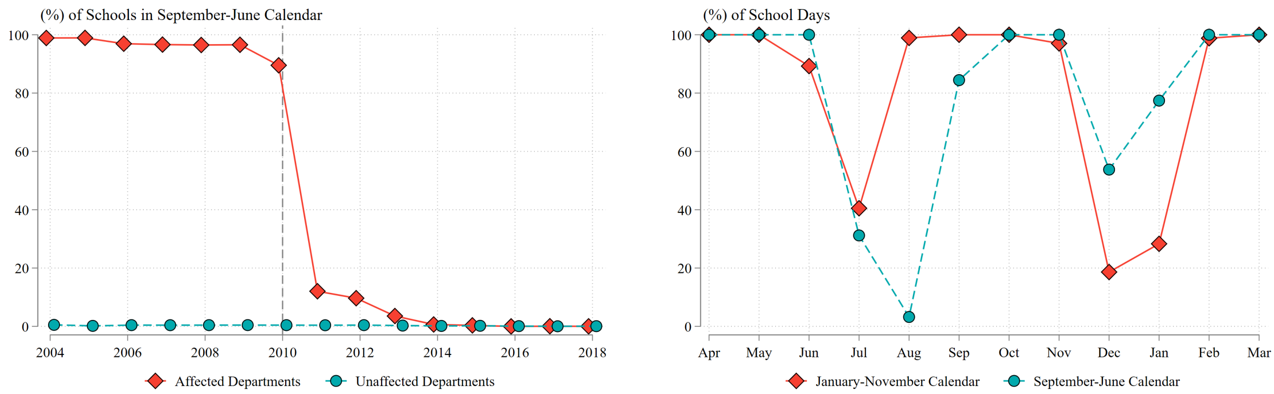
education provision.

This increased flexibility led authorities in Nariño and Valle del Cauca to modify the public school calendar. After 2010, all public schools in these two departments were required to transition to the January–November calendar to align the school year with national planning and budget execution cycles (Santiago de Cali. Secretaría de Educación Municipal, 2008).[20] During this transition, public schools maintained the required 40 weeks of instructional time. Private schools, by contrast, have always been free to choose which calendar to adopt nationwide.

Figure 4a plots the share of public schools adopting the September-June calendar in the departments of Nariño and Valle del Cauca (here onward "affected" departments) compared with the rest of the country. Prior to 2010, the period preceding the calendar reform, virtually all public schools in the affected departments operated under the September-June calendar, whereas public schools in the rest of the country consistently followed the January-November one. Beginning 2011, and following the implementation of the calendar reform, all public schools in Nariño and Valle del Cauca transitioned to the January-November calendar, aligning their academic schedules with those used elsewhere in the country.

Figure 4: The School Calendar Reform

(a) Schools (%) under Sept.-June Calendar (b) Calendar Shift in Affected Departments



Notes: Panel (a) shows, for each year, the share of public rural schools operating under the September–June calendar. The shares are reported separately for schools in Nariño and Valle del Cauca (red dots) and for schools in the rest of the country (blue dots). Panel (b) plots the proportion of school days (i.e., days of instruction) in each month as a share of total monthly workdays. The plotted values correspond to the average across the affected departments of Nariño and Valle del Cauca. Source: Own elaboration based on data from the Colombian School Census (Form C-600) and the Secretaries of Education of Nariño and Valle del Cauca.

The school calendar reform induced changes in the distribution of instructional days across months. Figure 4b presents the average monthly share of instructional days under the September—June calendar prior to the reform and under the January–November calendar adopted thereafter in affected departments. The reform substantially altered the timing of school holidays throughout the year. Prior to the reform, the bulk of vacation time occurred in July and August, with shorter breaks in January and December, closely resembling academic calendars in Northern Hemisphere countries. Following the reform, vacation time became

[20] De Roux and Riehl (2022) provide a more detailed discussion of the school calendar reform.

concentrated in January and December, with a markedly shorter mid-year break, primarily in June.

As a consequence, schools in the affected departments abruptly modified their academic calendars, altering the timing of instruction in specific regions of the country. Departments not covered by the reform were unaffected and therefore continued to operate under the existing school calendar.

3.2. Agricultural Activity

Colombia is a middle income country where around 23% lives in rural areas and 22% of the workforce is employed in the agricultural sector. Agricultural production varies depending on the area of the country, with coffee, rice, and maize being the most common agricultural products. Affected departments are intensive in the production of stimulants (mainly coffee), rice, maize, fruits and nuts, and sugarcane, whereas the rest of the country specializes in stimulants, maize, rice, yams and roots, and sugarcane. Appendix Figure A.4 plots the main crop at the *vereda* level for all the country and highlights the two affected departments.[21]

Colombia is located very close to the Equator, implying that temperature fluctuations do not follow a seasonal pattern. Instead, temperature varies primarily with altitude: lower-lying areas are warmer, while higher-altitude regions are colder. Despite the relative stability of temperatures throughout the year, climatic conditions do vary seasonally in terms of precipitation rather than temperature. As a result, some degree of climate seasonality is present (although to a much lesser extent than in countries with pronounced seasons) while temperature remains relatively constant over the year.

This climatic context, characteristic of equatorial countries, allows for the production of a wide range of agricultural goods depending on the altitude of cultivated areas. Consequently, Colombia exhibits substantial heterogeneity both in the types of crops produced and in the timing of their production. This, in turn, leads to significant variation in agricultural calendars across regions. Appendix Figure A.5 illustrates this heterogeneity by presenting the harvesting calendars of the three main crops in the affected departments. Specifically, we plot the share of each crop's total annual harvesting activity that occurs in each calendar month (see Appendix Figures A.6 and A.7 for detailed information on harvesting calendars in these two departments).

Harvesting intensity varies substantially across crops and throughout the year. For example, maize harvesting is concentrated mainly in February and around the middle of the year, whereas stimulant crops, predominantly coffee, are harvested primarily between April and June. This heterogeneity is central to our analysis, as it allows us to identify areas within the affected departments that are more or less exposed to the reform.

[21] A *vereda* is an administrative territorial division in the rural areas of municipalities, typically formed by a grouping of land parcels bounded by geographic features and major roadways.

4. Data

We combine four data sources to construct a school-level panel containing information on school progression, geographic location, and exposure to agricultural seasonality.

First, we use the school census from 2004 to 2018.[22] This census is compiled annually by the central government through surveys administered to school principals, who report detailed information on enrollment, infrastructure, and teaching staff. In particular, principals indicate the number of students enrolled in the previous year and classify them as currently enrolled on time, repeating a grade, having dropped out, or having transferred to another institution. We complement these data with georeferenced information on school locations.

Second, we compute harvested areas for different crops at the *vereda* level (geographic units smaller than municipalities) using data from the Global Agro-Ecological Zones (GAEZ) v4, produced by the Food and Agriculture Organization of the United Nations (FAO).[23] The GAEZ data are constructed on grids of approximately 9 × 9 kilometers at the equator and provide information on harvested areas for 25 crop groups.[24] We georeference these grids to the *vereda* level and match them to the school census. This procedure allows us to precisely identify the agricultural production in the areas surrounding each school in the data.

Third, we use information on harvesting calendars at the department–crop level provided by the Rural Agricultural Planning Unit (Unidad de Planificación Rural Agropecuaria, UPRA) of the Colombian Ministry of Agriculture.[25] These data report the timing and intensity of harvesting seasons for each crop in every department.

Fourth, we use administrative records from the Secretaries of Education of Nariño and Valle del Cauca detailing the academic calendars of public schools in these departments for the 2005–2008 period (pre-reform) and the 2011–2015 period (post-reform).

Combining these four data sets we build a school level panel that includes a total of 31,636 schools, representing all the schools in the country. Out of these, 59.57% correspond to rural and 88.36% to public, and 59.26% to rural, public schools (Appendix Figure A.8). Importantly, the data include information on crop harvesting in the *vereda* where the school is located. Table A.3 describes the school-level panel, which constitutes our estimating data set.

Overall, enrollment in rural schools declined over time across all departments in the sample. However, the reduction was substantially larger in the treated departments. Enrollment fell by 24% in Nariño and by 18% in Valle del Cauca, compared to a decline of only 9% in the rest of the country. Over the same period, dropout rates decreased and passing rates increased across all schools.

Similar patterns emerge when disaggregating by educational level, with one important difference. The decline in total enrollment is driven entirely by primary schools, whereas

[22]These data come from Form C-600 of the Colombian Ministry of Education, which is publicly available.

[23]The data are available at: `https://www.gaez.fao.org/`.

[24]The crop groups include: wheat, rice, maize, sorghum, millet, barley, potato and sweet potato, cassava, yams and other roots, sugar beet, sugar cane, pulses, soybean, rapeseed, sunflower, groundnut, oil palm fruit, olives, cotton, banana, tobacco, vegetables, stimulants, fodder crops, and other crops.

[25]Available at: `https://www.upra.gov.co/es-co/eva/eva-2019`.

enrollment at the secondary level exhibits only a minimal decline or even a slight increase.

5. Empirical Strategy

This sharp and uniform calendar transition constitutes the core quasi-experimental variation exploited in our empirical strategy. By comparing schools in affected departments with appropriately selected schools in the rest of the country, we examine how changes in the timing of the school year—specifically, the redistribution of instructional and vacation days across months—affected school progression for rural children. We further analyze whether these effects are driven by increases in the overlap between academic calendars and local agricultural harvesting seasons in the most affected areas.

To estimate the effect of the change in the academic calendar, we compare schools in the two affected departments (i.e., Nariño and Valle del Cauca) with schools in the rest of Colombia. We focus specifically on rural and public schools, as these are the most directly influenced by agricultural calendars. This setup involves comparing a relatively small group of treated schools (1,668) with a much larger group of untreated schools across the rest of the country (16,885).

Given the large pool of untreated schools, identifying an appropriate counterfactual may be challenging and prone to researcher bias. To address this concern, we implement a Synthetic Difference-in-Differences (SDID) estimator, which provides a flexible and data-driven approach to constructing counterfactuals under weaker assumptions than the standard Difference-in-Differences (DID) framework (Arkhangelsky et al., 2021). The SDID method combines features of the DID design with the Synthetic Control approach (Abadie and Gardeazabal, 2003; Abadie et al., 2010, 2015; Abadie and L'hour, 2021), generating a weighted combination of untreated units that closely matches pre-treatment trends in the treated group. This framework enables causal inference under less restrictive assumptions than standard DID.

Formally, the SDID procedure assigns unit weights, $\hat{\omega}_i$, to schools in the untreated group so that the weighted average of their pre-treatment outcome trajectories closely matches that of the treated schools during the pre-exposure period (2004–2009). In addition, SDID assigns time weights, $\hat{\lambda}_t$, which balance pre- and post-treatment periods for the untreated units in the estimation. The estimator solves the following optimization problem:

$$\left(\hat{\tau}, \hat{\mu}, \hat{\alpha}, \hat{\beta}\right) = \underset{\tau,\mu,\alpha,\beta}{\operatorname{argmin}} \left\{ \sum_{i=1}^{N} \sum_{t=1}^{T} \left(y_{it} - \mu - \alpha_i - \beta_t - W_{it}\tau\right)^2 \hat{\omega}_i \hat{\lambda}_t \right\} \tag{2}$$

where y_{it} denotes the outcome for school i in year t, $W_{it} \in \{0, 1\}$ indicates treatment exposure, N is the number of schools, and T the number of years. The terms α_i and β_t represent school and year fixed effects, respectively. The parameter of interest, τ, measures the Average Treatment Effect on the Treated of the academic-calendar reform on schools in treated departments.

Our main outcomes of interest are total school enrollment (in logs), and the dropout rate, measured annually relative to the number of students enrolled in each school in the baseline year. We also present additional results for school promotion rates. While informative, this outcome is potentially subject to attrition bias, as it is defined conditional on students remaining enrolled in school.

Importantly, our SDID strategy is not affected by variation in treatment timing or by differential treatment intensity (de Chaisemartin and D'Haultfœuille, 2020). All affected schools experienced the calendar change simultaneously and to the same extent. Therefore, our identification strategy relies on three key milder assumptions: (1) the absence of differential pre-trends; (2) the absence of other policies specifically targeting the affected departments; and (3) the stable unit treatment value assumption (SUTVA). We provide evidence supporting the first assumption using event-study estimates. Regarding the second, we did not identify any other policy interventions affecting Nariño or Valle del Cauca during this period. Finally, SUTVA could be violated if the treatment induced migration or population changes in the affected departments. We provide evidence against this in Section 6.4.

6. School-Level Effects of the Reform

6.1. Overlap Between School and Agricultural Calendars

The calendar reform modified the degree of overlap between academic and agricultural calendars in the affected departments. To quantify this change, we construct a school-level measure of overlap between the two calendars in three steps:

1. Using department-level school calendars, we compute the proportion of non-instructional days in month m for each affected department d and each academic calendar $c \in \{A, B\}$. We denote this proportion by V_{mdc}.

2. Using department- and crop-specific harvesting calendars, we identify harvesting-intensive months for each crop. We define an indicator variable, $\mathbb{1}_{\{m \in \mathcal{I}_j\}}$, equal to one if month m for crop j falls within the top quartile of the annual distribution of harvesting activity (i.e., the three most intensive months), denoted by $\mathcal{I}_j$, and zero otherwise.[26]

3. Combining these two measures, we define the overlap between academic and agricultural calendars for each school s under calendar c as:

$$O_{sc} = \sum_{j \in J} \omega_{sj} \left(\frac{1}{12} \sum_{m=1}^{12} \max \left\{ \mathbb{1}_{\{m \in \mathcal{I}_j\}} - V_{mdc}, 0 \right\} \right). \tag{3}$$

The term inside the brackets captures the share of instructional days during harvesting-intensive months (i.e., $1 - V_{mdc}$) and is equal to zero during non-intensive months.

[26]The selection of the set $\mathcal{I}_j$ might vary depending on how many months we define as harvesting intensive. We provide robustness checks in Section 6.4 varying the definition of $\mathcal{I}_j$ and show that our results do not depend on this.

Averaging this expression across months yields the mean share of instructional days a student would forgo if they participate in the labor market for a given crop j under calendar c. We then aggregate across crops using ω_{sj}, the share of crop j's harvested area in the *vereda* where school s is located. The resulting measure, O_{sc}, represents the weighted average share of potential school days lost due to agricultural labor participation. Larger values indicate greater overlap between instructional days and harvesting periods, and thus a higher opportunity cost of schooling during peak agricultural seasons.

4. Finally, we compute a school-level exposure measure, O_s, defined as the change in overlap induced by the calendar reform:

$$\Delta O_s = O_{sA} - O_{sB}. \tag{4}$$

A positive value of ΔO_s indicates that the post-reform January–November calendar (Calendar A) increases the overlap between academic activities and harvesting periods relative to the pre-reform September–June calendar (Calendar B) in school s.

Intuitively, the overlap measure captures changes in the opportunity cost of schooling faced by students in schools differentially exposed to the calendar reform. Consider a student living in a rural area where potatoes, primarily harvested in August, constitute the dominant crop. Under the pre-reform calendar, most days in August were school holidays, allowing children to participate in harvesting activities during a peak agricultural month. Under the post-reform calendar, August becomes a full instructional month. As a result, the student faces a sharper trade-off between attending school and working during the harvest season. With binding time constraints, this increased overlap raises the opportunity cost of schooling and may lead some students to reduce attendance or drop out altogether.

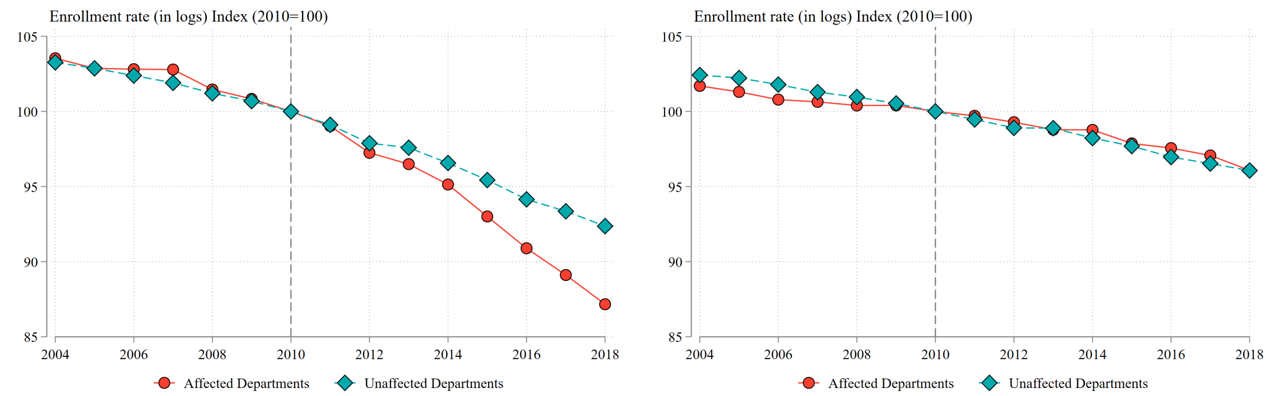
Appendix Figure A.9 presents the average change in overlap for schools in both affected departments across the main crops in each region. We document substantial heterogeneity in overlap changes across crops and departments. For instance, while the overlap associated with maize harvesting increases markedly in Nariño, it decreases slightly in Valle del Cauca following the reform. This heterogeneity is central to our analysis, as it implies that exposure to the reform depends jointly on the dominant crops in each *vereda* and on department-specific harvesting calendars. Overall, the reform increased the calendar overlap in 2%, as captured by the overall weighted average presented in the bottom of Appendix Figure A.9.

6.2. Effects of the Reform on School Attendance

The calendar reform decreased public school enrollment by inducing student dropout and decreasing school promotion. To see this, we begin by plotting the evolution of school enrollment, normalized to the year prior to the reform, in Figure 5. We present estimates separately for rural (Panel 5a) and urban (Panel 5b) schools. Prior to the reform, school enrollment in affected and unaffected departments evolved in parallel indicating no differential pre-reform trends. However, after the reform we observe a sudden decline in school enrollment among rural schools in affected departments, with the gap widening over time through 2018. We do not see any change in enrollment among urban schools.

Figure 5: Public School Enrollment in Affected and Unaffected Departments

(a) Rural (b) Urban



Notes: The figure shows the average difference in the (log) number of enrolled students in schools in Nariño and Valle del Cauca relative to schools in the rest of Colombia, for each year compared to 2010 (the baseline year). Estimates come from a regression controlling for school and year fixed effects. Vertical lines indicate 95% and 90% confidence intervals. Standard errors are clustered at the school level. Source: Own elaboration based on data from DANE.

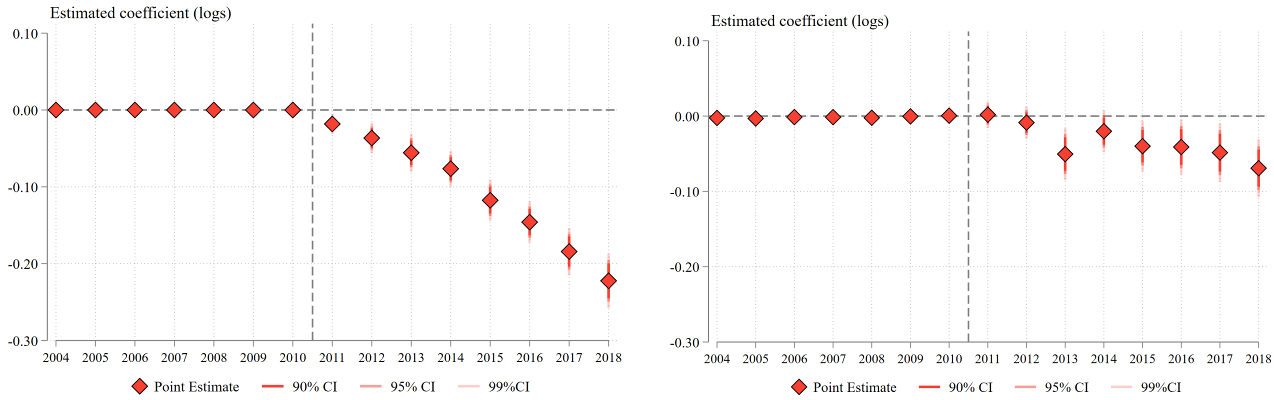
Although suggestive, this evidence indicates that the reform could have decreased rural school enrollment in the affected departments. More direct evidence comes from estimating the SDID specification in Equation 2 using enrollment as outcome. We present the results in Figure 6. The reform led to a persistent decline in enrollment in rural schools in affected departments. The negative effect emerges immediately after the reform and grows over time, remaining statistically significant through the end of the sample period. By 2018, average enrollment in treated schools had fallen by nearly 25% relative to the pre-reform baseline. Given an average baseline enrollment of approximately 78 students per school, this corresponds to a reduction of about 19 students per school.

School enrollment in levels may simply capture a scale effect and does not allow us to distinguish dropout from grade retention or overall changes in population. Therefore, to better understand the effects we again implement the SDID methodology using school dropout rates as outcome. We report the effects on Figure 7.[27] The calendar reform increased dropout rates among schools in the affected departments in around 1% to 2%, whereas urban schools remained mostly unaffected. On average across the post-reform years, the dropout rate in treated rural schools rose by approximately 1.7 percentage points relative to the baseline, reaching 2.5 percentage points by the end of the sample period. This corresponds to roughly a 50% increase relative to the pre-reform dropout rate of about 5% in 2010.

[27] Appendix Table A.4 reports the distribution of school-level weights ω_i estimated using the SDID methodology for the two main outcomes of interest. The first row shows the number of schools in the control group receiving a zero weight. We then grouped schools into deciles based on the magnitude of their weights and reported the average weight within each decile. For both outcomes, more than 10,000 schools received non-zero weights.

Figure 6: Effect of the Calendar Reform on Rural School Enrollment

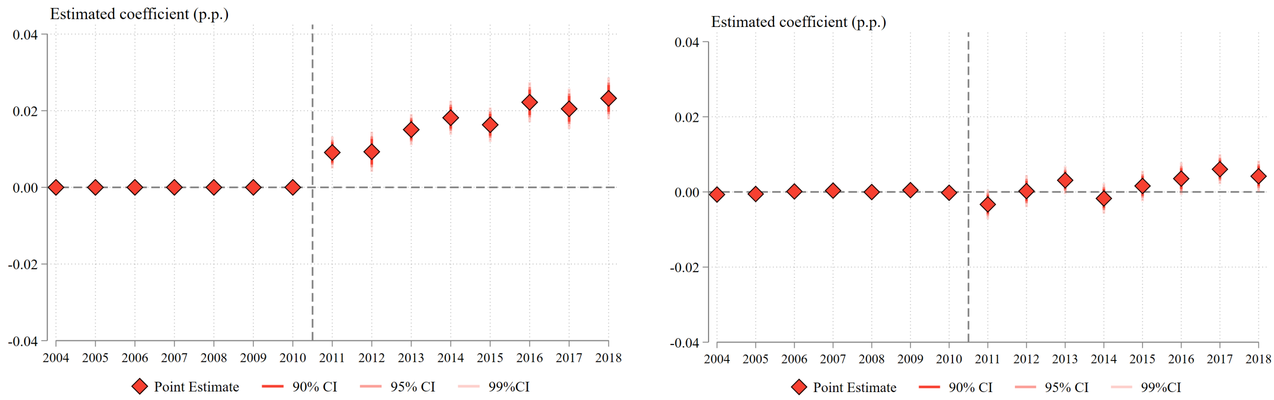
(a) Rural (b) Urban



Notes: The figures show the estimated effect of the 2010 change in the academic calendar on the corresponding outcomes for public-rural, and public-urban schools in Nariño and Valle del Cauca, compared to the synthetic control constructed following the methodology described in Section 5. The vertical lines represent the 90%, 95%, and 99% confidence intervals, based on bootstrapped standard errors with 50 repetitions.

Figure 7: Effect of the Calendar Reform on Dropout

(a) Rural (b) Urban



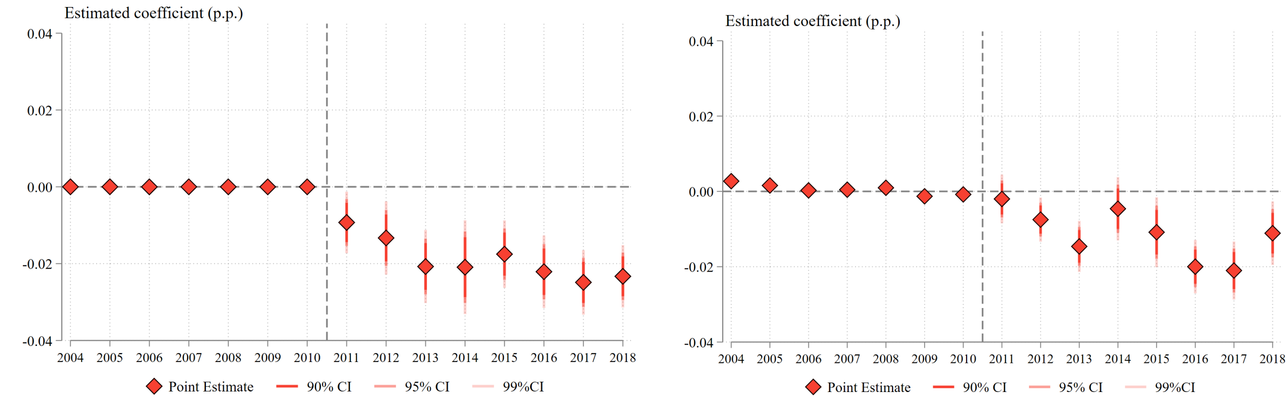
Notes: The figures show the estimated effect of the 2010 change in the academic calendar on school dropout between rural and urban schools in Nariño and Valle del Cauca, compared to the synthetic control constructed following the methodology described in Section 5. The vertical lines represent the 90%, 95%, and 99% confidence intervals, based on bootstrapped standard errors with 50 repetitions.

The reform induced rural students to drop out but also affected grade promotion. We analyze the effect of the reform using grade promotion rates as outcome in Figure 8. We again observe that rural students in affected departments were more likely to fail the grade after the reform relative to their unaffected counterparts. The reform increased grade retention by approximately 2.5% relative to baseline, corresponding to a decline of about 3% compared to the average passing rate in treated departments in 2010.

The effect on grade promotion helps explain the persistent increase in dropout rates documented earlier in Figure 7. The calendar reform appears to operate along both an extensive and an intensive margin of school progression. On the extensive margin, some

Figure 8: Effect of the Calendar Reform on Grade Promotion

(a) Rural (b) Urban



Notes: The figures show the estimated effect of the 2010 change in the academic calendar on the corresponding grade promotion defined as the share of students who approved a grade over the total enrollment in that grade. Panel 8a presents results for rural schools whereas 8b for urban schools. Treatement is defined as the schools in Nariño and Valle del Cauca, compared to the synthetic control constructed following the methodology described in Section 5. The vertical lines represent the 90%, 95%, and 99% confidence intervals, based on bootstrapped standard errors with 50 repetitions.

students responded to the higher opportunity cost of schooling by dropping out immediately after the reform. On the intensive margin, other students remained enrolled but faced greater difficulty balancing academic responsibilities with competing activities, such as agricultural work, leading to lower academic performance and, over time, an increased likelihood of eventual dropout.

Taken together, these results indicate that the transition from the September–June to the January–November academic calendar had significant adverse effects on educational progression in rural areas of the treated departments. The reform led to sizable and persistent reductions in school enrollment driven by increased dropout rates and grade retention rates.

Heterogeneity of the effect: The effects of the reform were concentrated on primary school students. Appendix Figure D.15 presents the results on school dropout separately for students in secondary and primary school. The effects are driven by primary-school students. By the end of the sample period, the reform reduced primary-school enrollment by approximately 35% on average, an effect largely attributable to a substantial increase in dropout rates. In contrast, we find no statistically significant effects on enrollment or dropout rates among secondary-school students.[28]

6.3. Effects of the Reform by Exposure to Calendar Overlap

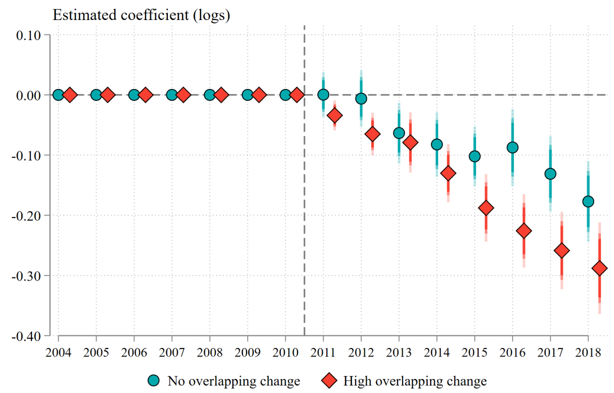
The calendar reform affected academic progression among students in affected departments where the change in calendar overlaps more with the agricultural calendar. We exploit the calendar overlap measure introduced in Section 6.1 to analyze the effects of the reform among

[28] We additionally examine heterogeneity by gender in Appendix Figure D.16, and do not find any substantial difference between male and female students.

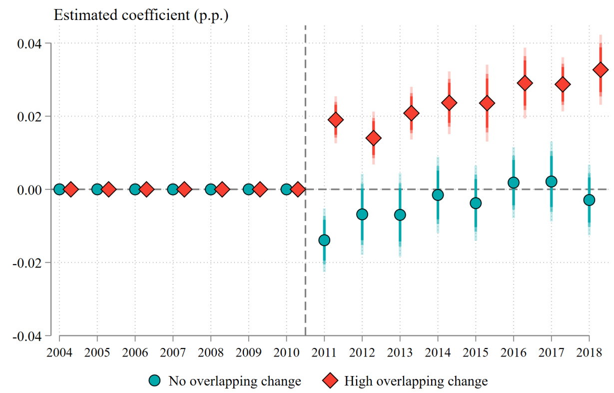
veredas that were and were not exposed to the calendar overlap. We estimate heterogeneous effects across schools that experienced little or no increase in overlap (or even a reduction) and those that experienced a substantial increase.[29] The results are presented in Figure 9.

Figure 9: Effects of the Reform by Levels of Exposure to Calendar Overlap

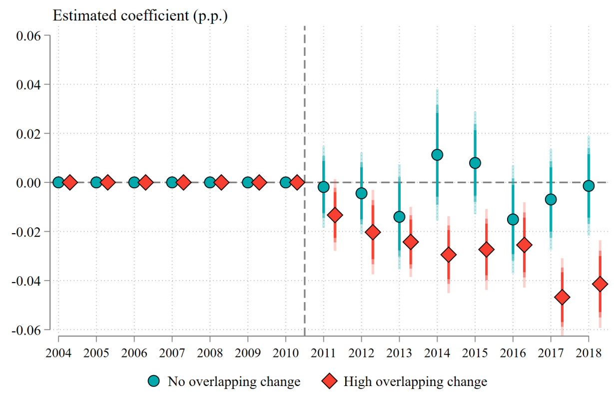
(a) Enrollment (in logs)



(b) Dropout rate



(c) Grade Promotion



Notes: The figures show the estimated effect of the 2010 change in the academic calendar on the corresponding outcomes for public and rural schools in Nariño and Valle del Cauca, compared to the synthetic control constructed following the methodology described in Section 5. No overlapping change corresponds to schools where the overlap measure in Equation 4 is zero or negative. High overlapping change corresponds to schools that fall within the top quartile of the measure of the change in Overlap in Equation 4. The vertical lines represent the 90%, 95%, and 99% confidence intervals, based on bootstrapped standard errors with 50 repetitions. Source: Own elaboration based on data from DANE.

Schools located in areas where harvesting seasons overlap more closely with instructional days face larger increases in school dropout. The adverse effects of the calendar reform on enrollment are strongly driven by schools experiencing larger increases in overlap. By the end of the sample period, the decline in enrollment among high-overlap schools is approximately 50% larger than that observed among low-overlap schools. Consistent with this pattern, we find no meaningful effect on dropout rates for low-overlap schools, whereas the increase in

[29] We classify schools as *No Overlap* if their change in overlap, ΔO_s, is zero or negative, and as *High Overlap* if it falls within the top quartile.

dropout is concentrated among schools with substantial increases in overlap.

This evidence supports the interpretation that the calendar reform affected school progression primarily by increasing the overlap between academic schedules and local harvesting seasons. In schools where this overlap rose the most, students faced a higher opportunity cost of attending and remaining in school due to the outside option of agricultural work. Under binding time constraints, this increase in opportunity cost translated into higher dropout rates and lower enrollment.

Reconciling the Estimates. The magnitudes implied by the Colombian reform are slightly larger, but still broadly consistent with those obtained from our cross-country instrumental variable estimates in Section 2. The cross-country evidence suggests that a 1 percentage point increase in calendar overlap raises school dropout by 0.4 to 0.5 percentage points. The Colombian calendar reform increased the average overlap between school and agricultural calendars by approximately 2 percentage points, leading to a 1 to 2 percentage point increase in school dropout across affected schools. Consistent with the country level estimates, a 1 percent increase in overlap raises school dropout by about 0.5 to 1 percent. This modest discrepancy is consistent with the local nature of the SDID estimate, which captures effects for rural primary school students in two highly agrarian departments, whereas the cross country IV averages across a substantially more heterogeneous set of countries and is likely attenuated by measurement error in country level calendar overlap.

6.4. Robustness of the School-Level Estimates

We provide additional evidence supporting our main results through three complementary robustness exercises. First, we show that our findings are not sensitive to alternative definitions of harvesting intensity months (i.e., the set defined in $\mathcal{I}_j$). Second, we assess whether our results are consistent with the stable unit treatment value assumption (SUTVA), which requires that schools in the control group are not affected by policy-induced changes in the composition of students. Third, we re-estimate the effects using a conventional difference-in-differences (DiD) design with a comparison group constructed independently of the SDID procedure.

Harvesting Intensity. Our baseline specification in Figure 9 defines harvesting intensity using the top quartile of the annual distribution of harvesting activity, corresponding to the three most intensive months of the year. Figure A.13 presents SDID point estimates obtained under alternative definitions of intensive harvesting months. For ease of comparison, we pool the dynamic effects into a single estimate and include the baseline specification. The results remain stable when defining harvesting intensity using either only the most intensive month or the two most intensive months of the year.

SUTVA. Our estimates could be biased if the reform affected outcomes in the untreated group of schools. The primary threat to SUTVA in this context is the possibility that the reform induced students to migrate from treated to untreated departments, thereby contaminating the counterfactual. We provide two pieces of evidence supporting the validity of the SUTVA assumption. First, we examine whether the reform affected school transfer rates and report the results in Figure A.12a.[30] We find no evidence of a reform-induced increase in transfer rates, suggesting that students in affected departments did not relocate to schools in unaffected departments. Second, we compare trends in the share of children who migrated within the last five years between treated and untreated departments. If the reform induced migration, we would expect to observe differential trends across these groups. As shown in Figure A.12b, no such divergence is apparent. Together, these findings provide strong support for the SUTVA assumption.

Difference-in-Differences. Finally, we assess whether our results are driven by the weights implicitly assigned by the SDID estimator. To do so, we implement a conventional DiD design using a set of untreated departments constructed to be comparable to the treated departments of Valle del Cauca and Nariño. This comparison group is built in two steps. First, we restrict the pool to untreated departments whose primary agricultural products overlap with those of the treated departments—namely stimulants (coffee) and rice.[31] Second, within this restricted pool, we select the three most similar departments based on a set of pre-treatment covariates.[32] Figure A.13 presents the DiD estimates using this comparison group. The resulting patterns closely mirror those obtained using SDID, providing additional support for the robustness of our main findings.

7. Child Labor Responses to the Reform

The enrollment decline documented in Section 6 is consistent with a time-allocation mechanism in which children substitute schooling for agricultural work. We test this directly by examining whether the calendar reform increased child labor, using nationally representative household survey data and a municipality-level difference-in-differences design. We estimate the following specification:

$$E_{i,m\in d,t} = \sum_{t\neq 2010} \tau_t (W_m \times \beta_t) + \alpha_m + \beta_t + \gamma_t X_{m,t_0} + \epsilon_{imt}, \tag{5}$$

where $E_{i,m\in d,t}$ is a dummy variable equal to one if child i in municipality m of department d works in rural activities in year t, and zero otherwise. W_m is a treatment indicator equal to one if municipality m belongs to one of the affected departments. As control municipalities, we use the same matched set of departments employed in the difference-in-differences ro-

[30]The transfer rate in Figure A.12a is defined at the municipality level (rather than the school level), as our interest lies in movements across locations rather than across schools within the same location.

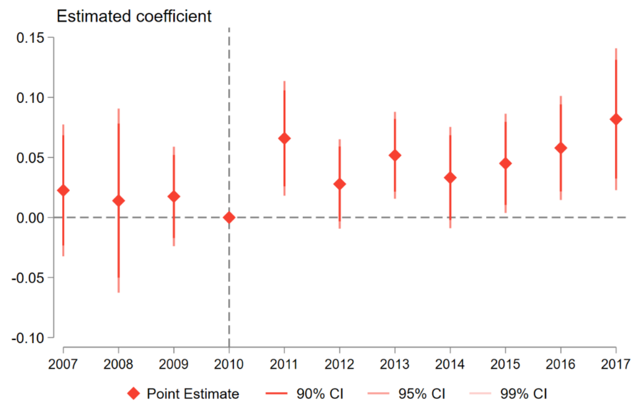
[31]This restriction excludes Bogotá, D.C., Bolívar, Boyacá, Caquetá, Cesar, Cundinamarca, Chocó, La Guajira, Norte de Santander, San Andrés y Providencia, and Amazonas.

[32]Specifically, we compute a standardized index based on: (i) the share of agriculture in departmental GDP; (ii) the log of the rural population; (iii) the log of public expenditure; and (iv) the log of public revenues (as a proxy for state capacity). We then calculate Euclidean distances in the standardized covariate space and select the three closest untreated departments. This procedure identifies Risaralda, Sucre, and Arauca as the most comparable departments.

bustness exercise of Section 6.4, namely Risaralda and Sucre.[33] The terms α_m and β_t denote municipality and year fixed effects, while X_{m,t_0} is a vector of predetermined municipality-level characteristics obtained from CEDE–Universidad de los Andes, interacted with year fixed effects to flexibly control for time-varying shocks that may be correlated with both municipality characteristics and child labor outcomes.[34]

Figure 10 reports the estimated τ_t coefficients. Prior to the reform, the probability of children engaging in rural labor evolves in parallel across treated and control municipalities, with coefficients close to zero, supporting the parallel-trends assumption underlying the design. Following the reform, the probability rises sharply in affected municipalities, by approximately 5 to 10 percentage points, and remains elevated through the end of the sample period. The persistence of the effect mirrors the dynamics of the dropout response documented in Section 6 and is consistent with a long-lasting reallocation of children's time toward farm work in affected areas.

Figure 10: Effect of the Reform on Child Labor



Notes. This figure plots the estimated coefficients τ_t from Equation 5. Source: Own elaboration based on data from DANE.

These causal estimates are reinforced by descriptive patterns in the same data. Appendix Figure A.14 provides three complementary views of child labor in rural areas. Panel (a) plots the share of children working in rural activities over time and shows that, in affected departments, this share approximately doubled between the pre-reform period and 2017, while it remained essentially flat in the rest of the country. Panel (b) summarizes this pattern as a raw before-after comparison. The share of primary-school-age children working in rural activities rose by approximately one percentage point in affected departments (about a 20 percent increase relative to pre-reform levels) and declined slightly elsewhere. Panel (c) disaggregates the post-reform increase by educational attainment within treated departments and shows that the rise is concentrated among children with completed primary education and incomplete secondary education, which precisely the margins along which dropout increased in Section 6.

[33] Arauca is excluded because it is not surveyed at the same frequency as the rest of the Colombian departments in the household survey.

[34] The pre-treatment controls include per capita GDP, the number of terrorist attacks at the municipality level, the homicide rate, rural population, and agricultural GDP.

Taken together, the causal and descriptive evidence suggests that the calendar reform increased the probability that rural children work and reduced the share who remain in school. These results are consistent with a time allocation mechanism in which students substitute schooling for agricultural work. Overall, greater overlap between academic calendars and agricultural cycles appears to raise the opportunity cost of schooling, leading households to substitute children's schooling with labor supply during peak agricultural periods.

8. Conclusions

This paper studies the economic consequences of time conflicts between social institutions and economic activities, focusing on the overlap between school calendars and peak labor demand in agrarian economies. We document that academic calendars across countries in southern latitudes are systematically misaligned with local agricultural cycles, and we show that this misalignment reflects colonial institutional legacies rather than adaptation to local economic conditions. Former colonies that gained independence after their colonizers had institutionalized public schooling tend to retain inherited calendar structures, whereas countries that became independent earlier adapted their calendars to local conditions. Exploiting this colonial legacy as a source of identifying variation, our cross-country instrumental variable estimates indicate that a one percentage point increase in the overlap between school and agricultural calendars raises the share of primary-school-age children out of school by approximately 0.4 percentage points, with effects concentrated among former colonies.

To examine the underlying mechanism, we exploit a 2010 calendar reform in Colombia that shifted public schools in Nariño and Valle del Cauca from a September–June to a January–November academic calendar, increasing the overlap with local harvesting periods in affected regions. Using administrative school-level data and a synthetic difference-in-differences design, we find that the reform reduced enrollment by nearly 25 percent, raised dropout rates by approximately 1.7 percentage points on average—rising to 2.5 percentage points by the end of the sample, a 50 percent increase relative to the pre-reform baseline—and lowered grade promotion. The effects are concentrated among primary-school students in rural areas and are largest in *veredas* where the reform generated the greatest increase in calendar overlap. Consistent with a time-allocation mechanism, child labor participation rose in treated departments following the reform, particularly among children at the margin of school continuation.

Taken together, the cross-country and within-country evidence point to a common mechanism: when school calendars overlap with periods of high agricultural labor demand, the opportunity cost of schooling rises and households substitute children's schooling with farm work. The magnitudes implied by the Colombian natural experiment are consistent with those obtained from the cross-country instrumental variable estimates, suggesting that institutional timing is a quantitatively important and previously overlooked determinant of human capital accumulation.

Our findings have direct policy implications. Much of the existing response to school dropout in developing countries has focused on resource-intensive interventions such as conditional cash transfers or investments in school inputs. Our results suggest that adjusting the timing of the school year to better align with local economic conditions offers a complementary and largely costless margin for improving educational outcomes. More broadly, the evidence highlights that inherited features of institutional design—even those as routine as the timing of the academic year—can have first-order consequences for economic development, and that realigning social institutions with local economic conditions can yield substantial gains for human capital accumulation.

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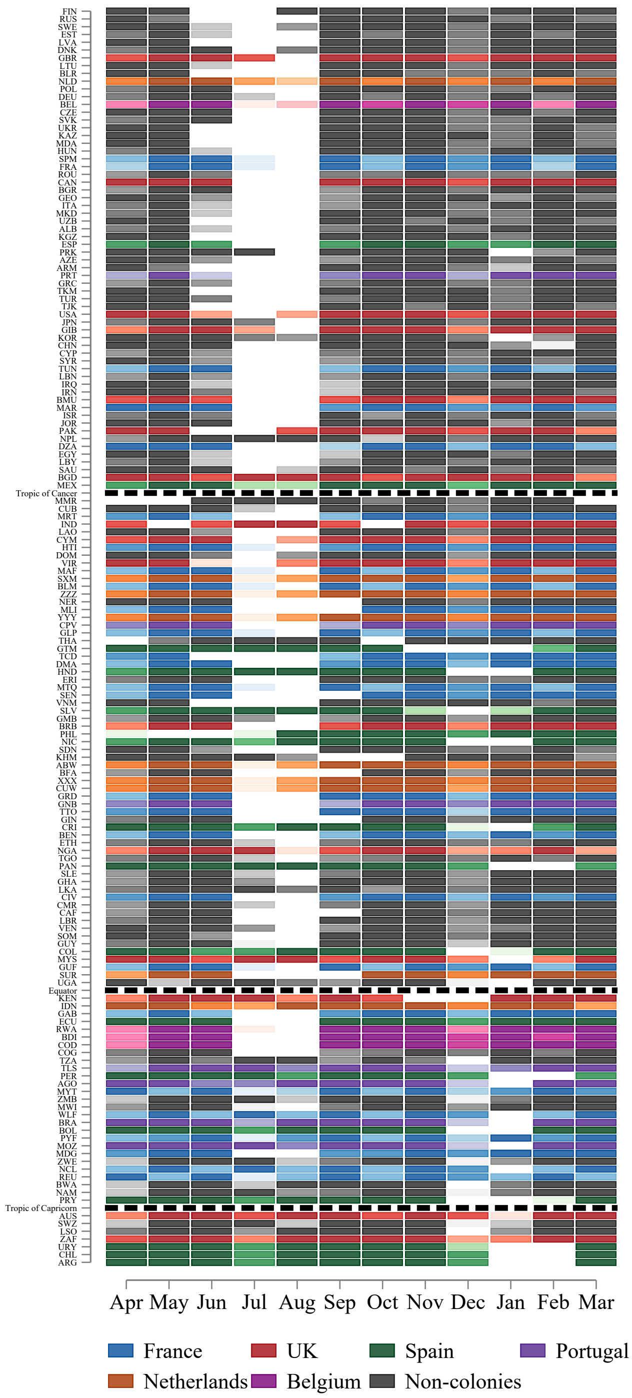
A. Additional Figures and Tables

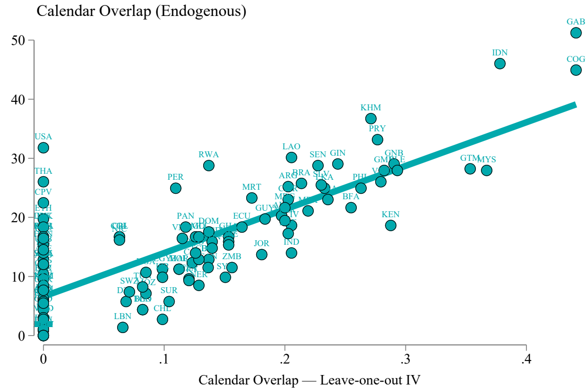
Appendix Figure A.1: Worldwide Academic Calendars by Latitude and Colonizer



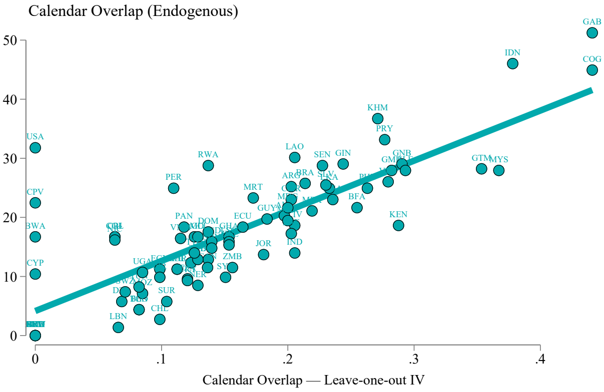
Notes: The figure shows the share of school days in each month. For each country, the information corresponds to the most recent school calendar data available. Source: Own elaboration based on official sources.

Appendix Figure A.2: First-Stage Relationship

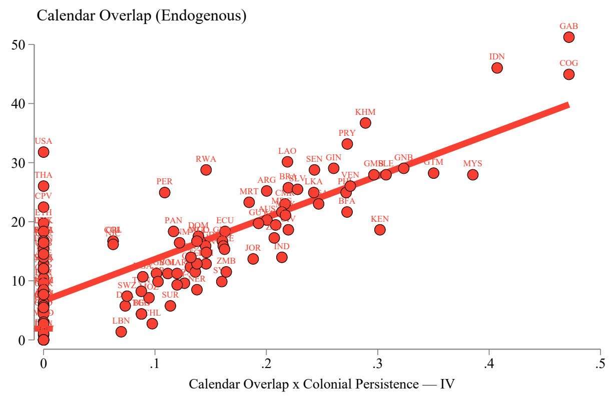
(a) Leave-one-out overlap, Full sample



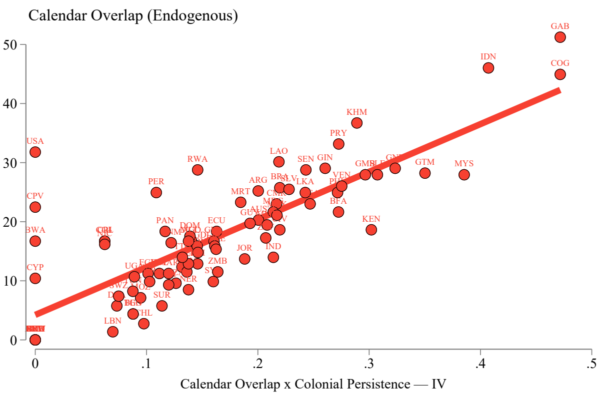
(b) Leave-one-out overlap, Colonies



(c) Overlap × colonial persistence, Full sample

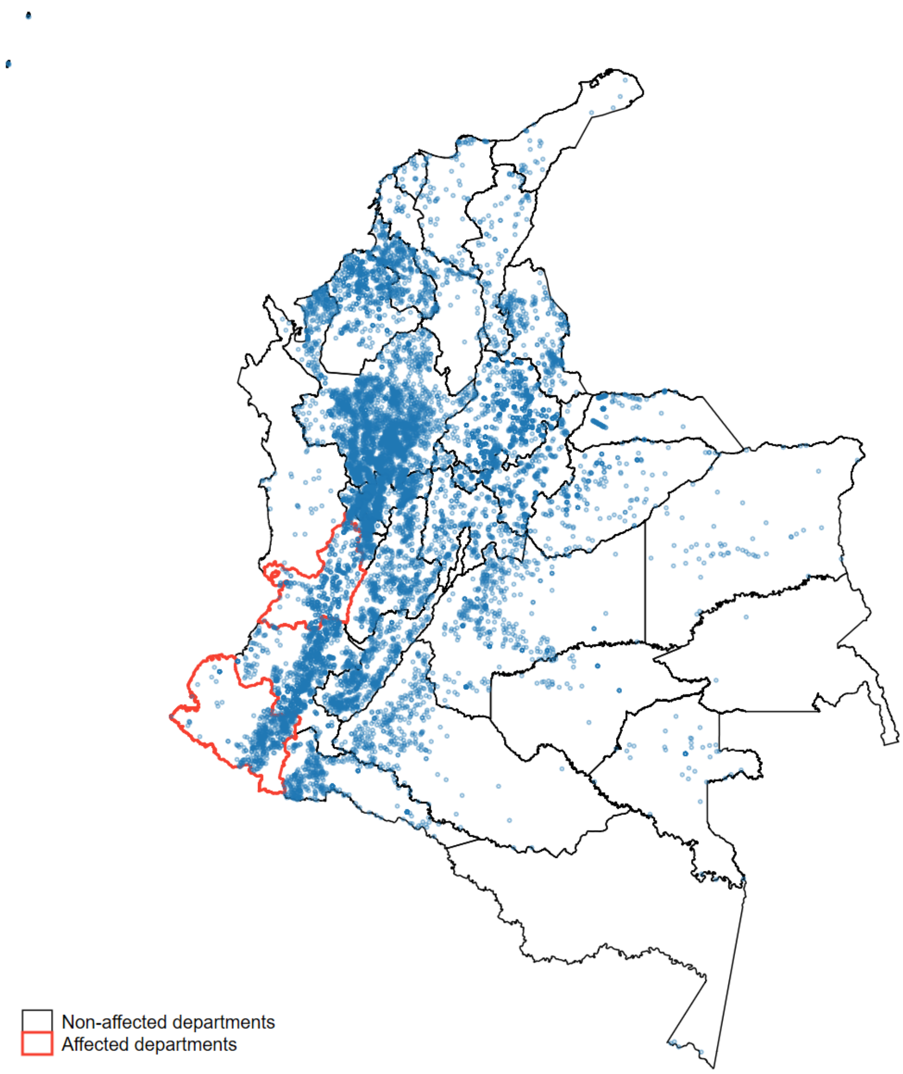


(d) Overlap × colonial persistence, Colonies



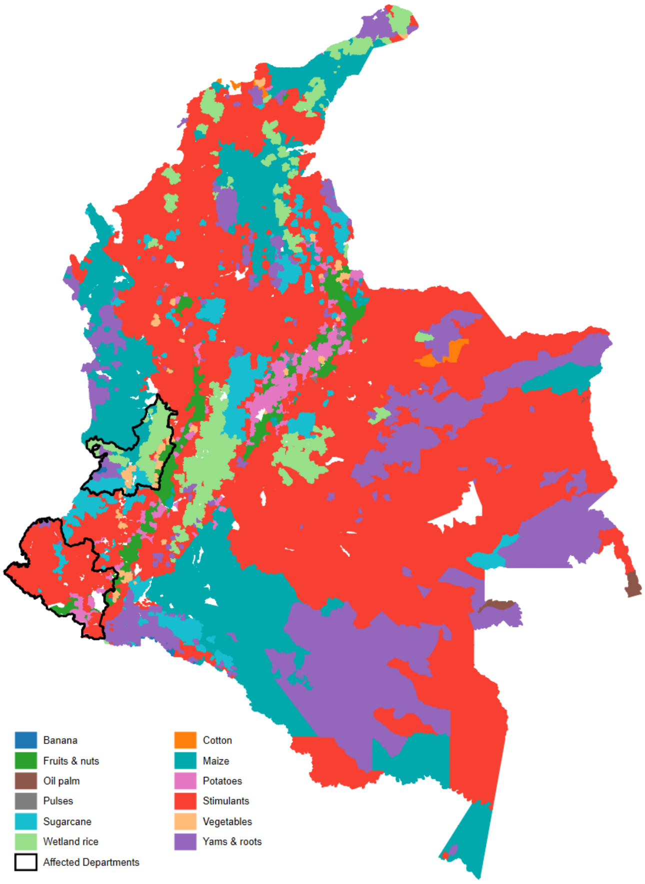
Notes: The figures shows a scatterplot between the measured overlapping between harvesting and school calendars according to equation 2.3, and the IVs Z_i^{LOO} and Z_i^{CP}.

Appendix Figure A.3: Schools Distribution



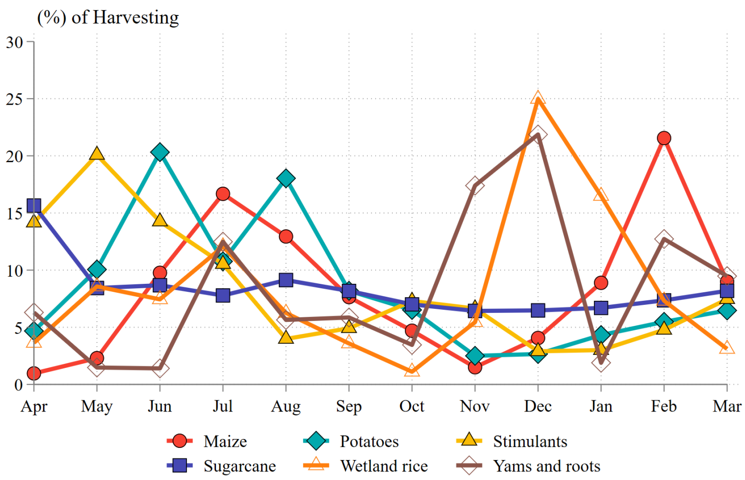
Notes. Each dot represents a school in the estimation sample. Source: Own elaboration based on data from DANE.

Appendix Figure A.4: Main Crop by *Vereda*



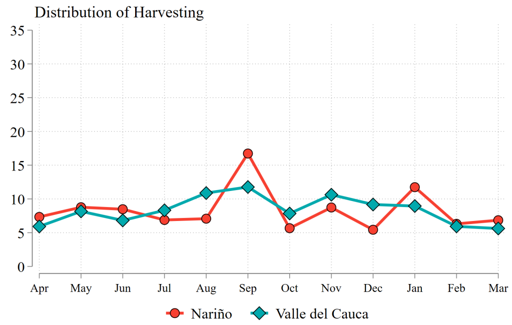
Notes. The figure shows the main harvested crop in each *vereda*. Stimulants include coffee, tea, and cocoa. *Veredas* shown in white indicate areas for which no information is available. Source: Own elaboration based on data from the Global Agro-Ecological Zones (GAEZ) v4 - FAO.

Appendix Figure A.5: Harvesting Calendars for Main Crops in Affected Departments

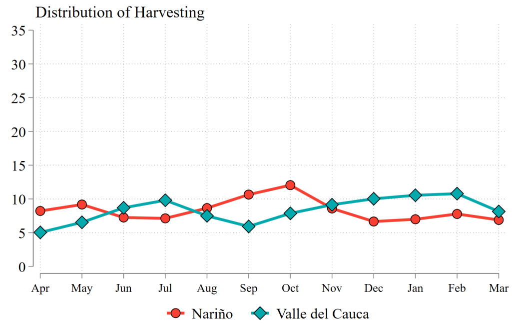


Notes. This figure plots the proportion of days dedicated to harvesting activities in each month, relative to the total annual harvesting for each crop. Stimulants refer to coffee, tea, and cocoa. Data come from the Colombian Ministry of Agriculture.

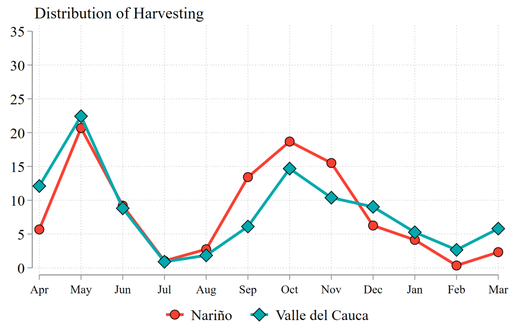
Appendix Figure A.6: Harvesting Calendars - Nariño and Valle del Cauca



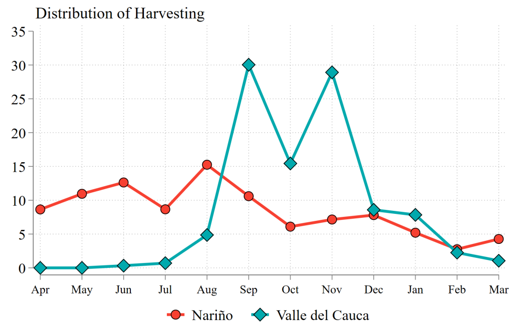
(a) Banana



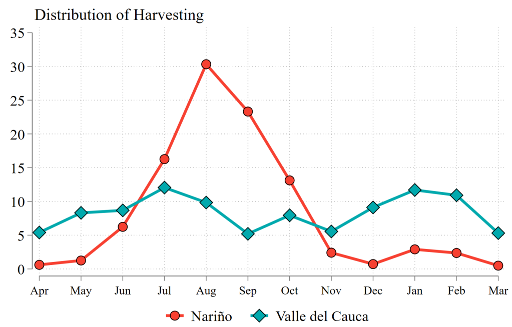
(b) Fruits and Nuts



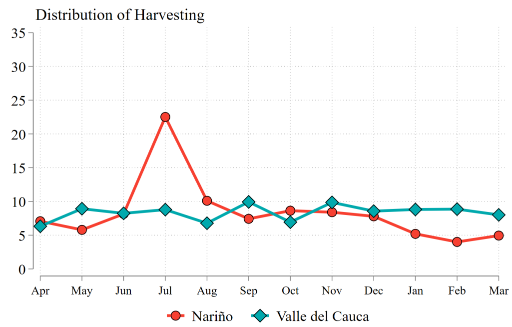
(c) Maize



(d) Potato and Sweet Potato



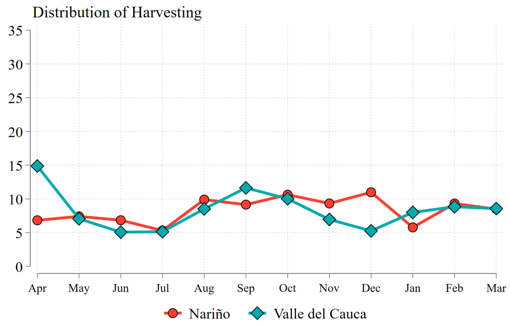
(e) Stimulants



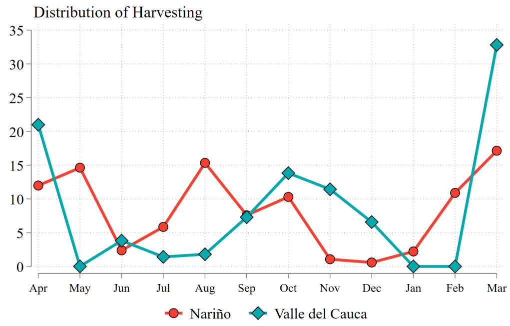
(f) Sugarcane

Notes. The figures show the proportion of days dedicated to harvesting activities in each month, relative to the total annual harvesting for each crop. Source: Own elaboration based on data from the Colombian Ministry of Agriculture.

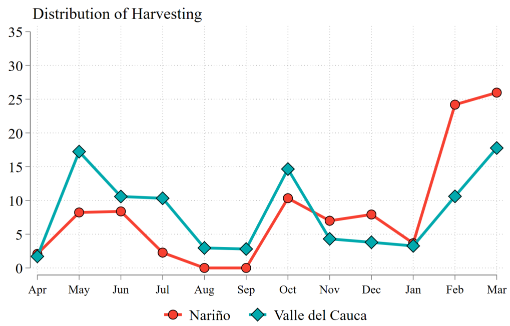
Appendix Figure A.7: Harvesting Calendars - Nariño and Valle del Cauca



(a) Vegetables



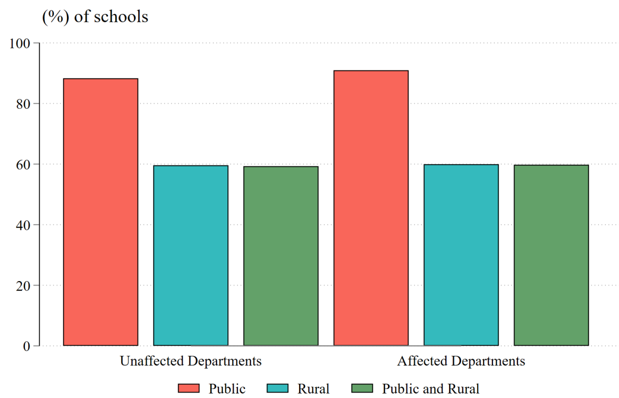
(b) Wetland Rice



(c) Yams and Other Roots

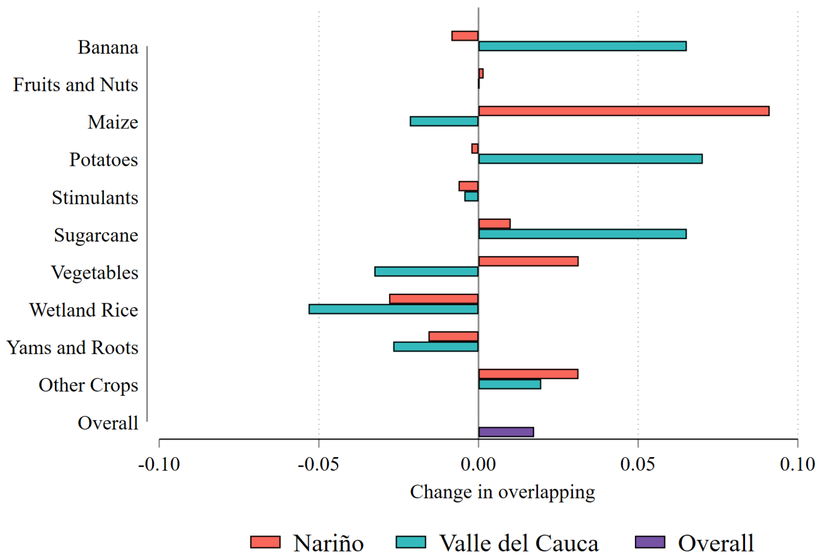
Notes. The figures show the proportion of days dedicated to harvesting activities in each month, relative to the total annual harvesting for each crop. Source: Own elaboration based on data from the Colombian Ministry of Agriculture.

Appendix Figure A.8: Proportion of Public and Rural Schools



Notes: The figure shows the percentage of schools that are public, rural, or both in 2010, in affected departments (i.e., Nariño and Valle del Cauca), and in the rest of the country. Data come from the Colombian census of schools (Form C-600).

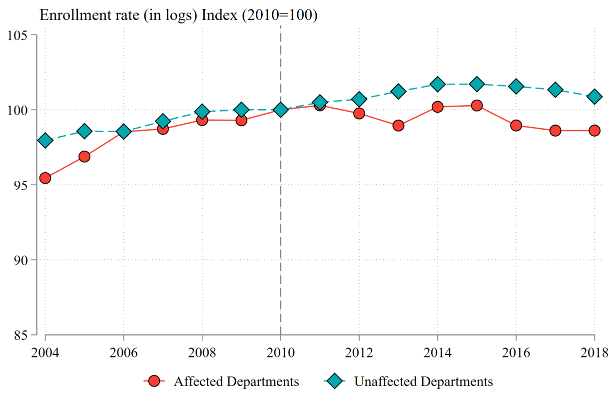
Appendix Figure A.9: Change in Calendar Overlap Induced by the Reform



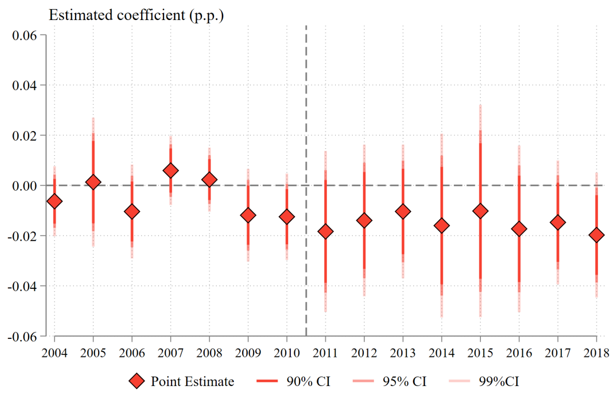
Notes: The figure plots the average change in overlap between the academic and harvesting calendars before and after the reform, by crop, based on the most harvested crop in each *vereda* where schools are located. The overall average, shown by the purple bar, equals 0.02.

Appendix Figure A.10: Effects of the Reform on Private Schools

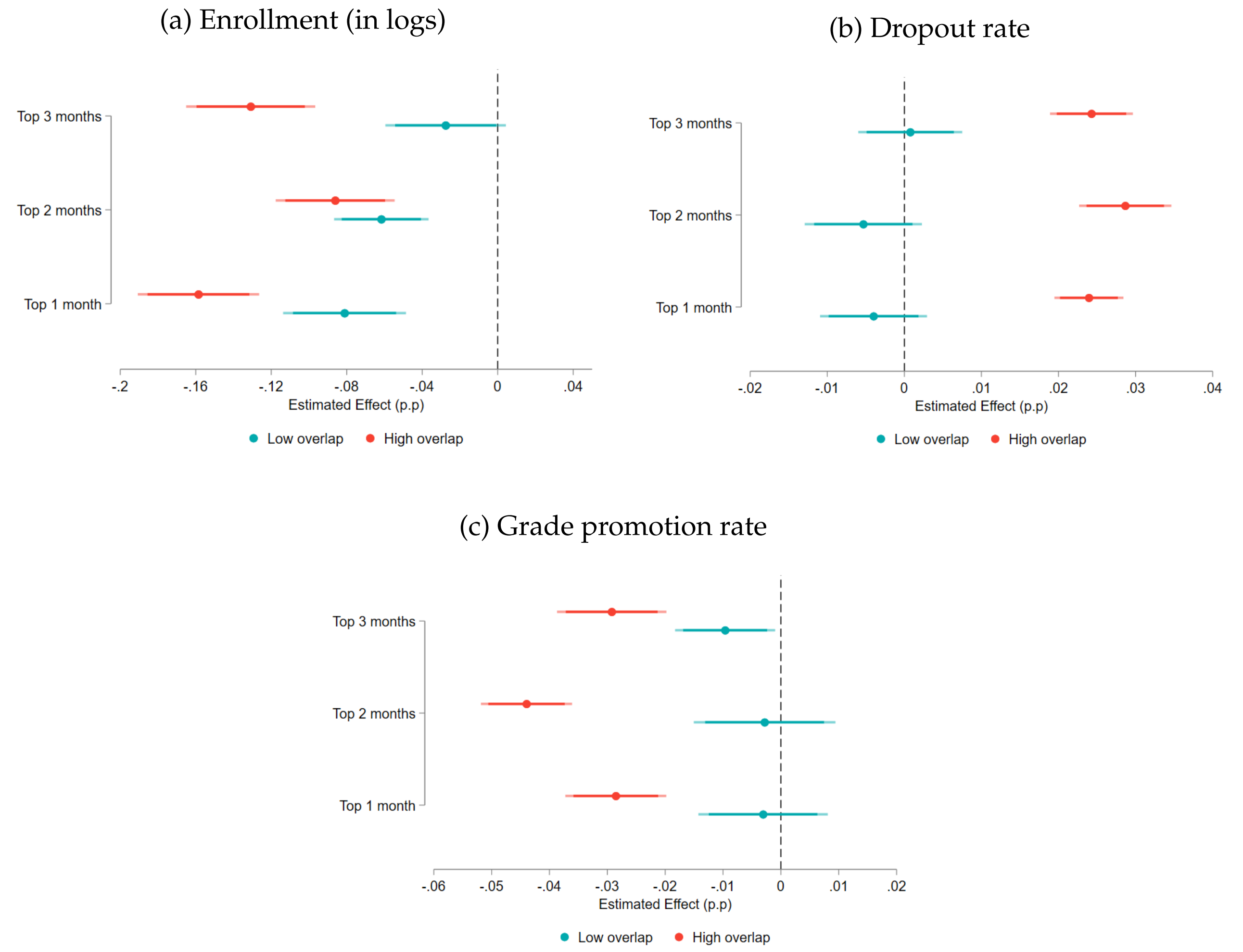
(a) Enrollment



(b) Dropout Rates



Appendix Figure A.11: Effects Varying the Definition of Harvesting Intensive Months ($\mathcal{I}_j$)

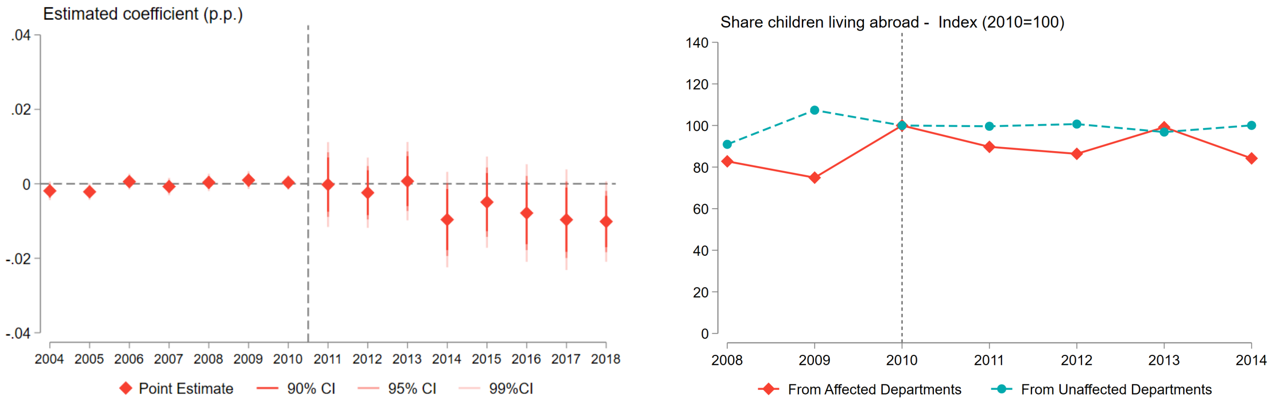


Notes: The figure shows the estimated effect of the 2010 change in the academic calendar on the corresponding outcomes for public and rural schools in Nariño and Valle del Cauca, compared to the synthetic control constructed following the methodology described in Section 5. The vertical lines represent the 90%, 95%, and 99% confidence intervals, based on bootstrapped standard errors with 50 repetitions. Source: Own elaboration based on data from DANE.

Appendix Figure A.12: Evidence Against the Violation of *SUTVA*

(a) Effects on School Transfer Rate

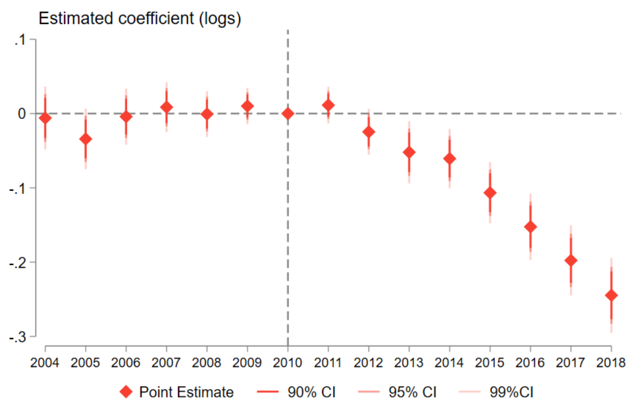
(b) Share of Migrant Children in Time



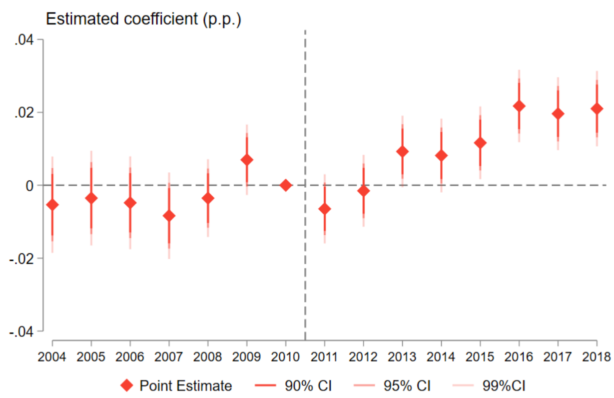
Notes: Panel A.12a plots the estimated effect of the 2010 change in the academic calendar on the average transfer rate at the municipality level for public and rural schools in Nariño and Valle del Cauca, compared to the synthetic control constructed following the methodology described in Section 5. The vertical lines represent the 90%, 95%, and 99% confidence intervals, based on bootstrapped standard errors with 50 repetitions. Source: Own elaboration based on data from DANE. Panel A.12b presents the percentage of children aged 5 to 15 who report living in the mentioned departments five years ago and migrated. Data from "Gran Encuesta Integrada de Hogares".

Appendix Figure A.13: Results using Difference-in-Differences

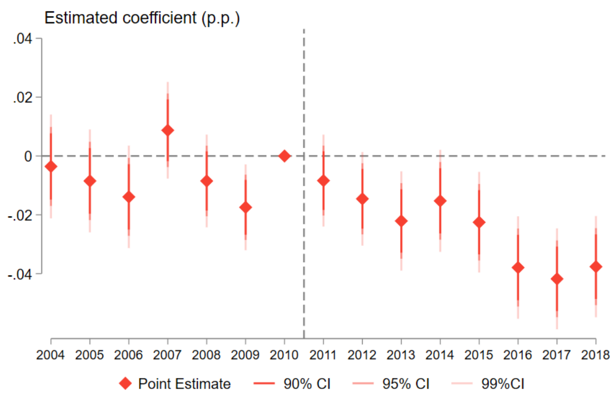
(a) Enrollment (in logs)



(b) Dropout rate

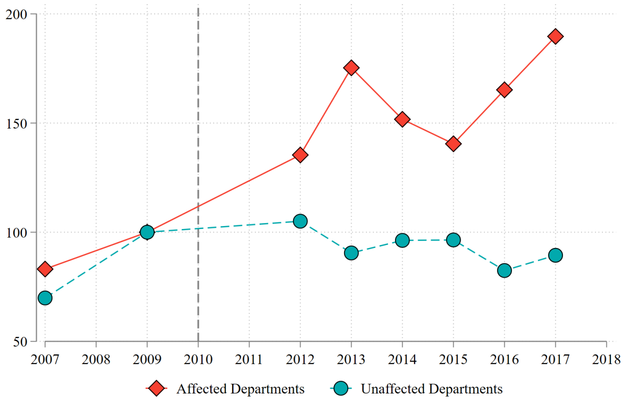


(c) Grade Promotion

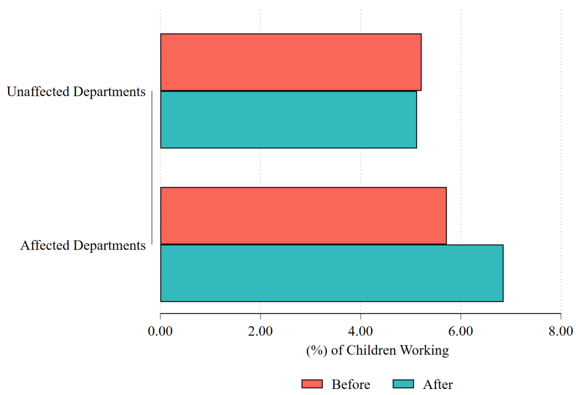


Notes: The figure shows the estimated effect of the 2010 change in the academic calendar on the corresponding outcomes for public and rural schools in Nariño and Valle del Cauca compared to similar departments (Arauca, Risaralda, and Sucre). The vertical lines represent the 90%, 95%, and 99% confidence intervals, based on school-level clustered standard errors. Source: Own elaboration based on data from DANE.

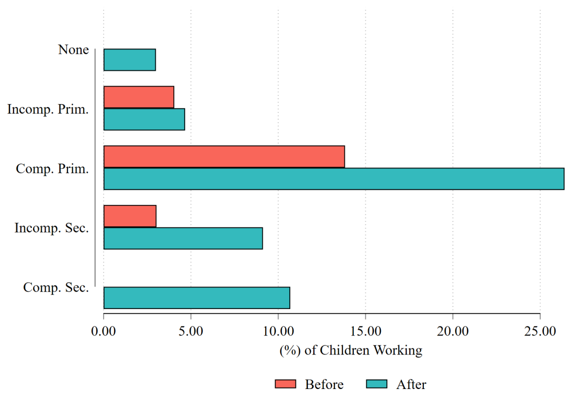
Appendix Figure A.14: Share of Children Working in Agriculture



(a) Evolution over time



(b) In Primary School



(c) By Educational Level

Panel (a) shows the evolution of the share of children working in agriculture and silviculture over time, normalized to 100 in 2009, for Nariño and Valle del Cauca compared to the rest of Colombia. Panel (b) shows the share of children with incomplete or complete primary education working in agriculture and silviculture before and after the academic calendar change, for Nariño and Valle del Cauca compared to the rest of Colombia. Panel (c) shows the share of children working in agriculture and silviculture before and after the academic calendar change, by educational level, for Nariño and Valle del Cauca. Source: Own elaboration based on data from DANE.

Appendix Table A.1: Descriptive Statistics of Key Variables

	Mean	SD	p25	p50	p75	Min	Max
Panel A: All countries							
Z_i (instrument)	10.955	11.743	0.000	9.189	18.817	0.000	47.166
Out-of-school share	8.602	10.496	1.409	4.166	11.940	0.050	45.072
O_i (overlap)	14.199	10.551	5.753	13.836	19.726	0.000	51.233
Colony indicator	0.667	0.473	0.000	1.000	1.000	0.000	1.000
Panel B: Colonies (colony = 1)							
Z_i (instrument)	16.433	10.798	9.189	14.591	21.972	0.000	47.166
Out-of-school share	11.278	11.653	1.818	6.821	17.420	0.122	45.072
O_i (overlap)	17.260	10.721	10.137	16.712	24.932	0.000	51.233
Panel C: Non-colonies (colony = 0)							
Z_i (instrument)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Out-of-school share	3.250	4.119	0.907	1.896	4.151	0.050	20.217
O_i (overlap)	8.076	7.006	0.822	6.986	13.973	0.000	26.027

Notes. Z_i is the instrumental variable, O_i is the observed overlap (in percentage) between the school calendar and the agricultural calendar. Out-of-school share is the percentage of primary-school-age children out of school. Colony indicator equals 1 if the country was a former colony of Belgium, France, Portugal, Spain, the Netherlands, or the UK, and 0 otherwise. Panel A reports statistics for the full sample; Panel B restricts to former colonies; Panel C restricts to non-colonies. Source: own elaboration based on administrative records, World Bank Indicators, Penn World Table version 11.0, and Sacks et al. (2010).

Appendix Table A.2: Calendar Overlap and School Dropout Rates by Colonies and Non-Colonies

	Dependent variable: Dropout rate				
	(1)	(2)	(3)	(4)	(5)
Panel A: Main effects					
Calendar Overlap	0.237***	0.167*	0.222***	0.211***	0.211***
	(0.077)	(0.088)	(0.083)	(0.068)	(0.071)
Observations	126	126	126	126	126
Panel B: Colonies					
Calendar Overlap	0.114	0.126	0.214**	0.167*	0.163*
	(0.107)	(0.107)	(0.103)	(0.085)	(0.091)
Observations	84	84	84	84	84
Panel C: Non-colonies					
Calendar Overlap	0.069	0.038	0.056	0.044	-0.014
	(0.114)	(0.090)	(0.089)	(0.081)	(0.098)
Observations	42	42	42	42	42
Geographic controls	No	Yes	Yes	Yes	Yes
Macroeconomic controls	No	No	Yes	Yes	Yes
Demographic controls	No	No	No	Yes	Yes
Trade controls	No	No	No	No	Yes

Notes. The dropout rate is defined as the share of primary school-age children out of school. For each country, we use the latest available value during the 2010–2019 period. Geographic controls: country latitude. Macroeconomic controls: GDP (in logs) and consumption share of GDP. Demographic controls: population and employment-to-population ratio. Trade controls: share of trade in GDP and the total trade volume between each country and the set of colonizers, comprising Belgium, France, Portugal, Spain, the Netherlands, and the UK. Source: own elaboration based on administrative records, World Bank Indicators, Penn World Table version 11.0, and Sacks et al. (2010).

Appendix Table A.3: Descriptive Statistics

	Before				After			
	Affected	Unaffected	DID	SDID	Affected	Unaffected	DID	SDID
Panel A: Overall								
No. Students Enrolled	78.57	77.07	87.75	91.41	70.68	75.42	80.56	88.34
Dropout rate	0.074	0.085	0.106	0.086	0.034	0.043	0.054	0.043
Passing rate	0.840	0.808	0.782	0.808	0.874	0.847	0.835	0.847
Observations	1,668	16,885	1,112	10,008	1,668	16,885	1,112	10,008
Panel B: Primary level								
No. Students Enrolled	56.28	56.08	66.62	64.92	42.67	56.08	66.62	53.72
Dropout rate	0.073	0.084	0.107	0.085	0.032	0.041	0.053	0.041
Passing rate	0.840	0.807	0.781	0.807	0.879	0.850	0.836	0.850
Observations	1,668	16,885	1,112	10,008	1,668	16,885	1,112	10,008
Panel C: Secondary level								
No. Students Enrolled	22.28	20.99	21.12	26.49	28.02	28.25	25.48	34.62
Dropout rate	0.081	0.091	0.097	0.091	0.046	0.060	0.059	0.060
Passing rate	0.851	0.837	0.825	0.835	0.848	0.830	0.824	0.827
Observations	1,668	16,885	1,112	10,008	1,668	16,885	1,112	10,008
Panel D: Teachers								
No. Teachers	3.84	3.25	3.63	3.85	3.68	3.55	3.87	4.12
Share Male Teachers	0.32	0.31	0.40	0.31	0.34	0.33	0.40	0.33
Share Teachers with Postsecondary	0.70	0.64	0.72	0.65	0.83	0.75	0.81	0.76
Observations	1,668	16,679	1,111	9,890	1,668	16,679	1,111	9,890
Panel E: Crop Harvesting								
Harvested area (ha)	158.3	110.2	90.7					
No. of products	9.8	11.1	10.4					
Main crops: harvested area (ha)								
Stimulants	28.2	24.6	19.2					
Wetland Rice	26.0	13.0	18.7					
Maize	25.8	16.6	12.0					
Observations	2,400	29,905	6,777					

Notes. Panels A-C report the average of each variable listed in the first column across schools. Panel D reports the average harvested area and the average number of distinct crops across all *veredas* in affected and unaffected departments. Source: Own elaboration based on data from DANE and the Global Agro-Ecological Zones (GAEZ) v4, FAO.

Appendix Table A.4: Synthetic Difference-in-Differences Weights

Group	Enrollment		Dropout	
	No Schools	Weight	No Schools	Weight
No weight	6807		6791	
Decile				
1	1008	.000095904	1010	.000094891
2	1008	.000099163	1009	.000099050
3	1008	.000099235	1010	.000099162
4	1008	.000099289	1009	.000099239
5	1007	.000099334	1009	.000099295
6	1008	.000099375	1010	.000099339
7	1009	.000099419	1009	.000099375
8	1007	.000099477	1010	.000099418
9	1008	.000099608	1009	.000099512
10	1007	.000101455	1009	.000101405

Notes. The first row reports the number of schools in the control group that receive a zero weight, ω_i, when implementing the SDID methodology for each outcome variable. The subsequent rows report the average weight within each decile of the weight distribution among schools that receive a non-zero weight.

B. Worldwide School and Agricultural Calendars

B.1. Data Construction

In this appendix, we describe the construction of the school and agricultural calendars for each country in our sample, as well as the measure of overlap between them.

School Calendar. We hand-collected academic calendar information from the official websites of ministries of education or equivalent government bodies in each country, using the most recently available calendar at the time of data collection. For each country, we recovered the start and end dates of the academic year, as well as the dates of all main school breaks. We then constructed a day-level indicator variable equal to one if school is in session on a given day of the year and zero otherwise.

For countries with multiple regional calendars, we selected the calendar of the most populous region or capital. Specifically, we used England for the United Kingdom, Berlin for Germany, the Central Region for the Netherlands, the French Community for Belgium, Washington D.C. for the United States, and Ontario for Canada. For Nigeria, India, and Indonesia, however, we deliberately deviated from this convention. Rather than selecting the capital region, we selected the calendar of the region that is the primary producer of the country's main crop as identified in the harvesting data: Kano state for Nigeria (sorghum), West Bengal for India (rice), and Central Java for Indonesia (rice). This choice ensures that the school calendar used in the overlap calculation reflects the institutional environment actually faced by farming households in the main crop-producing areas.

Harvesting Calendar. To construct harvesting calendars, we rely on data from Sacks et al. (2010), which reports the start and end dates of harvesting seasons for the main crops in each country, along with the corresponding harvested area at the national level. We define the main crop as the one with the largest harvested area, or as the crop flagged as primary in the database when such a designation is available. For Nigeria, India, and Indonesia, we use the harvesting calendars for sorghum, rice (Aman and Boro seasons), and rice (both seasons), respectively.

Overlap Measure. Based on the school and harvesting calendars described above, we compute for each country the share of the year in which both school is in session and the main crop harvest is underway. Formally, this is the number of days on which both activities overlap, divided by 365. This measure captures the extent to which the institutional school calendar conflicts with the peak labor demand period in agriculture.

Educational Laws. To measure the number of years elapsed between the institutionalization of each colonizer's education system and the independence of each colony, we identify for each colonizer the foundational law that established public primary schooling as a state responsibility. These laws share a common logic: they replaced church-dominated or locally fragmented schooling with a centralized, state-regulated system of primary education, thereby creating the institutional template—including the academic calendar—that was subsequently transmitted to colonial territories.

For France, we use the Loi Guizot of 28 June 1833 (Loi sur l'instruction primaire), which was the first law to create a durable national primary school system, requiring every municipality to maintain at least one school, establishing a mandatory curriculum, and creating a national teacher certification system and a network of teacher-training colleges. For Belgium, we use the Loi Nothomb of 23 September 1842 (Loi organique de l'instruction primaire), which was the founding act of Belgium's education system as an independent state, obliging every municipality to maintain at least one primary school and embedding religious instruction within the academic calendar. For the Netherlands, we use the Schoolwet van 1806 (Wet voor het Lager Schoolwezen en de Onderwijzers), which, despite being preceded by two short-lived school acts in 1801 and 1803, was the first durable organic law of Dutch primary education, remaining in force for over fifty years and establishing classroom-based instruction, teacher examinations, and national school inspections as the pillars of a secular public school system. For Spain, we use the Ley de Instrucción Primaria of 21 July 1838 (Ley Someruelos) together with its Reglamento of 26 November 1838, which collectively established the first functioning liberal primary school system in Spain, requiring municipalities to maintain public schools, introducing teacher certification, and creating provincial supervision of education.[35] For Portugal, we use the Carta de Lei de 6 de Novembro de 1772, enacted under the Marquis of Pombal, which abolished Jesuit-controlled schooling, created a state-funded network of royal primary schools across Portugal and its empire, and introduced the subsídio literário—a dedicated national tax to fund teachers' salaries—marking the first systematic intervention of the Portuguese state in public primary education.[36] For the United Kingdom, we use the Elementary Education Act of 1870 (the Forster Act), which was the first law to establish a national framework for public primary schooling in England and Wales, filling the gaps left by the existing patchwork of voluntary and church schools by creating elected local school boards empowered to build and maintain publicly funded schools, levy local taxes for education, and—for the first time—work toward universal provision of elementary schooling across the country.

Independence Years. For each country in our sample, we use the year of independence from its corresponding colonizer. In most cases, this corresponds to the year in which the country formally declared or was granted independence. For a small number of cases, the year we use requires clarification. For Bangladesh, we use 1947—the year of the partition of British India and the creation of Pakistan, of which Bangladesh (then East Pakistan) was a part—rather than 1971, the year of Bangladesh's independence from Pakistan, since our interest is in the duration of exposure to the British institutional framework. For the Philippines, we use 1898—the year Spain ceded the territory following the Spanish-American War—rather than 1946, the year of formal independence from the United States, since our colonizer of interest is Spain and 1898 marks the effective end of Spanish institutional influence over the country. For the Dominican Republic, we use 1865—the year of its final independence from Spain following the War of Restoration—rather than 1844, the year of its independence from Haiti, since our colonizer of interest is Spain. In all three cases, the years we use correspond to the moment at which the country ceased to be under the direct institutional influence of the colonizer whose education system we are studying, which is the relevant date for our analysis.

B.2. Robustness to the Instrumental Variable Strategy

We provide robustness checks to our results in Section 2.3 by introducing a second instrument that exploits the interaction between the school calendar of the colonizing country, the agricultural calendar predicted by their latitude, and the degree of exposition to colonial education institutions. Let $c(i)$ denote the country that colonized country i and let $\mathbb{L}_i$ denote the set of countries located at latitudes similar to that of country i. We construct the following

[35]The institutional framework established by the *Ley Someruelos* was later consolidated and extended by the *Ley de Instrucción Pública* of 9 September 1857 (*Ley Moyano*), which introduced compulsory and free elementary schooling and integrated primary, secondary, and higher education into a single national system. While the *Ley Moyano* is often cited as the more comprehensive foundational law of Spanish education, we use the 1838 law as our reference date as it marks the first effective state intervention in primary schooling.

[36]Subsequent nineteenth-century reforms, notably those of 1822, 1835, and 1844, sought to reorganize and expand primary schooling in Portugal under liberal constitutional governments, but were largely left incomplete due to the country's severe economic difficulties and political instability during this period. We nonetheless retain the 1772 Pombaline reform as our reference date, as it constitutes the original act by which the Portuguese state assumed direct responsibility for public education, displacing the Jesuit institutional model that had governed schooling in Portugal and its overseas territories since the sixteenth century.

instrument:

$$Z_i = \frac{|\mathbb{S}_{c(i)} \cap \mathbb{A}_{\mathbb{L}_i}|}{|\mathbb{D}|} \times (Y^{educ}_{c(i)} - Y^{indep}_i),$$

where $\mathbb{S}_{c(i)}$ denotes the set of school days in the colonizing country $c(i)$, $\mathbb{A}_{\mathbb{L}_i}$ corresponds to the set of days of high agricultural activity predicted by the latitude of country i, and the term in parentheses captures the difference in years between the institutionalization of the colonizer's school calendar ($Y^{educ}_{c(i)}$) and the year in which country i gained independence (Y^{indep}_i). Using this instrument, we estimate the Equations 1.

This alternative instrument combines two sources of variation in a manner similar to a shift-share design. Its validity therefore relies on either the *share* component (Goldsmith-Pinkham et al., 2020) or the *shift* component (Borusyak et al., 2021) being uncorrelated with current school dropout in country i. In our setting, both components are plausibly orthogonal to contemporary educational outcomes.

The *share* component corresponds to the same used in Section 2.3, and quantifies the overlap that would arise if former colonies adopted the school calendar of their colonizer while facing agricultural conditions determined by their latitude. This term isolates variation in school calendars inherited from the colonizer while accounting for local agricultural cycles. Its exogeneity is plausible because colonial powers originally designed their domestic school calendars to reflect their own climatic and agricultural conditions rather than those of the territories they later administered. Moreover, by using agricultural calendars derived from countries located at similar latitudes, the instrument captures agricultural conditions predicted by geography rather than country-specific institutional choices.

The *shift* component captures the extent to which colonial institutions influenced the determination of school calendars in country i. Specifically, it weights the inherited calendar variation by the time elapsed between the educational reform in the colonizing country and the independence of the colony. Countries that gained independence later were more likely to inherit the colonizer's calendar, while those that became independent earlier had greater scope to adopt calendars adapted to local conditions. This timing is plausibly exogenous to current educational outcomes because the date of colonial independence relative to the timing of educational reforms in the colonizing country was largely determined by geopolitical and historical forces unrelated to contemporary school dropout.

Taken together, this second instrument captures the overlap that country i would have experienced if it had adopted the colonizer's calendar while facing agricultural conditions determined by its latitude, with greater weight placed on countries whose institutional choices were more strongly shaped by colonial rule. Even if one of the components is not exogenous, it suffices that the other component is orthogonal to guarantee the consistency of the estimator (Goldsmith-Pinkham et al., 2020; Borusyak et al., 2021). This provides additional evidence to our strategy detailed in Section 2.3.

Table B.5 presents the results of the estimations using this version of the instrument. We observe precisely estimated positive coefficients in both cases, proving that our results are robust to additional instruments with additional sources of exogeneity.

Appendix Table B.5: Effect of Calendar Overlap on School Dropout Rates

	Dependent variable: Dropout rate				
	(1)	(2)	(3)	(4)	(5)
Panel A: Full sample					
Calendar Overlap	0.529***	0.399***	0.416***	0.416***	0.402***
	(0.104)	(0.098)	(0.096)	(0.096)	(0.096)
First-stage F	159.65	114.12	113.41	121.05	122.92
Observations	126	126	126	126	126
Panel B: Former colonies					
Calendar Overlap	0.343***	0.262***	0.330***	0.329***	0.317***
	(0.115)	(0.094)	(0.101)	(0.103)	(0.102)
First-stage F	92.52	91.31	78.44	80.18	82.48
Observations	84	84	84	84	84
Geographic controls	No	Yes	Yes	Yes	Yes
Macroeconomic controls	No	No	Yes	Yes	Yes
Demographic controls	No	No	No	Yes	Yes
Trade controls	No	No	No	No	Yes

Notes. The dropout rate is defined as the share of primary school-age children out of school. For each country, we use the latest available value during the 2010–2019 period. Geographic controls: country latitude. Macroeconomic controls: GDP (in logs) and consumption share of GDP. Demographic controls: population and employment-to-population ratio. Trade controls: share of trade in GDP and the total trade volume between each country and the set of colonizers, comprising Belgium, France, Portugal, Spain, the Netherlands, and the UK. Source: own elaboration based on administrative records, World Bank Indicators, Penn World Table version 11.0, and Sacks et al. (2010).

C. Historical Evolution of the Academic Calendar in Colombia

The academic calendar in Colombia has undergone substantial transformations since the early nineteenth century. These changes reflect shifting priorities in educational administration, evolving degrees of centralization, regional heterogeneity, and growing recognition of climatic and institutional differences across the country. From an initially centralized system that tightly regulated vacations and examinations nationwide, Colombia progressively moved toward differentiated academic calendars across regions—later formalized as Calendar A and Calendar B—before adopting a decentralized framework that allows territorial entities to define calendars within national guidelines.

C.1. Colonial Period (Before 1820s)

During the colonial period, particularly before the eighteenth century, education in Spain and its colonies was primarily provided by the Church in a decentralized manner. Since the sixteenth century, instruction was largely delivered by Catholic religious orders—such as Jesuits, Franciscans, and Dominicans—who focused mainly on teaching Christian doctrine and basic literacy in Indigenous languages, while learning Spanish was often optional. Education was typically delivered in *escuelas de primeras letras*, institutions that provided basic instruction by introducing children to Christian principles and values, teaching them to read, familiarizing them with the four basic arithmetic operations, and developing writing skills through exemplars and guided practice (Anguita Osuna, 2019). Over time, however, strong pressure (especially from archbishops, the Council of the Indies, and Crown officials) emerged to promote instruction in Spanish, as Indigenous languages were increasingly viewed as obstacles to the diffusion of Christianity.

During the eighteenth century, the Spanish Crown introduced the Bourbon reforms to modernize state capacity in the colonies (Chiovelli et al., 2023). As part of these reforms, and influenced by Enlightenment ideas, Carlos III promoted an education reform aimed at reducing the Church's influence over schooling and expanding educational access among local and Indigenous populations (Herrera, 2004; Anguita Osuna, 2019; García, 2005). This process gained momentum after the suppression of the Society of Jesus, which entailed the expulsion of Jesuit members from Spain and its colonies in 1767. Nevertheless, education remained accessible only to a small elite, with broad segments of society excluded (García, 2005). Instructional institutions were scarce in the Kingdom of New Granada (which encompassed present-day Colombia), as evidenced by the presence of only one free *escuela de primeras letras* in Santa Fe, the capital of the kingdom and the site of present-day Bogotá (García, 2005). Importantly, school calendars during this period played little role in shaping educational access.

C.2. Early Republican Regulation and Centralization (1820s–1870)

The landscape of Colombian society in the early years of national consolidation highlighted the need for a new and more structured educational system. Independence leaders promoted the creation of civic educational institutions, such as *colegios* and public schools, framed within republican ideals of citizenship and Enlightenment thought, although resources and administrative capacity were limited. Efforts were made to implement laws and establish institutions that expanded access and provided practical instruction, but their reach remained uneven, and religious actors continued to exert significant influence (Báez Osorio, 2006).

Historical overviews suggest that school calendars were not a major policy concern in the early republic (Báez Osorio, 2006). Educational provision was still being organized, and formal structures such as fixed academic calendars were not yet nationally institutionalized.

Nonetheless, the earliest national regulation potentially affecting the academic calendar dates to 1824, when Vice President Francisco de Paula Santander issued a decree establishing that school vacations should coincide with the recesses observed by courts and tribunals, as defined in the Law of October 12, 1821. Under Articles 70 and 71 of that law, judicial activity was suspended only during major religious feast days, Holy Week, and December. Consequently, school vacations were institutionally anchored to these same periods.

This framework was reinforced by the General Law of 1826, which explicitly defined the structure of the academic year. Article 112 stipulated that annual vacations would run from the conclusion of examinations in November until January 1, and that no additional recesses would be permitted beyond religious feast days and Easter. Contemporary correspondence illustrates that this reform curtailed earlier local practices. In December 1826, students from the *Colegio de Boyacá* protested the elimination of a traditional vacation period running from late July to mid-October, which was replaced by a single end-of-year recess in December following the enactment of Santander's legislation. The governor of Boyacá responded that the matter fell under central authority, and the reform was ultimately reaffirmed.

This episode suggests that, prior to the reforms promoted under Santander's administration, academic calendars in at least some institutions followed a timing that differed substantially from the post-1826 national standard and appears to have been closer to the patterns inherited from the Spanish period. In particular, the existence of a long mid-year interruption, with instruction extending across the calendar year. From 1826 onward, this earlier arrangement—rooted in pre-republican institutional practice—was explicitly displaced by a centrally imposed calendar more closely resembling the January-November calendar.

The emphasis on standardization continued with the Organic Decree of Public Instruction of 1870, which formalized a system of two academic terms per year, each lasting five months. Schools were to open on January 10 and July 10 and close on May 31 and November 30, with vacations in June and December. This decree established a nationally uniform structure that would remain influential for decades.

C.3. Consolidation and Incremental Adjustments (1880s–1890s)

Late nineteenth-century sources indicate both continuity and incremental adjustments within this centralized framework. Institutional correspondence from 1888 shows that intermediate examinations were held in late July, followed by short vacations, while final examinations took place in November. National decrees in 1892 and subsequent regulations consistently defined the academic year as running from February (or January) to November, with vacations concentrated in December–January.

However, some institutional and regional variation emerged. For example, the *Colegio Público de Barranquilla*, established in 1892, followed an academic year running from August to June. Regulations for normal schools and primary schools in 1893 retained the February–November or January–November structure but clarified enrollment periods, examination timing, and paid vacation months. These variations, however, remained exceptions within an otherwise standardized national system.

C.4. Departmental Differentiation in the Early Twentieth Century (1900s–1940s)

By the early twentieth century, departmental regulations increasingly reflected differentiated academic timing. Resolutions from 1906 illustrate this divergence clearly. In the Department of Cauca, which at the time included territories that later became the departments of Nariño and Valle del Cauca, secondary and professional institutions were required to operate on an academic year running from October 1 to July 20. By contrast, in the Department of

Huila the school period was fixed from January 10 to November 30, with additional vacations during Holy Week and in late July.

A significant event occurred in 1913, when the Governor of Antioquia decreed that the academic year should begin in mid-September and end in June. The decree explicitly justified this structure by reference to pedagogical considerations, climatic conditions, and the convenience of students pursuing studies abroad.

Regional differentiation became increasingly pronounced in the southwest. Decree 1457 of 1939 required the Rural Normal School of Popayán to suspend classes at the end of July and resume them in October. Decree 3087 of 1945 further confirmed that institutions in the southwest operated under a calendar distinct from that followed in other regions. By this period, Colombia effectively maintained multiple regional academic calendars, though they had not yet been formally labeled.

C.5. Formal Recognition of Dual Calendars (1950s–early 1960s)

The regional division of academic calendars became explicit and institutionalized in the mid-twentieth century. Decree 0075 of 1951 clearly differentiated academic timing across regions: colleges in Valle del Cauca and Nariño were to implement the new curriculum beginning in October, while institutions in the rest of the country would do so beginning in February. This marked the first nationwide decree to formally recognize a dual calendar structure aligned with regional geography.

An attempt to unify the system followed with Decree 3109 of 1956, which mandated the unification of calendars beginning in September 1958. However, subsequent amendments—particularly Decree 1254 of 1957—introduced transitional adjustments, reflecting practical difficulties in implementing uniformity.

Rather than eliminating differentiation, reforms in the early 1960s codified it more precisely. Decree 45 of 1962 and Decree 1710 of 1963 established detailed academic periods, vacations, and examination schedules separately for the central-eastern and south-western regions, covering both secondary and primary education. These distinctions were further reinforced by Decree 2720 of 1963, which formally distinguished Calendar A (central-eastern region) and Calendar B (south-western region) and explicitly allowed schools to choose which calendar to follow.

C.6. Attempts at Unification and Reinstatement of the Dual System (Late 1960s–1980s)

A renewed effort to impose national uniformity came with Decree 1816 of 1967, which standardized instructional days and vacation lengths nationwide while allowing calendars to differ only in start dates. This reform was implemented gradually between 1968 and 1969.

However, the reform proved unsustainable. Decree 1902 of 1969 reversed course, citing reduced end-of-year vacations, administrative constraints in educational planning, the need for mid-year teacher training, climatic conditions in the southwest, and requests from school communities. The decree reinstated a clear territorial division: Calendar B for Nariño, Cauca, Valle del Cauca, and Putumayo, and Calendar A for the rest of the country.

This dual structure persisted through the 1970s and was reaffirmed in subsequent regulations. Decree 691 of 1972 established a provisional calendar following a nationwide suspension of activities, while Decree 174 of 1982 maintained Calendars A and B for both public and private institutions at the preschool and primary levels.

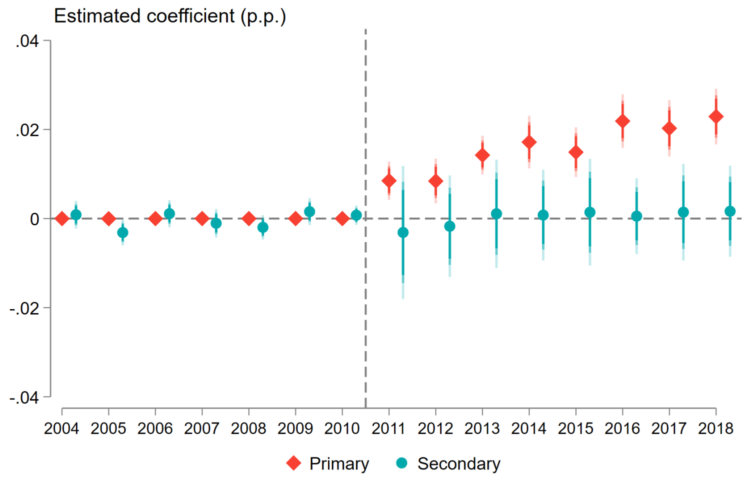
C.7. Decentralization and Contemporary Framework (2000s–Present)

A major institutional shift occurred with the decentralization reforms of the early 2000s. Law 715 of 2001 assigned departments responsibility for organizing education provision in non-certified municipalities, including defining the academic calendar, while granting certified municipalities autonomy over education provision. Decree 1850 of 2002 required certified territorial entities to issue annual academic calendars for all public institutions within their jurisdiction, explicitly allowing calendars to account for regional economic conditions and institutional traditions.

While this framework preserved the historical distinction between Calendars A and B, it also enabled greater coordination and gradual convergence in academic timing, particularly in certified and urban jurisdictions. As a result, contemporary academic calendars reflect both long-standing regional differentiation and increased institutional coordination within a decentralized governance structure.

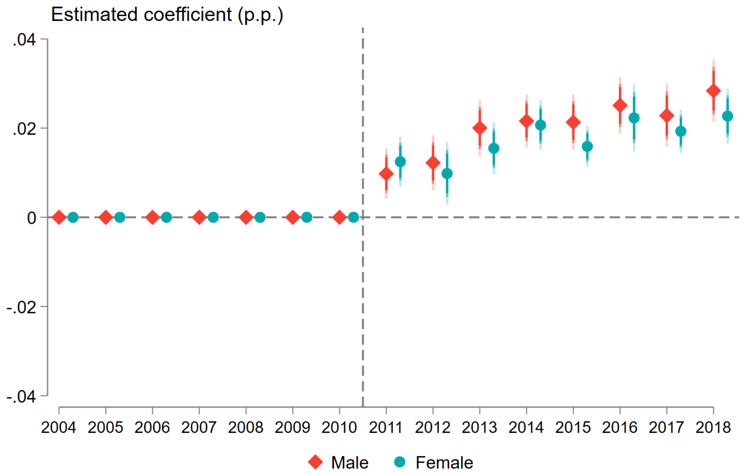
D. Heterogeneous Effects

Appendix Figure D.15: Effect of the Reform on Dropout Rates by Educational Level



Notes: The figures show the estimated effect of the 2010 change in the academic calendar on the corresponding outcomes for public and rural schools in Nariño and Valle del Cauca, compared to the synthetic control constructed following the methodology described in Section 5. The estimates are presented separately for students in primary and secondary education. The vertical lines represent the 90%, 95%, and 99% confidence intervals, based on bootstrapped standard errors with 50 repetitions. Source: Own elaboration based on data from DANE.

Appendix Figure D.16: Effects of Reform on Dropout Rates by Gender



Notes: The figures show the estimated effect of the 2010 change in the academic calendar on the corresponding outcomes for public and rural schools in Nariño and Valle del Cauca, compared to the synthetic control constructed following the methodology described in Section 5. The estimates are presented separately for girls and boys. The vertical lines represent the 90%, 95%, and 99% confidence intervals, based on bootstrapped standard errors with 50 repetitions. Source: Own elaboration based on data from DANE.