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Joel Huesler,
University of Bern

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Joel Huesler[1],
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Abstract

This paper investigates the impact of hurricanes on school attendance in Jamaica from 1892 to 1942, a period marked by significant natural disasters, including four category two hurricanes. By integrating monthly school attendance data from the fourteen Jamaican parishes with assessments of potential storm destruction, the paper quantifies the effect of hurricanes on school attendance. The average effect of a category two hurricane was a 9.1% decrease in school attendance in the month of the hurricane, followed by decreases of 8.6% and 7.2% in the following two months. Consequently, nearly 400 children miss school for one month, with over 310 children missing school for three months. Mediation analysis further indicates a decline in school performance by up to 3.23%, indirectly caused by decreased school attendance. This paper highlights the lasting impact of hurricanes on educational outcomes, especially in countries with agrarian economies and underdeveloped education systems.

JEL Codes: I25, N36, N96, Q54

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[1]Corresponding Author: Joel Huesler (Joelhuesler@gmail.com**)**

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1 Introduction

The educational history of Jamaica is a complex narrative deeply intertwined with its colonial past. Since the 17th century, the island's colonial masters largely overlooked the educational needs of the local population (Mulcahy, 2008). The abolition of slavery in the 19th century marked a transformative phase, introducing elementary schools established by missionaries for the descendants of emancipated slaves (Moore and Johnson, 2004). These missionary efforts were later bolstered by the British government's investment in building schools and providing financial grants (Board of Education, 1901). However, the primary intent behind these efforts was to cultivate 'civilized citizens' from the descendants of the enslaved (Moore and Johnson, 2004). While the government financed the construction of educational facilities, the burden of school fees persisted until their removal in 1892 (Laws of Jamaica, 1892). The enforcement of compulsory elementary education in 1912 marked a significant milestone in Jamaica's educational history (Moore and Johnson, 2004). During this period, school attendance in Jamaica experienced fluctuations but remained comparable to other regions in the Caribbean, Central, and South America (Frankema, 2009).

The 19th and 20th centuries in Jamaica were also characterized by devastating hurricanes, which severely impacted infrastructure, including educational institutions, and disrupted student attendance. For example, the 1912 hurricane caused extensive damage; The Governor's Report (1912) documented that *"[t]he parishes of Westmoreland and Hanover, and in rather less degree, St. James were the principal sufferers. Out of 126 schoolhouses in these parishes, 57 were completely destroyed and 41 more or less seriously damaged: 19 teachers' houses were destroyed and 26 damaged."* (The Governor's Report, 1912, p.431). Despite the historical significance of these events, there is a paucity of research on the impact of natural disasters on school attendance during this period. One notable exception is Naylor et al. (2022), who investigated the impact of extreme weather events on school attendance in the Outer Hebrides during the latter third of the 19th century.

The damage to school infrastructure and the disruption to attendance caused by hurricanes in Jamaica are particularly significant within the context of the island's colonial history. During the colonial era, education was a critical tool for social control and economic advancement, aimed at cultivating a disciplined and proficient labor force to support the

plantation economy and broader colonial interests (Moore and Johnson, 2004). As Jamaica transitioned from a labor-intensive, slave-based agricultural economy to one increasingly reliant on mechanized agriculture (Huesler and Strobl, 2023), the importance of education became even more pronounced. This shift necessitated a more technically skilled workforce to manage and operate new machinery, thereby elevating the role of education in fostering the necessary competencies (Higman et al., 2005). Given the weak establishment of the Jamaican school system during this period, the economy's need for a technically skilled workforce was particularly vulnerable to disruptions caused by hurricanes. These disruptions likely hampered children's educational outcomes, thereby impeding the economy's ability to transition smoothly and converge to its real growth path. This underscores a critical gap in understanding how natural disasters influenced Jamaica's efforts to transform its society through education.

This paper aims to fill this gap by examining the impact of hurricanes on school attendance in Jamaica from 1892 to 1942, a period characterized by several significant hurricanes. This period saw Jamaica experience four category two hurricanes, including the *1903 Jamaican hurricane*, the hurricanes of 1912 and 1915, and the *1917 Nueva Gerona hurricane*. To quantify the impact of these hurricanes on school attendance, monthly data on elementary school attendance across the fourteen Jamaican parishes was combined with a measure of potential storm destruction. This measure integrated storm tracks with a wind field model to estimate wind speeds at parish centroids, serving as proxies for potential destruction.

The findings of this paper confirm that hurricanes significantly reduced average monthly school attendance in affected parishes. On average, a category two hurricane[1] caused a 9.1% decrease in attendance during the hurricane month, an 8.6% decrease the following month, and a 7.2% decrease two months after the hurricane. Therefore, the findings suggest that on average nearly 400 children are absent from school for one month, more than 375 for two months, and upwards of 310 children for three months following the impact of a hurricane. Furthermore, mediation analysis indicates a decline in school performance on average of 2.77% to 3.23% due to hurricanes, which is indirectly caused by decreased school attendance. These findings underscore the importance of maintaining school attendance and the role of trained teachers in mitigating the educational impacts of tropical storms.

[1] With wind speeds exceeding 154km/h.

This paper provides new insights, enhancing two distinct strands of literature. First, it underscores the substantial effects of hurricane strikes on school attendance. With an expansive panel consisting of 80 countries, Cuaresma (2010) demonstrate that natural disasters affect global education outcomes by decreasing secondary school enrolment. Furthermore, in Nigeria, more than 40% of the respondents reported a decrease in school attendance due to floods and local windstorms between 2009 and 2013 (Adeagbo et al., 2016). Similarly, rural Haiti saw nearly half of the children abandon school attendance in the aftermath of Hurricane Matthew (Cook and Beachy, 2018). Comparable results have been reported for natural disasters in Indonesia Rush (2018), rainfall shocks in Uganda Agamile and Lawson (2021) and cyclones in Fiji Takasaki (2017). However, focussing on agricultural shocks, Baker et al. (2020) show that Boll Weevil increased school attendance by lowering the opportuinity costs of attending school. This paper further contributes by using monthly parish level data which spans over 50 years. Moreover, during this period of time, I analyse how multiple hurricanes with different wind speeds, also across parishes, affected school attendance. The findings align with these studies, showing a significant decrease in school attendance in Jamaican parishes affected by hurricanes.

Secondly, this paper highlights the potential long-term implications of these short-term disruptions. Although I do not directly measure long-term impacts, the observed declines in attendance and performance suggest adverse effects on students' future educational attainment and economic growth. This aligns with the broader literature on the role of education in economic development, as discussed by Barro et al. (2013), Long (2006), and Hanushek and Wößmann (2007). Research by Deuchert and Felfe (2015) that inspected the aftermath of Super Typhoon Mike in 1990 on the educational progress of children in the Cebu Islands (Philippines) confirmed that natural disasters have a profound and long-lasting impact on educational outcomes, leading to a decrease in exam scores, an increase in grade repetitions, and an overall decrease in educational attainment over time. Regular school attendance, as shown by Lamdin (1996) and Roby (2004), plays a key role in improving student performance and mitigating learning losses even from minimal absences. Thus, natural disasters, such as hurricanes, which historically disrupt school attendance, have far-reaching implications on education and, consequently, economic growth.[2] This was confirmed by a study conducted by Sala-i Martin et al. (2004) that involved nearly 90 countries from 1960 to 1999, revealing a direct correlation between economic growth

[2]However, it must be mentioned that school attendance is not only important for economic growth but also for *nation building* as in Imperial Germany (Cinnirella and Schueler, 2018).

and primary school enrolment rates.[3] Moreover, Spencer (2017) and Spencer et al. (2016) further demonstrated the adverse impact of hurricanes on student performance in Jamaica (1993-2010). Recently, Arceo-Gomez and López-Feldman (2024) show that increased temperature decreases school performance in Mexico. This paper, therefore, underscores the importance of maintaining school attendance in the face of natural disasters to support educational performance of students, which is likely to impact long-term economic growth.

Moreover, this paper makes a contribution to the existing literature by applying a wind field model to estimate the impact of hurricanes on educational data in the late 19th and early 20th centuries. In addition, two distinctive datasets are employed: a monthly dataset on school attendance spanning 50 years at the parish level in Jamaica and a yearly dataset from 1880-1892 that is even more detailed, providing school-level data for 1060 schools, including yearly test scores and the number of teachers (both trained and untrained). Both data sets are archival in nature and were digitised specifically for the purposes of this study. The extensive and detailed nature of the data allows for a more precise estimate of the immediate effects of hurricanes on educational infrastructure and attendance, providing valuable insights.

The remainder of the paper is structured as follow. Section 2 provides a historical background on education and hurricanes in Jamaica, followed by a discussion of the data in Section 3. Summary statistics are presented in Section 4, with results in Sections 5 and 6. The paper concludes in Section 7.

2 Historical Background

2.1 Education

2.1.1 Early Development of Formal Education (1834-1837)

The development of formal education in Jamaica, beginning in the pre-emancipation period of 1834, catered primarily for the children of free parents, served primarily by seven Church of England schools scattered across the island (Board of Education, 1901). As Holt (1991) notes, by 1837, a significant portion of the student population comprised children of apprentices or those who gained freedom post-1834, indicating the initially limited access to education. However, by 1837, Holt (1991) shows that *"[...] 8,321 children of*

[3]Similar results were obtained by Ogundari and Awokuse (2018) and Artadi and Sala-i Martin (2003) in their studies conducted in (sub-Saharan) Africa.

apprentices were attending day school, which means—given that approximately 20,000 of the 38,754 freed children of apprentices were of school age by 1837—that just three years after abolition over 40 percent were in school."(Holt, 1991, p.152).

2.1.2 Expansion and Policy Initiatives (1865-1908)

Following the Morant Bay Rebellion in 1865, the administration of Governor Sir John Peter Grant saw a significant expansion of public services, including primary education (Jeffrey, 1980). A significant policy initiative was the introduction of the 'payment by results' system, which linked financial grants to schools to the performance of students in core subjects and the efficiency of teachers (Jeffrey, 1980).

Education during the 19^{th} century in Jamaica transcended mere transmission of knowledge. As Moore and Johnson (2004) highlights, it played a pivotal role in reshaping the mindset of the majority black population. The primary objective was to cultivate compliant, civilized, and loyal British colonial subjects, especially targeting the lower classes. This educational approach was designed to provide basic literacy and numeracy skills while instilling an ideology that maintained their subservient roles within a socio-political system dominated by a white minority (Moore and Johnson, 2004; Holt, 1992). This was especially visible with the introduction of the 'payment by results' system in the 19^{th} century, which tied school funding to student performance in core subjects and teacher efficiency (Jeffrey, 1980). The ultimate objective of this reform was accordingly to Jeffrey (1980), to produce a literate labour force capable of serving the colonial economy while simultaneously preventing the emergence of individuals capable of challenging the existing social order. The post-emancipation period saw a significant shift in Jamaica's educational landscape. The British government's investment of £50,000 for schoolhouse construction and a matching grant initiative for colonies led to an increase in educational opportunities (Board of Education, 1901; Holt, 1991). By 1837, over 12,000 children attended one of the 183 elementary schools, and by 1908, despite some reductions due to amalgamations, the number of schools was still substantial at 690 (Board of Education, 1901; Moore and Johnson, 2004). This is illustrated graphically in Figure 1 with data from Moore and Johnson (2004). Education during this era was heavily influenced by a Victorian religious and moral order, contrasting starkly with local Afro-creole beliefs (Moore and Johnson, 2004).

2.1.3 Implementation of the Education Code

A significant enhancement was the implementation of the Education Code in 1867, which established a system of grants-in-aid contingent on school performance (Handbook of Jamaica, 1883, p.129). Annual inspections played a crucial role in maintaining educational standards. Inspectors assessed various aspects of school management and student performance. The results were documented, schools were classified into three levels based on their efficiency, and schools were provided with detailed feedback to improve their teaching methods and overall educational quality. These categorisations determined the amount of government aid they received (Handbook of Jamaica, 1883, p.129). The inspection process revealed that a significant proportion of schools failed to meet the required standards. However, it also prompted improvements in management and teaching practices over time (Handbook of Jamaica, 1883, p.129). By 1875, there was a growing demand among parents for enhanced educational opportunities for their children, and the number of efficient schools gradually increased, reflecting a notable improvement in student performance and attendance (Handbook of Jamaica, 1883, p.130). The introduction of standardised examinations and performance-based grants provided an additional incentive for schools to enhance the quality of their education (Handbook of Jamaica, 1883, p.131). Schools were required to meet specific standards in various subjects, with marks awarded to determine the relative merits of the work submitted for examination. This system facilitated the identification of schools that were performing well and those that required improvement (Handbook of Jamaica, 1883, p.131). According to (Handbook of Jamaica, 1883, p.131). schools were annually inspected by the School Inspector, whereas she/he examined the following subjects: Reading, Writing from dictation, Arithmetic, Scripture knowledge, General knowledge, Grammar and Composition, Geography and History, Handwriting, Singing as well as Organization. In total, a maximum of 84 points is obtainable whereas most schools were not able to obtain even 2/3 of the maximum (Handbook of Jamaica, 1883, p.131).

2.1.4 Role of Mission Societies and Churches (1838-1910)

Mission societies and churches were instrumental in shaping the educational system following emancipation in 1838, establishing elementary schools for freed slaves, ensuring that their influence permeated the education sector (Moore and Johnson, 2004). Their influence remained strong even after the inception of the crown colony government in 1866

(Moore and Johnson, 2004). Although the government did support the education sector, its role was largely supplementary[4], unlike other colonies such as Trinidad where the government was a significant provider of primary education (Moore and Johnson, 2004). This church-led education system was characterised by a specific ideological orientation. According to Moore and Johnson (2004), the ultimate aim was to produce a new kind of Jamaican citizen, someone who would rise above the ignorance propagated during slavery and emerge as a "civilized citizen" (Moore and Johnson, 2004). Despite the ideological focus, the state still sought to establish a comprehensive and universal education system, in line with the goal of state-sponsored education to not only teach skills, but also educate workers about their societal roles and obligations (Holt, 1991). During the late 19th and early 20th centuries, the government's role in education was minimal, contributing mainly through financial grants to support the schools operated by these religious groups. This system created a framework where education was accessible primarily through church-affiliated institutions, which shaped the curriculum and moral outlook of the students (Board of Education, 1901).

2.1.5 Legislative Reforms (1892-1914)

The Elementary Education Law of 1892 Laws of Jamaica (1892) laid the foundation for public elementary schools. A *Public Elementary School* was defined as an institution primarily providing elementary education, where tuition fees did not exceed sixpence per week (Laws of Jamaica, 1892). The 1899 amendment Laws of Jamaica (1899) further detailed the duties of the Board of Education, which included advising on matters related to public elementary schools, recommending changes to the Code of Regulations, and managing the establishment and closure of schools. The amendment set age limits for school attendance, specifying that children could attend public elementary schools from ages six to fourteen, with special provisions for kindergarten education for those aged four to eight (Laws of Jamaica, 1899).

However, the path to educational reform was far from straightforward. Despite the theoretical support for an enhanced education system, the actual implementation was sluggish due to the lack of appropriations (Holt, 1991). The primary advocates of educational reform were coloured assemblymen who, as Holt (1991) highlighted, championed the cause

[4]Even in 1910, only roughly 10% of the elementary schools were indeed government schools, while the rest of the schools were church schools (Moore and Johnson, 2004).

of increased educational budgets, the establishment of more schools on the island, the creation of local professional schools for doctors and lawyers, and technical training schools. However, this agenda faced opposition from planters who generally resisted measures to expand education (Holt, 1991).[5]

2.1.6 Challenges and Government Interventions (1910-1914)

As the education system evolved, various challenges emerged. For example, irregular attendance due to agricultural commitments and the need for children to contribute to household labour was a significant problem, as pointed out by Underhill (2010) and Board of Education (1901). The government sought to address this by implementing compulsory education in certain areas, but the impact was minimal. The 1910 amendment Laws of Jamaica (1910) established School Boards for towns and districts, which were responsible for managing government elementary schools within their jurisdictions. These boards were empowered to enforce compulsory school attendance and could create by-laws to regulate their proceedings. The law mandated that school managers render accounts and vouchers for all expenditures related to grants received. The role of the "Superintending Inspector of Schools" was pivotal. This officer, later titled "Director of Education" in 1911 Laws of Jamaica (1911), was responsible for overseeing the administration of education funds and ensuring compliance with educational standards. The law mandated the appointment of inspectors by the Governor to inspect and examine schools, thus maintaining quality and adherence to regulations. The exact number of school inspectors was not fixed by the laws; instead, the Governor was given the authority to appoint as many as necessary to fulfill the duties required (Laws of Jamaica, 1911). In 1912, schooling was made mandatory in Kingston, Falmouth, and Lucea, but this move had limited success due to various societal and financial constraints (Moore and Johnson, 2004). To increase school attendance, the government implemented stringent measures, such as laws that allowed school boards to declare persistently absent children as "incorrigible truants", and the use of corporal punishment (Moore and Johnson, 2004)[6]. Parents were also held accountable if their children failed to attend school, they could face fines or even imprisonment (Moore and Johnson,

[5] In this manner Holt (1991) mentions that "[...] planters generally opposed all measures to expand education. Very likely the idea of spending money primarily for the benefit of the black majority did not appeal to most planters. Most of the white estate managers had no family or children, at least none they chose to recognize officially [...]." (Holt, 1991, p.196).

[6] By 1913 a new law allowed school boards to declare persistently absent children as incorrigible truants and authorized the use of corporal punishment under court orders (Laws of Jamaica, 1913).

2004).[7] The consolidated Elementary Education Law of 1914 Laws of Jamaica (1914) reinforced compulsory education. It mandated that children attend school from ages six to fourteen, with penalties for parents or guardians who failed to ensure compliance. The law also provided for scholarships to encourage continued education beyond elementary school (Laws of Jamaica, 1914).

2.1.7 Efforts to Improve School Attendance and Funding

Despite these obstacles, Jamaica has made impressive progress in promoting school attendance. By 1900, the island's gross enrolment rate in primary schools was significantly higher than in other Latin American and Caribbean countries, such as Argentina, Chile, the Dominican Republic, Brazil and Bolivia (Frankema, 2009). However, the financial burden of education continued to challenge full school attendance (Moore and Johnson, 2004). The cost of school fees, writing and reading materials, and proper clothing were significant barriers for many families (Moore and Johnson, 2004). In an attempt to address this, the Jamaican government abolished the mandatory school fee in 1892, which led to a significant increase in school attendance (Board of Education, 1901).[8]

Subsequently, schools were funded through an additional house tax, which proved to be a more successful financing strategy, generating an increase in revenue of more than 50% compared to previous school fees (Laws of Jamaica, 1892). In 1892 government expenditure on education was more than £56,000, which was about 8% of total government expenditure (The Governor's Report, 1895). This proportion has remained relatively constant over time, although in absolute terms it has increased considerably. In 1944, education expenditure was £568,000 and total expenditure £7.4 million (Blue book of Jamaica, 1945).

2.1.8 School Terms and Vacations

As the education system continued to evolve in the 19^{th} and 20^{th} centuries, the term and vacation dates began to take shape. Although specific data for Jamaican primary schools is scarce, records for three high schools in Handbook of Jamaica (1895) and for primary schools in Barbados provide some insight. For example, the Rectory School in Port Maria,

[7] It should be noted that the enforcement of these penalties, particularly fines and imprisonment, varied and faced challenges, as highlighted by Moore and Johnson (2004). The enforcement of these penalties was already provided for in Law 31 of 1892 (Laws of Jamaica, 1892).

[8] Similar have been found for the 19^{th} century U.S. (Go and Lindert, 2010).

York Castle High School, and Kingston Collegiate School typically allotted five weeks for Christmas, one week for Easter, and six weeks for the midsummer holidays (Handbook of Jamaica, 1895, p.336). In Barbados, primary school students typically had a week off for Christmas, a week off for Easter, and a one month summer break in August (Board of Education, 1905).

2.1.9 Secondary Education Reforms (1892)

In response to the necessity for an enhanced level of education, the government enacted the Secondary Education Law in 1892. This legislation facilitated the establishment of secondary schools in major urban centres and provided scholarships for high-performing students to pursue their studies at the secondary or post-secondary level (Handbook of Jamaica, 1892). The objective of this law was to address the discrepancy between the elementary and secondary levels of education, thereby establishing a more comprehensive and unified educational system (Handbook of Jamaica, 1892). The secondary education system in Jamaica during the late 19th and early 20th centuries was initially driven by missionary societies and the colonial government, with the objective of producing a middle-class cadre imbued with British cultural and moral values (Moore and Johnson, 2004). Despite the initial limitations of early efforts being confined to expensive private institutions, government interventions, such as the enactment of Law 34 of 1879 and Law 32 of 1892, resulted in the establishment of national grammar schools and the provision of public funding to facilitate broader access to secondary education (Moore and Johnson, 2004). Notable educational establishments such as Jamaica High School (subsequently renamed Jamaica College) were based on the British grammar school model, offering a challenging curriculum that included classical languages, sciences, and moral education (Moore and Johnson, 2004). These schools aimed to educate future leaders for public service and instill loyalty to the British Empire. By combining religious and academic education, institutions like York Castle High School and Calabar Institution also played a significant role. The overarching objective of secondary school was to create an educated class capable of supporting colonial administration and advancing the civilising mission of the British Empire (Moore and Johnson, 2004).

2.1.10 Summary of Educational Reforms

In conclusion, the evolution of Jamaica's education system from the late 19th to early 20th centuries was characterised by significant reforms and challenges. The shift from a predominantly church-led education system to a more integrated approach involving both voluntary and government schools reflected the island's commitment to expanding educational access (Board of Education, 1901). The introduction of compulsory education, the elimination of school fees, and the restructuring of the school calendar were pivotal steps in this process, despite the ongoing challenges of irregular attendance and financial constraints (Board of Education, 1901). The efforts to enhance education during this period established a foundation for future advancements and a more inclusive educational landscape in Jamaica.

2.2 Hurricanes

Historically, hurricanes caused great damage in many parts of Jamaica. Between 1892 and 1942. The famous 1903 Jamaican hurricane struck Jamaica in August 1903 with wind speeds exceeding 170km/h, causing great damage. In fact, it caused so much damage to the railway system that the Jamaican railway was unprofitable in the following two years (Satchell and Sampson, 2003). The The Jamaica Gleaner (1903a) wrote the following about the impact of the hurricane on Port Royal schools: *"Four of our teachers have been hard hit during the recent hurricane, their school houses having been blown down [...]."*(The Jamaica Gleaner, 1903a, p.5). Hence, teachers were often also directly affected by the storms.[9] In the parish of St. Catherine the impact of the hurricane was even more severe as *"[a]ll the churches and school houses have either been completely demolished [or] badly damaged. Hundreds of houses have been destroyed, and the peasantry are homeless."* (The Jamaica Gleaner, 1903b, p.10).

A few years later, the 1912 hurricane made landfall in Jamaica with winds up to 170km/h. As a result, crop yields decreased rapidly as many plants were destroyed (The Governor's Report, 1912). In the parish of Westmoreland, the hurricane caused even more damage, as *"[t]here has been a loss of about 30% on the cane crops and the buildings on some of the estates suffered severely. A considerable amount of damage was also done to*

[9] *"The Union would not be worth its existence, if at a time as this it did not make some efforts to afford tangible help to those members who need it. Teachers as a rule have very little money laid by, it is with them in nine cases out of ten a hand-to-mouth existence, therefore to those who have lost schoolhouses, residences, books, furniture, cultivation, etc., it is like mockery to talk of sympathy without extending a helping hand."*(The Jamaica Gleaner, 1903a, p.5).

cocoanut trees, breadfruit and other valuable trees, while house property was destroyed and many people left homeless. The wharves were all washed away and a considerable amount of goods lost." (The Governor's Report, 1912, p.117). Similarly, in Manchester, more than 150 houses were destroyed and in many parishes several school buildings were damaged, indicating how severely the population was directly affected by the storm (The Governor's Report, 1912). However, the hurricane also destroyed almost half of the school buildings in Hanover, Westmoreland, and St. James (The Governor's Report, 1912). In Grange Hill, Westmoreland, the hurricane destroyed school buildings, so the school was not kept until temporary buildings were put up in the following year (The Jamaica Gleaner, 1912).

The *1915 Galveston hurricane* hit Jamaica in mid-August with more than 157km/h before making landfall in Galveston. In parishes such as Portland or Trelawny, the hurricane directly affected crop production, so losses of up to 65% occurred (The Governor's Report, 1915). However, the hurricane also affected schooling. *"During the past year there has been a general, if slight, falling off in the attendance [...]. It is thought to be due to the hard time induced by the war and by the hurricane of last autumn. The poorer peasants whose ground crops were badly damaged, if not destroyed, and who in consequence have to produce their food from the shops cannot provide their children with food and decent clothes to go to school."* (The Governor's Report, 1915, p.341). Therefore, the reason for the decrease in school attendance is not only due to damaged buildings, but also to the lack of food or income of parents. But not only school buildings were destroyed, but also school materials and furniture so that *"[t]he storm, besides destroying many desks, presses and benches, has left the roof in such a condition that makes the building unsafe to work in."* (The Jamaica Gleaner, 1915, p.14). Moreover, hurricanes also cause great destruction to roads and bridges, as mentioned by The Governor's Report (1915) for the parishes of Hanover and St. Thomas, where *"[...] during the hurricane, the roads themselves being rendered impassable in some cases for weeks."* (The Governor's Report, 1915, p.453).

Only two years later, the *1917 Nueva Gerona hurricane* hit Jamaica in September with wind speeds up to 160km/h. In the parish of Port Maria, the hurricane caused considerable damage to school buildings and teachers' houses. However, as mentioned in The Governor's Report (1917) *"[i]n only one or two cases was the school work suspended for any great length of time. Where the schoolrooms were completely wrecked, the managers, teachers and people of the district quickly met together and erected a temporary booth or shed under which the school could assemble."* (The Governor's Report, 1917, p.187). In the following

ten years, there were no major hurricanes.

Hence, there were several channels on how hurricanes affected school attendance. First, hurricanes destroyed school houses, the furniture (e.g., desks or chairs), or teachers' houses so that no education could have been provided. Second, by destroying transportation infrastructure such as roads, which hindered children to be able to arrive at school. Third, hurricanes might have caused great damage to the homes of the students or their families' crops, causing students to help at home. Furthermore, some parents were unable to buy clothes or food for their children, as hurricane damages were costly, causing children to not attend school.

However, schools were not only affected by tropical storms. In 1907, the Kingston Earthquake destroyed numerous schools in Jamaica (Handbook of Jamaica, 1925). In addition, epidemics contributed to reduced school attendance. For example, the influenza epidemic in 1918 led many schools to close during November and December, resulting in the average attendance across all parishes dropping to only one third compared to the previous year (The Jamaica Gazette, 1919; Moore and Johnson, 2004).

3 Data

3.1 Educational Data

The empirical analysis of this paper is based on an exhaustive geo-referenced database of all Jamaican government elementary schools over the period 1892 to 1942. The primary data source for elementary school attendance in this study is drawn from two significant publications: The Jamaica Gazette and The Jamaican Bluebooks, covering the period from 1869 to 1942 (The Jamaica Gazette, 1942; Blue book of Jamaica, 1892).

The Jamaica Gazette is the official weekly newspaper of the Jamaican government, providing detailed monthly records of school attendance per parish, compiled by the superintending inspector of schools from 1892 to 1942. *The Jamaican Bluebooks* offer information on school attendance from 1869 to 1892 (Blue book of Jamaica, 1892). The data in *the Jamaica Gazette* is monthly and at the parish level, whereas the data in the *Jamaican Bluebooks* is annual and at the school level. The Bluebooks data is more granular compared to the Gazette data but contains variables that are not homogeneous over time, making the analysis challenging. For this reason, only data on attendance, school marks, and the number of trained and untrained teachers were used. Additionally, the data on

school grades is at the annual level for each school, and all 1,060 distinct schools were georeferenced for the analysis.

The annual data in the *Bluebooks* provide valuable information on the structure and outcomes of the educational system during the study period. The primary examinations analysed were standardised tests administered annually in a variety of subjects (Handbook of Jamaica, 1883, p. 131). The curriculum typically included subjects such as reading, writing from dictation, arithmetic, scripture knowledge, general knowledge, grammar and composition, geography and history, handwriting, and singing. School inspections played a crucial role in maintaining educational standards, with inspectors assessing various aspects of school management and student performance. The exams were graded on a point system, with a maximum of 84 points obtainable. The results of these inspections were documented, and schools were classified into three levels based on their efficiency, which determined the amount of government aid received (Handbook of Jamaica, 1883, p. 129). However, most educational institutions struggled to achieve even two-thirds of the maximum score, reflecting the challenges in maintaining high educational standards (Handbook of Jamaica, 1883, p. 131).

In addition, I calculated the monthly share of children attending school from the total population from the Jamaican Population Census of 1871, 1881, 1891, 1911, and 1921 which were taken from Handbook of Jamaica (1881, 1925). In the absence of census data for 1901 and 1931, estimates from *The Jamaica Vital Statistics* were used (The Governor's Report, 1901, 1936). To obtain monthly estimates, the population data was linearly interpolated. Subsequently, the monthly share of children attending school was calculated by dividing the school attendance figures for a given month by the interpolated population estimate from the preceding months. Additionally, these population data were used to determine each parish's share of the total population.

Furthermore, I incorporate the impact of the 1907 Kingston, a pivotal moment in Jamaica's history, earthquake on school attendance patterns. The Rossi-Forel scale, used to measure the intensity of the earthquake, is incorporated from Cornish (1908). For each parish, an average value of the Rossi–Forel scale was calculated, with intensity levels ranging from 6 in parishes such as Hanover and Westmoreland to the maximum level of 11 in Kingston. It is important to note that the original Rossi-Forel scale goes up to 10, but Cornish (1908) extended it to 11 for areas that experienced the most severe damage (Cornish, 1908, p.255). This inclusion is vital to understanding the potential fluctuations

in school attendance due to this major natural disaster.

Additionally, an influenza dummy is introduced into the model. Historical records indicate a significant drop in school attendance during the influenza (or Spanish Flu) epidemic, largely due to the widespread closure of schools in November and December 1918 (The Jamaica Gazette, 1919). Therefore, the influenza dummy variable is set to one for the months of October, November and December in 1918, as well as for January and February in 1919.

3.2 Hurricane and Climate Data

To assess the influence of hurricanes on school attendance, this paper uses a model to estimate the wind speed at the centroids of Jamaican parishes. The methodology follows Strobl (2012), utilizing a wind field model[10] developed by Boose et al. (2004), which incorporates Holland (1980)'s equation for cyclostrophic wind and sustained wind speed. This model involves tracking the trajectory of each hurricane in both time and space and applying the model of Boose et al. (2004) to determine the wind speeds experienced in the Caribbean region. By taking into account important factors such as speed of movement, direction, maximum wind speed, and landfall, this model then provides us with the localised wind speeds at each landfall location throughout the hurricane's lifetime. Using the six-hourly *HURDAT best tracks* data from the *National Hurricane Centre's Hurricane Database*, I estimated the wind speeds at the centroids of Jamaican parishes, following the method recommended by Strobl (2012). This approach allows for a nuanced assessment of storm exposure variability across different regions. According to Emanuel (2011)'s recommendation on power dissipation, I proceeded to cube the local wind speeds obtained. This step is crucial because it has been observed that the monetary damage caused by hurricane strikes increases cubically with the wind speed. As the obtained number becomes very large, I divide it by 1 million. For the purposes of this analysis, only wind speeds greater than 119km/h were considered, corresponding to tropical storm conditions. The wind speed at every parish centroid is estimated in the manner of Strobl (2012):

[10]This wind field model has been applied to various papers (see e.g. Huesler and Strobl, 2023; Ouattara and Strobl, 2013; Del Valle et al., 2020; Noy and Strobl, 2023; Mohan and Strobl, 2017; Del Valle et al., 2018).

$$V = GF\Big[V_m - S(1 - sin(T))\frac{V_h}{2}\Big] \times \Big[\Big(\frac{R_m}{R}\Big)^B exp\Big(1 - \Big(\frac{R_m}{R}\Big)^B\Big)\Big]^{\frac{1}{2}} \quad (1)$$

In this formula, V_m represents the maximum sustained wind speed within the hurricane. The angle between the forward trajectory of the hurricane and a radial line from the centre of the hurricane to a specific location, denoted as P, is indicated by T. The forward velocity of the hurricane is expressed as V_h. The radius at which maximum winds occur, R_m, and the radial distance from the centre of the hurricane to point P, R, are also integral components of the equation (Strobl, 2012).

3.3 Population weighted destruction index

In addition to assessing the influence of cubic wind speeds on school attendance, I incorporate a population-weighted hurricane destruction index derived from Strobl (2012). This index is constructed using the same windfield model employed in the previous section. Instead of only estimating the wind speed at a parish centroid, the population-weighted destruction index allows me to estimate the potential destruction caused in the entire parish. The intuition behind the destruction index is that a hurricane with the same wind speed would cause greater damage in a parish with higher population density compared to a parish with lower population density. Therefore, population statistics are used from the *History Database of the Global Environment (HYDE 3.2)* (Klein Goldewijk et al., 2017). This database provides population approximations on a 0.083 x 0.083 degree grid, equivalent to a 9.5 x 9.5km area. An estimation of the wind speed in each grid cell, when combined with the corresponding population, serves as an indicator of potential damage. Thus, a grid cell with higher wind speed and larger population would yield greater destruction than one with a lower wind speed and population. Importantly, there are no endogeneity concerns with respect to population migration, since the (decadel) population data predate hurricanes. After reestimating equation (1) at the grid cell level, one obtains an estimated wind speed $v_{j,t}$ for every 9.5 x 9.5km cell j at time t. Subsequently, the population-weighted hurricane destruction index is calculated in the manner of Strobl (2012):

$$DESTR_{i,r,t} = \Big(\sum_{j=1}^{J} \int_0^{\tau} v_{j,t}^{\lambda} w_{i,j,r,t}\, dr\Big) \text{ if } v_{j,t} > 119\text{km/h} \quad \text{and 0 otherwise} \tag{2}$$

$DESTR_{i,r,t}$ is the estimated total destruction caused by a storm r during the lifetime of the storm τ in a parish i at time t.[11] Furthermore, J is the set of grid cells in parish i and, according to Strobl (2012), λ is set to 3. The time depending population weight is $w_{i,j,r,t}$ and corresponds to the population in every cell of the grid in the previous decade.[12] As Jamaica is a rather small island (approximately 250 x 80km), I interpolated the 6-hourly *HURDAT best tracks* to obtain more precise, two-hourly, wind speeds vj, t.

4 Summary Statistics

Between 1892 and 1942, Jamaica experienced 28 tropical storms, ten of which had wind speeds exceeding 119km/h. As can be seen from Table 1, the average wind speed of these storms was roughly 87.4km/h. Among these, four were categorized as category two hurricanes (with wind speeds surpassing 154km/h). Table 1 shows that the highest estimated wind speed was 173.8km/h, which is just below the threshold for a category three hurricane. During the 50 years observed, each parish experienced at least one tropical storm. The frequency of category two hurricanes varies significantly. Portland, St. Ann, and St. Thomas did not experience any category two hurricanes, while St. Catherine and St. James were hit by three. Figure 2 shows the tracks of storms with wind speeds above 119km/h, indicating that northern Jamaican parishes were more frequently and severely affected by powerful hurricanes. Moreover, the summary statistics further show that the average parish had around 60,000 inhabitants, with the smallest being Trelawny (31,696 inhabitants) and the largest St. Catherine (130,274 inhabitants). The Rossi-Forel scale for the Kingston earthquake varied significantly across parishes, with a low of 6 in Westmoreland and Hanover and highs of 10 in St Andrew and 11 in Kingston.

School attendance figures show an average of 4,363 children attending school per parish, with the range spanning from 2,441 in Trelawny to 6,018 in St. Elizabeth. Figure 3a

[11] I divide $DESTR$ by 10^10 to get more feasible numbers.

[12] Hence, for 1892-1900 $HYDE$ data from 1890 is used, 1900 for 1901-1910, 1910 for 1911-1920, 1920 for 1921-1930 and 1930 for 1931-1940 and 1940 the years after 1934.

illustrates the spatial distribution of the average monthly school attendance, highlighting higher attendance in southern parishes such as St. Elizabeth, Manchester, Clarendon, and St. Catherine, compared to northern and eastern parishes. However, this changes when analysing the spatial distribution of average school attendance as a share of the total population, illustrated in Figure 3b. Now, southern parishes still have higher attendance rates, but the dispersion decreased considerably.

Temporal variations in school attendance are also evident. In Figure 4 the evolution of monthly school attendance (log) by parish is illustrated. The figure provides some information on school attendance in Jamaica. First, there exists a positive trend with respect to school attendance. Therefore, more children were able to attend school over time. Second, there exists considerable seasonality. On average, in February, school attendance is highest, with 5,264 children attending school per parish on average, and lowest in December, when only 3,173 children attend school. Furthermore, school attendance is more than 20% higher in the first half of the year compared to the second half. Third, there was a pronounced drop in school attendance during the Spanish Flu in late 1918, when many schools closed.

For the period 1872 to 1892, where data was collected annually, average school attendance per parish was considerably lower (2,258) compared to post-1892 (4,363). The data also reveal that an average of 57% of teachers were trained, with significant variation between parishes, from 34.3% in Kingston to 78% in Hanover, and an increasing trend over time. Academic performance, measured as *Avg. Mark*, averaged 38.37 across parishes, with a range from 35.7 in St. Thomas and St. Mary to 43.7 in Manchester. Moreover, there is not only a spatial variation but also a temporal variation in *Avg. Mark*. In general, the value increases from 30 in 1869 to almost 45 in 1892. For the period 1880-1892, the annual data is more granular than in previous years, as it is not at the parish level but at the school level. During that period, the average attendance was 50.68, with an average of 89.15 pupils enrolled in each school. The average mark was also slightly higher at 41.92.

In addition to examining the evolution of school attendance over time, it is also crucial to consider the proportion of children attending school in relation to the total number of school-aged children. For this reason, I estimated the number of school-aged children with ages between six and fourteen years for the years between 1892 and 1942 using data on births from Handbook of Jamaica (1883-1930) and The Governor's Report (1904-1938). Furthermore, the mean annual attendance was calculated for each parish and aggregated to

obtain the mean annual school attendance in Jamaica. Figure 1 illustrates the proportion of school-aged children who are attending school. The figure demonstrates a U-shaped form, with a high proportion of children attending school during the initial years (1892-1893), a lower proportion attending school between 1912 and 1920, and a gradual increase to the highest proportion attending school at the beginning of the 1940s. This is consistent with the historical development of education in Jamaica. The high proportion of children attending school in 1892-1893 can be attributed to the abolition of school fees. The decline in attendance between 1918-1920 was caused by the influenza pandemic. The subsequent increase in the number of students attending school was due to the stricter enforcement of compulsory education.

5 Effect of Hurricanes on School Attendance

This section analyses the relationship between hurricanes and school attendance in Jamaica. Using a fixed-effects panel regression model, the potential decrease in monthly school attendance due to hurricanes is examined:

$$\begin{aligned} LOG(ATT_{i,t}) = \beta_0 + \sum_{k=0}^{p} \beta_{k+1} \cdot HURR_{i,t-k} \\ + \alpha_z + \delta_m + \theta_i + \epsilon_{i,t} \end{aligned} \tag{3}$$

where α_z and δ_m are yearly and monthly fixed effects, θ_i are parish fixed effects, $LOG(ATT_{i,t})$ is the Log of school attendance and $HURR$ is the cubic wind speed divided by 1 million in parish i at time t, ..., $t+k$. Moreover, I cluster the standard errors on parish level. As hurricane strikes are random and exogenous events, using time- and entity-fixed effects isolates, according to Elliott et al. (2023); Huesler (2024); Mohan and Strobl (2021), the random, unanticipated realisations from the distribution of potential damages from hurricanes.[13] This in turn allows me to estimate their effect on $ATTEND$ causally.[14]

[13] Yearly fixed effects account for events such as World War 2 or price shocks that affected all parishes equally. Monthly fixed effects account for seasonal patterns, and parish fixed effects account for parish-specific differences that could affect school attendance, such as varying education policies or differences in the average distance to the nearest school.

[14] The estimated effect can be interpreted as causal for several reasons. First, there were no official warning systems which could have caused anticipation of hurricanes. Second, the geographical location choices of schools μ_i capture local distribution $f_{H_i}(H_i)$. Therefore, $H_{it} - \mu_i$ are random realisations from $f_{H_i}(H_i)$. Finally, information in *Departmental Reports* and *Jamaican Gazettes* indicate that schools

Controlling for seasonality is achieved by using monthly fixed effects, while yearly fixed effects account for year-specific common effects. The analysis incorporates multiple control variables to provide a comprehensive understanding of the influence of the hurricane on parish-level school attendance. First, a linear trend at the parish level in school attendance is taken into account. This control is designed to capture inherent patterns within individual parishes that might result from a variety of factors not explicitly incorporated into the regression model. Next, the analysis takes into account the population share of each parish in the previous year. This approach allows for the evaluation of the potential influence of hurricanes in a comparative context. For instance, if a hurricane strikes a parish with a significantly larger population relative to other parishes, the hurricane's consequences are hypothesised to be more pronounced than in a less populated parish. Furthermore, since influenza caused school closure (The Jamaica Gazette, 1919), the influenza dummy is set to one for the months of October, November, and December in 1918, as well as for January and February in 1919. Lastly, the Rossi-Forel scale, along with two of its lags, is integrated into the model to account for the potential impact of the Kingston Earthquake. The Rossi-Forel scale provides an estimate of an earthquake's intensity, thereby enabling the potential influence of seismic activity on school attendance to be captured.

The results of the estimation of the effect of Category One (two) hurricanes, where wind speeds exceed 119km/h (154km/h), on school attendance are in the first (third) column of Table 2. In the first column and third column, only the effect of $HURR_{t,..,t-7m}$, $EARTHK_{t,...,t-6m}$ as well as the location and time fixed effects are included. However, the results already indicate that hurricanes lead to significantly lower school attendance in the month of and the months after a hurricane. In column (2) and (4), I further control for $INFLUENZA$ which severely reduced school attendance in the end of 1918 and for $LINTREND$, which are parish-level linear trends and control for the underlying temporal trends specific to each parish. Incorporating $LINTREND$ allows me to account for any systematic time-dependent patterns that might influence school attendance, but are not related to hurricanes.

In column (6) ATT_{t-1m} is included. As expected, the effect of $HURR$ remains highly significant. The results from column (4) are further illustrated graphically in Figure 7. As is visible from Figure 7, $HURR$ decreases school attendance in the beginning but the effect becomes zero after three months. Moreover, the effect is also economically significant.

affected by hurricanes were rebuilt and not abandoned which also aligns with the fact that no migration occurred after shocks as agricultural production and sugar-estate-level production recovered after shock.

Taking the average category two hurricane in the underlying data set (163km/h), one can conclude that $HURR_t$ reduces the average school attendance by 9.1%, $HURR_{t-1m}$ by 8.6% and $HURR_{t-2m}$ by 7.2%. Taking the average school attendance per parish (4,363 children), these results indicate that on average almost 400 children miss school one month, over 375 two months, and over 310 children miss three months of school after a hurricane strike. Nevertheless, the effect becomes insignificant after $t - 2m$. In general, the mechanism behind the decrease in school attendance could be related to the resilience of educational attendance in the face of domestic infrastructure damage. Children, due to their limited ability to contribute to reconstruction efforts, might continue attending school despite damage to their home. Additionally, mandatory schooling laws could require attendance unless the school facilities themselves are compromised or the infrastructure is severely damaged, preventing children from reaching school.

In Table 2 columns (1-2) and (5-6) and Figure 8[15], the same estimates have been carried out, but including category one hurricanes (wind speeds exceeding 119km/h). The results are comparable in significance, although slightly lower in magnitude. The results in column (2) indicate that taking the average hurricane (142km/h) reduces school attendance by 4.7% in t, 3.0% in $t - 1m$ and by 2.6% in $t - 2m$. However, the results increase when taking the average category two hurricane (163km/h) so that it reduces school attendance on average by 7.1% at t, 4.6% at $t - 1m$ and by 3.9% in $t - 2m$.

To test the robustness of the results, the same models are applied but include a lead in Table 3, which controls for pre-Trends. As the effect of the lead is insignificant, the results show that there are no pre-existing trends or expectations. Therefore, the results of the paper capture the effect of hurricanes on school attendance. Furthermore, the effect of $HURR_t$, $HURR_{t-1m}$ and $HURR_{t-2m}$ in Table 3 is similar[16] compared to those where no lead is included.

In Table 4, I estimate the baseline model in columns (1) and (3) but also include $LOG(ATT_{i,t-1})$ in columns (2) and (4). Columns (1) and (2) show the results for wind speeds exceeding 119km/h and (3) and (4) for wind speeds exceeding 154km/h. In general, including $LOG(ATT_{i,t-1})$ increases the impact of $HURR_t$ but leads to an insignificant impact of $HURR_{t-1}$. Therefore, the results imply that average school attendance decreases by 6.3% points to 9.2% points when the average wind speed of category two hurricanes

[15]This figure contains the result from column (2) of table 2.

[16]The estimations with one additional lead are slightly higher when taking a threshold of 119km/h and slightly lower with a threshold of 154km/h.

in the data set was taken. Furthermore, the positive significant effect of $LOG(ATT_{i,t-1})$ implies that there exists a positive path dependency with respect to $ATTEND$. Since the results in Table 4 do not differ too much from those of the baseline specification, it can be interpreted as further evidence of the robustness of the results.

5.1 Population weighted destruction index

To further illustrate the robustness of the results, a population-weighted hurricane destruction index is applied in the manner of Strobl (2012), which is based on the windfield model used in the first part of the results. The effect of $DESTR$ on $ATTEND$ is estimated as follows:

$$LOG(ATT_{i,t}) = \beta_0 + \sum_{k=0}^{p} \beta_{k+1} \cdot DESTR_{i,t-k} + \alpha_z + \delta_m + \theta_i + \epsilon_{i,t} \tag{4}$$

In general, the signs and significance of the results in Table 5 are similar to those of the baseline model. The results in column (4) suggest that taking the average non-zero destruction, $ATTEND$ decreases by 1.81% in t. This is approximately one-quarter of the results from the baseline specification. Similarly, I estimate a population-weighted hurricane destruction index with a threshold of 154km/h. The results in Table 6 suggest that taking the average non-zero destruction, $ATTEND$ decreases by 2.7% (compared to 8.6% in the baseline specification). Due to population weighting, areas with higher population densities are expected to experience more destruction compared to those with lower population densities. As a result, the destruction index generally underestimates the damage caused, reducing the impact on school attendance. It is worth noting that Jamaica was still a plantation economy at the beginning of the 21^{st} century. Therefore, since a significant portion of the population lived outside of the major urban centres and many schools were located in sparsely populated regions, the findings from using the population-weighted destruction index may underestimate the actual impact of storms on school attendance. Thus, the results of taking the population-weighted hurricane destruction index can be seen as a lower bound.

5.2 Fisher randomization test

To further assess the robustness of the findings, a Fisher-type randomization test is applied for the estimates of the hurricane impact on school attendance (Fisher et al., 1937). To this end, the hurricanes were randomly distributed across parishes and over time and were subsequently evaluated using the baseline model in column (5) of Table 2. This process was carried out 1,000 times (while keeping the control variables fixed), generating a total of 1,000 t-values for each respective coefficient.

Figure 10 illustrates the distribution of t-values for the coefficients of $HURR_t$ in model 5 of Table 2, with the t-value from the initial baseline model indicated by a red dotted line. Moreover, the same process has been done for $HURR_{t-1m}$, which is presented in Figure 11. As the distribution of t-values from the Fisher randomization test is in both cases not centred around the t-value obtained from the initial model, it can be concluded that the impact of hurricanes on school attendance is unlikely to be a result of chance. Therefore, the impact of hurricane strikes on school attendance can be interpreted as causal, reinforcing the conclusions drawn from the baseline model.

6 Effect of Tropical Storms on Academic Performance

Figure 6 illustrates the temporal evolution of marks. As evidenced by Figure 6, there is a general increase in marks, irrespective of whether the average, the upper and lower 10% or the upper and lower 25% are considered. However, this increase is not linear, with some years exhibiting a significant decrease in marks. Two good examples are the drops in marks after the hurricanes in 1880 and 1886.

In addition to the fixed effect OLS results presented in the previous sections, it is possible that school attendance acts as a mediator. Hence, tropical storms may affect the marks obtained both directly and indirectly through school attendance. To investigate this possibility, I conducted a mediator analysis following the approach of Imai et al. (2010, 2011). Figure 9 provides a graphical illustration of the mediation analysis. The mediation analysis is estimated with yearly data for the subsample from 1872 to 1892 as data on marks is unavailable for more years. The mediation is estimated using the following two equations, as described in Gunzler et al. (2013):

$$SchoolAttendance_{i,t} = \beta_0 + \beta_{xz} \times HURR_{i,t} + \alpha_i + \delta_t + PTT_{i,t} + \epsilon_{z,i,t} \tag{5}$$

$$Marks_{i,t} = \gamma_0 + \gamma_{zy} \times SchoolAttendance_{i,t} + \gamma_{xy} \times HURR_{i,t} + \alpha_i + \delta_t + PTT_{i,t} + + \epsilon_{y,i,t} \quad (6)$$

These models are then estimated using the yearly data from 1880-1892 for which I also have a dummy variable indicating whether a teacher was trained or not. In both models I control for location fixed effects α, year fixed effects δ and I control for whether a school has a trained teacher (PTT). The mediation analysis is carried out in R by using the *mediation* library (Tingley et al., 2014) with robust standard errors bootstrapped over 1,000 simulations allows for investigating three effects. These comprise the direct effect (ADE) of $HURR$ on academic performance ($MARKS$), the indirect mediation effect (ACME), and the total effect of $HURR$ on $MARKS$. The analysis delves into the heterogeneity of these impacts, examining not only the average but also the distributional changes in academic marks due to tropical storms.

Table 7 presents the analysis findings on the impact of tropical storms on academic achievement within parishes, considering two minimum wind speed thresholds, namely 119km/h and 154km/h, across six distinct models. The results reveal a consistent and significant mediating effect of school attendance, as indicated by the average causal mediation effect (ACME). This suggests that school attendance is a crucial factor in mitigating the negative impact of tropical storms on academic performance.

For models that use the 119 km/h threshold (columns 1 to 3), the ACME values range from -0.106 to -0.666, all significant at the 1% level. For models employing the 154km/h threshold (columns 4 to 6), the ACME values range from -0.108 to -0.670, significant at the 1% levels. This indicates that increased wind speeds from tropical storms significantly reduces academic performance through affecting school attendance.

The direct effect of tropical storms on academic marks (ADE) is generally not significant, except in columns (2) and (4), where it is significant at the 10% level. This finding implies that the primary pathway through which tropical storms affect academic performance is through reduced attendance rather than a direct impact.

Therefore, a typical non-zero Category 1 (and above) Hurricane, with an average wind speed of 160.9km km/h, leads to a decrease in academic marks by 2.77% when the ACME is -0.673, by 2.30% when the ACME is -0.553. Similarly, using a higher storm threshold of 154km/h shows that a typical non-zero Category 2 Hurricane, with

an average wind speed of 168.9 km/h, results in a decrease in academic marks by 0.52 to 4.23%. However, as the estimated $ACME$ decreases between column (2) and (3) and (5) to (6) when *Teacher Trained* is included, it must be noted that having a teacher with training reduces the negative impact of hurricane strikes on academic performance. In summary, the results consistently demonstrate that tropical storms have a detrimental impact on academic performance in all categories. Furthermore, I emphasise the crucial role of school attendance in mitigating these adverse consequences.

Table 8 contains the results from the first and second stage. The results from the first stage, in Panel A, indicate a statistically significant negative effect of hurricanes on the average yearly school attendance rate. In particular, the coefficient for $HURR_t$ is consistently negative in all models, demonstrating that hurricane exposure has a substantial negative impact on school attendance. To illustrate, in columns (1) and (4), the coefficient for $HURR_t$ is -0.009, which is significant at the 5% level. The effect is even more pronounced in columns (2) and (5), where the coefficients are -0.056 and -0.052, respectively, both significant at the 1% level. These findings are robust and confirm that hurricane events have a significant disruptive effect on average yearly school attendance on school level. The second stage results demonstrate a positive and highly significant relationship between school attendance and academic performance. The coefficients for $Attendance_t$ are positive and significant at the 1% level across all models, indicating that increased school attendance is strongly associated with improved test scores. The statistically significant mediation effect demonstrates that reduced school attendance is a crucial channel through which hurricanes alter academic outcomes.

The results show that hurricanes with higher wind speeds cause more damage, which may result in pupils receiving disproportionately lower grades because they have to help repair the damage at home. Stronger storms may destroy more of the harvest, such as sugar and bananas, which could force children to help with reconstruction efforts instead of studying, resulting in a decrease in academic performance. Hence, similar results have been found for the impact of natural disasters on academic performance in the 21^{st} century (Thamtanajit, 2020; Sapkota and Neupane, 2021; Khalid et al., 2024).

The paper also illustrates alterations in the distribution of marks. Not only did I notice a reduction in average marks, but also an increase in the variability of marks between schools, suggesting a broader range of academic results after storms. This raises concerns about the worsening of academic inequality in the aftermath of environmental

disasters, especially as, depending on the model, between one-third and almost half of the effect of tropical storms on school performance is mediated by average school attendance.

7 Conclusion

This study provides a comprehensive analysis of the relationship between natural disasters and educational results, focussing on the impact of hurricanes on school attendance in colonial Jamaica from 1872 to 1942. By combining parish-level school attendance data with historical hurricane tracks, the research highlights the significant consequences of these natural events in a primarily agrarian society. The findings indicate substantial educational disruptions due to hurricanes, with category two hurricanes causing an average attendance drop of 9.1% in the hurricane month, followed by declines of 8.6% and 7.2% in the subsequent two months. The mediation analysis reveals that tropical storms significantly reduce academic performance, primarily through decreased school attendance. The average causal mediation effect indicates that school attendance is crucial in mitigating these adverse impacts, with trained teachers further reducing the negative effects. Stronger storms lead to greater academic declines and increased variability in marks, raising concerns about worsening academic inequality post-storm. These findings highlight the importance of maintaining school attendance and teacher training to mitigate the educational impacts of natural disasters.

The broader implications of these findings are manifold. First, they contribute to the growing literature on the impact of natural disasters on educational outcomes, complementing existing studies that examine similar dynamics in different contexts (Cuaresma, 2010; Bustelo et al., 2012; Adeagbo et al., 2016). This paper also enriches historical research on the socio-economic impact of natural disasters (Naylor et al., 2022), especially in agrarian societies that rely on vulnerable sectors such as agriculture, which is particularly prone to the impact of hurricanes (Cook and Beachy, 2018; Baez and Santos, 2007).

Furthermore, this paper underscores the potential long-term implications of these short-term disruptions. Although I do not directly measure long-term impacts, the observed declines in attendance and performance suggest adverse effects on students' future educational attainment and economic growth. This aligns with broader literature on the role of education in economic development, as discussed by Barro et al. (2013), Long (2006), and Hanushek and Wößmann (2007). The historical context of Jamaica, which was

dependent on plantations during the period under study, provides a crucial lens through which to understand these dynamics. Thus, the historical disruptions caused by hurricanes likely had far-reaching implications for education and economic growth in Jamaica. This paper therefore emphasises the vulnerability of such agricultural-dependent economies like Colonial Jamaica to environmental shocks.

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9 Appendix

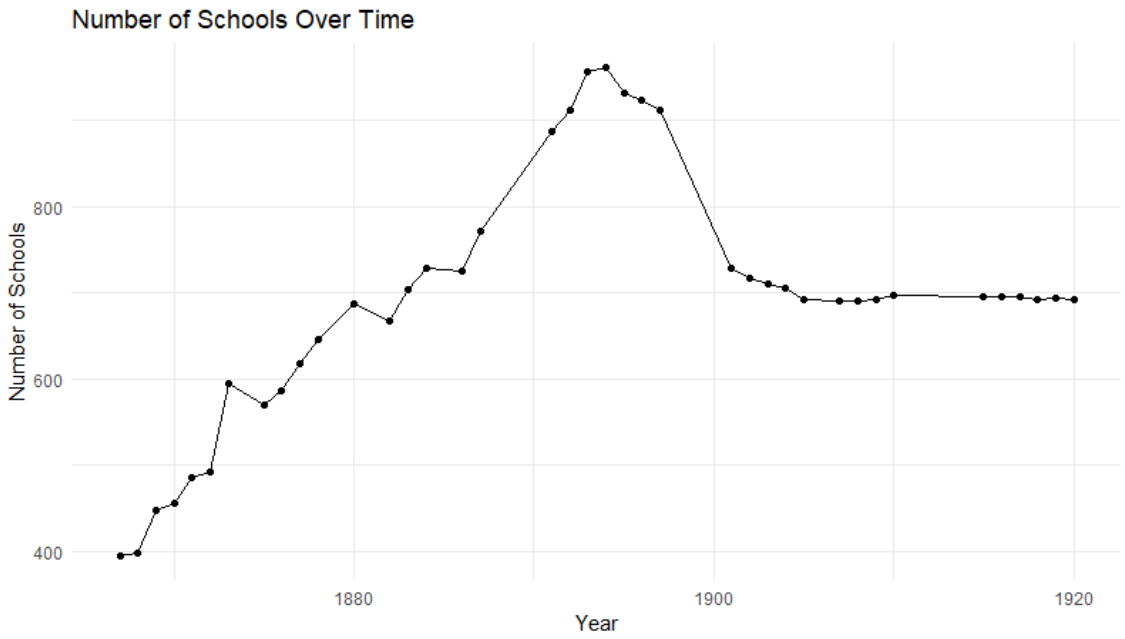


Figure 1: Number of Schools over time. The data for this graph is obtained from Moore and Johnson (2004). Moore and Johnson (2004) used data from the Blue book of Jamaica (1867-1905), The Governor's Report (1882-1920) as well as from various letters.

Table 1: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Monthly & Parish-Level: 1892-1942					
Windspeed	931	87.37	24.78	62.1	173.8
Population	8,989	63,546.84	20,928.27	31,70	130,274
Attendance (post 1892)	8,989	4,362.92	1,881.61	132	12,588
Earthk	8,989	0.013	0.326	0	11
Yearly & Parish-Level: 1872-1892					
Avg. Attendance	266	2,258	1,130.88	341	5,641
Share: Teachers Trained	266	0.57	0.16	0.12	0.92
Avg. Mark	263	38.37	5.39	26.33	58.15
Yearly & School-Level: 1880-1892					
Windspeed	1,310	136.8	32.53	90.3	178.9
Avg. Attendance	9,322	50.68	23.61	1	320
Pupils on Books	9,322	89.15	40.36	0	536
Avg. Mark	9,322	41.92	10.10	1	89

Windspeed represents the average wind speed of tropical storms in kilometers per hour, *Population* denotes the average population of parishes, *Attendance (post 1892)* refers to the average monthly school attendance after 1892, *earthquake* represents the Rossi Forel scale of the Kingston earthquake, *Avg. Attendance (pre 1892)* is the average monthly school attendance before 1892, *Share: Teachers Trained* is the share of trained teachers among the total, *Avg. Mark* Represents the average academic performance mark.

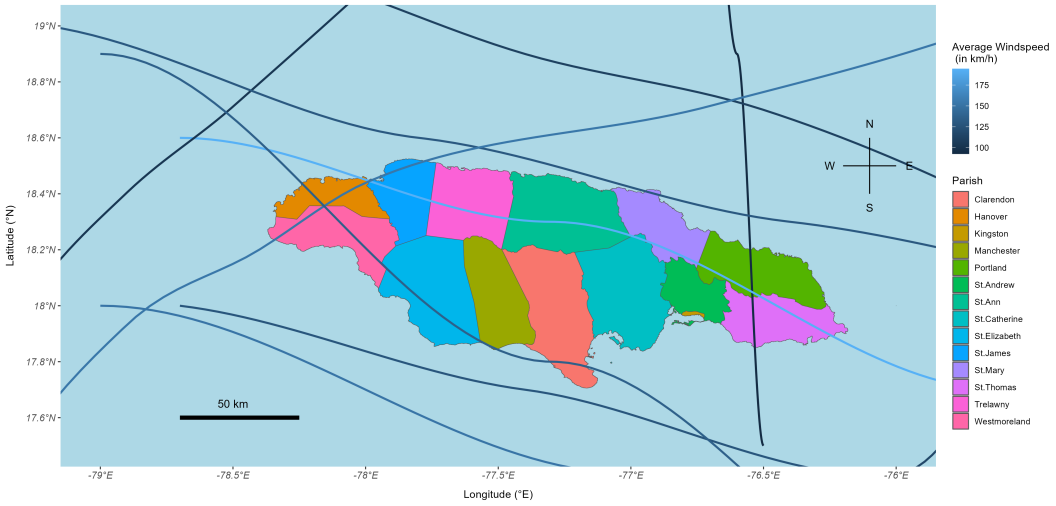
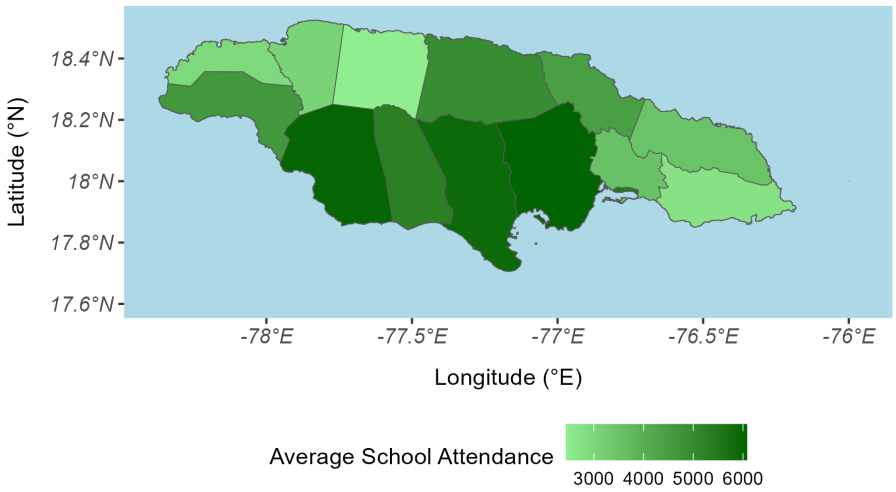
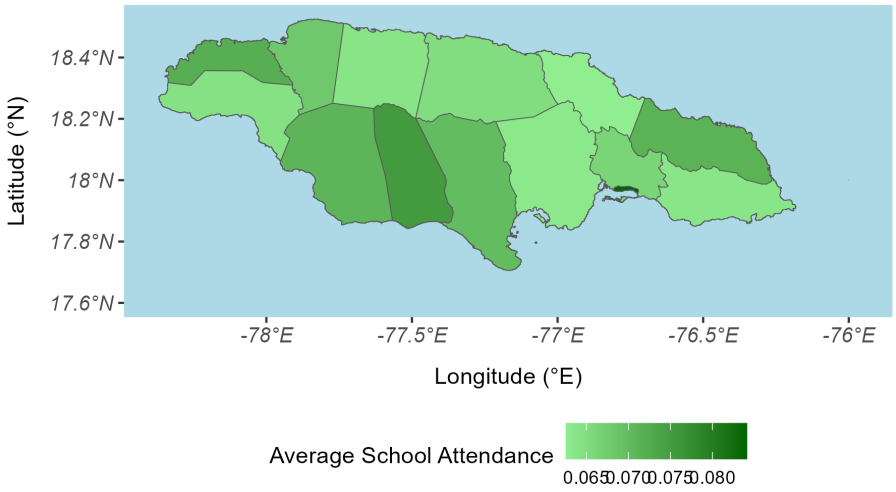


Figure 2: Spatial Distribution (and intensity) of Hurricanes between 1895 and 1942.



(a) School Attendance



(b) School Attendance (LOG) as share of Population

Figure 3: Spatial Distribution of: (a) School Attendance, (b) School Attendance (LOG) as share of Population.

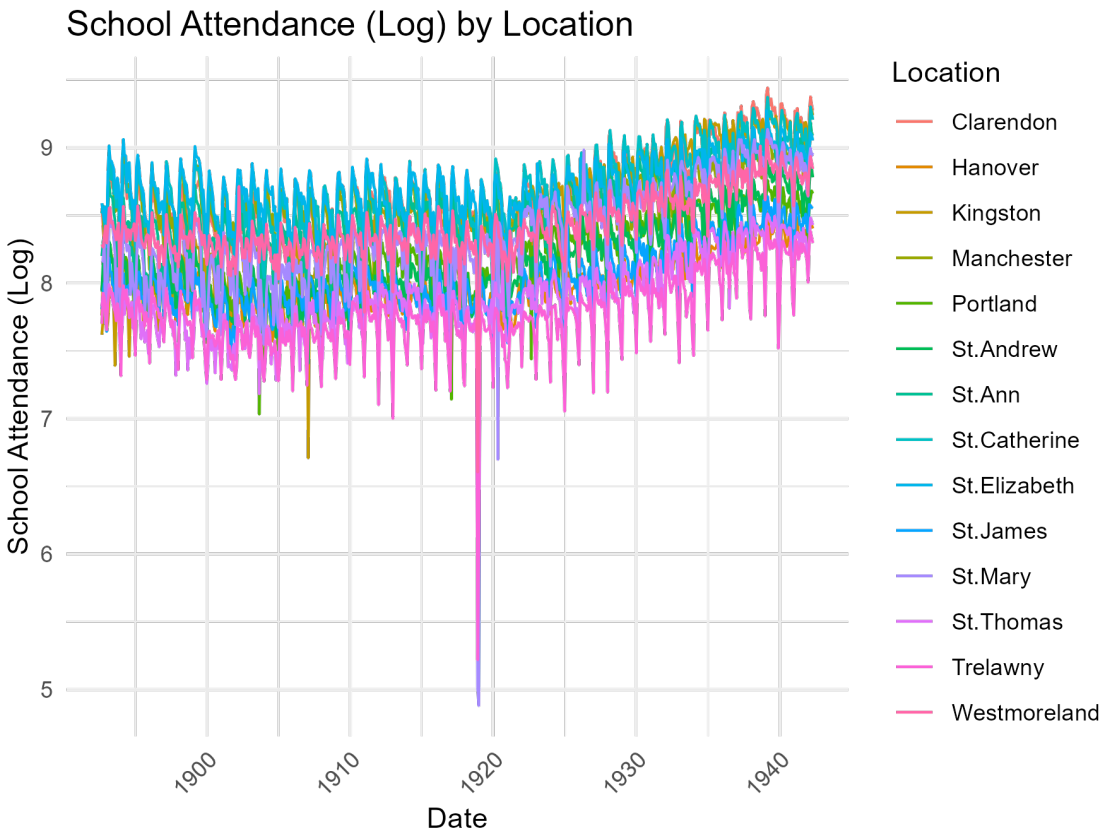


Figure 4: School Attendance (LOG) over time

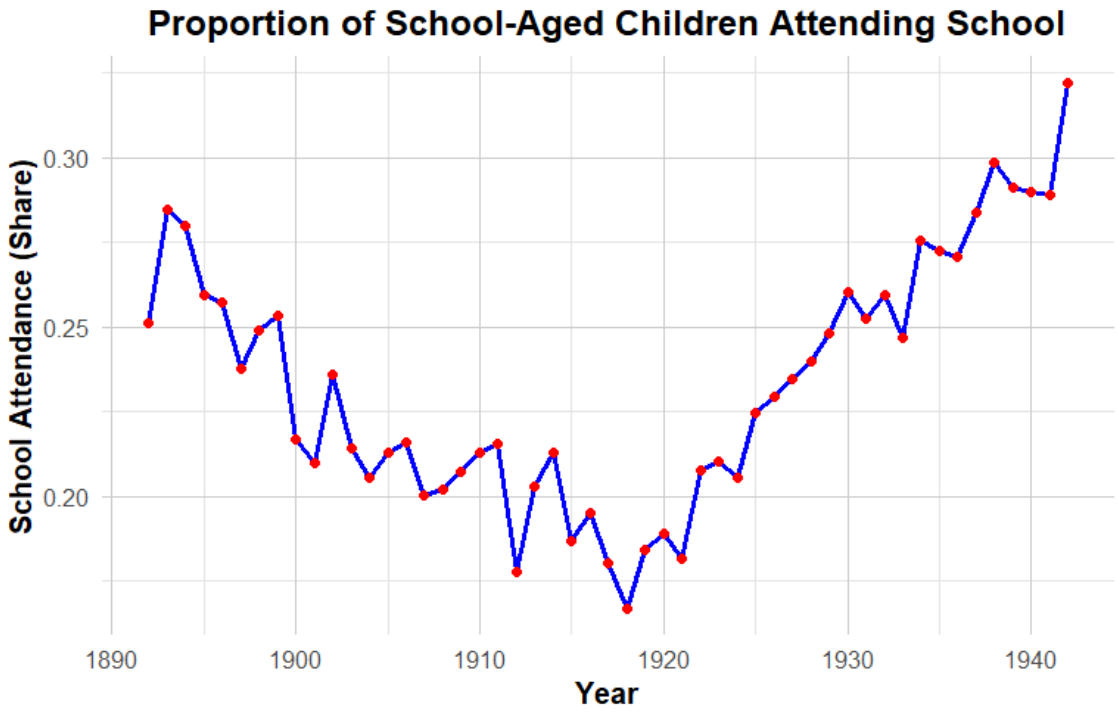


Figure 5: Proportion of School-Aged Children (6-14 years old) Attending School

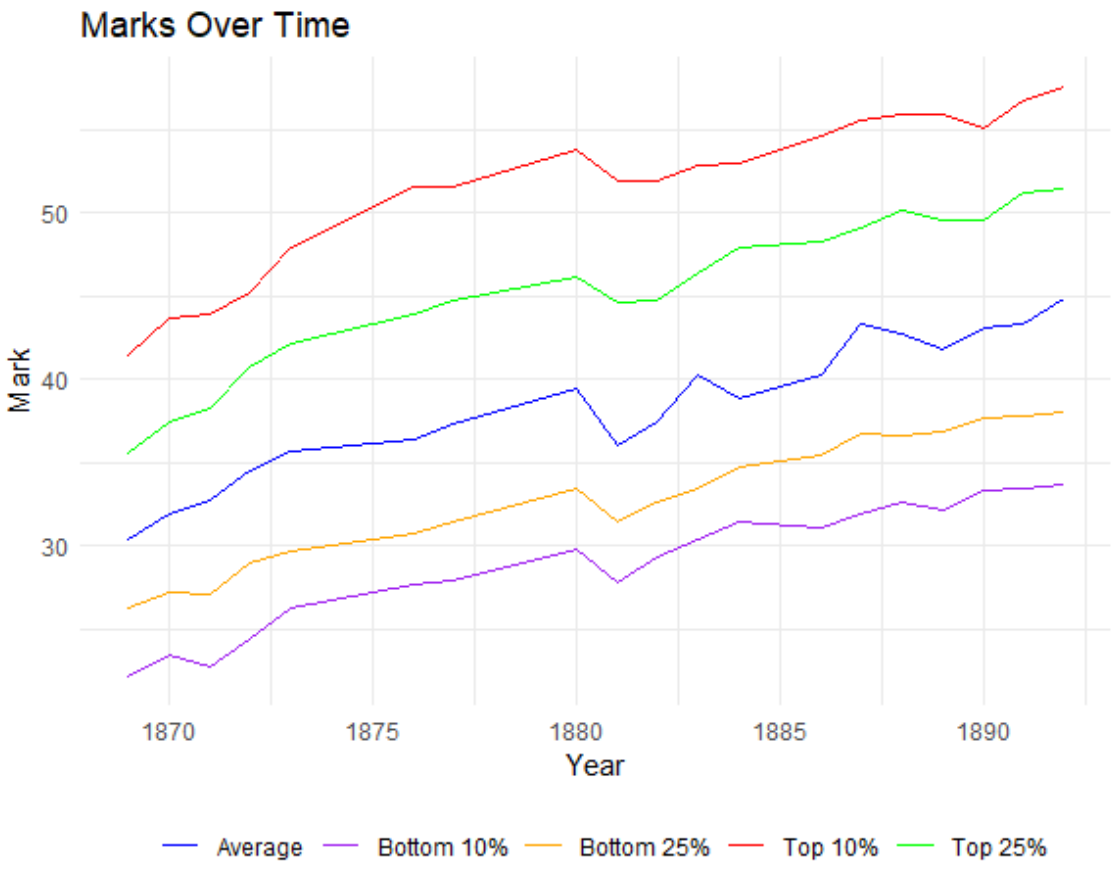


Figure 6: Marks over time

Table 2: Effect of Hurricanes on School Attendance

Model:	(1) 119km/h	(2) 119km/h	(3) 154km/h	(4) 154km/h	(5) 119km/h	(6) 119km/h
Variables						
$HURR_t$	-0.0182***	-0.0163***	-0.0215***	-0.0209***	-0.0182***	-0.0151***
	(0.0053)	(0.0050)	(0.0069)	(0.0065)	(0.0053)	(0.0048)
$HURR_{t-1m}$	-0.0151***	-0.0106**	-0.0238***	-0.0199***	-0.0151***	0.0014
	(0.0058)	(0.0054)	(0.0068)	(0.0064)	(0.0058)	(0.0035)
$HURR_{t-2m}$	-0.0163***	-0.0091*	-0.0238***	-0.0165***	-0.0163***	-0.0007
	(0.0056)	(0.0051)	(0.0068)	(0.0064)	(0.0056)	(0.0028)
$HURR_{t-3m}$	-0.0077*	0.0011	-0.0117***	-0.0024	-0.0077*	0.0077***
	(0.0040)	(0.0037)	(0.0043)	(0.0043)	(0.0040)	(0.0030)
$HURR_{t-4m}$	-0.0052	0.0038	-0.0046	0.0039	-0.0052	0.0053*
	(0.0040)	(0.0037)	(0.0048)	(0.0047)	(0.0040)	(0.0031)
$HURR_{t-5m}$	-0.0033	0.0067	-0.0003	0.0080*	-0.0033	0.0046
	(0.0046)	(0.0042)	(0.0049)	(0.0047)	(0.0046)	(0.0035)
$HURR_{t-6m}$	-0.0035	0.0082	0.0007	0.0098	-0.0035	0.0051
	(0.0057)	(0.0053)	(0.0074)	(0.0072)	(0.0057)	(0.0043)
$HURR_{t-7m}$	0.0003	0.0003	0.0006	0.0026	0.0003	-0.0017
	(0.0060)	(0.0055)	(0.0075)	(0.0062)	(0.0060)	(0.0048)
$EARTHK$	-0.0244	-0.0467**	-0.0248	-0.0469**	-0.0244	-0.0409*
	(0.0184)	(0.0223)	(0.0184)	(0.0223)	(0.0184)	(0.0218)
$EARTHK_{t-1m}$	-0.0076	-0.0297**	-0.0080	-0.0298**	-0.0076	-0.0055
	(0.0083)	(0.0123)	(0.0083)	(0.0123)	(0.0083)	(0.0071)
$EARTHK_{t-2m}$	-0.0024	-0.0232**	-0.0027	-0.0233**	-0.0024	-0.0088
	(0.0064)	(0.0109)	(0.0064)	(0.0109)	(0.0064)	(0.0067)
$EARTHK_{t-3m}$	-0.0038	-0.0247**	-0.0042	-0.0248**	-0.0038	-0.0131*
	(0.0056)	(0.0104)	(0.0056)	(0.0104)	(0.0056)	(0.0068)
$EARTHK_{t-4m}$	-0.0012	-0.0221**	-0.0016	-0.0222**	-0.0012	-0.0097
	(0.0051)	(0.0101)	(0.0051)	(0.0102)	(0.0051)	(0.0069)
$EARTHK_{t-5m}$	-0.0058	-0.0266***	-0.0061	-0.0268***	-0.0058	-0.0155**
	(0.0043)	(0.0098)	(0.0043)	(0.0098)	(0.0043)	(0.0067)
$EARTHK_{t-6m}$	-0.0025	-0.0234**	-0.0028	-0.0236**	-0.0025	-0.0101
	(0.0038)	(0.0096)	(0.0038)	(0.0096)	(0.0038)	(0.0067)
$INFLUENZA$		-0.5483***		-0.5454***		-0.2375***
		(0.0886)		(0.0893)		(0.0851)
$LINTREND$		-14.80***		-14.57***		-5.602***
		(0.7770)		(0.7460)		(0.8874)
$Attendance_{t-1m}$						0.5335***
						(0.0386)
$HURR_{t-8m,\ldots,t-12m}$	No	Yes	No	Yes	No	Yes
$EARTHK_{t-7m,\ldots,t-12m}$	No	Yes	No	Yes	No	Yes
Fit statistics						
Observations	8,807	8,807	8,807	8,807	8,807	8,807
Within R^2	0.00797	0.11368	0.00466	0.11145	0.00797	0.37787

*Heteroskedasticity-robust standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.* Parish level, yearly and monthly fixed effects are included in all models. $HURR$ represents the cubic wind speed divided by 1 million, $EARTHK$ represents the Rossi Forel scale of the Kingston earthquake, $INFLUENZA$ is an Influenza dummy for October, November, and December in 1918, as well as for January and February in 1919, $LINTREND$ are parish-level linear trends and $Attendance_{t-1m}$ is the parish level attendance in the previous period.

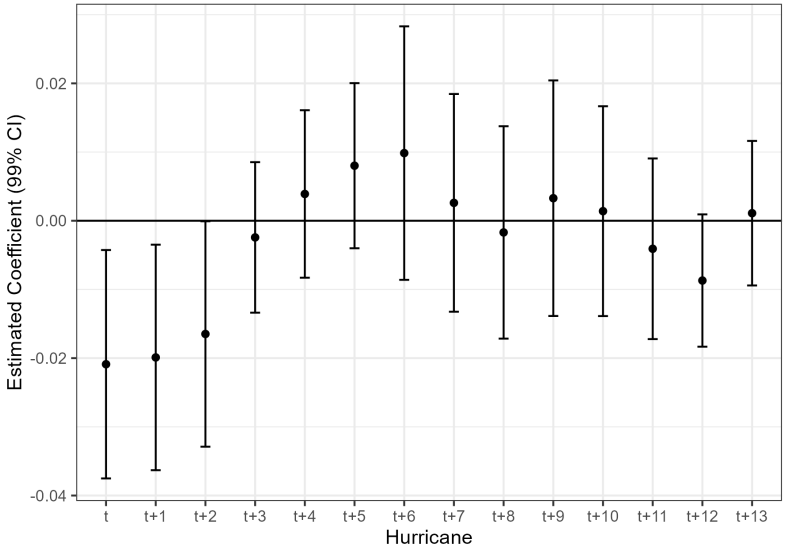


Figure 7: Impact of hurricanes (95% CI) on school attendance (154km/h)

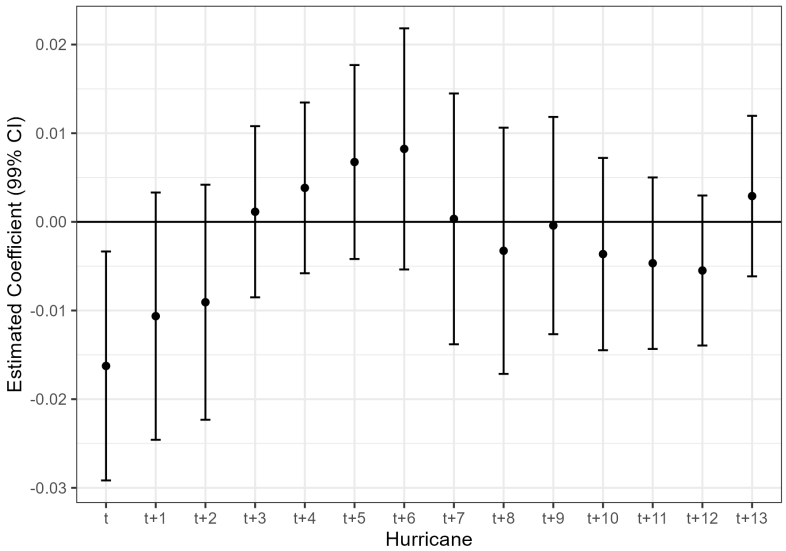


Figure 8: Impact of hurricanes (95% CI) on school attendance (119km/h)

Table 3: Effect of Hurricanes on School Attendance

Model:	(1) 119km/h	(2) 119km/h	(3) 154km/h	(4) 154km/h	(5) 119km/h	(6) 119km/h
Variables						
$HURR_{t+1m}$	0.0031	0.0031	0.0044	0.0053	0.0054	0.0053
	(0.0044)	(0.0045)	(0.0044)	(0.0059)	(0.0059)	(0.0061)
$HURR_t$	-0.0193***	-0.0193***	-0.0177***	-0.0214***	-0.0214***	-0.0207***
	(0.0056)	(0.0056)	(0.0053)	(0.0069)	(0.0069)	(0.0065)
$HURR_{t-1m}$	-0.0151***	-0.0151***	-0.0106**	-0.0236***	-0.0237***	-0.0198***
	(0.0058)	(0.0058)	(0.0054)	(0.0068)	(0.0068)	(0.0064)
$HURR_{t-2m}$	-0.0162***	-0.0162***	-0.0088*	-0.0236***	-0.0237***	-0.0163**
	(0.0056)	(0.0056)	(0.0052)	(0.0068)	(0.0068)	(0.0064)
$HURR_{t-3m}$	-0.0076*	-0.0077*	0.0014	-0.0115***	-0.0115***	-0.0023
	(0.0040)	(0.0041)	(0.0038)	(0.0043)	(0.0043)	(0.0043)
$HURR_{t-4m}$	-0.0051	-0.0051	0.0040	-0.0045	-0.0046	0.0041
	(0.0040)	(0.0040)	(0.0037)	(0.0048)	(0.0049)	(0.0047)
$HURR_{t-5m}$	-0.0031	-0.0029	0.0070	-0.0001	-4.93×10^{-5}	0.0082*
	(0.0046)	(0.0046)	(0.0043)	(0.0050)	(0.0050)	(0.0047)
$HURR_{t-6m}$	-0.0033	-0.0034	0.0085	0.0009	0.0010	0.0100
	(0.0057)	(0.0057)	(0.0053)	(0.0074)	(0.0074)	(0.0072)
$HURR_{t-7m}$	0.0003	-0.0016	0.0004	0.0007	0.0007	0.0027
	(0.0060)	(0.0064)	(0.0055)	(0.0075)	(0.0076)	(0.0062)
$EARTHK_t$	-0.0244	-0.0502**	-0.0467**	-0.0247	-0.0506**	-0.0469**
	(0.0184)	(0.0224)	(0.0223)	(0.0184)	(0.0224)	(0.0223)
$EARTHK_{t-1m}$	-0.0076	-0.0330***	-0.0297**	-0.0079	-0.0334***	-0.0298**
	(0.0083)	(0.0126)	(0.0123)	(0.0083)	(0.0126)	(0.0123)
$EARTHK_{t-2m}$	-0.0024	-0.0278**	-0.0232**	-0.0028	-0.0282**	-0.0233**
	(0.0064)	(0.0112)	(0.0109)	(0.0064)	(0.0112)	(0.0109)
$EARTHK_{t-3m}$	-0.0038	-0.0294***	-0.0247**	-0.0042	-0.0297***	-0.0248**
	(0.0056)	(0.0107)	(0.0104)	(0.0056)	(0.0108)	(0.0104)
$EARTHK_{t-4m}$	-0.0012	-0.0267**	-0.0221**	-0.0016	-0.0271**	-0.0222**
	(0.0051)	(0.0105)	(0.0101)	(0.0051)	(0.0105)	(0.0102)
$EARTHK_{t-5m}$	-0.0058	-0.0312***	-0.0266***	-0.0061	-0.0317***	-0.0268***
	(0.0043)	(0.0101)	(0.0098)	(0.0043)	(0.0102)	(0.0098)
$EARTHK_{t-6m}$	-0.0024	-0.0279***	-0.0233**	-0.0028	-0.0283***	-0.0236**
	(0.0038)	(0.0100)	(0.0096)	(0.0038)	(0.0100)	(0.0096)
$INFLUENZA$			-0.5483***			-0.5454***
			(0.0886)			(0.0893)
$LINTREND$			-14.84***			-14.60***
			(0.7820)			(0.7499)
$HURR_{t-7m,\ldots,t-12m}$	No	Yes	No	Yes	No	Yes
$EARTHK_{t-7m,\ldots,t-12m}$	No	Yes	No	Yes	No	Yes
Fit statistics						
Observations	8,793	8,793	8,793	8,793	8,793	8,793
Within R^2	0.00801	0.01268	0.11373	0.00470	0.00906	0.11147

*Heteroskedasticity-robust standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.*
Parish level, yearly and monthly fixed effects are included in all models. $HURR$ represents the cubic wind speed divided by 1 million, $EARTHK$ represents the Rossi Forel scale of the Kingston earthquake, $INFLUENZA$ is an Influenza dummy for October, November, and December in 1918, as well as for January and February in 1919 and $LINTREND$ are parish-level linear trends.

Table 4: Effect of Hurricanes on School Attendance

Model:	(1) 119km/h	(2) 119km/h	(3) 154km/h	(4) 154km/h
Variables				
$HURR_t$	-0.0155***	-0.0146***	-0.0201***	-0.0212***
	(0.0050)	(0.0048)	(0.0063)	(0.0074)
$HURR_{t-1m}$	-0.0096*	0.0020	-0.0186***	-0.0037
	(0.0053)	(0.0035)	(0.0063)	(0.0040)
$HURR_{t-2m}$	-0.0077	7.75×10^{-5}	-0.0148**	-0.0007
	(0.0051)	(0.0027)	(0.0063)	(0.0035)
$HURR_{t-3m}$	0.0026	0.0084***	-0.0006	0.0097**
	(0.0037)	(0.0030)	(0.0043)	(0.0039)
$HURR_{t-4m}$	0.0055	0.0059*	0.0057	0.0085*
	(0.0038)	(0.0032)	(0.0048)	(0.0044)
$HURR_{t-5m}$	0.0086**	0.0051	0.0099**	0.0066*
	(0.0043)	(0.0036)	(0.0048)	(0.0040)
$HURR_{t-6m}$	0.0106**	0.0058	0.0118	0.0074
	(0.0050)	(0.0041)	(0.0073)	(0.0056)
$INFLUENZA_t$	-0.5435***	-0.2385***	-0.5443***	-0.2386***
	(0.0893)	(0.0857)	(0.0893)	(0.0858)
$LINTREND$	-17.05***	-6.262***	-16.49***	-5.597***
	(0.8894)	(1.028)	(0.8391)	(0.9918)
$EARTHK_t$		-0.0295		-0.0295
		(0.0182)		(0.0182)
$EARTHK_{t-1m}$		0.0054*		0.0054*
		(0.0028)		(0.0028)
$EARTHK_{t-2m}$		0.0026		0.0026
		(0.0023)		(0.0023)
$EARTHK_{t-3m}$		-0.0018		-0.0017
		(0.0025)		(0.0025)
$EARTHK_{t-4m}$		0.0014		0.0014
		(0.0026)		(0.0026)
$EARTHK_{t-5m}$		-0.0040*		-0.0040*
		(0.0024)		(0.0024)
$EARTHK_{t-6m}$		0.0011		0.0012
		(0.0024)		(0.0024)
$Attendance_{t+1m}$		0.5384***		0.5389***
		(0.0391)		(0.0390)
Fit statistics				
Observations	8,541	8,541	8,541	8,541
R^2	0.87010	0.90963	0.86977	0.90950
Within R^2	0.10980	0.38067	0.10753	0.37980

*Heteroskedasticity-robust standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.* Parish level, yearly and monthly fixed effects are included in all models. $HURR$ represents the cubic wind speed divided by 1 million, $EARTHK$ represents the Rossi Forel scale of the Kingston earthquake, $INFLUENZA$ is an Influenza dummy for October, November, and December in 1918, as well as for January and February in 1919 and $LINTREND$ are parish-level linear trends.

Table 5: Effect of Hurricanes on School Attendance

Model:	(1) 119km/h	(2) 119km/h	(3) 119km/h	(4) 119km/h
Variables				
$DESTR_m$	-10.20^{***}	-7.81^{***}	-5.90^{***}	-5.87^{***}
	(1.53)	(2.02)	(1.88)	(1.88)
$DESTR_{t-1m}$		-5.46^{**}	-2.91	-2.91
		(2.28)	(2.10)	(2.1)
$DESTR_{t-2m}$		-1.24	1.19	1.19
		(1.92)	(1.77)	(1.77)
$DESTR_{t-3m}$		-1.89	0.93	0.948
		(1.96)	(1.75)	(1.75)
$DESTR_{t-4m}$		-2.54	1.48	1.50
		(2.02)	(1.84)	(1.84)
$DESTR_{t-5m}$		-4.82^{**}	0.49	0.43
		(1.99)	(1.87)	(1.88)
$INFLUENZA$		-0.54***	-0.54***	-0.55***
		(0.09)	(0.09)	(0.09)
$LINTREND$			-16.40***	-16.35***
			(0.88)	(0.88)
$EARTHK_t$				-0.0235
				(0.0181)
$EARTHK_{t-1m}$				-0.0071
				(0.0081)
$EARTHK_{t-2m}$				-0.0004
				(0.0062)
$EARTHK_{t-3m}$				-0.0018
				(0.0054)
$EARTHK_{t-4m}$				0.0006
				(0.0049)
$EARTHK_{t-5m}$				-0.0036
				(0.0042)
$EARTHK_{t-6m}$				-0.0005
				(0.0037)
Fit statistics				
Observations	8,541	8,541	8,541	8,541
R^2	0.85446	0.86492	0.86974	0.87005
Within R^2	0.00262	0.07429	0.10733	0.10947

*Heteroskedasticity-robust standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.* Parish level, yearly and monthly fixed effects are included in all models. $DESTR$ represents the population weighted destruction index, $EARTHK$ represents the Rossi Forel scale of the Kingston earthquake, $INFLUENZA$ is an Influenza dummy for October, November, and December in 1918, as well as for January and February in 1919 and $LINTREND$ are parish-level linear trends.

Table 6: Effect of Hurricanes on School Attendance

Model:	(1) 154km/h	(2) 154km/h	(3) 154km/h	(4) 154km/h
Variables				
$DESTR_t$	−10.60**	−11.10**	−8.68**	−8.65**
	(4.58)	(4.54)	(4.33)	(4.33)
$DESTR_{t-1m}$		−11.10**	−6.82	−6.80
		(4.54)	(4.22)	(4.22)
$DESTR_{t-2m}$		−5.87*	−0.29	−0.27
		(3.00)	(2.95)	(2.96)
$DESTR_{t-3m}$		−4.22	1.91	1.93
		(3.20)	(3.23)	(3.23)
$DESTR_{t-4m}$		−3.01	3.63	3.65
		(3.09)	(3.03)	(3.03)
$DESTR_{t-5m}$		−2.75	4.71	4.73
		(3.93)	(3.87)	(3.87)
$DESTR_{t-6m}$		−2.37	3.55	3.41
		(3.04)	(2.66)	(2.69)
$INFLUENZA$		-0.5385***	-0.5444***	-0.5450***
		(0.0885)	(0.0893)	(0.0893)
$LINTREND$			-16.49***	-16.43***
			(0.8389)	(0.8391)
$EARTHK_t$				-0.0236
				(0.0181)
$EARTHK_{t-1m}$				-0.0072
				(0.0081)
$EARTHK_{t-2m}$				-0.0005
				(0.0062)
$EARTHK_{t-3m}$				-0.0019
				(0.0054)
$EARTHK_{t-4m}$				0.0005
				(0.0049)
$EARTHK_{t-5m}$				-0.0037
				(0.0042)
$EARTHK_{t-6m}$				-0.0005
				(0.0037)
Fit statistics				
Observations	8,541	8,541	8,541	8,541
R^2	0.85415	0.86436	0.86962	0.86993
Within R^2	0.00049	0.07049	0.10648	0.10862

*Heteroskedasticity-robust standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.* Parish level, yearly and monthly fixed effects are included in all models. $DESTR$ represents the population weighted destruction index, $EARTHK$ represents the Rossi Forel scale of the Kingston earthquake, $INFLUENZA$ is an Influenza dummy for October, November, and December in 1918, as well as for January and February in 1919 and $LINTREND$ are parish-level linear trends.

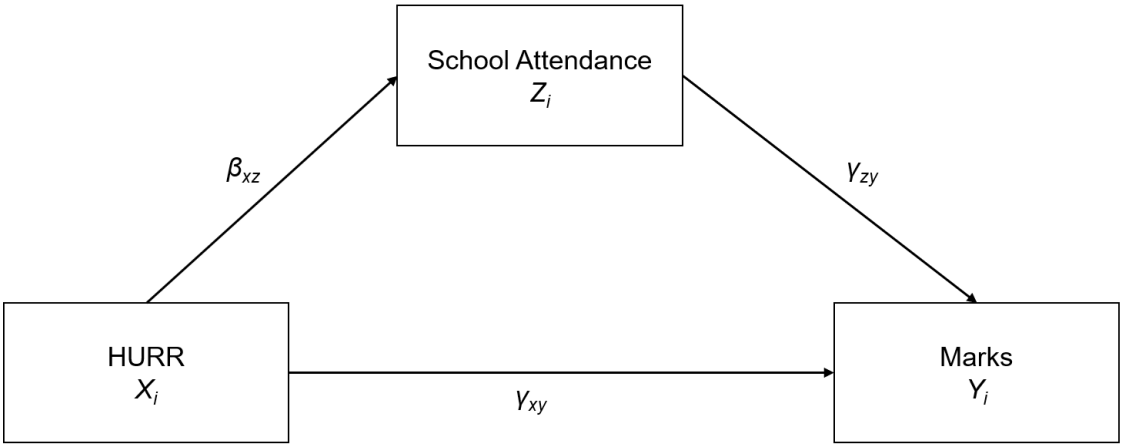


Figure 9: Graphical Illustration of the Mediation Analysis

Table 7: Mediation Analysis

	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
$ACME$	-0.109 ***	-0.673***	-0.595 ***	-0.100**	-0.213**	-0.166*
ADE	0.081	0.005	0.030	0.133 *	0.243	0.226
Total Effect	-0.028	-0.668*	-0.489	0.033	0.031	0.060
Location FE	Yes	Yes	Yes	Yes	Yes	Yes
Yearly FE	No	Yes	Yes	No	Yes	Yes
Teacher Trained	No	No	Yes	No	No	Yes
Observations	9322	9322	9322	9322	9322	9322

Robust standard-errors in parentheses. The mediator in all regressions is Average Attendance (in log), dependent variable is $MARKS$, the independent variable is $HURR$, whereas the threshold is set at 119km/h (columns 1 to 3) or 154km/h (columns 4 to 6). Location-fixed effects are included in all regressions. Yearly-fixed Effects are included in columns (2), (3), (5) and (6) and a variable indicating whether the teacher is trained or not is included in columns (3) and (6). $ACME$ is the average mediation effect and ADE is the average direct effect. Signif. Codes:***: 0.01,**: 0.05,*: 0.1

Table 8: Mediation Analysis: First and Second Stage

	Panel A: First Stage					
	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
$HURR_t$	-0.009**	-0.056***	-0.052***	-0.009**	-0.056***	-0.052***
	(0.004)	(0.017)	(0.016)	(0.004)	(0.017)	(0.016)
Adj. R^2	0.098	0.130	0.204	0.098	0.130	0.001
	Panel B: Second Stage					
	(1)	(2)	(3)	(4)	(5)	(6)
$Attendance_t$	12.335***	11.986***	10.435***	12.335***	11.986***	10.435***
	(0.027)	(0.276)	(0.276)	(0.274)	(0.276)	(0.276)
$HURR_t$	0.087	0.017	0.003	0.087	0.017	0.003
	(0.062)	(0.318)	(0.308)	(0.004)	(0.318)	(0.308)
Adj. R^2	0.339	0.350	0.392	0.339	0.350	0.392
Location FE	Yes	Yes	Yes	Yes	Yes	Yes
Yearly FE	No	Yes	Yes	No	Yes	Yes
Teacher Trained	No	No	Yes	No	No	Yes
Observations	9,321	9,321	9,321	9,321	9,321	9,321

Robust standard-errors in parentheses. Dependent Variable in Panel A is *Average Attendance (log)* and the dependent Variable in Panel B is *MARKS*. The independent variable is $HURR$, whereas the threshold is set at 119km/h (columns 1 to 3) or 154km/h (columns 4 to 6). Town-fixed effects are included in all regressions. Yearly-fixed Effects are included in columns (2), (3), (5) and (6) and a variable indicating whether the teacher is trained or not is included in columns (3) and (6). Signif. Codes:***: 0.01,**: 0.05,*: 0.1

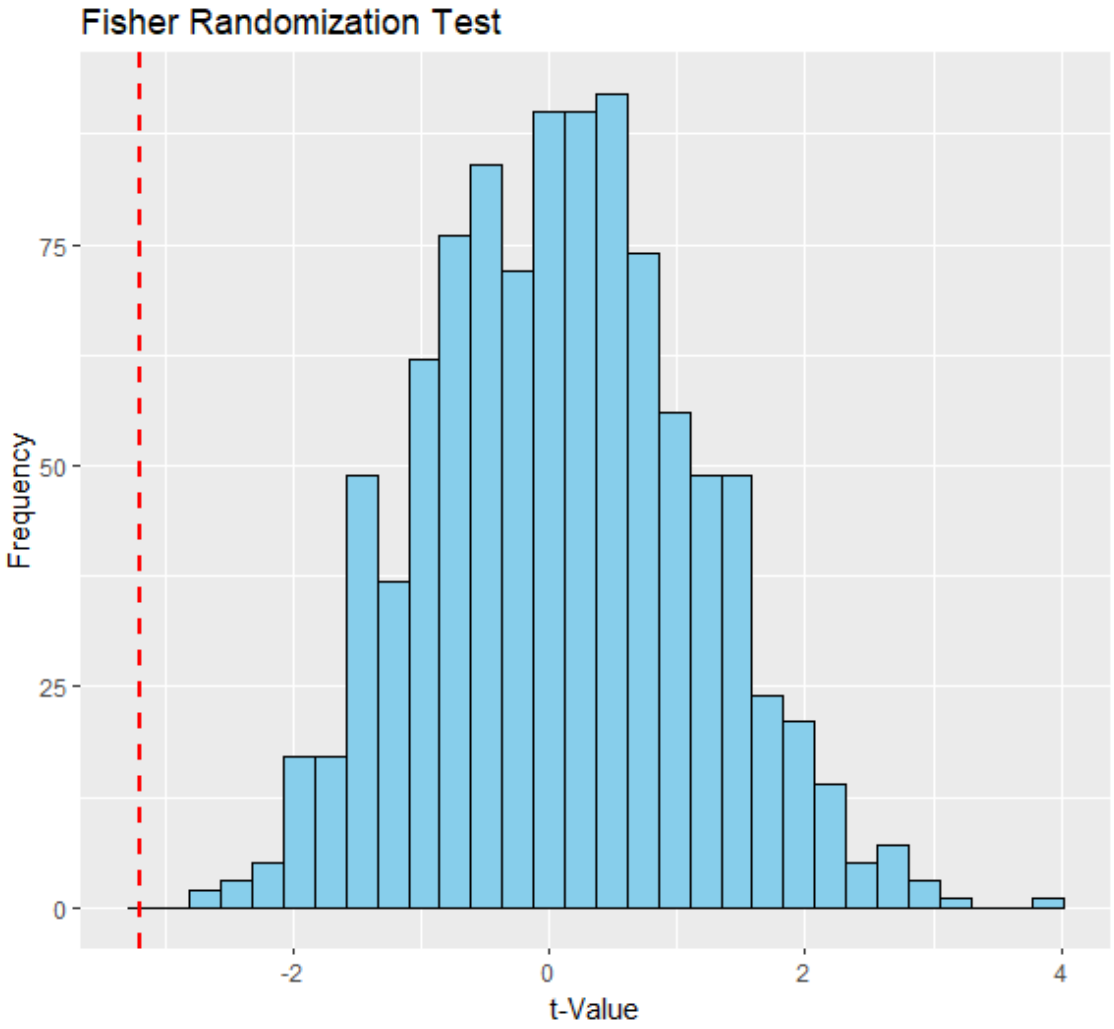


Figure 10: Fisher Randomization Test: $HURR_t$

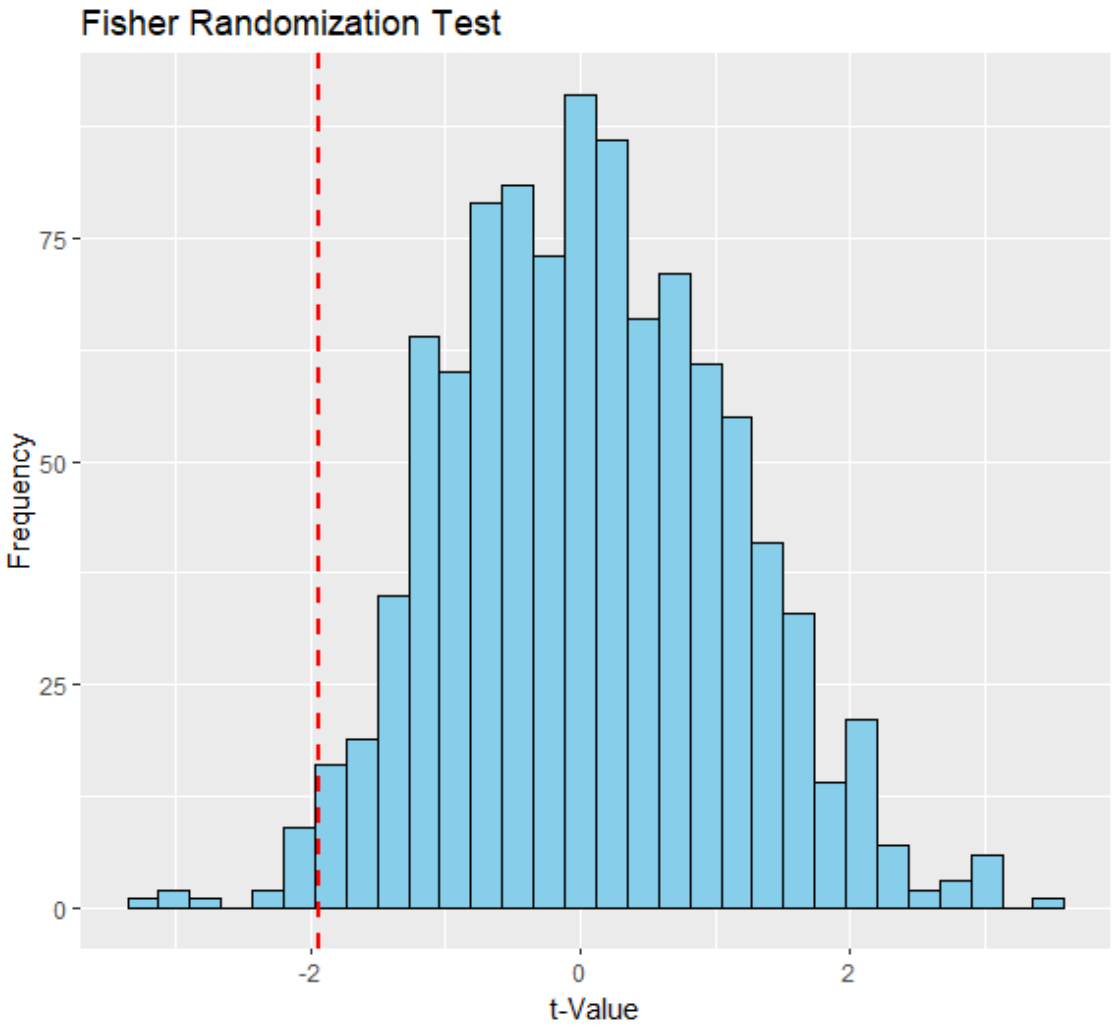


Figure 11: Fisher Randomization Test: $HURR_{t-1m}$

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