

Synthetic Control Analysis of Mobile Money Adoption following CBDC Implementation in The Bahamas

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Abstract

This study evaluates the impact of The Bahamas' Central Bank Digital Currency (CBDC), the Sand Dollar, on mobile money usage by using the Synthetic Control Method (SCM). By choosing a selection of Small Island Developing States (SIDSs) that did not adopt CBDCs, we construct a synthetic counterfactual scenario to estimate what mobile money adoption would have looked like in the absence of the Sand Dollar. Our results showed that mobile money usage in The Bahamas significantly diverged from its counterpart, suggesting that the Sand Dollar played a critical role in accelerating financial participation.

Keywords

Central Banking, Monetary Policy, Supply of Money and Credit, Financial Inclusion

1. Introduction

In October of 2020, The Bahamas' Central Bank became the world's first monetary authority to introduce a Central Bank Digital Currency (CBDC), named the Sand Dollar. It was designed and introduced in the hopes of increasing financial inclusion and improving the payment system of the nation, something which The Bahamas' Central Bank asserts it has significantly advanced at Wright et al. (2022). In theory, Sand Dollar can also lower the cost of transactions (Mishra & Prasad, 2024) and increase the efficiency of monetary policy transmission.

The launch of the Sand Dollar placed The Bahamas at the center of an increasingly heated debate concerning the role of CBDCs in contemporary financial systems. Whereas other countries continue to be researched and conduct pilot tests of their respective digital currencies, an examination of the Sand Dollar's effect is

an opportunity to gain insight into the early-stage CBDC implementation and impact. In particular, this research focuses on the influence of the Sand Dollar on financial digital inclusion within The Bahamas. Using a Synthetic Control Method (SCM), this study approximates what the path of financial inclusion in The Bahamas would have been, had the Sand Dollar not been launched, producing thereby a counter-fact that could be used to compare and track the performance of the CBDC in enhancing financial inclusion in its adoption phase.

2. Background

The Sand Dollar is the CBDC issued and backed by the Central Bank of The Bahamas. It serves as a digital equivalent of the physical Bahamian Dollar, but not a replacement for physical money; rather, it would circulate parallel to physical money. This digital currency, which can be accessed on mobile wallets and can be used to make payments to approved merchants, initiate peer-to-peer transfer and receive assistance from the government.

Many other Small Island Developing States (SIDSs) face similar kinds of obstacles to the financial access problem in The Bahamas, such as geographic isolation, high cost of doing business for mainstream commercial banks and shallow financial infrastructure in rural areas. The Sand Dollar has been designed to overcome these obstacles by offering a secure and easy digital substitute for cash. Another significant characteristic of the Sand Dollar is that it can be used even when there is little internet connection in some areas, thanks to low-bandwidth wallet applications that allow it to work with low-end mobile devices. The usage metrics of the Sand Dollar have been growing steadily since its launch. For example, in March 2023, there were 101,636 consumer wallets and 1512 merchant wallets with \$1.02 million Sand Dollars in circulation. By December 2023, circulation had grown by 65% to \$1.69 million (Central Bank of The Bahamas, 2024), with increases in both consumer wallet and merchant wallet registration. But while the growth is significant on paper, take-up has been relatively slow given the period of time since launch and the level of government promotion and public awareness campaigns. Over three years after deployment, many question the degree to which the Sand Dollar has entered and affected the daily lives of Bahamians.

The raw numbers offer a surface-level picture of adoption, but they don't reveal how things might have looked in the absence of a CBDC, or how much of this adoption can be truly credited to the Sand Dollar initiative itself. For that reason, this paper applies a more rigorous methodology to explore the broader question of impact.

3. Literature Review

There has been growing academic interest in the evolving character of currencies, specifically with the emergence of CBDCs. The majority of recent studies have been written on the design and implications of CBDCs from a theoretical perspective. For example, Auer and Boehme (2021) wrote on to what extent CBDCs can redefine payment systems and act to advance financial inclusion, especially in less

developed banking systems. Studies by [Kiff et al. \(2020\)](#) and [Adrian and Mancini Griffoli \(2019\)](#) took note of the difference between wholesale and retail CBDCs and how these could impact monetary systems differently.

Other studies, such as [Carstens \(2021\)](#), have pointed to the potential for CBDCs to improve the transmission of monetary policy and the efficiency of cross-border payments. These studies contribute to a growing body of theory around CBDCs, outlining the potential benefits and costs of public digital money. However, the majority of this work is conceptual or simulation-based. There is limited empirical evaluation of implemented CBDCs because very few have been implemented at the national level yet.

Against the backdrop of rapid expansion of CBDC pilot programs across the world, including Nigeria's eNaira, the Eastern Caribbean's DCash, and Thailand's Digital Baht, a demand for real-world evidence is increasingly required. This paper is unique in its approach to quantify the impact of CBDC by employing the Synthetic Control Method, while many other case studies of CBDCs are often literature reviews and desk studies. Despite the differences in approach, the findings of this early CBDC program prove to be similar to the effects of the eNaira, which suggests an improvement in financial inclusion ([Esoimeme, 2021](#)). The Bahamian Sand Dollar is one of very few live CBDCs with multi-year data on rollout, usage, and public uptake. This study contributes to the existing studies by presenting initial data-driven evaluations of an early-stage CBDC and quantifying its real impact on financial inclusion and drawing lessons that can be used by other countries undertaking similar initiatives.

4. Data, Methodology, and Results

This study investigates the impact of The Bahamas' Sand Dollar on the digital financial inclusion landscape in The Bahamas, specifically focusing on mobile money adoptions. The analysis applies the Synthetic Control Method (SCM) developed by [Abadie, Diamond, and Hainmueller \(2010\)](#), which allows for the construction of a data-driven counterfactual scenario of the trajectory of mobile money adoption in The Bahamas had the Sand Dollar not been introduced in 2020. SCM is particularly appropriate for policy evaluation in cases where the intervention affects a single unit (The Bahamas) and no obvious untreated twin exists. By building a synthetic version of The Bahamas as a weighted average of other countries that did not implement a CBDC during the period under study, the method enables a credible causal estimation of the policy's effect.

The primary outcome variable is the percentage of adults who report owning or using a mobile money account. This measure, drawn primarily from the World Bank's Global Findex dataset 2014, 2017, and 2021 and supplemented with national financial access surveys from Central Bank of Bahamas Press Release, 2022, 2023 and Central Bank of Bahamas Annual Report & Statement of Account 2019 to 2023, serves as a proxy for digital financial inclusion ([Demirguc-Kunt et al., 2015, 2018, 2022](#)). Mobile money usage is widely recognized as a leading indicator

of financial accessibility in small economies where physical banking infrastructure is often lacking. For The Bahamas, updated national figures were used to extend the series through 2023. The year 2020 is designated as the treatment year, reflecting the official launch of the Sand Dollar nationwide in October of that year. A donor pool of 34 countries was used to construct the counterfactual scenario for the SCM (Central Bank of The Bahamas, 2019, 2020, 2021, 2022, 2023a, 2023b).

While the Sand Dollar was officially launched in October of 2020, we will still treat the full year of 2020 as the treatment year for three reasons. Firstly, prior to the nationwide release, the Central Bank of The Bahamas initiated pilot programs in Exuma and Abaco in late 2019, accompanied by a widespread public education campaign. These early efforts contributed to market awareness and limited transaction activity well before the formal October launch. Second, during the onset of the COVID-19 pandemic in mid-2020, the government publicly announced plans to integrate the Sand Dollar into its emergency relief strategy, including its use for stimulus disbursements. These announcements likely affected both user expectations and institutional readiness, thereby introducing anticipatory effects that began before Q4. Finally, financial inclusion metrics, such as those from the World Bank's Global Findex, are typically reported on an annual basis, making it methodologically consistent to treat 2020 as a discrete treatment period rather than segmenting it into sub-annual intervals.

The donor pool consists of Small Island Developing States (SIDSs) and Caribbean nations that did not launch CBDCs between 2014 and 2023; additionally, only countries with reliable and ready data participated in the SCM. Donor countries were selected based not only on regional similarities but also on macroeconomic, technological, and demographic comparability. Countries that lacked data for key predictor variables were excluded from the pool to avoid bias or distortion in the model estimation. The criteria for the exclusion from the pool are if one of the predictors in **Table 1** is missing. This careful curation of the donor pool addresses concerns regarding the validity of comparisons and ensures that the selected control countries exhibit similar characteristics prior to intervention.

Table 1. Mean value of predictor variable from 2015 to 2019 from significantly weighted donors to construct the counterfactual scenario of The Bahamas.

| <i>Mean Value of Predictor Variables Pre-treatment (2015-2019) from Significantly Weighted Donors</i> | | | | | | | |
|---|----------------------|-------------------------------|--------------------|--------------------------------------|--------------------------------|------------------------------------|------------------------|
| Country | GDP per Capita (USD) | Mobile Subscription (per 100) | Internet Usage (%) | Financial Access Point (per 100,000) | Mobile Phone Penetration Rates | Banking Sector Development Metrics | Digital Literacy Rates |
| The Bahamas | 31358.42 | 114.78 | 85.34 | 57.62 | 96.5 | 86.3 | 82.7 |
| Barbados | 17423.86 | 121.53 | 81.76 | 44.89 | 94.2 | 91.5 | 79.5 |
| Fiji | 6184.75 | 117.86 | 49.97 | 20.73 | 88.7 | 63.8 | 58.3 |
| Jamaica | 5358.24 | 102.64 | 54.58 | 17.85 | 90.4 | 58.2 | 62.5 |
| Seychelles | 16476.32 | 176.18 | 58.84 | 40.57 | 93.8 | 72.6 | 66.8 |
| Trinidad & Tobago | 16223.56 | 147.35 | 77.26 | 32.94 | 91.6 | 81.7 | 73.2 |

Continued

| | | | | | | | |
|-------------|----------|--------|-------|-------|------|------|------|
| Maldives | 10289.47 | 166.82 | 63.78 | 18.92 | 90.2 | 69.5 | 59.4 |
| Belize | 4884.65 | 67.34 | 47.22 | 13.76 | 83.6 | 52.4 | 53.7 |
| Cape Verde | 3574.28 | 111.75 | 57.86 | 34.18 | 85.3 | 65.7 | 57.2 |
| Saint Lucia | 11468.93 | 102.87 | 50.82 | 21.76 | 87.2 | 73.8 | 61.3 |

To construct the synthetic control unit, a set of relevant predictor variables was selected to closely mirror the structural characteristics of The Bahamas in the pre-treatment period (2015-2019). These predictors (see **Table 1**) include GDP per capita, mobile cellular subscriptions per 100 people, internet penetration rates, number of financial institution access points, mobile phone usage rates, banking sector development indicators (such as credit to the private sector and bank account penetration), and digital literacy scores. All predictor variables were standardized to account for differences in scale and were averaged across the pre-treatment years to reflect underlying economic structures rather than annual fluctuations.

The optimization problem underlying the SCM is solved by minimizing the weighted discrepancy between The Bahamas and a convex combination of donor countries based on these predictor variables. The resulting synthetic Bahamas was composed predominantly of Barbados (45.3%), Trinidad and Tobago (39.1%), and Seychelles (13.2%), with all other countries in the donor pool assigned weights near zero (**Table 2**). These three nations were identified as the best pre-treatment matches across multiple dimensions, including mobile technology diffusion and digital financial infrastructure, making them reliable contributors to synthetic control. Countries such as Belize or Fiji, while regionally and structurally similar, may have received zero weight due to more significant discrepancies in key predictors such as mobile penetration rates, GDP per capita, or digital infrastructure indicators. The SCM does not manually exclude these countries, but rather optimally down-weights them if their inclusion would worsen pre-treatment fit. The fact that only a few countries were selected also highlights the uniqueness of The Bahamas' pre-treatment characteristics and supports the credibility of the synthetic control match.

Table 2. Weighting for the construction of the Synthetic Control Method, rounded to 3 significant figures.

| <i>Countries in the Donor Pool and Corresponding Weights in the Synthetic Bahamas</i> | | |
|---|----------------------------------|-----------------|
| No. | Country name | Weight to 3 s.f |
| 1 | Barbados | 45.3% |
| 2 | Jamaica | 1.20% |
| 3 | Trinidad and Tobago | 39.1% |
| 4 | Saint Lucia | 1.20% |
| 5 | Saint Vincent and the Grenadines | 0.00% |

Continued

| | | |
|----|-------------------------|-------|
| 6 | Saint Kitts and Nevis | 0.00% |
| 7 | Grenada | 0.00% |
| 8 | Dominica | 0.00% |
| 9 | Antigua and Barbuda | 0.00% |
| 10 | Belize | 0.00% |
| 11 | Suriname | 0.00% |
| 12 | Guyana | 0.00% |
| 13 | Fiji | 0.00% |
| 14 | Samoa | 0.00% |
| 15 | Solomon Islands | 0.00% |
| 16 | Tonga | 0.00% |
| 17 | Vanuatu | 0.00% |
| 18 | Kiribati | 0.00% |
| 19 | Comoros | 0.00% |
| 20 | Seychelles | 13.2% |
| 21 | Maldives | 0.00% |
| 22 | Cape Verde (Cabo Verde) | 0.00% |
| 23 | Mauritius | 0.00% |
| 24 | São Tomé and Príncipe | 0.00% |
| 25 | Botswana | 0.00% |
| 26 | Namibia | 0.00% |
| 27 | Lesotho | 0.00% |
| 28 | Eswatini | 0.00% |
| 29 | Armenia | 0.00% |
| 30 | Georgia | 0.00% |
| 31 | Moldova | 0.00% |
| 32 | North Macedonia | 0.00% |
| 33 | Albania | 0.00% |
| 34 | Montenegro | 0.00% |

The model's fit is assessed by examining how closely the synthetic control replicates the real-world trajectory of The Bahamas prior to treatment. The pre-treatment fit is remarkably strong, with a Root Mean Square Error (RMSE) of 0.1957 and an R^2 value of 0.9969. This close alignment confirms that the synthetic control accurately models The Bahamas' mobile money adoption trends before the introduction of the Sand Dollar. Such a strong fit strengthens the credibility of the estimated treatment effect in the post-intervention period. Notably, this pre-treatment performance also satisfies a core assumption of SCM: that the control unit would have followed a similar trend as the treated unit in the absence of interven-

tion.

Having constructed a reliable synthetic control scenario and verified its pre-treatment accuracy, the analysis proceeds to assess the effect of the Sand Dollar on mobile money usage. The following section presents and interprets these results.

5. SCM Result Analysis

The Synthetic Control Method (SCM) estimates show that The Bahamas' mobile money account ownership was, on average, 10.94 percentage points above that of its synthetic counterfactual case, which is a representative of The Bahamas that did not implement the Sand Dollar. As can be seen from **Figure 1**, the post-2020 divergence of the actual and synthetic trajectories increases more significantly, indicating a significant and long-run impact owing to the launch of the CBDC. To interpret this result as causal rather than spurious, it is necessary to untangle the mechanisms and context-specific factors that underpinned this result.

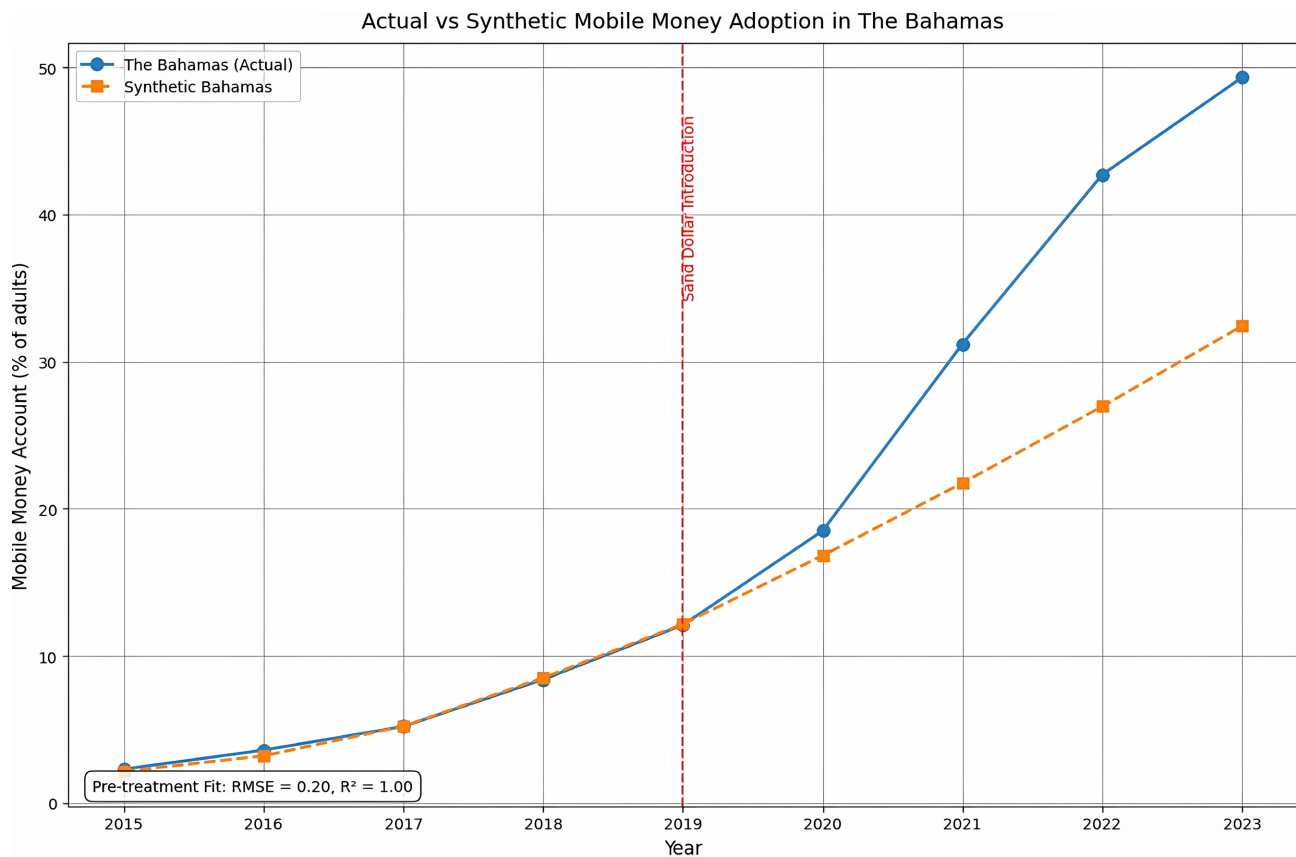


Figure 1. Synthetic and factual trajectories of mobile money, measure in percentage of adults from 2015 to 2023 in The Bahamas.

One key channel through which the Sand Dollar likely expanded financial inclusion is its ability to extend banking-like services to underserved populations, especially in the Family Islands, where physical banking infrastructure is either sparse or entirely absent. The archipelagic geography of The Bahamas presents

substantial logistical and economic barriers to maintaining traditional banking branches, making digital solutions more viable and, in some cases, the only feasible option. By providing a government-backed and mobile-accessible currency, the Sand Dollar effectively offered many households a secure and low-cost entry point into the formal financial system. This aligns with the Central Bank of The Bahamas statement to enhance equitable access to financial services across all islands (Central Bank of The Bahamas, 2019) and speaks to the unique needs of Small Island Developing States (SIDSs), where geographic dispersion magnifies financial exclusion.

Secondly, the integration of the Sand Dollar into private-sector payment ecosystems may have played a significant role in its adoption. Unlike voluntary fintech innovation, which often lacks incentives to reach low-income or rural users, the centralized policy push behind the CBDC enabled partnerships with local merchants, utility providers, and payroll systems. The government worked to normalize usage through both regulatory support and public awareness campaigns, leading to the Sand Dollar being incorporated into everyday financial activities, such as bill payments, transportation, and retail purchases. This institutional backing contrasts sharply with donor countries in the synthetic control group, such as Seychelles or Trinidad and Tobago, which have relied exclusively on organic growth in mobile fintech, often resulting in slower adoption and less targeted expansion into financially excluded areas.

Thirdly, the timing of the Sand Dollar's launch, which was during the onset of the COVID-19 pandemic, likely accelerated its impact (Yun, 2024). The crisis brought about a global shift toward digital and contactless payments, with concerns over virus transmission reducing reliance on cash. In The Bahamas, the government strategically utilized the Sand Dollar to disburse emergency relief payments to citizens, a move that not only increased visibility but also trust and necessity of usage (Bossone & Ardic, 2021). This specific application of the CBDC may have catalyzed adoption among populations who had previously been financially excluded or hesitant to engage with digital finance platforms. Although the pandemic had global effects, the SCM's use of a donor pool composed of countries similarly affected by COVID-19 allows us to control for this shared shock and therefore isolate the portion of the adoption surge that is plausibly attributable to the Sand Dollar itself.

It is worth noting, however, that generalizing these findings to other contexts must be done cautiously. The Bahamas' relatively small population, concentrated government structure, and high mobile phone penetration make it particularly well-suited for a CBDC implementation of this nature. In larger or less digitally integrated countries, these results may not be directly replicable. Nonetheless, the findings from this case offer valuable insights into the mechanisms through which a CBDC can influence financial behavior when introduced in a conducive policy and technological environment. The institutional and infrastructural conditions under which the Sand Dollar succeeded, such as digital ID compatibility, merchant integration,

and early crisis-related adoption, should be critically examined by policymakers in other jurisdictions seeking similar outcomes.

6. Evaluation of SCM Using Placebo Test

To ensure that results drawn from the SCM are not due to random fluctuations, we conduct a placebo test to test the SCM results. The placebo test reassigns the treatment to an earlier date (2016), and a leave-one-out analysis, in which each major contributing country is systematically excluded to evaluate the sensitivity of the results. Both tests yielded consistent outcomes, with no artificial effects observed in the placebo scenario and stable post-treatment gaps despite donor exclusions. These robust checks confirm that the observed post-2020 divergence is not the result of statistical noise or the influence of a single outlier in the donor pool.

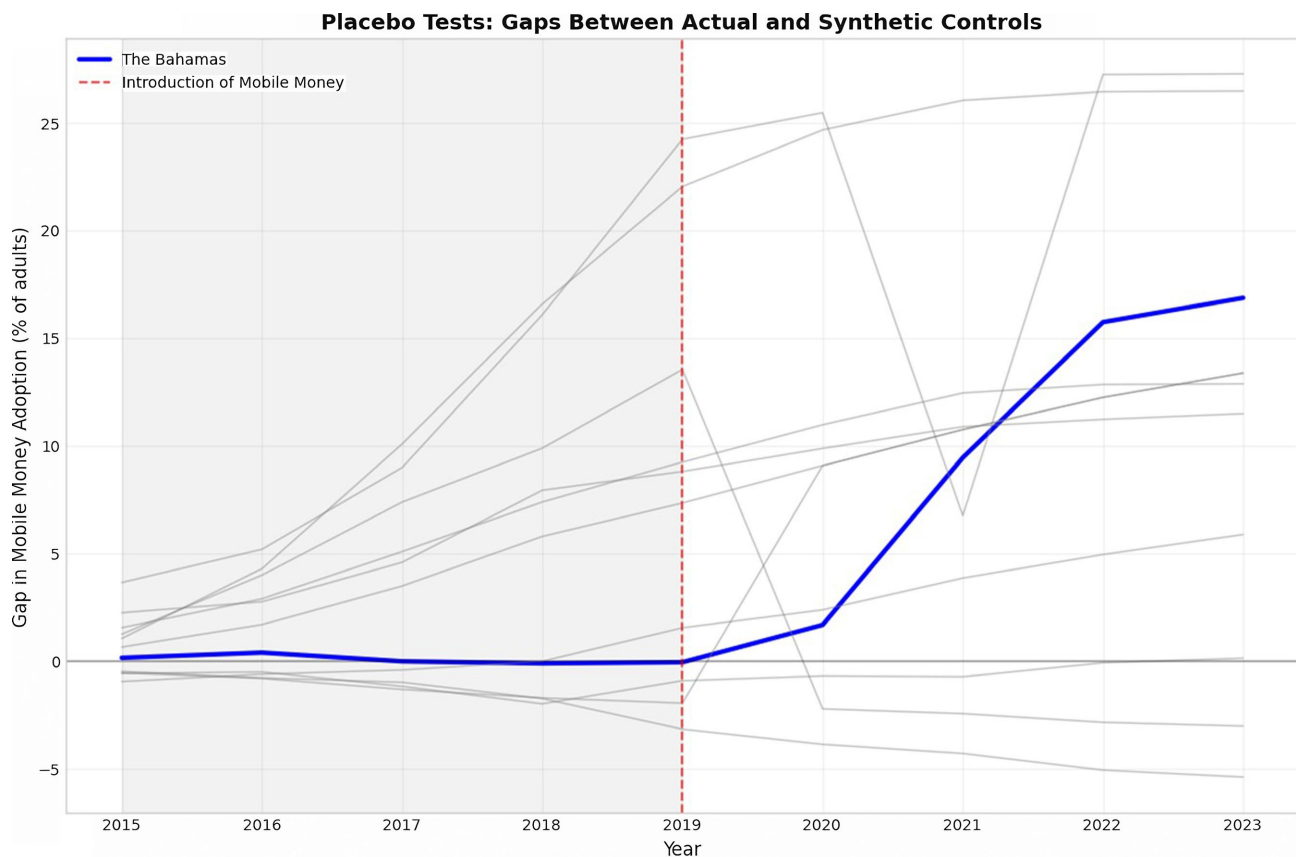


Figure 2. Placebo tests for gaps between actual and synthetic controls.

Placebo test analysis validates the results of SCM and provides proof of the impact on mobile money following the introduction of CBDCs in The Bahamas. **Figure 2** illustrates the placebo gaps for all the control countries. Whereas control countries exhibit varied trends with fluctuating positive and negative gaps that in cases exceed 20%, The Bahamas displays a distinctly persistent increasing trend following the 2019 intervention. Referring to **Figure 2**, this is particularly con-

vincing with the synthetic scenario The Bahamas boasting a near zero pre-treatment gap, with an RMSE of 0.1957 and R-squared of 0.9969, strongly contrasting with its high post-treatment divergence. The difference in response pattern in The Bahamas and all countries studied presents strong evidence that the apparent increase in mobile money adoption reflects a true treatment effect and not random fluctuation or unobserved confounding factors. This consistent conduct in all placebo tests reinforces our confidence in attributing the high adoption rates of mobile money due to the specific CBDC program launched in The Bahamas rather than to additional regional trends or statistical occurrences.

It is also important to address the potential effects of the COVID-19 pandemic that occurred simultaneously with the introduction of the Sand Dollar in 2020. The suggested risk could be that the observed changes reflect the broader shifts in global behavior due to the pandemic rather than the effect of the CBDC itself, as the pandemic likely influenced the digital payment behavior and adoption of mobile money across most countries. Even so, because the donor pool consists exclusively of countries that were also affected by the pandemic, similar to The Bahamas, the Synthetic Control Method (SCM) implicitly controls and accounts for this global shock by creating a counterfactual scenario that is also affected by the pandemic. Through the comparison of The Bahamas to a weighted average of similarly exposed countries, the model isolates the portion of the observed divergence that can be attributed specifically to the Sand Dollar, rather than to pandemic-driven trends.

7. Conclusion

This study applies the Synthetic Control Method (SCM) to measure the impact of The Bahamas' central bank digital currency, the Sand Dollar, on financial inclusion as captured by mobile money adoption. Results indicate that mobile money usage increased by a mean of 10.94 percentage points following the launch of the Sand Dollar compared to a counterfactual scenario where the CBDC is not launched. To determine the robustness of these findings, we conducted placebo tests by applying the same procedures to test each country within the donor sample. The findings confirmed that the identified effect in The Bahamas is unique and not probably a result of chance association, lending support to the argument that the expansion of digital financial inclusion is causally connected to the introduction of the Sand Dollar.

Having said that, caution needs to be used in interpreting the findings. Sand Dollar launched during the COVID-19 pandemic period when digital financial services picked up globally due to movement restrictions and increased adoption of contactless payments. Although our strategy keeps the effects of common shocks constant by comparing The Bahamas with other countries that were also similarly affected by the pandemic, we cannot completely exclude the effects of the CBDC from contemporaneous changes in behavior and policy. Also, because The Bahamas is a unique case with a small, highly digitized island nation with a highly inno-

vative central bank, our findings might not be easily comparable to larger or less digitally penetrated economies.

Further, while this research focuses on adoption of mobile money as an indicator of financial inclusion, financial inclusion is a multi-dimensional notion encompassing not only access but also usage and product quality, such as credit, insurance, and long-term savings. Future research must consider both whether CBDCs have impacts on these wider aspects of financial inclusion and if their impacts are persistent.

Despite these limitations, this research shares some of the first real-world findings on CBDC implementation results. For other Small Island Developing States and developing economies more generally, the Bahamian experience offers lessons aplenty on national digital currency potential benefits and design implications. Above all, the findings highlight the importance of mobile infrastructure readiness, private sector participation, and high-quality public outreach in enabling adoption. With increasing numbers of countries experimenting with or launching CBDCs, the eventual cross-country evaluations will be required to build an end-to-end understanding of their effects.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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