Goldbach, Stefan; Nitsch, Volker

Working Paper

Cryptocurrencies and capital flows: Evidence from El Salvador's adoption of Bitcoin

Darmstadt Discussion Papers in Economics, No. 247

Provided in Cooperation with:
Darmstadt University of Technology, Department of Law and Economics

Suggested Citation: Goldbach, Stefan; Nitsch, Volker (2024) : Cryptocurrencies and capital flows: Evidence from El Salvador's adoption of Bitcoin, Darmstadt Discussion Papers in Economics, No. 247, Technische Universität Darmstadt, Department of Law and Economics, Darmstadt, https://doi.org/10.26083/tuprints-00028016

This Version is available at:
https://hdl.handle.net/10419/302552

Darmstadt Discussion Papers in ECONOMICS

TECHNISCHE UNIVERSITÄT DARMSTADT

Cryptocurrencies and Capital Flows: Evidence from El Salvador's Adoption of Bitcoin

Stefan Goldbach, Volker Nitsch

Nr. 247

Arbeitspapiere der
Volkswirtschaftlichen Fachgebiete der
Technischen Universität Darmstadt

ISSN 1438-2733

Printed in Germany
Technische Universität Darmstadt
Department of Law and Economics
D – 64289 Darmstadt
Germany
www.wi.tu-darmstadt.de

August 11, 2024
Forthcoming: Applied Economics Letters

Cryptocurrencies and Capital Flows: Evidence from El Salvador's Adoption of Bitcoin*

Stefan Goldbach
Deutsche Bundesbank

Volker Nitsch
Technische Universität Darmstadt

Abstract
This paper explores a monetary experiment, the adoption of Bitcoin as legal tender in El Salvador in 2021, to analyze the impact of digital currencies on international capital flows. Using a difference-in-differences approach, we find that, instead of making transfers easier, El Salvador's official cross-border financial activity has decreased after the monetary change. This finding may reflect an increase in uncertainty. However, it is also in line with findings that link digital assets to illegal activity as previously officially recorded financial transfers may have been replaced by unrecorded activities.

JEL Code: E42; E58; F21; F32; F38

Keywords: crypto-assets; digital currency; legal tender; bitcoin

E-mail: nitsch@vwl.tu-darmstadt.de

Word count: 2039

* We thank Christoph Fischer, Clemens Graf von Luckner, Axel Jochem, Sören Karau, and Frank Pisch for helpful comments and suggestions. The views expressed in this paper are those of the authors and do not necessarily coincide with the views of the Deutsche Bundesbank or the Eurosystem.

1. Motivation

On September 7, 2021, with the decision to make Bitcoin legal tender, El Salvador became the first (and still only) country in the world to officially adopt a crypto asset as national currency. The main aim of this measure, according to the "Bitcoin Law", is to improve the population's access to financial services.[1] In fact, the country's president, Nayib Bukele, claims that "[b]y using Bitcoin, the amount received [in remittances] by more than a million low income families will increase in the equivalent of billions of dollars every year."[2] Still, the economic and financial consequences of this unconventional policy decision are largely unknown. The International Monetary Fund (2022), for instance, warns that "[t]he adoption of a cryptocurrency as legal tender […] entails large risks for financial and market integrity, financial stability, and consumer protection. It also can create contingent liabilities."

In this short paper, we examine the effect of the adoption of Bitcoin on one important aspect of macroeconomic activity, international capital transmission. In particular, we ask: What is the impact of the unprecedented and largely unexpected changeover to a digital currency on El Salvador's cross-border financial flows?[3] To analyze this issue, we use a standard difference-in-differences approach, which we apply on two different data sets, each with its own advantages. While no analysis is preferable to the other, our results turn out to be remarkably consistent. Irrespective of the data set that we use, we find evidence of a significant decline in El Salvador's official capital flows following the country's adoption of Bitcoin as legal tender. A possible explanation for this finding is that the monetary change to a digital currency, instead of making cross-border financial transactions easier, has been associated with a general increase in business uncertainty, both in El Salvador and abroad. Alternatively, our estimates of a decline in capital flows are also in line with Graf von Luckner, Reinhart, and Rogoff's (2023, p. 105) emphasis that "Bitcoin can be and is being used to circumvent taxes and regulations" as previously officially recorded financial transfers may have simply been replaced by unrecorded activities.[4]

2. Evidence from Aggregate Balance of Payments Data

We begin our analysis by examining conventional capital flow data from the national balance of payments statistics. This data is available for a large set of countries, including El Salvador, at quarterly frequency from the International Monetary Fund's International Financial Statistics. In addition to information on inflows and outflows, we also explore data on four types of disaggregated capital flows: foreign direct investment, portfolio debt investment, portfolio equity investment, and other investment.[5] Following Cerutti, Claessens, and Rose

[1] See https://www.diariooficial.gob.sv/seleccion/30534.
[2] See https://twitter.com/nayibbukele/status/1401337860343668736.
[3] Plans to adopt Bitcoin as legal tender were first announced on June 5, 2021, that is, three months before the actual implementation; see, for instance, https://www.reuters.com/world/americas/el-salvadors-president-says-will-send-bill-make-bitcoin-legal-tender-2021-06-05/.
[4] Along similar lines, Foley, Karlsen, and Putniņš (2019) estimate that one-quarter of Bitcoin users are involved in illegal activity. Alvarez, Argente, and Van Patten (2023) present results from a survey on the usage of Bitcoin in El Salvador.
[5] The coverage of cross-border financial transactions in crypto assets, including remittances, in the balance of payments is still under discussion; see, for instance,

(2019), all capital flows (which can take both positive and negative values) are expressed as percentages of GDP.

Instead of analyzing the full sample of countries, we restrict our analysis on Central America, effectively comparing the evolution of the international capital position of El Salvador (the treatment country) to international capital movements of countries in the immediate vicinity of El Salvador (our control group). In particular, our sample includes, besides El Salvador, Costa Rica, Guatemala, Honduras, and Nicaragua. The countries do not only share a wide set of common features (such as language, size and level of economic and financial development); they also form an economic integration scheme for more than half a century, the Central American Common Market.

Based on this sample, we analyze the impact of making digital assets legal tender on capital flows in a standard difference-in-differences setting, using quarterly data and imposing symmetric time windows around the date of El Salvador's adoption of Bitcoin (Q3/2021). Formally, we estimate regression equations of the form:

$$(1) \qquad CapitalFlow_{i,t} = \alpha_i + \beta_t + \gamma\, SLV_i \times Post_t \{+ \delta\, Z_{it}\} + \varepsilon_{i,t}\,,$$

where $CapitalFlow_{i,t}$ is the capital flow of country i at time t, α_i is a set of country-specific fixed effects which absorbs any time-invariant differences in the countries' external financial positions, β_t is a set of time fixed effects that capture developments common across all countries, Z_{it} is a vector of auxiliary control variables, and the main variable of interest is the interaction term between an indicator of whether country i is El Salvador, SLV_i, and an indicator equal to one if period t is after the adoption of Bitcoin, $Post_t$.

In our default specification of equation (1), we estimate a plain-vanilla difference-in-differences model without additional regressors (i.e., we set δ to zero). Table 1a reports the results. There are two panels; the top panel reports estimation results for a relatively narrow time window of +/- 4 quarters (i.e., a sample period from Q3/2020 to Q2/2022), while the bottom panel extends the sample to +/- 8 quarters. Across columns, we vary the dependent variable, distinguishing between the directions and main types of capital flows. We begin with inflows of capital from abroad and present results for total capital inflows as regressand in the first column of the table. At this aggregate level, the estimates of γ are negative, but statistically indifferent from zero, indicating that the adoption of a digital currency had no significant impact on capital flows. Next, we decompose the outcome into different types of capital inflows. As shown in columns (2)-(5), the results vary considerably across flow type. For both foreign direct investment and bond portfolio investment, the estimated γ coefficient is negative, economically large and statistically significant. The point estimates imply a relative decline in (net) investment inflows (in percent of GDP) by more than 3 percentage points after El Salvador's adoption of Bitcoin as legal tender. Interestingly, the declines are partly offset by a relative increase in other investment. While the ebbing of inflows into El Salvador may reflect an increase in uncertainty after making a cryptocurrency legal tender, the observed shift in the composition of capital inflows, along with the relative stability of the estimated coefficients across the different time windows, indicates that capital flow

https://www.imf.org/external/pubs/ft/gfs/gfsac/pdf/Recording_Crypto_Assets_MacroStats_July_22.pdf. According to current conventions, transactions in Bitcoin are typically recorded in the current account.

responses may be also driven by other factors. Finally, we tabulate the analogues for outflows of capital in columns (6)-(10). Reassuringly, our results turn out to be reasonably robust. The adoption of Bitcoin is followed by a considerable reduction of equity and bond portfolio flows, with other types of outflows being much less affected.

In extensive robustness checks, we also estimate more demanding specifications of equation (1). In particular, we experiment with a wide range of additional macroeconomic control variables, often at the cost of a decline in sample size due to limited data availability. Table 1b presents the results of one of these analyses.[6] In this extension, we control for country-specific levels of uncertainty at quarterly frequency, a measure taken from Ahir, Bloom, and Furceri (2022). The results seem generally plausible and intuitive. For one thing, capital flows tend to fall as uncertainty increases. More notably, however, the estimated effect of the introduction of Bitcoin on capital flows often shrinks in magnitude, but remains statistically significant, which indicates that uncertainty explains only part of the effect.

3. Evidence from Disaggregate Capital Flows Data

In a second exercise, we repeat our analysis using a radically different data set of capital flows. In particular, we use highly disaggregated (and confidential) data from the German balance of payments statistics. Instead of tabulating national aggregates, this data set covers bilateral capital flows to and from Germany at granular level. In particular, we observe individual statistical entries in the balance of payments, allowing us to analyze, for instance, cross-border financial activities by declarant.[7] Moreover, the data is available at monthly frequency. With this data, although it covers a country's bilateral financial relationship with Germany and, therefore, only a fraction of El Salvador's total capital flows, we are able to apply a difference-in-differences design as in equation (1) (using the same control group of countries as before) to analyze the impact of El Salvador's adoption of Bitcoin on capital flows.[8] Since our data is based on individual transactions declared to Deutsche Bundesbank, capital flows are strictly positive (there are no zeroes at the country-month level in our sample). Consequently, our dependent variable is in levels, and we apply a Poisson pseudo maximum likelihood estimator.

Table 2a reports the results. Again, we tabulate separate estimates for inflows and outflows (from the German counterpart's perspective), and we gradually extend our sample period from +/- 6 months in the top panel to +/-18 months in the bottom panel. In column (1) of the table, we present estimates of γ for bilateral capital inflows (in euros) at the country-month level. As shown, the estimated coefficients are consistently negative and statistically significant, irrespective of the sample period that is analyzed. This finding is in support of our earlier results; it indicates that capital flows substantially decreased after the adoption of Bitcoin. Moreover, although the magnitude of the effect gets smaller for longer time windows, it remains highly significant for the period of +/- 18 months--a period in which financial actors should have already become increasingly familiar with the new digital

[6] For other variables, the results are often insignificant, inconclusive, and leave our main findings unchanged.
[7] For a more detailed description of the dataset, see, for instance, Besedeš, Goldbach, and Nitsch (2017).
[8] El Salvador does not report capital flows by country.

environment. In column (2), we replace capital flow values with a measure of the extensive margin of a bilateral financial relationship, the number of statistical entries in the balance of payments. For this count variable of declarations of financial activities, we observe a similar pattern of a significantly negative, though moderately declining effect of Bitcoin on capital flows. Analogous results for a measure of the intensive margin, the average value per entry, are presented in column (3). Finally, we obtain qualitatively similar results for capital outflows, as shown in columns (4)-(6). As shown in Table 2b, the results are also robust to the inclusion of a control for uncertainty. Overall, there is consistent evidence that El Salvador's decision to make Bitcoin legal tender has been associated with a decline in the country's official international capital flows.

4. Summary

This paper adds to a rapidly growing literature that aims to better understand the impact of digital currencies. In particular, we are interested in the effects on international capital flows. To avoid the challenge of limited data availability on digital currency transactions, we make use of a monetary experiment, El Salvador's decision to declare Bitcoin as legal tender. Applying a difference-in-differences approach, we find that capital flows decline after the adoption of a digital currency. While this drop may reflect a lack of experience and an increase in uncertainty after the monetary change, it could also indicate a shift towards officially unrecorded financial activities.

Disclosure of Interest:

The authors confirm that there are no relevant financial or non-financial competing interests to report.

Declaration of Funding:

No funding was received.

References:

Ahir, Hites, Nicholas Bloom, and Davide Furceri. 2022. "The World Uncertainty Index," NBER Working Paper 29763.

Alvarez, Fernando, David Argente, and Diana Van Patten. 2023. "Are Cryptocurrencies Currencies? Bitcoin as Legal Tender in El Salvador," Science. 382, Issue 6677.

Besedeš, Tibor, Stefan Goldbach, and Volker Nitsch. 2017. "You're Banned! The Effect of Sanctions on German Cross-Border Financial Flows," Economic Policy. 32 (April): 263-318.

Cerutti, Eugenio, Stijn Claessens, and Andrew K. Rose. 2019. "How Important is the Global Financial Cycle? Evidence from Capital Flows," IMF Economic Review. 67 (March): 24-60.

Foley, Sean, Jonathan R. Karlsen, and Tālis J. Putniņš. 2019. “Sex, Drugs, and Bitcoin: How Much Illegal Activity Is Financed through Cryptocurrencies?,” Review of Financial Studies. 32 (May): 1798-1853.

Graf von Luckner, Clemens, Carmen M. Reinhart, and Kenneth Rogoff. 2023. “Decrypting New Age International Capital Flows,” Journal of Monetary Economics. 138 (September): 104-122.

International Monetary Fund. 2022. “IMF Executive Board Concludes 2021 Article IV Consultation with El Salvador,” Press Release No. 22/13.

Table 1a: The Effect of Bitcoin Adoption on Capital Flows in Aggregate Data

	Inflows					Outflows				
	Total	**FDI**	**Portfolio Debt**	**Portfolio Equity**	**Other**	**Total**	**FDI**	**Portfolio Debt**	**Portfolio Equity**	**Other**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
	+/- 4 Quarters									
El Salvador × Post	-1.021 (1.000)	-4.377** (0.583)	-3.108** (0.668)	-0.011 (0.012)	6.475** (0.369)	-4.109# (1.870)	-0.608* (0.156)	-4.786** (0.236)	0.184 (0.368)	1.100 (1.687)
Obs.	40	40	40	40	40	40	40	40	40	40
R^2	0.65	0.66	0.40	0.78	0.74	0.53	0.34	0.55	0.82	0.31
	+/- 8 Quarters									
El Salvador × Post	-3.192 (1.547)	-2.811** (0.384)	-3.006** (0.575)	-0.017 (0.019)	2.642# (0.1.137)	-3.682* (0.945)	0.110 (0.136)	-2.462** (0.365)	-1.355** (0.063)	0.025 (0.908)
Obs.	80	80	80	80	80	80	80	80	80	80
R^2	0.38	0.62	0.24	0.61	0.44	0.40	0.23	0.29	0.37	0.32

Notes: OLS estimation. The dependent variable is the type of capital flow specified in the top two rows of each column (expressed as percentage of GDP). Robust standard errors (clustered by country) are in parentheses. **, * and # denote significance at the 1 %, 5 % and 10 % level, respectively.

Table 1b: The Effect of Bitcoin Adoption on Capital Flows in Aggregate Data, Additional Results

	Inflows					Outflows				
	Total	**FDI**	**Portfolio Debt**	**Portfolio Equity**	**Other**	**Total**	**FDI**	**Portfolio Debt**	**Portfolio Equity**	**Other**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
	+/- 4 Quarters									
El Salvador × Post	-0.454	-2.259*	-2.499*	-0.018	4.321*	-5.352*	-0.131	-5.939**	0.449	0.269
	(1.006)	(0.686)	(0.731)	(0.021)	(1.045)	(1.486)	(0.393)	(0.750)	(0.516)	(1.301)
Uncertainty	-2.059	-7.703*	-2.214	0.024	7.833#	4.517	-1.734	4.194	-0.963	3.021
	(5.201)	(2.471)	(1.879)	(0.048)	(3.346)	(3.015)	(1.560)	(2.768)	(0.701)	(3.075)
Obs.	40	40	40	40	40	40	40	40	40	40
R^2	0.65	0.70	0.41	0.79	0.77	0.55	0.38	0.61	0.82	0.32
	+/- 8 Quarters									
El Salvador × Post	-4.730**	-2.496**	-2.982*	-0.025	0.773	-4.602**	0.158	-2.602**	-1.433**	-0.726
	(0.855)	(0.314)	(0.947)	(0.025)	(1.230)	(0.755)	(0.343)	(0.455)	(0.251)	(0.646)
Uncertainty	5.615	-1.151	-0.086	0.029	6.823*	3.356	-0.177	0.508	0.283	2.742
	(4.931)	(2.455)	(3.821)	(0.029)	(1.741)	(2.702)	(1.376)	(1.457)	(0.758)	(1.333)
Obs.	80	80	80	80	80	80	80	80	80	80
R^2	0.40	0.62	0.24	0.62	0.48	0.40	0.23	0.29	0.37	0.34

Notes: OLS estimation. The dependent variable is the type of capital flow specified in the top two rows of each column (expressed as percentage of GDP). Robust standard errors (clustered by country) are in parentheses. **, * and # denote significance at the 1 %, 5 % and 10 % level, respectively.

Table 2a: The Effect of Bitcoin Adoption on Capital Flows in Disaggregate Data

	Inflows			Outflows		
	Value	**Number**	**Avg. Value**	**Value**	**Number**	**Avg. Value**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	+/- 6 Months					
El Salvador × Post	-1.210**	-0.432**	-0.630**	-1.171**	-0.275**	-0.922**
	(0.183)	(0.054)	(0.213)	(0.198)	(0.058)	(0.190)
Obs.	65	65	65	65	65	65
Pseudo R^2	0.78	0.52	0.55	0.78	0.58	0.53
	+/- 12 Months					
El Salvador × Post	-0.859**	-0.247**	-0.460*	-0.668*	-0.300**	-0.468*
	(0.152)	(0.046)	(0.198)	(0.270)	(0.050)	(0.232)
Obs.	125	125	125	125	125	125
Pseudo R^2	0.76	0.54	0.54	0.76	0.58	0.57
	+/- 18 Months					
El Salvador × Post	-0.543**	-0.261**	-0.179	-0.464**	-0.206**	-0.166
	(0.144)	(0.054)	(0.154)	(0.146)	(0.072)	(0.153)
Obs.	185	185	185	185	185	185
Pseudo R^2	0.75	0.56	0.56	0.66	0.57	0.36

Notes: PPML estimation. The dependent variable is specified in the top two rows of each column. Robust standard errors (clustered by country) are in parentheses. **, * and # denote significance at the 1 %, 5 % and 10 % level, respectively.

Table 2b: The Effect of Bitcoin Adoption on Capital Flows in Disaggregate Data, Additional Results

	Inflows			Outflows		
	Value	**Number**	**Avg. Value**	**Value**	**Number**	**Avg. Value**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	+/- 6 Months					
El Salvador × Post	-1.012**	-0.338**	-0.511#	-1.001**	-0.186*	-0.875**
	(0.215)	(0.085)	(0.307)	(0.282)	(0.081)	(0.269)
Uncertainty	-0.753*	-0.339*	-0.370	-0.622	-0.326	-0.145
	(0.345)	(0.167)	(0.362)	(0.863)	(0.364)	(0.504)
Obs.	65	65	65	65	65	65
Pseudo R^2	0.79	0.52	0.55	0.78	0.58	0.53
	+/- 12 Months					
El Salvador × Post	-0.660**	-0.070	-0.440#	-0.294	-0.223**	-0.306
	(0.167)	(0.092)	(0.250)	(0.337)	(0.076)	(0.371)
Uncertainty	-0.782**	-0.667*	-0.063	-1.448#	-0.275	-0.553
	(0.289)	(0.303)	(0.241)	(0.750)	(0.288)	(0.669)
Obs.	125	125	125	125	125	125
Pseudo R^2	0.76	0.54	0.54	0.77	0.58	0.58
	+/- 18 Months					
El Salvador × Post	-0.300*	-0.077	-0.130	-0.205	-0.190*	-0.059
	(0.119)	(0.092)	(0.144)	(0.129)	(0.092)	(0.100)
Uncertainty	-0.993**	-0.732**	-0.164	-1.023#	-0.061	-0.353
	(0.319)	(0.276)	(0.206)	(0.582)	(0.343)	(0.243)
Obs.	185	185	185	185	185	185
Pseudo R^2	0.76	0.56	0.56	0.66	0.57	0.36

Notes: PPML estimation. The dependent variable is specified in the top two rows of each column. Robust standard errors (clustered by country) are in parentheses. **, * and # denote significance at the 1 %, 5 % and 10 % level, respectively.

ISSN: 1438-2733