On The Benefits of Repaying

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Outline

- Objective of the Paper
- The Latin American debt crisis
  - The three phases of the Latin American debt crisis
  - Colombia
- Colombia's default probability
- Counterfactual analysis
- Reputation
- Conclusions

Objective of the Paper

Estimating the **benefits of repaying** when everybody else defaults

- Large literature that tries to estimate the costs of defaults
  - → **On GDP growth:** Sturzenegger (2004), Borensztein and Panizza (2009), De Paoli, Hoggarth, and Saporta (2009), Jorra (2011), Levy Yeyati and Panizza (2011), Asonuma and Trebesch (2016), Reinhart and Trebesch (2016), Asonuma, Chamon, Erce, and Sasahara (2019), Esteves, Kelly, and Lennard (2021)
  - → **On reputation:** Ozler (1993), Eichengreen and Portes (1986), Jorgensen and Sachs (1989), Flandreau and Zumer (2004), Borensztein and Panizza (2009), Gelos, Sahay, and Sandleris (2011), Tomz (2012), Cruces and Trebesch (2013), Catão and Mano (2017)
  - → **On trade:** Rose (2005), Martinez and Sandleris (2011)
- Colombia is the only large Latin American country which is normally deemed as not having defaulted in the 1980s
- We use archival research and econometric techniques to study what happened

Estimating the **benefits of repaying** when everybody else defaults

> *To fulfill one's contracted obligations is extremely honorable, but to do so when everyone is defaulting and in times of crisis is a thousand times more valuable.*
>
> Alberto Hueyo (Minister of Finance of Argentina, 1932-33)

> *Maintaining the role of "good debtor" and being an exceptional case in Latin America and in most of the developing world will improve Colombia's future market access.*
>
> Luis Jorge Garay (Colombia's Chief Debt Negotiator in the 1980s)

The Latin American debt crisis

- The "Mexican Weekend"

  On August 13, 1982, after closing the country's foreign exchange market, Mexican finance minister Jesùs Silva Herzog traveled to Washington to inform the Fund and the Treasury that Mexico was no longer able to service its $86 billion of external debt

- Mexico was soon followed by Argentina, Brazil, Chile, Ecuador, and several other countries in Africa, Asia, and Europe
  - → 26 countries "defaulted" between 1982 and 1983 and other 29 in the rest of the 1980s
  - → Latin America and the Caribbean was the most severely affected region. Out of the region's 23 countries with more than one million inhabitants, 22 "defaulted" between 1980 and 1989
  - → Note the quotation marks

The three phases of the crisis

- **Phase 1 (1982-85):** it's just a liquidity problem!
  - → Fiscal adjustment and coordinated reprofiling of principal repayments
  - → Concerted lending at relatively high rates and large upfront cash commissions
  - → Increase in borrowing costs and in the PV of external debt
- **Phase 2 (1985-89):** Baker Plan and "New Money"
  - → New disbursement from the World Bank and RDBs
  - → Softer financial conditions and lower cost of credit
  - → First hint that debt relief might be needed:
    The reality of the marketplace may well have to be taken into account by the banks to ensure the success of future financing packages and the maintenance of solidarity among the financial community (Jacques de Larosière, 1987)

The three phases of the crisis

- **Phase 3 (1989-98):** The Brady Plan
  - $\rightarrow$ Announced by US Treasury Secretary Nicholas Brady in March 1989
  - $\rightarrow$ It focused on debt reduction with direct financial support from the official sector
  - $\rightarrow$ It envisioned a transformation of defaulted bank loans into collateralized bonds
  - $\rightarrow$ Over 1990-1998, 11 countries implemented Brady exchanges

The Case of Colombia

- In the run-up to the crisis, Colombia's macro and fiscal indicators were slightly better than those of the median country in LAC, but Colombia was never the best performer
  - $\rightarrow$ Rapid deterioration of Colombia's economic situation in the first half of the 1980s
  - $\rightarrow$ Net capital inflows collapsed in 1982; Colombia was unable to access the international capital market (Garay, 1991)
  - $\rightarrow$ At the end of 1982, the government declared a 5-day state of economic emergency
  - $\rightarrow$ During the 1983 Article IV, the authorities expressed concerns that if reserves dropped by more than \$1 billion there could be widespread market panic (reserves dropped by \$1.6 billion)

Debt levels and macroeconomic indicators in the run-up to the Latin American debt crisis

Ext. debt/GDP 1981		P. Bal./GDP 1978-81		CAC/GDP 1978-81		Real growth 1978-81		Inflation 1978-81		Spread (bps) 1981	
GTM	15.2	BRA	5.31	T & T	3.1	PAR	10.33	ELS	4.14	VEN	57
T & T	15.8	CHL	4.19	VEN	0.61	MEX	8.77	HTI	4.67	MEX	62
PAR	19.6	MEX	2.16	ELS	0.55	CHL	7.38	GTM	8.18	COL	66
URY	19.86	PER	0.39	ARG	-0.2	PAN	6.74	DOM	8.32	CHL	70
COL	24.24	ARG	-0.12	COL	-0.8	HTI	5.05	HON	8.6	ECU	70
MEX	30.89	COL	-0.88	GTM	-4.12	ECU	5.02	PAN	10.13	ARG	80
BRA	32.42	HON	-1.3	HTI	-4.55	COL	4.96	JAM	12.81	URY	93
DOM	34.01	DOM	-1.35	MEX	-4.58	URY	4.7	T & T	15.3	CRI	93
ELS	36.55	BOL	-9.27	ECU	-5.65	T & T	4.39	PAR	15.85	PAN	125
ECU	36.93			JAM	-6.29	HON	4.31	VEN	17.5	BRA	205
PER	42.17			PAR	-6.32	BRA	3.93	CRI	19.2	BOL	222
HON	46.51			BOL	-6.46	GTM	3.44	COL	22.8		
ARG	46.6			DOM	-6.85	PER	2.7	NIC	23.1		
CHL	50.44			HON	-7.24	CRI	2.34	BOL	23.9		
BOL	65.3			BRA	-7.32	BOL	1.1	CHL	36.0		
JAM	83.42			CHL	-8.17	JAM	0.63	URY	51.1		
PAN	88.8			NIC	-9.57	ARG	-0.45	PER	67.9		
NIC	107.6			CRI	-13.45	VEN	-0.75	BRA	72.3		
CRI	146.5			PAN	-23.24	ELS	-2.66	ARG	130		

Mean	48.85		-0.4		-5.76		3.3		28.15		104
Med	36.74		-0.5		-5.97		4.31		17.5		86
σ	33.99		4.07		5.71				30.23		55

Colombia minus regional average											
Difference	-25.9		-0.53		5.25		1.74		-5.59		-41.45
	(35.3)		(4.54)		(5.85)		(4.15)		(31.75)		(58.65)

Source: IMF (1987)

Colombia

- By mid-1984, Colombia was unable to service its external debt
- However, rather than suspending its payments, it negotiated with its foreign creditors a series of arrangements that would refinance the majority of payments coming due over 1985-94
  - → 4 arrangements: the "Jumbo" arrangement of 1985 ($1 billion); the "Concorde" arrangement of 1987 ($1 billion); the "Challenger" arrangement of 1989 ($1.5 billion), and the "Hercules" arrangement of 1991 ($1.8 billion)
  - → Participation in these exchanges was not fully voluntary
  - → While the Colombian authorities strove to maintain their reputation of "good debtor" in the international capital market, Colombian loans traded in the secondary market at a deep discount

Secondary market prices of syndicated loans

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Argentina	66	35	21	13	21	32	43		
Brazil	75	46	40	22					
Chile	67	61	57	59	73.3	90	90	90	95
Colombia	84	63	58	64	64	75	75	85	90
Ecuador	65	37	13	14	19.8	22	28	52	
Mexico	56	50	43	36					
Panama	67	35	20	12	13	21	29	53	53
Peru	18	7	5	6	4	11	19	67	56
Venezuela	74	57	41	34					

Source: Klingen, Weder di Mauro, and Zettelmeyer (2013)

Colombia's debt renegotiations

Date and Name	Amount	Disbursement	Grace Period	Spread	Maturity	Notes
Apr. 1985, Jumbo	$1 billion	$515 mill. planned for 1985 $485 mill. planned for 1986, but all disbursed in 1986	3.4 years	LIBOR +150 bps for the first 4 years, LIBOR+138 bps (1+3/8) for the remaining 6 years. Effective average cost: LIBOR+1.93	8.4 years	Quarterly disbursements conditional on IMF monitoring
Jan. 1988, Concorde	$1 billion (corresponding to 70% of payments due to banks in 1987-88)	Planned for 1987-88, but only signed and disbursed in 1988	5.0 years	LIBOR+93 bps (15/16). Effective average cost: LIBOR+1.42	10 years.	Authorities had to share copies of Article IV reports with creditors
Jun. 1989, Challenger	Syndicate Loan of $1.47 billions and facility of $185 millions	1989-90 (first disbursement October 1989)	6 years for the syndicated loan and 5 years for the facility	LIBOR+87 bps (7/8) for the syndicate loan and LIBOR+93 bps (15/16) for the facility. Effective average cost: LIBOR+1.11	12 years for the syndicated loan and 10 years for the facility	
Dec. 1990, Hercules	Syndicate Loan of $1.575 billion & facility of $200 million. (corresponding to 90% of principal payments coming due over 1991-94)	1991-94	6.2 years	LIBOR+100 bps for the syndicate loan & LIBOR+150 bps for the facility. Effective average cost: LIBOR+1.24	12.6 years	

Source: IMF Article IV 1988, 1989, 1991, and Garay (1991)

Colombia

Colombia external debt strategy has been to achieve a return to normal access to international capital markets. Consistent with this strategy, the authorities have avoided a formal debt rescheduling and have tried to maintain the exposure of commercial banks and multilateral institutions to Colombia that roughly match amortizations payment as they fall due.
(IMF, 1989 pages 39-41)

Colombia

The Colombian authorities were disappointed by the fact that their efforts to act as good debtor did not grant them a better treatment.

in accordance with its exceptional status of good debtor country, the international financial system should have given Colombia a more favorable treatment, rewarding Colombia by differentiating it from other countries with payment problems would have set a clear precedent (page 18)....the commercial banks should be criticized for not having given better recognition to a good debtor in the midst of a generalized debt crisis (page 29)
(Garay, 1991)

Colombia's special treatment

- Colombia did not want an IMF program
- Private creditors' "advisory" committees requested that Colombia should be subject to a form of IMF "enhanced" surveillance in which the Fund would certify and monitor Colombia's adjustment program
- Colombian authorities wanted to have the Fund's Executive Board's and not just the staff's 'seal of approval' without the stigma that might be associated with a formal stand-by arrangement (Boughton, 2001, P. 413)
- Directors did not like it
- Until the last minute, the Colombian authorities doubted that the Board would approve this unusual arrangement (Junguito, 1985)
- But...

Colombia's special treatment

For cases such that of Colombia, when the Board was asked to make a judgment about an arrangement that had no precise precedent, Mr Dallara said, the Fund ought to develop new techniques only with considerable caution and with awareness of potential risks and benefits. Appropriately, the Fund has never been called an excessively innovative institution, but it had devoted great care and caution in examining the Colombian economy, and the benefits outnumbered the risks... Under the circumstances it was appropriate for the Fund to accept and perform the proposed monitoring role.
(Minutes of the Executive IMF Board Meeting, July 26, 1985)

Colombia's special treatment

- Reasons for this special treatment
  - → Cooperation on drug traffic control
  - → Geopolitics (the US was losing friends in Latin America)
  - → Strong relationship with the Fed.
    Paul Volcker, wanted to make the point that the US was not using a
    one-size-fits-all approach towards Latin America's debt problems. The
    Colombian authorities' determination to be a "good debtor" made
    Colombia a good candidate for a more favorable treatment
    (In July 1986, Paul Volcker received the Cruz de Boyaca, one of the
    highest honors granted by Colombia)

Colombia's default probability

- Archival research shows that Colombia's fundamentals were similar to those of the Latin American countries that defaulted

- We test whether in the 1980s Colombia's default probability was different from that of other Latin American countries

- We proceed in two steps.
  1. We use LASSO-logit to select a parsimonious set of variables which are good predictors of the probability of default

       Our data cover 87 countries over the period 1976-2017 and include 77 defaults.
       Data on defaults are from Asonuma and Trebesch (2016).
       When a country has several consecutive restructurings, we only keep the first episode

  2. We estimate a model with the selected variables to predict Colombia's default probability and compare it with the probability of default of LAC countries when they actually defaulted

Colombia's default probability vis-à-vis LAC
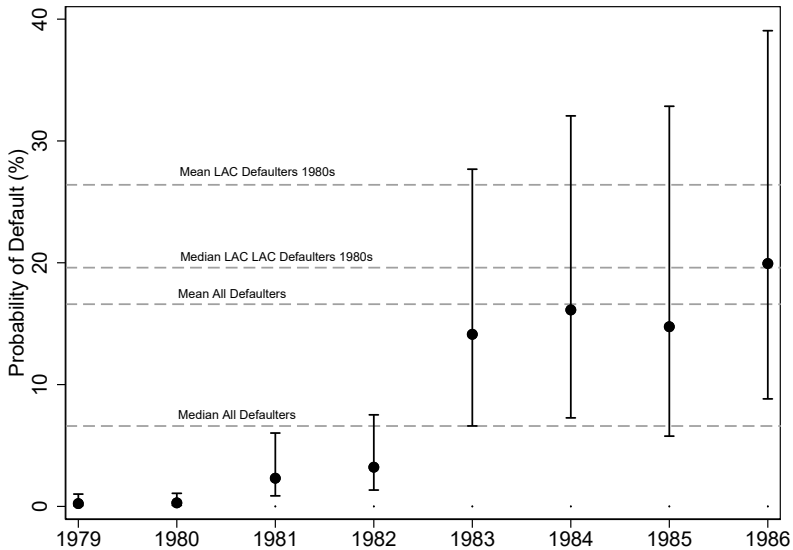
LAC default probability vis-à-vis Colombia
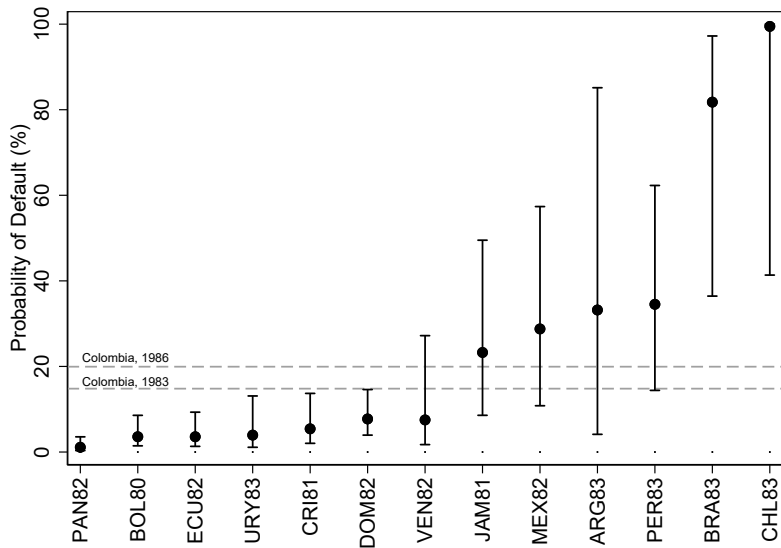
Counterfactual Analysis

- We study whether Colombia enjoyed short-run benefits by not defaulting in the 1980s
- We build a counterfactual with the synthetic control method (SCM) (Abadie and Gardeazabal, 2003) and the synthetic difference-in-differences method (SDID) (Arkhangelsky, Athey, Hirshberg, Imbens, and Wager, 2020)
- SDID is a generalization of the standard SCM which further improves identification by accounting for unobservable time-invariant factors and common shocks

SCM: Variables

- We build counterfactuals for real GDP, inflation, exports, and imports
    - We choose 1981 as treatment date as it precedes the beginning of the Latin American crisis in 1982
    - We exclude Bolivia and Jamaica from the donor pool as they defaulted before 1981
    - We estimate the effect of non–defaulting up to 1985 to limit the possibility that other shocks might confound the SCM estimates
    - As a baseline and to avoid to 'cherry-picking' the set of predictors in the SCM, we choose to match the pre-treatment outcomes of interest on their lagged values only, with no additional controls (Doudchenko and Imbens, 2016 and Ferman, Pinto, and Possebom, 2020)

SCM: Fit

- Depending on the variable considered, different countries carry higher weights in the construction of the counterfactual
- We assess goodness of fit with the ratio of the pre-treatment RMSPE and the RMSPE obtained with a model with zero fit defined as in Adhikari and Alm (2016)
  - If the $RMSPE_j$ is 0, then the ratio index is equal to zero, indicating a perfect fit. A ratio index equal to one suggests that the $RMSPE_j$ is identical to the zero fit model
  - We find that the ratio to the benchmark $RMSPE$ is close to zero across all models, suggesting that our synthetic control performs well in approximating the pre-treatment dynamics of the variables considered

Country weights and goodness of fit

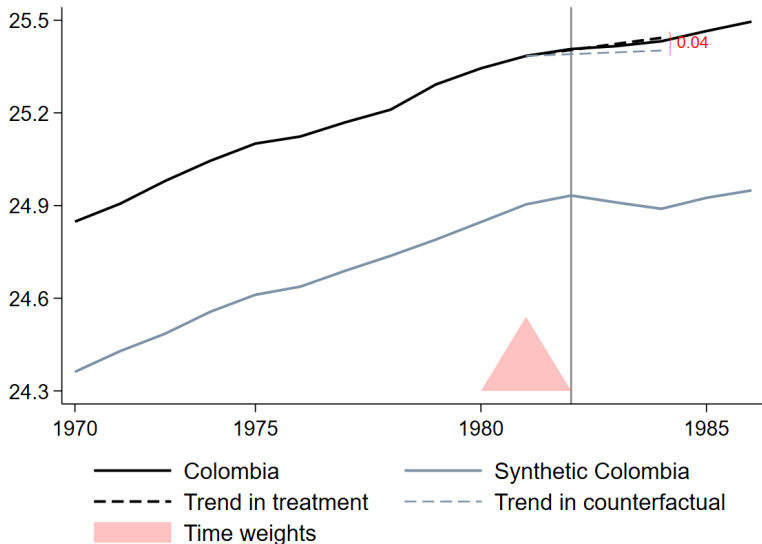|	Log of GDP	Inflation	Log of Export	Log of Import
ARG	0.038	0.008	0.000	0.000
BRA	0.126	0.000	0.149	0.000
CHL	0.036	0.000	0.000	0.278
CRI	0.231	0.000	0.482	0.000
DOM	0.000	0.181	0.000	0.000
ECU	0.000	0.000	0.004	0.000
MEX	0.276	0.711	0.365	0.032
PAN	0.138	0.000	0.000	0.391
PER	0.000	0.000	0.000	0.000
URY	0.000	0.099	0.000	0.169
VEN	0.155	0.000	0.000	0.130
Pre-treat. RMSPE	0.006	2.194	0.094	0.058
Ratio to bench. RMSPE	0.000	0.013	0.003	0.004

SCM: Log of real GDP
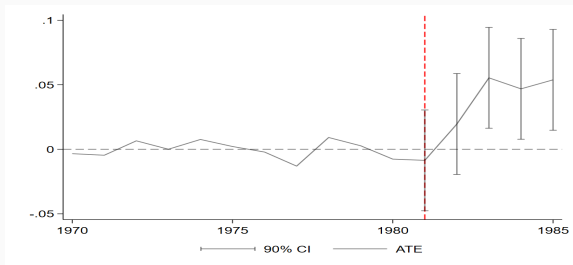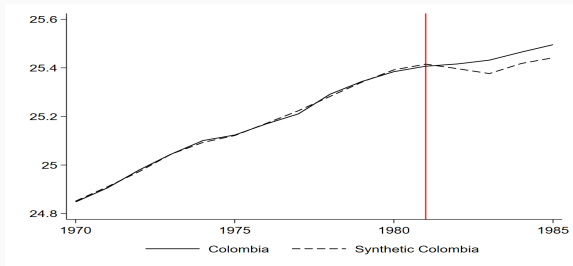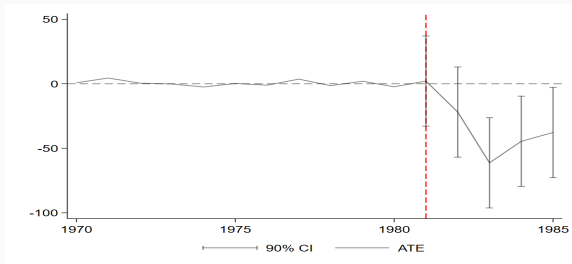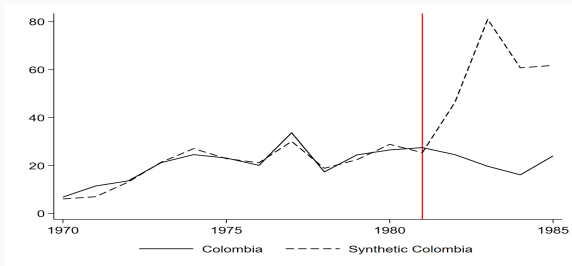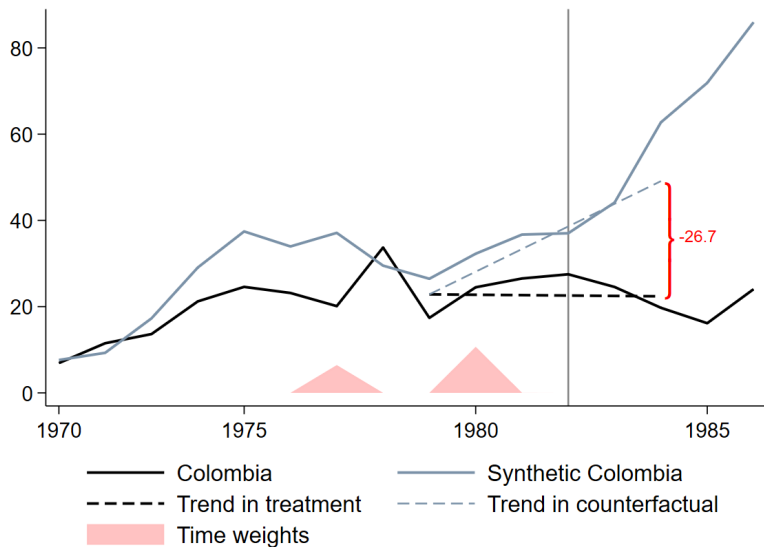
SCM: Log of real exports
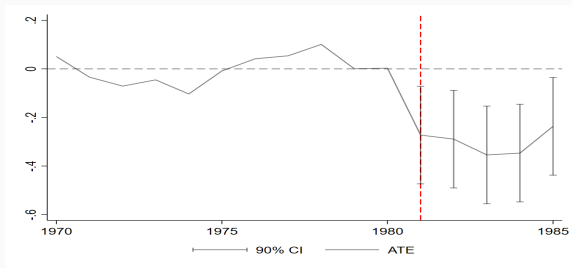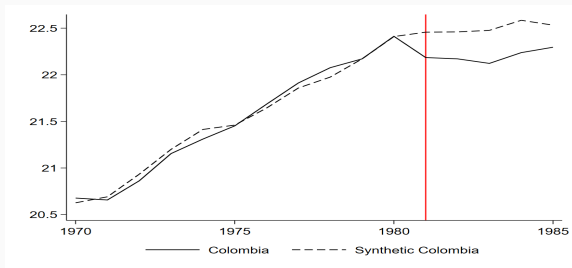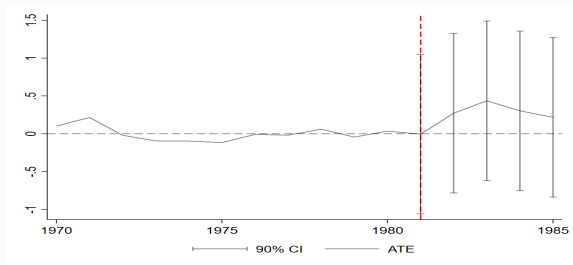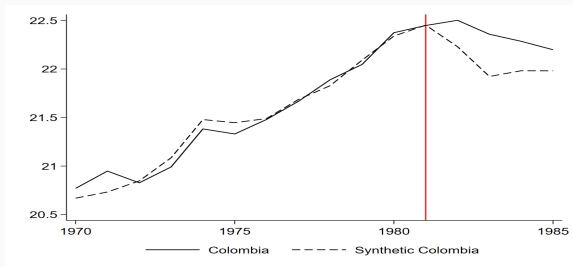
SDID

- Given that SDID includes fixed effects, the actual and counterfactual series are not supposed to overlap in the pre-treatment period
- The figures includes four lines
    1. The actual value of the variable of interest (the solid black line)
    2. The synthetic control (the solid blue line)
    3. The actual trend (the dashed black line)
    4. The counterfactual trend (the dashed blue line)
- The red brackets show the treatment effect which is given by the distance between the actual trend and the trend that we would have observed if Colombia had defaulted
- The triangles describe the time weights λ_t

SDID: Log of real GDP

Legend:
- **Colombia** (solid black line)
- **Synthetic Colombia** (solid blue line)
- **Trend in treatment** (dashed black line)
- **Trend in counterfactual** (dashed blue line)
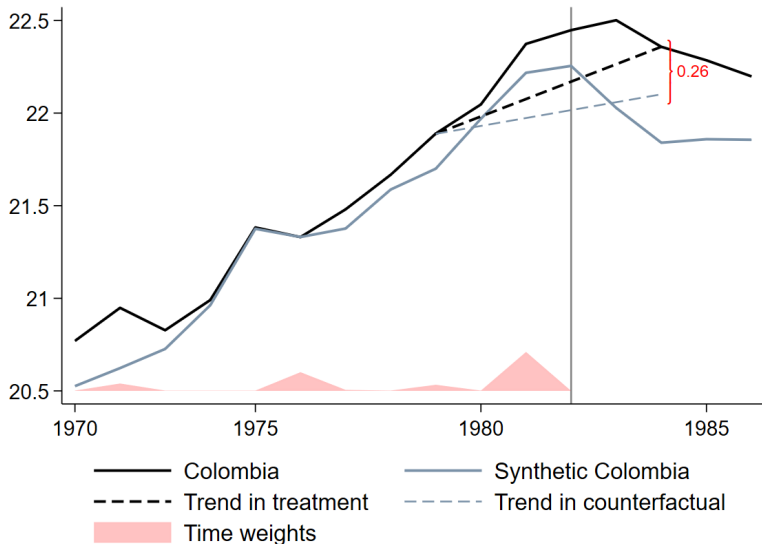- **Time weights** (pink shaded region)

-26.7

SDID: Log of real exports
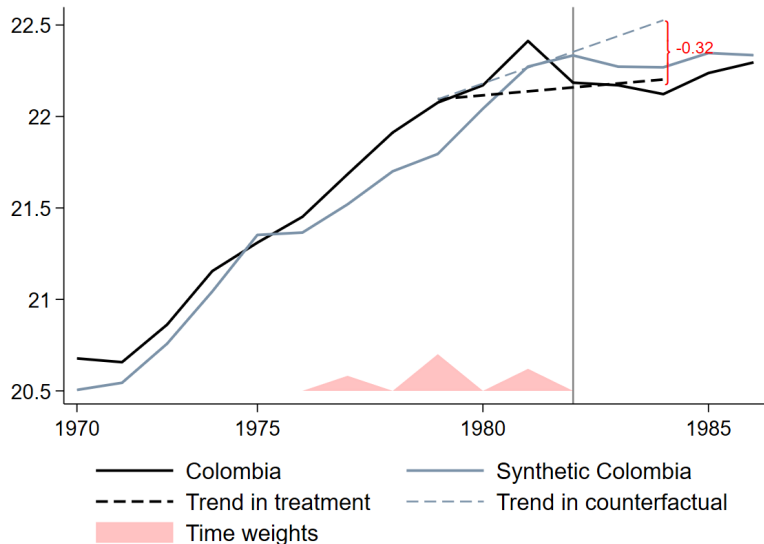
SDID: Log of real imports

Reputation

- Sovereign debt models in the tradition of Eaton and Gersovitz (1981) assume that reputation is the main driver of willingness to repay
- The results of the empirical literature that tests for these reputational effects are mixed
- The Colombian authorities in the 1980s thought that defaulting would have had large reputational effects (Garay, 1989)
  - → Cline (1995) suggests that Colombia's strategy paid off: its first credit rating in 1993 was investment grade by S&P and only one notch below investment grade by Moody's
  - → However, Chile received higher credit ratings and Mexico was rated just one notch below Colombia
  - → Primary market yields of Colombian unenhanced international bonds issued in the first half of the 1990s were close to those of Mexico and Uruguay and higher than Chilean yields

Foreign currency credit ratings for Latin American sovereigns

	1993		1994		1995	
	Moody's	S&P	Moody's	S&P	Moody's	S&P
Argentina	B1	BB-	B1	BB-	B1	BB-
Brazil	B2	NR	B2	NR	B1	B
Chile	**Baa3**	**BBB**	**Baa2**	**BBB+**	**Baa1**	**BBB+**
Colombia	Ba1	**BBB-**	Ba1	**BBB-**	Ba1	**BBB-**
Mexico	Ba2	BB+	Ba2	BB+	Ba2	BB
Trinidad and Tobago	Ba2		Ba2		Ba2	
Uruguay			Ba1	BB+	Ba1	BB+
Venezuela	Ba1	BB	Ba2	BB-	Ba2	B+

Source: IMF (1993), Table 9 and IMF (1995b), Table 6. Investment grade issuers in bold

Spreads at launch for unenhanced USD international bonds issued by Latin American sovereigns

	1991	1992	1993	1994
Argentina	375	324	301	250
Chile	150	150		
Colombia			215	153
Mexico	201	215	208	
Uruguay		275	228	158
Venezuela	235		386	

Source: IMF (1995a), Table A6 and IMF (1995b), Table A8

A test of long-run reputation

- Endogeneity: Differences in ratings and yields may be associated with unobservable differences in fundamentals
- Event study aimed at testing if long-term reputational effects are at play during a crisis period, when they should matter the most
- Sudden stop which followed the Russian default of August 1998
  - $\rightarrow$ In the early 1990s, several Latin American countries started experiencing large capital inflows (short-lived reversal in the aftermath of the "Tequila" and Asian crises)
  - $\rightarrow$ By mid-1998 about one-quarter of total investment (6% of GDP) of the LAC7 was financed by foreign capital (Calvo and Talvi, 2005).
  - $\rightarrow$ The Russian default put an abrupt end to these flows
  - $\rightarrow$ Flows to the LAC7 fell from \$100 billion over the period 97Q3-98Q2 to \$37billion in 98Q3-99Q2
  - $\rightarrow$ Average sovereign yield spreads tripled

A test of long-run reputation

- The fact that the crisis occurred in a country that represented less than 1% of global output and that had no significant economic ties with Latin America allows us to treat this event as an exogenous financial shock from the point of view of Latin American countries (Calvo, 2004)
- There are two dates that mark the explosion of the Russian crisis
  - → Thursday August 13, 1998 (Crash of the Russian stock market)
  - → Monday August 17, 1998 (The decision of the Russian authorities to devalue the ruble, default on the domestic debt, and declare a moratorium on payments to foreign creditors)

Latin EMBI spreads around the Russian default
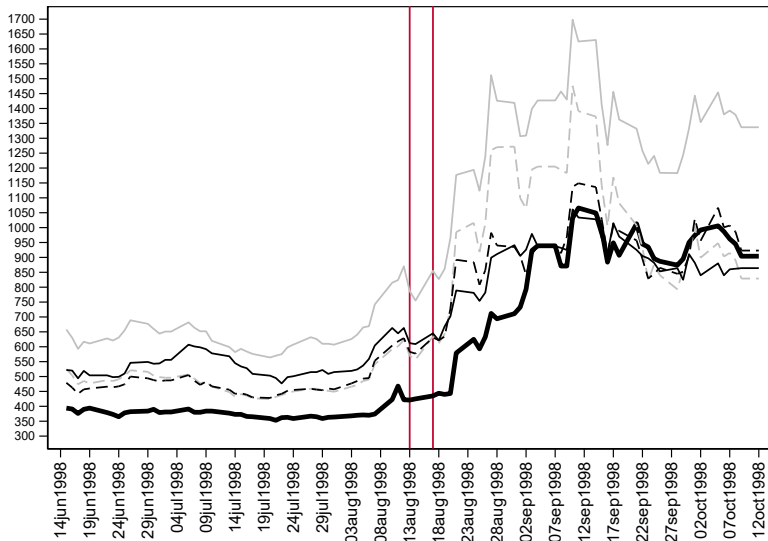
Note: Argentina: dashed grey line; Brazil: solid grey line; Colombia: thick black line; Mexico: dashed black line; Peru: thin solid black line. The figure does not include Chile because it was not part of the EMBI in 1998.

Event study: Details

- We regress daily changes in Colombian EMBI spreads (S_{C_t}) on daily changes in "market" spreads (S_{M_t}) over an estimation window that precedes the event:

$$\Delta S_{C_t} = \alpha + \beta \Delta S_{M_t} + \epsilon_t \qquad (1)$$

- In the baseline, we use a 90-day estimation window ending 4 days before the event (robust to using 60 and 120-day windows)
- We close the estimation window on August 9 (results are robust to ending the estimation window on August 13) and build the baseline event window around August 17
- The "market" spread is the first principal factor of changes in Argentinean, Brazilian, Mexican, and Peruvian spreads (robust to using the first and second principal factors of all seven LAC countries included in the EMBI in 1998)

Event study: Details

- Use the estimates of Eq. (1) to predict changes in spreads during the event window. Excess ("abnormal") changes in spreads are out-of-sample forecast error

  - The excess change in spread is $A\Delta S = \Delta S_{C_t} - \hat{\alpha} - \hat{\beta}\Delta S_{M_t}$.

- Denoting the length of the event window as W, the accumulated change in excess spreads is:

$$CA\Delta S = \sum_{i=1}^{W} A\Delta S_i \tag{2}$$

- A **positive** value of $CA\Delta S$ indicates that the country is doing **worse** than predicted by the "market."

  - The average daily excess spread is defined as $\frac{CA\Delta S}{W}$ with variance $\frac{\sigma_{A\Delta S}^2}{W}$ ($\sigma_{A\Delta S}^2$ is the variance of abnormal spreads during the estimation window). The t statistic for the average accumulated excess spreads is given by $\frac{CA\Delta S}{\sigma_{A\Delta S}\sqrt{W}}$.

Colombian abnormal spreads after the Russian default

	(1)	(2)	(3)	(4)	(5)	(6)
			6-day event window			
Av. Abn. Spr.	6.43**	9.13***	8.69***	9.98***	5.56**	1.83
	(2.38)	(3.89)	(3.61)	(4.52)	(2.39)	(0.79)
			12-day event window			
Av. Abn. Spr.	8.40***	10.57***	10.23***	11.21***	9.23***	7.45***
	(6.20)	(9.01)	(8.51)	(10.16)	(7.94)	(6.44)
			Estimation Window			
N. Days	90	90	120	60	90	90
Ending on	Aug. 9	Aug. 13	Aug. 9	Aug. 9	Aug. 9	Aug. 9
N. of fact.	1	1	1	1	1	2
Countries for		ARG, BRA, MEX, PER				ARG, BRA, MEX, PER
Market spreads						PAN, PER, VEN

Abnormal returns t-test in parenthesis, ** statistically significant at 5% confidence level, *** statistically significant at 1% confidence level

Conclusions

- Novel approach to address a classic question in international finance: why do countries repay their debts in the absence of strong enforcement of creditors' rights?
- Rather than asking what are the costs of default, we study the benefits of repaying at time of widespread sovereign default
- In terms of economic fundamentals, Colombia in the early 1980s was similar its neighboring defaulting countries
- Archival research points to the fact that main differences were political in nature
- The case of Colombia turns out to be more complicated than what it is usually thought
- Our results support the view that default episodes should not be treated as binary events (Meyer, Reinhart, and Trebesch, 2019) and that more research is needed in order to understand the short and long-term economic effects of different debt rescheduling strategies

Technical stuff: LASSO

- We start with 22 candidate measures of solvency, liquidity, domestic and external volatility, macroeconomic performance, and political and institutional quality (see Manasse, Schimmelpfennig, and Roubini, 2003, Manasse and Roubini, 2009, and Fioramanti, 2008).

- LASSO is a variable selection algorithm commonly used in machine learning (Park and Casella, 2008; Tibshirani, 1996).

- The LASSO-logit estimator is defined as:

$$\beta^L =_\beta \sum_{i=1}^{N} [y_i X_i \beta - ln(1 + e^{X_i \beta})] - \lambda \sum_{j=1}^{p} |\beta_j|$$

- β^L is the vector of parameters to be estimated, y is the dependent variable, **X** is a matrix of controls, and $\lambda |\beta|$ is a penalty scalar to the maximization problem.

Technical stuff: LASSO

- The penalty helps selecting a parsimonious specification of the model by assigning a zero coefficient to the redundant components of **X**.
- The hyper-parameter λ determines the size of the penalty.
  - Setting $\lambda = 0$ is equivalent to estimating a simple logit model (no variable is excluded from the model) and setting $\lambda = \infty$ forces all coefficients to zero
  - A standard technique for choosing λ is k-fold cross-validation. We use a standard 5-fold cross-validation
  - The cross-validation procedure determines an optimal value of $\lambda = 0.356$ and the LASSO estimator selects 17 variables
- After selecting λ, the routine implements a logistic LASSO for variable selection and then it computes a logit estimation retaining only the selected variable to predict the probability of observing an episode of sovereign default

Technical stuff: SCM

- SCM is a data-driven procedure that allows building counterfactual outcomes for observational units that are subject to a treatment (Abadie and Gardeazabal, 2003).
- Unlike a standard difference-in-difference estimation that considers a simple average of the control units, the SCM relies on a weighted average of the control observations (Athey and Imbens, 2017).
- For a given value of the non-default indicator $ND_j \in \{0, 1\}$ and values of an outcome $Y_{i,t}$, we define potential outcomes $Y_{j,t}(ND_j)$ as follows:

$$Y_{j,t}(ND_j) = \begin{cases} Y_{j,t}(0) & \text{if } ND_j = 0 \\ Y_{j,t}(1) & \text{if } ND_j = 1 \end{cases}$$

Technical stuff: SCM

- While we do not observe Colombia in both states, SCM builds a counterfactual for Colombia, i.e. the outcome of interest in the absence of the ND_j treatment.
- It finds the weighted average of all potential comparison units which best mimics the treated outcome during the pre-treatment period based on the idea that a combination of units that were not subject to the treatment (donor pool) may approximate the characteristics of the treated unit significantly better than any control unit alone.

Technical stuff: SCM

- Given a vector of weights $\vec{W} = (w_2, ..., w_{n+1})$, the synthetic control estimators of $Y_{1,t}(0)$ and the average treatment effect $\tau_{1,t}$ are defined as:

$$\hat{Y}_{1,t}(0) = \sum_{j=2}^{j+1} w_j Y_{j,t}$$

and

$$\hat{\tau}_{1,t} = Y_{1,t}(1) - \hat{Y}_{1,t}(0)$$

- For inference on the synthetic control estimates, we follow Firpo and Possebom (2018) who propose a placebo test-based approach to compute confidence intervals based on the permutation test framework of Imbens and Rubin (2015). This method extends and formalizes the procedure suggested by Abadie, Diamond, and Hainmueller (2010) and Abadie, Diamond, and Hainmueller (2015).

Technical stuff: SCM

- First, we run permutations (placebos) by re-assigning the treatment to one of the control countries in each iteration. We proceed as if each of the countries in the donor pool did not default

- Second, for each $j \neq 1$ country, we compute a test statistic that corresponds to the ratio of the mean squared prediction errors (RMSPE) as:

$$RMSPE_j = \frac{\sum_{t=T_{0+1}}^{T}(Y_{j,t} - \hat{Y}_{j,t}(0))^2)/(T - T_0)}{\sum_{t=0}^{T_0}(Y_{j,t} - \hat{Y}_{j,t}(0))^2/T_0}$$

- Where T_0 is the time of the treatment. This is the ratio of the post-treatment to the pre-treatment mean squared prediction errors.

- Finally, we invert the test statistic given by the $RMSPE_j$ to compute the confidence sets.

Technical stuff: SDID

- The standard synthetic control estimator does not allow controlling for unobserved heterogeneity through the inclusion of country and time fixed effects
- The synthetic difference-in-difference (SDID) estimator combines synthetic control and difference-in-differences (Arkhangelsky, Athey, Hirshberg, Imbens, and Wager, 2020)
  - Like SCM, SDID stregthens the plausibility of the parallel trend assumption by re-weighting and matching pre-treatment trends. Like DID, it allows controlling for country and time fixed effects
  - SDID provides a double-robustness property to the estimator because it employs fixed effects in modelling the outcome variables and also applies weights to the control units. As long as one of these two balancing approaches is effective, SDID produces unbiased estimates

Technical stuff: SDID

- Weights for the control units $\hat{\omega}_j$ are first estimated to match pre-treatment trends in the outcome of the treated unit. Time weights $\hat{\lambda}_t$ are also estimated to achieve balance in pre-treatment time periods ($\hat{\lambda}_t = 0$ in the SCM).

$$\left(\hat{\tau}^{sdid}, \hat{\mu}, \hat{\alpha}, \hat{\beta}\right) =_{\tau,\mu,\alpha,\beta} \left\{ \sum_{j=1}^{N} \sum_{t=1}^{T} \left(Y_{j,t} - \mu - \alpha_j - \beta_t - ND_j\tau_{1,t}\right)^2 \hat{\omega}_j\hat{\lambda}_t \right\}$$

- Unit weights are included to ensure that the average outcome for the treated unit is parallel to the average outcome for the control units. As the difference between treated and controls varies over time in the pre-treatment period, time weights adjust for the pre-treatment difference that is predictive of the outcomes in the post-treated period.