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ABSTRACT

This paper explores the relationship between inflation and the existence of a publicly-traded, long-maturity, nominal, domestic-currency bond market. Bond holders suffer from inflation and could be a potent anti-inflationary force; I ask whether their presence is apparent empirically. I use a panel data approach, examining the difference in inflation before and after the introduction of a bond market. My primary focus is on countries with inflation targeting regimes, though I also examine countries with hard fixed exchange rates and other monetary regimes. Inflation-targeting countries with a bond market experience inflation approximately three to four percentage points lower than those without a bond market. This effect is economically and statistically significant; it is also insensitive to a variety of estimation strategies, including using political and fiscal instrumental variables. The existence of a bond market has little effect on inflation in other monetary regimes, as do indexed or foreign-denominated bonds.

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"I used to think if there was reincarnation, I wanted to come back as the president or the pope or a .400 baseball hitter. But now I want to come back as the bond market. You can intimidate everybody."

- James Carville, *Wall Street Journal* (February 25, 1993, p. A1)

1. Introduction

Debt is issued in many varieties: public and private, long- and short-maturity, nominal and real, and so forth. Since most countries do not have a complete set of bond markets, new ones are sometimes added. For instance, Poland introduced 10-year fixed rate government bonds in 1999; Korea followed in 2000.[1] In this paper, I ask the question: does the very existence of such bond markets help keep inflation low and stable? One might imagine so, since bond vigilantes are a potentially formidable political force who benefit from low stable inflation. My objective is to show empirically for an important set of countries, those with inflation-targeting monetary regimes, the presence of a long, nominal, local-currency bond market is indeed associated with inflation that is approximately three-four percentage points lower.

This finding seems intuitive. Financing government spending through seigniorage is usually regressive. Money creation causes an inflation tax which is paid more by the poor, since they disproportionately tend to hold money instead of assets that earn interest or are otherwise protected from inflation. If a government begins to finance its deficit by issuing bonds to the rich instead of money to the poor, it creates a powerful constituency for low inflation.[2] The consequences of inflation become more concentrated when they are borne by the (1%) rich rather than the (99%) poor. The logic of collective action implies that the free-rider problem is reduced, and anti-inflation measures are more likely to be pursued. Hence the public good of low inflation is likely to be more prevalent when bonds are held, as they are owned by a relatively small powerful interest group necessarily opposed to the redistributionary consequences of inflation. That is, inflation is likely to be lower when the consequences of inflation tax are borne more by bond-holders and less by money-holders. This effect can also operate without any growth in bonds relative to money, if the nature of debt is transformed. Debt which is short-maturity, indexed,

and/or foreign-currency denominated does not provide the anti-inflationary bulwark/incentives of long, nominal, local-currency bonds.

The existence of a bond market could also have the opposite effect on inflation. Bond markets may facilitate and thus increase the size of government debt. As long-maturity, nominal, local-currency debt increases so do the immediate government benefits (i.e., bond-holder losses) from unexpected inflation. Thus, one might expect countries with bond markets to have higher inflation (at least temporarily); the linkage, if any, is theoretically ambiguous. Accordingly, I turn now to an empirical investigation.

2. Empirical Strategy and Methodology

My objective is to investigate whether the presence of a (long, nominal, local-currency) bond market is correlated with inflation. There are obviously other determinants of inflation, especially in the short run. As a consequence, my methodology is relatively low-frequency, relying on annual data for a broad panel of countries. I begin with a conventional least-squares panel estimator:

$$\pi_{it} = \beta Bond_{it} + \gamma X_{it} + \{\delta_i\} + \{\varepsilon_t\} + \eta_{it} \quad (1)$$

where π_{it} is the inflation rate for country i at time t, $Bond_{it}$ is a binary variable (1 if country i has a bond market at time t, 0 otherwise), {X} is a vector of controls linked to inflation via a set of nuisance parameters γ, {δ} and {ε} are respectively country- and time-specific fixed effects, and η is a residual to represent all other influences on inflation. I use five covariates (X) to control for other inflation determinants unlikely to be affected by bond market participants: a) polity (a measure of autocracy/democracy); b) income (the natural logarithm of real GDP per capita); c) size (log population); d) openness (trade as a percentage of GDP); and e) demeaned real GDP growth.[3] Since I include comprehensive sets of both time- and country-specific fixed effects, this can be interpreted

as a difference-in-differences estimator.[4] The coefficient of interest to me is β, the partial-correlation between a bond market and inflation.

Why and when do bond markets get created? It is natural to think that low and stable inflation is a necessary prerequisite for the existence of a long, nominal, local-currency bond market.[5] Perhaps then the presence of a bond market cannot be treated as exogenous for inflation; perhaps some common cause creates the conditions for both a fall in inflation and the creation of a bond market?

I try to handle this potential simultaneity problem in a few ways. First, I estimate (1) only for inflation-targeting regimes (hereafter "IT"). These are regimes that have proven remarkably durable and consistently deliver inflation that is low and stable compared with alternate regimes. Thus I begin by restricting my attention to a set of countries that would already seem to have the necessary conditions to establish a bond market. As a robustness check, I also consider other monetary regimes such as hard fixed exchange rate regimes. Only IT regimes have made a policy commitment to low inflation, thereby legitimizing anti-inflation forces such as the bond market. It is thus reasonable to expect the effect (if any) of the bond market to be strongest for IT regimes. Hard fixed exchange rate regimes may indirectly deliver low inflation or not; they are directly oriented only towards the exchange rate.

I also try two econometric strategies to deal with potential simultaneity. I use a variety of different treatment estimators to estimate β. These may be useful to handle any selection issue, since countries may choose in principle to create a bond market when the conditions are ripe, because of an actual or expected fall in inflation. I also estimate (1) with instrumental variables, relying on fiscal and political variables to construct instruments for bond market existence. I use the size of government spending in the economy and the age of the country as my instrumental variables, and show that my results are insensitive to reasonable alternatives. My IV results indicate

an economically and statistically significant effect of a bond market on inflation, just like those estimated with least squares.

3. The Data Set

I am interested in estimating β in equation (1), the effect of a bond market on inflation during inflation targeting regimes, *ceteris paribus*. Besides data on inflation, controls, and the monetary regime, I need information on whether or not a country has a bond market.

I begin with the GFDatabase from *Global Finance Data* (hereafter "GFD"). GFDatabase is advertised as providing data "spanning more than 200 global markets and extending coverage back to 1265."[6] I employ GFD's Fixed Income Database which is self-described as:

> "recorded electronically for current and historical markets covering 200 countries. GFD provides complete yield curve coverage with data on Interbank Rates, Swap Rates, Treasury-Bill Yields and Long-term Government Bond Yields. The Fixed Income Database enables you to follow changes in yields over different maturities going back several decades using yields at 3 months and 10 years, as well as maturities between and beyond these benchmarks. GFD provides data from both the public sector and the private sector."[7]

In practice, bonds data from GFD appear to be available for those traded with sufficient liquidity to have prices quoted, typically over the counter, often after an initial auction. I rely initially on series for government bonds, since the corporate analogues from GFD tend to follow government bonds in time. I am interested in long, nominal, fixed-rate, local-currency bonds, since these are the most affected by inflationary pressures. I begin with bonds which have a maturity of at least a decade. Ten years is an international benchmark, a maturity well outside the horizon of current monetary policy, and a horizon sufficiently long that bond prices are responsive to inflation. I also consider use GFD to construct series on shorter maturity, indexed, and foreign-denominated bonds, as robustness checks.

I have checked GFD against other data sources, which typically seem less complete than GFD. For instance GFD provides data for 819 bonds in its "Government Bond Yields" database from some 105 countries; 70 of these countries have bonds with a maturity of at least a decade. By way of contrast, Bloomberg and *The Financial Times* each provide data for twenty 10-year government bond yields (all covered by GFD). In Table 17b of its *Quarterly Review*, the BIS provides data (dis-aggregated by government, non-financial and financial corporations) for 28 countries with "long-term" domestic bonds and notes; long-term is defined as a maturity of more than one year. Investing.com provides a wide range of data; it covers 59 countries with 10-year (or greater) government bonds. The most comprehensive alternative to GFD I have found is Dealogic, which covers 73 countries (and territories, such as Jersey and Puerto Rico). I have checked the GFD data for errors against all these sources (and others), and corrected some omissions.[8]

Other data series are more straightforward. I extract series on inflation (both CPI and GDP) from the World Bank's *World Development Indicators*. The *WDI* also supplies series for real (PPP-adjusted) GDP per capita, population, and trade as a proportion of GDP.[9] I use polity2, which ranges from -10 (autocracy) to +10 (democracy), taken from the *Polity IV* project.[10] Dates for the start of inflation targeting regimes are taken from Rose (2013). For hard fix exchange rate regimes, I use the Reinhart-Rogoff (2004) data set, updated through 2010 by the Ilzetzki, Reinhart and Rogoff.[11]

In all, I have annual data for over 200 countries between 1970 and 2012 (with gaps). However, most of my focus is on a subset of this data set, namely IT countries. These are tabulated in Appendix Table A1, along with two dates: the start of inflation targeting, and the start of bond markets. Four IT countries do not have bond markets during the sample (Albania, Ghana, Guatemala, and Romania). The bond markets of a number of countries began long before IT (including Australia, Canada, New Zealand, Norway, South Africa, Sweden, Switzerland, and the UK). Finally, a number of bond markets came into being after IT, including those for: Armenia, Brazil,

Chile, Colombia, Czech Republic, Iceland, Indonesia, Israel, Korea, Mexico, Peru, Romania, and Turkey. This variation provides the identification required for my empirical approach.

Table 1 provides some descriptive statistics on inflation across bond markets and monetary regimes. Panel A shows that countries with bond markets experience lower and more stable inflation than do countries without bond markets; both the mean and standard deviation of (either measure of) inflation are lower by statistically significant amounts, as shown by the t/F tests to the right of the table. Panel B examines only countries with bond markets, and shows that within this class, inflation targeters experience inflation that is lower and more stable than hard fixers or other countries. Panel C is an analogue for countries without bond markets; here average inflation is similar for inflation targeters and hard fixers, though inflation is more stable with IT. Countries without bond markets in the "sloppy centre" of monetary regimes which are neither inflation targeters nor hard fixers, experience high and unstable inflation. The number of observations is also recorded in Panels A-C; it is interesting to note that there are more IT countries with bond markets than without, but countries using hard fixes or other monetary regimes usually do not have bond markets. Finally, Panel D compares inflation moments within a given monetary regime, for countries with and without bond markets. The top left t-test is significantly different from zero at all conventional confidence levels, indicating that the average CPI inflation rate is higher for inflation targeters *without* bond markets than for inflation targeters *with* bond markets. The F-test immediately to the right is also large, indicating that inflation volatility is also higher for IT countries without bond markets than IT countries with bond markets. Analogues for GDP inflation, hard fixers, and the sloppy centre are tabulated in the remainder of the panel.

Together, the panels of Table 1 paint a suggestive picture. IT countries with bond markets seem to have lower and more stable inflation than those without bonds, while results for other monetary regimes are less clear. This impression is bolstered by the evidence in Figure 1, which provide graphical evidence for inflation targeters with and without bond markets. In the pair of

histograms at the left of the figure, I plot CPI inflation for IT countries with (below) and without (above) bond markets. The histograms give the impression that inflation is typically lower for inflation targeters with bond markets. The same view emerges from the analogous histograms for GDP inflation in the middle column. The top-right chart graphs the quantiles of CPI inflation for inflation targeters with bond markets (on the y-axis) against inflation quantiles for those without bond markets (on the x-axis).[12] A diagonal line is provided for reference; if inflation were similarly distributed across inflation targeters with and without bond markets, the data would be plotted along the diagonal. In fact, the data are below the diagonal; IT countries without bond markets have systematically higher inflation than those with bonds. The quantile plot for GDP inflation in the lower-right delivers the same message.

Figure 2 provides a different take. This provides a pair of event studies (one for each measure of inflation) that characterize inflation around the creation of bond markets, again restricting attention to IT countries. I show average inflation starting three years before bond market creation (at the extreme left) and continuing until three years afterward (at the extreme right); a confidence interval is provided by the empirical (5%, 95%) quantiles. This exercise is limited, since there are only 14 cases where inflation targeters introduced a bond market during my sample. Still, the introduction of a long bond market seems associated with lower inflation.

4. Results

My benchmark results for (1) are recorded in Panel A of Table 2. This presents estimates of β from (1), along with robust standard errors (clustered by country). IT countries with a bond market experience CPI inflation that is 2.9% lower than those without bond markets, holding a variety of other features constant. The robust t-ratio is -2.9, significantly different from zero at the 1% significance level. The estimate for GDP inflation is over four percentage points, again

economically and statistically large. That is, the null hypothesis that the bond market is *not* associated with lower inflation, is grossly inconsistent with the data. Rather, inflation targeting countries have inflation that is three to four percentage points lower when a (long nominal local-currency) bond market exists. The same is not true of different monetary regimes, as can be seen in Panel B; while countries with bond markets seem to have *higher* inflation, the coefficients are imprecisely estimated for both hard fixers and countries in the sloppy centre.

Sensitivity Analysis

Most of Table 2 is sensitivity analysis intended to show that the default estimate in Panel A is not a fluke that can be easily dismissed. Panel C shows that the key (β) coefficients are robust to changes in the precise data sample. I successively drop: a) early/late observations; b) observations for poor/rich countries (annual real GDP per capita less than $10k/greater than $40k); c) observations for small/large countries (population <10 million/> 100 million); and d) outlier observations (those with residuals greater than 2.5 standard deviations from zero). While standard errors typically rise as observations are dropped from the sample, the point estimates of β remain reasonably stable and significant in both economic and statistical senses.

Panel D shows that the precise econometric technique does not seem to matter much. I successively: a) replace robust with conventional standard errors; b) replace fixed with random country effects; c) drop country effects; d) drop time effects; and e) drop the control covariates (X in equation (1)). Again, none of the perturbations in Panel D undermine confidence in the default estimate.[13]

I check the robustness of the precise measure of the bond market in Panel E. First, I substitute a five-year lag of the bond market in place of its contemporaneous variable. Next, I substitute shorter maturity bonds (technically "notes"), those between five and nine years, instead

of requiring that bonds be trading for maturities of at least ten years. The effect of the bond market on inflation remains statistically and economically significant through both of these checks.

The final pair of checks, recorded at the bottom of Table 2, is expected to fail. My hypothesis is that only bond-holders significantly affected by domestic inflation can be expected to provide support for anti-inflationary policies. I test this by successively replacing my long, nominal, domestic-currency bond market dummy variable with analogous dummies for bonds that are a) indexed or adjusted for inflation; and b) denominated in foreign exchange rather than domestic currency.[14] In the former case, the point estimates shrink but remains negative, measured with sufficient imprecision as to be insignificantly different from zero; in the latter case, the point estimates are actually positive, though again insignificantly different from zero.

All this bolsters confidence in the basic result: the presence of a long, nominal, local-currency bond market within an IT regime is associated with inflation that is about three-four percentage points lower.

Business Cycles and Output

The evidence presented above indicates that inflation is strongly affected by the presence of a bond market. What of other phenomena? Since the major focus here is on monetary policy, it is natural to examine output over the business cycle. It would be worrying if bond-holders exert undue influence and induce inappropriately contractionary monetary policy.

Table 3 presents estimates that are analogous to those of (1), substituting a measure of the business cycle in place of inflation as the dependent variable. I estimate:

$$BC_{it} = \beta Bond_{it} + \gamma X'_{it} + \{\delta_i\} + \{\varepsilon_t\} + \eta_{it} \qquad (2)$$

where BC_{it} is a measure of country i's business cycle deviation from trend at time t, and X' is a set of control covariates. To ensure the robustness of my results, I de-trend real GDP using four

techniques: a) Baxter-King filtering; b) Christiano-Fitzgerald filtering; c) Hodrick-Prescott filtering; and d) de-meaned annual growth rates.[15] I estimate (2) after dropping real GDP growth from the covariate controls (X'). Equation (2) links a bond market presence to the average deviation of output from trend; in order to see if there is a linkage between the bond market and the *magnitude* of business cycle deviations, I re-run (2) after taking absolute values of the dependent variable.

The bond market seems to dampen the volatility of business cycles, as shown by the negative coefficients in the right-hand column of Table 3. Still, the estimates of β in Table 3 are all small, and none are statistically significant at conventional levels. In this (limited) sense, the existence of the bond market does not appear to affect either the average size of business cycle deviations or their magnitude, at least for IT countries.

Treatment Effect Estimates

In Table 4, I provide estimates for the effect of a bond market on inflation using a variety of different treatment effect estimators, all confined to inflation-targeting countries. For instance, I match bond market observations to those without bond markets using both the propensity score and nearest-neighbour matching techniques in the top pair of rows.[16] The estimated treatment effects of the bond market for both CPI and GDP inflation is between 3.6 and 5.1 percentage points. This is both economically and statically significant; it is also reassuringly close to the panel estimates of Table 2. The next row tabulates a similar effect estimated using a regression-adjusted treatment effect estimator, using the five control covariates as the regression model to predict potential outcomes. I also provide inverse-probability treatment effect estimates, and then combine this technique with regression adjustment in two ways. The bottom line for inflation targeters from a dozen treatment effect estimates is similar; inflation is approximately three to four percentage points lower for countries with bond markets.

Instrumental Variable Estimates

The existence (or absence) of a bond market is a variable that may be measured with error. It may also be simultaneously determined with inflation, even within the class of inflation-targeting countries. For both reasons, I now pursue instrumental variables estimation. In particular, I use two instrumental variables: the size of government spending relative to GDP, and the log of the length of time since national independence. I also show that my results do not depend on the exact choice of instrumental variables.

The motivation for my choice of IVs is simple: more mature governments are likely to have the institutional capacity necessary to create a bond market, and governments that spend more are likely to have a greater need to create one. More sophisticated strategies to develop instrumental variables undoubtedly exist. For instance, one could imagine focusing on wars, private-sector financial development, and/or instability associated with previous inflations.[17] I leave further elaboration for future research.

Table 5 presents evidence associated with instrumental variables estimation of (1). The top row contains the default results, instrumenting bond market existence with government spending (measured as a fraction of output) and the log of years of independence. These are not weak instrumental variables; the left-hand column tabulates the p-value for the hypothesis that both coefficients are zero in the first-stage regression of the bond market dummy variable on the two instrumental variables (as well as the other regressors of (1)). The p-value is low, indicating that the instrumental variables are significantly correlated with the bond market dummy variable.[18]

To the right, IV estimates of β are tabulated, along with robust standard errors. The coefficients for both measures of inflation are larger than those of least squares, indicating a drop in inflation effect of about eight percentage points in the presence of a bond market. While both coefficients are statistically large, so are the standard errors. Hausman tests are also presented for the hypothesis of equality between LS and IV estimates; these indicate no significant difference.

Succinctly, IV estimates of the coefficient of interest remain economically and statistically significant and negative; the existence of a bond market seems to lower inflation for IT countries.

The remainder of Table 5 shows that this result does not depend sensitively on the exact choice of instrumental variables. I consider six variants of my default pair of IVs. First, I cap the effect of independence at 100 years. Second, I substitute military for total government spending, since governments are particularly sensitive to security concerns. I pursue this line of reasoning further, by replacing government spending with a measure of "state fragility." State fragility is a composite measure intended to be "closely associated with its state *capacity* to manage conflict; make and implement public policy; and deliver essential services and its *systemic resilience* in maintaining system coherence, cohesion, and quality of life; responding effectively to challenges and crises, and sustaining progressive development."[19] The measure is a composite of eight sub-indices; those for "security effectiveness" and "security legitimacy" are particularly attractive as instrumental variables, since they are unlikely to be unrelated to inflation but are plausibly linked to the state's demand for fiscal resources.[20] Accordingly, I also present a perturbation with security effectiveness and legitimacy substituted for government spending. As an alternative, I use total central government debt in place of government spending. Finally, I drop government spending altogether, since this variable is only weakly correlated with bond market presence. Using the stock of government debt in place of the flow of government spending lowers the number of observations available and thus precision.[21] Otherwise, none of the exercises changes the results substantively.[22]

5. Conclusion

It is natural (if sometimes mistaken) to think that low and stable inflation is a necessary for a bond market. In this short paper, I ask the converse question: does the existence of a long nominal local bond market affect inflation?

My work is unabashedly empirical and delivers a clear answer: the very existence of a market for long maturity, nominal bonds denominated in local currency seems to lower inflation by three to four percentage points (bonds that are either indexed to inflation or denominated in foreign currency do not have a similar effect). This result is striking because it holds for countries with inflation-targeting regimes, countries which already seem disposed to low and stable inflation. Other monetary regimes, such as those dedicated to maintaining hard fixed exchange rates, do not have the same reaction. And the effect is intuitive; countries with bond markets have a powerful interest group opposed to inflation, one that often has considerable influence. Finally, and reassuringly, no effect of the bond market is apparent on real output.

This work could be improved in several ways. First, I have presented an intuitive empirical result; interpretation could be sharpened within an explicit theoretical framework. Second, a more structural approach to the issue of simultaneity might prove fruitful. Third, it might be possible to improve on my measure of bond market presence. I use a simply dummy variable for the existence of publicly-traded market for long nominal local-currency bonds; a more continuous measure would be preferable.

I conclude that bond markets constitute an effective bulwark in the defence of an inflation-targeting regime.

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Table 1: Descriptive Statistics

A: Inflation with and without the presence of bond markets

Inflation	With Bond Market			No Bond Market			Test for Equality	
	Mean	Std Dev	Obs	Mean	Std Dev	Obs	Mean (t)	Std Dev (F)
CPI	5.5	32.	1,108	56.	682.	2,967	2.5*	443**
GDP	5.7	30.	1,146	63.	638.	3,650	3.0**	459**

The tests are t/F tests for equality of means/standard deviations across observations without/with bond markets. One (two) asterisk(s) indicate rejection of equality at the .05 (.01) significance level.

B: Inflation across monetary regimes in the presence of bond markets

Inflation	Inflation Targeting			Hard Fix			Neither		
	Mean	Std Dev	Obs	Mean	Std Dev	Obs	Mean	Std Dev	Obs
CPI	3.2	2.2	277	5.9	54.	381	6.6	10.4	412
GDP	3.6	2.9	294	6.1	50.	383	6.6	9.5	4211

C: Inflation across monetary regimes without a bond market

Inflation	Inflation Targeting			Hard Fix			Neither		
	Mean	Std Dev	Obs	Mean	Std Dev	Obs	Mean	Std Dev	Obs
CPI	7.2	4.0	69.	6.6	22.	999	95.	951.	1,489
GDP	8.9	5.7	71.	13.1	169.	1,229	114.	933.	1,596

D: Tests for Equality of Inflation in the absence/presence of bond markets

	Inflation Targeting		Hard Fix		Neither	
	Mean (t)	Std Dev (F)	Mean (t)	Std Dev (F)	Mean (t)	Std Dev (F)
CPI	11.4**	3.4**	.3	.2	1.9	8300**
GDP	11.0**	3.9**	.8	11.**	2.4*	9600**

The tests are t/F tests for equality of means/standard deviations across observations without/with bond markets. One (two) asterisk(s) indicate rejection of equality at the .05 (.01) significance level.

Table 2: Effect of Presence of Long Bond Market on Inflation, for Inflation Targeters

	CPI Inflation	GDP Inflation
A: Default		
Inflation Targeters	-2.9**	-4.4**
	(1.0)	(1.1)
B: Different Monetary Regimes		
Analogue for Hard Fixers	7.3	.6
	(7.7)	(13.7)
Analogue for Other Monetary Regimes	74.	136.
	(53.)	(83.)
C: Sample Sensitivity		
Drop pre-1995	-2.6**	-4.1**
	(1.0)	(1.1)
Drop post-2006	-4.7**	-6.4**
	(1.2)	(1.3)
Drop Poor (real GDP p/c < $10k)	-5.4**	-6.5**
	(1.0)	(1.2)
Drop Rich (real GDP p/c > $40k)	-2.9**	-4.5**
	(1.0)	(1.1)
Drop Small (population <10m)	-2.8*	-4.5**
	(1.0)	(1.5)
Drop Large (population > 100m)	-1.8	-4.8**
	(1.2)	(1.6)
Drop >|2.5σ| outliers	-2.8**	-4.4**
	(.6)	(.6)
D: Estimator Sensitivity		
Conventional standard errors	-2.9**	-4.4**
	(.5)	(.7)
Random (not fixed) country effects	-3.2**	-4.5**
	(1.0)	(1.0)
Drop country effects	-3.2**	-3.8**
	(.9)	(1.0)
Drop time effects	-2.6**	-4.6**
	(.9)	(1.2)
Drop covariates	-2.8*	-4.5**
	(1.1)	(1.3)
E: Robustness of Bond Market Measure		
5-year lag of bond market, not contemporaneous	-1.9**	-3.4**
	(.5)	(.8)
5-9 year maturity bonds instead of ≥10 years maturity	-4.7**	-4.2*
	(1.0)	(1.7)
Indexed/Adjusted instead of nominal long bonds	-1.6	-2.7
	(1.3)	(1.9)
Bonds denominated in foreign exchange, not LCU	1.1	1.4
	(.6)	(.8)

Coefficients for dummy variable (=1 if bond market exists, =0 otherwise). Robust standard errors (clustered by country) recorded parenthetically unless otherwise indicated; coefficients significantly different from zero at .05 (.01) level marked with one (two) asterisk(s). Sample restricted to inflation targeters unless otherwise indicated. Each cell is the result of a single panel regression of inflation on bond market presence with comprehensive time- and country-specific fixed effects unless otherwise indicated. Control covariates included: a) polity; b) log real GDP per capita; c) log population; d) trade, %GDP; and e) demeaned real GDP growth. Default includes annual data for up to 32 IT countries, 1991-2012 (up to 116 hard fixers, 1987-2012; up to 129 others, 1987-2012).

Table 3: Effect of Presence of Long Bond Market on Business Cycle, for Inflation Targeters

Real GDP detrender	Business Cycle Deviation from Trend	Absolute Business Cycle Deviation from Trend
Baxter-King	.001 (.005)	-.005 (.004)
Christiano-Fitzgerald	.001 (.005)	-.000 (.007)
Hodrick-Prescott	-.002 (.006)	-.010 (.006)
Growth	.63 (1.57)	-1.92 (.99)

Coefficients for dummy variable (=1 if long bond market exists, =0 otherwise). Robust standard errors (clustered by country) recorded parenthetically; coefficients significantly different from zero at .05 (.01) level marked with one (two) asterisk(s). Sample restricted to inflation targeters. Each cell is the result of a single panel regression of business cycle deviation on bond market presence with comprehensive time- and country-specific fixed effects, and control covariates. Control covariates included: a) polity; b) log real GDP per capita; c) log population; and d) trade, %GDP; GDP growth excluded. Annual data for up to 32 IT countries, 1991-2012.

Table 4: Average Treatment Effect of Long Bond Market on Inflation, for Inflation Targeters

	CPI Inflation	GDP Inflation
Propensity Score Matching (three matches)	-3.6** (1.2)	-3.6** (.9)
Nearest-Neighbour Matching (three matches)	-3.9** (.6)	-5.1** (.8)
Regression Adjusted	-3.8** (.8)	-4.2** (1.0)
Inverse-Probability Weighted	-3.8** (.6)	-4.4** (.8)
Inverse-Probability Weighted with Regression Adjustment	-3.3** (.9)	-3.7** (.9)
Augmented Inverse-Probability Weighted	-3.6** (.8)	-4.1** (1.0)

ATE for dummy variable (=1 if long bond market exists, =0 otherwise). Robust standard errors recorded parenthetically; coefficients significantly different from zero at .05 (.01) level marked with one (two) asterisk(s). Sample restricted to inflation targeters. Each cell is the result of a treatment effects estimation; estimator listed in left-hand column. Matching covariates: a) polity; b) log real GDP per capita; c) log population; d) trade, %GDP; and e) demeaned real GDP growth.

Table 5: Instrumental Variables Estimates

Instrumental Variables	Weak IV? (p-value)	CPI Inflation		GDP Inflation	
		β_{IV}	Hausman $\chi^2(27)$	β_{IV}	Hausman $\chi^2(27)$
Log Years Independence, Gov't Spending (% GDP)	.00**	-8.0** (3.0)	2.9	-8.7** (3.7)	1.4
Log Years Indep. 100 year max, Gov't Spending (% GDP)	.00**	-9.0** (2.7)	5.3	-10.3** (3.2)	3.5
Log Years Independence, Military Spending (% GDP)	.00**	-6.4* (2.8)	1.7	-7.9* (3.6)	1.0
Log Years Independence, State Fragility	.00**	-7.9** (2.7)	4.0	-9.0** (3.3)	2.3
Log Years Independence, Security Effectiveness, Legitimacy	.00**	-4.1* (1.8)	.7	-7.1** (2.4)	1.7
Log Years Independence, Central Government Debt (% GDP)	.09	-13.2 (7.1)	3.0	-10.4 (7.0)	1.5
Log Years Independence	.00**	-8.0** (3.0)	2.9	-8.4** (3.7)	1.2

Instrumental variables estimates of (1); IVs recorded in left column. β_{IV} records coefficients for dummy variable (=1 if bond market exists, =0 otherwise); robust standard errors (clustered by country) recorded parenthetically, coefficients significantly different from zero at .05 (.01) level marked with one (two) asterisk(s). Hausman test for equality of IV and least squares coefficients. Sample restricted to inflation targeters. Comprehensive time- and country-specific fixed effects and five control covariates included but not recorded. Annual data for up to 32 IT countries, 1991-2012.

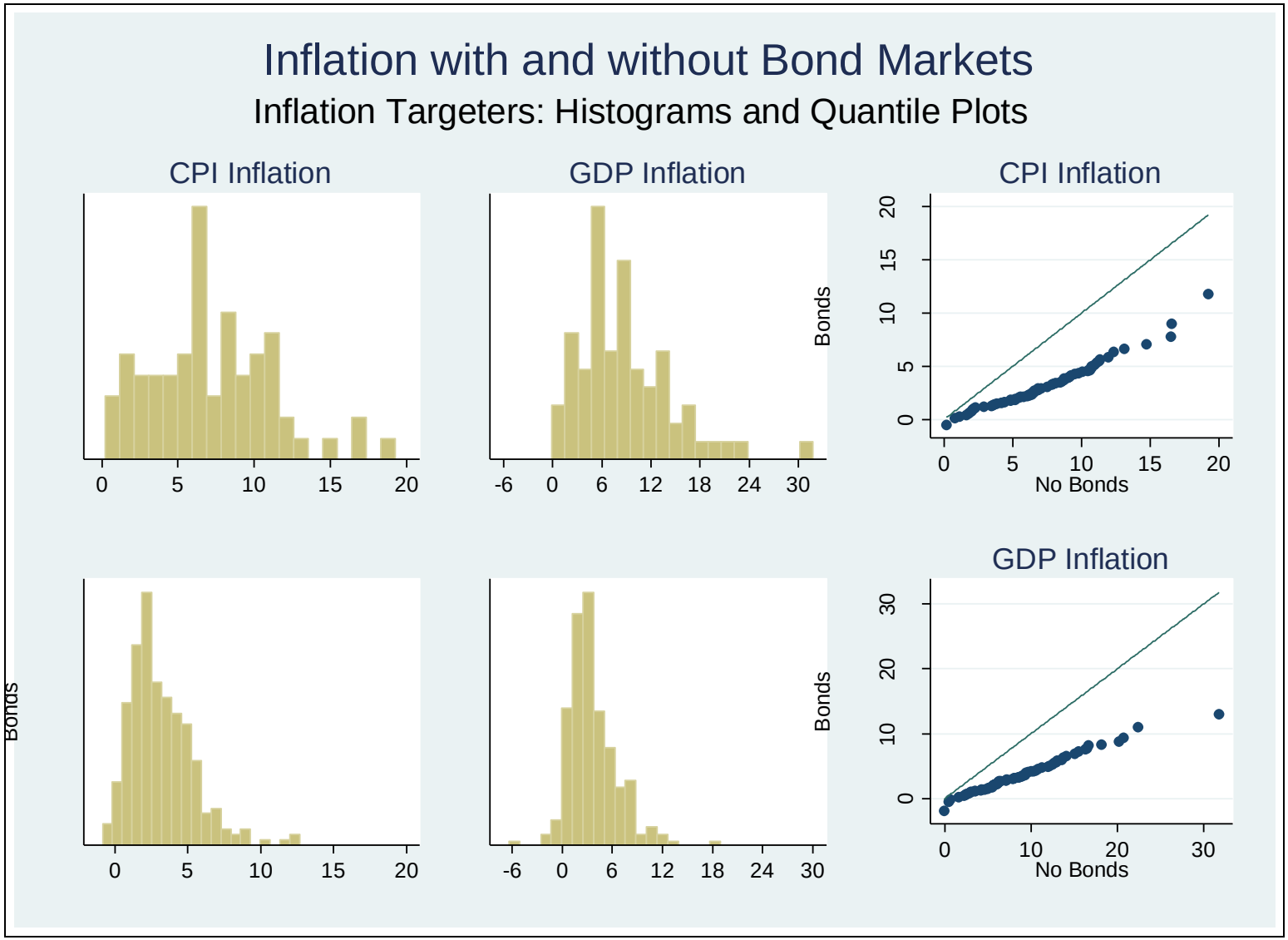
Inflation with and without Bond Markets
Inflation Targeters: Histograms and Quantile Plots
CPI Inflation
GDP Inflation
CPI Inflation
Bonds
No Bonds
GDP Inflation
Bonds
No Bonds
0
5
10
15
20
-6
6
12
18
24
30

Figure 1

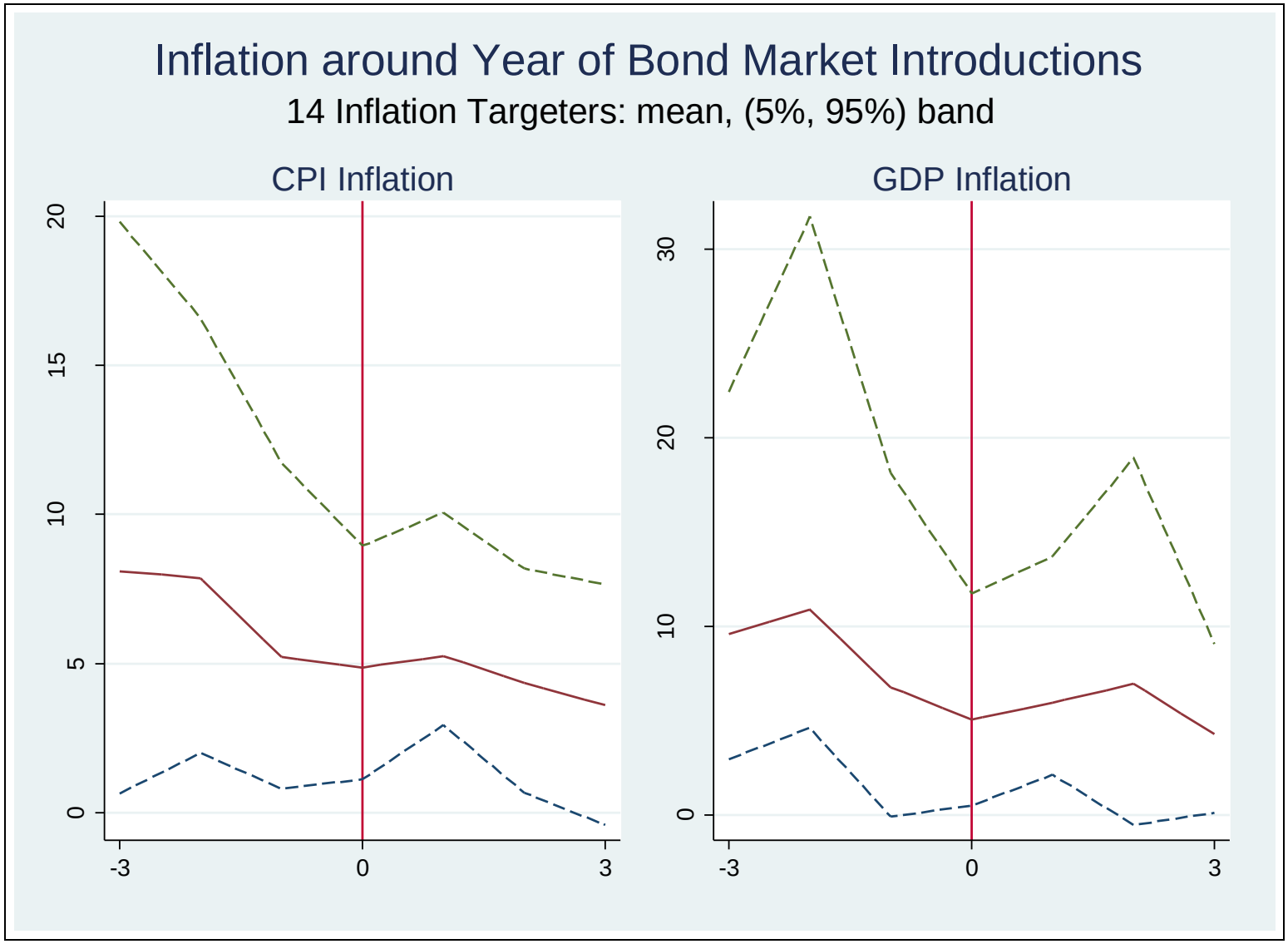
Inflation around Year of Bond Market Introductions
14 Inflation Targeters: mean, (5%, 95%) band
CPI Inflation
GDP Inflation
0
5
10
15
20
0
10
20
30
-3
0
3
-3
0
3

Figure 2

Appendix Table A1: Inflation Targeting Countries

	Inflation Targeting Begins	Bond Market Begins
Albania	2009	
Armenia	2006	2008
Australia	1993	1857
Brazil	1999	2007
Canada	1991	1853
Chile	1991	1993
Colombia	2000	2002
Czech Republic	1998	2000
Finland*	1993	1896
Ghana	2007	
Guatemala	2005	
Hungary	2001	1999
Iceland	2001	2004
Indonesia	2006	2009
Israel	1992	2001
Korea, Rep.	1998	2000
Mexico	1999	2001
New Zealand	1990	1861
Norway	2001	1822
Peru	2002	2008
Philippines	2002	1996
Poland	1999	1999
Romania	2006	2012
Serbia	2009	
Slovak Republic*	2005	1994
South Africa	2000	1860
Spain*	1995	1788
Sweden	1993	1788
Switzerland	2000	1899
Thailand	2000	1979
Turkey	2006	2012
United Kingdom	1993	1729

*Finland and Spain joined EMU in 1999; Slovakia joined in 2009.

Appendix Table A2: Effect of Presence of Inflation Targeting on Inflation, for Bond Marketers

	CPI Inflation	GDP Inflation
Default	-1.4	-1.2
	(1.7)	(1.6)
Analogue for Hard Fixers	2.3	2.4
	(3.4)	(3.4)

Coefficients for dummy variables (=1 if relevant monetary regime exists, =0 otherwise). Robust standard errors (clustered by country) recorded parenthetically; coefficients significantly different from zero at .05 (.01) level marked with one (two) asterisk(s). Sample restricted to country x year observations with bond market. Each cell is the result of a single panel regression of inflation on monetary regime dummy variable with comprehensive time- and country-specific fixed effects unless otherwise indicated. Control covariates included: a) polity; b) log real GDP per capita; c) log population; d) trade, %GDP; and e) demeaned real GDP growth. Annual data for up to 62 countries with long nominal LCU bond markets, 1987-2012.

Appendix Table A3: Bond Markets and the Choice of Monetary Regime

	Default	Drop Large Economies	3-year lag of Bond market
<u>Hard Fixed Exchange Rate</u>			
Bond Market	1.01**	.71*	1.16**
	(.35)	(.36)	(.37)
Log Population	-.37**	-.43**	-.36**
	(.10)	(.10)	(.11)
Log Real GDP p/c	.05	-.04	.07
	(.14)	(.14)	(.14)
Polity	-.05*	-.05*	-.05*
	(.02)	(.02)	(.02)
<u>Inflation Target</u>			
Bond Market	1.42**	1.03*	.70
	(.53)	(.44)	(.51)
Log Population	.15	.51**	.23
	(.16)	(.17)	(.17)
Log Real GDP p/c	.29	.89**	.51*
	(.25)	(.28)	(.26)
Polity	.21**	.24**	.24**
	(.06)	(.08)	(.06)
<u>Statistics</u>			
Observations	3402	3138	3081
Pseudo R^2	.14	.19	.15

Each column is the result of a multinomial logit estimation: default (omitted) cell is "sloppy centre". Coefficients for variables recorded in left-hand column. Robust standard errors (clustered by country) recorded parenthetically; coefficients significantly different from zero at .05 (.01) level marked with one (two) asterisk(s). Constants included in each column but not recorded.

Endnotes

[1] P39 of *Financial Market in Poland 1998-2001,* http://www.nbp.pl/en/systemfinansowy/financial_market.pdf, and p 74 of *Government Bond Market Development: The Korean Experience*, http://ksp.go.kr/common/attdown.jsp?fidx=220&pag=0000700003&pid=88.

[2] It is interesting to note that bonds have long been issued disproportionately to the rich. Pezzolo (2005, p147) writes:

> "Along with voluntary loans, some communes began to require forced loans from well to-do citizens. As far as we know, the first Italian government to do so was that of Venice, which in 1171, in order to prepare a fleet against the Byzantine emperor, decreed a loan from every citizen in relation to his patrimony, at an interest rate of 5 percent until the money was paid back (*donec pecunia imprestata restituatur*)."

[3] Romer (1993) has provided a compelling link between openness and inflation; accordingly, I include the ratio of trade to GDP.

[4] With a twist, since some countries are "treated" all the way through the sample, as they enter inflation targeting with a bond market.

[5] Natural, but perhaps mistaken. Even restricting attention to the OECD, a number of countries have experienced high inflation in the presence of a bond market; indeed, that is the norm. In the mid-1970s, Australia, Canada, and Denmark all experienced bouts of inflation of 15% or more while maintaining long bond markets; such inflationary episodes were more extended for Greece, Ireland, Italy, New Zealand, Spain, and the UK.

[6] https://www.globalfinancialdata.com/Databases/GFDatabase.html.

[7] https://www.globalfinancialdata.com/Databases/FixedIncomeDatabase.html.

[8] In particular, GFD seems to omit bonds of relevance from Armenia, Brazil, Chile, Israel, Kazakhstan, Nigeria, Peru, Trinidad and Tobago, Ukraine, and UAE.

[9] I fill in some observations missing from *WDI* with comparable series from the *Penn World Table* 7.1.

[10] http://www.systemicpeace.org/polity/polity4.htm.

[11] Available at http://personal.lse.ac.uk/ilzetzki/data/ERA-Annual%20coarse%20class.xls ; I use the first group of the coarse classification which includes: a) no separate legal tender; b) pre-announced peg or currency board arrangement; c) pre-announced horizontal band that is narrower than or equal to +/- 2%; and d) de facto peg. There is one exception: while I allow both Spain and Finland to be members of both hard fix and inflation target regimes during the run-up to EMU, I do not allow the Czech Republic to be classified as a hard fix after it begins inflation targeting.

[12] Quantiles are points taken at regular intervals from the cumulative distribution function of a random variable. Dividing ordered data into q essentially equal-sized data subsets is the motivation for q-quantiles; the quantiles are the data values marking the boundaries between consecutive subsets (http://en.wikipedia.org/wiki/Quantile).

[13] Adding the growth rate of either M1 or M2 to the vector of controls makes no substantive differences in my results.

[14] One cannot perform the same exercise on stock markets, since all IT countries had stock markets throughout the sample.

[15] I use standard parameter values for my filtering techniques: a smoothing parameter of 6.25 for Hodrick-Prescott (as suggested by e.g., Ravn and Uhlig); and for Christiano-Fitzgerald and Baxter-King bandpass filtering, minimal/maximal periodicities of two/eight years respectively, with a lead-lag length of three years (as suggested by e.g., Baxter and King).

[16] I match observations on the basis of the five control variables (X) from equation (1). Also, I use three matches; results remain strong if the exact number of matches is varied.

[17] A number of government bond markets, especially older ones, were created to provide a way for the government to finance fiscal deficits, especially those associated with war. The Bank of England was founded in order to issue and manage debt for the government during a war with France (http://www.bankofengland.co.uk/education/Documents/resources/postcards/history2.pdf), and the United States began to issue Treasury bonds in 1917 shortly after entering WWI (http://www.treasury.gov/about/history/Pages/1900-

Present.aspx). The martial origins of Italian and Dutch debt are discussed by Pezzolo (2005) and de Vries and van der Woude (1997) respectively. Alternatively, a long government bond market may be a necessary ingredient for a benchmark yield curve. Finally, modern aversion to inflation may reflect historical experience (Germany is often cited); bond markets may also be developed as a response to crises (East Asia after the crisis is a case in point). Such issues are worth considering in future research.

[18] The pair of IVs seem excludable from (1); the p-value of the joint hypothesis that both years of independence and government spending as a fraction of GDP can be excluded from the CPI (GDP) inflation equation is .12 (.23).

[19] More specifically (p7 of *State Fragility Index and Matrix* 2013): 'the measure of Fragility … scores each country on both Effectiveness and Legitimacy in four performance dimensions: Security, Political, Economic, and Social, at the end of the year 2013. Each of the Matrix indicators is rated on a four-point fragility scale: 0 "no fragility," 1 "low fragility," 2 "medium fragility," and 3 "high fragility" with the exception of the Economic Effectiveness indicator, which is rated on a five-point fragility scale (including 4 "extreme fragility"). The State Fragility Index, then, combines scores on the eight indicators and ranges from 0 "no fragility" to 25 "extreme fragility.' More details are available at http://www.systemicpeace.org/inscr/SFImatrix2013c.pdf

[20] Security effectiveness is a measure of general security and vulnerability to political violence, based on two assumptions: (1) the residual effects of low level and/or short wars diminish relatively quickly; and (2) the residual effects of serious or protracted wars diminish gradually over a 25-year period. Security legitimacy is a measure of state repression, drawn from separate annual indicators of U.S. State Department and Amnesty International reports. Further details are available at http://www.systemicpeace.org/inscr/SFImatrix2013c.pdf.

[21] The same problem, of limited observations, characterizes other fiscal variables. For instance, using the government's budget surplus or deficit (relative to GDP) instead of government spending reduces the sample size by twenty percent, while using the stock of central government debt (relative to GDP) reduces the sample size by over forty percent. Still, the latter is probably the preferable instrumental variable from a theoretical viewpoint; Missale and Blanchard (1991) present a model that ties the maturity of government debt to its size.

[22] Estimates for the equivalent of a reverse regression to (1) are presented in Appendix Table A2. Where (1) estimates the inflation effect of the existence of a bond market for inflation targeters, the results in Table A2 show that IT has no effect on inflation for countries with bond markets.

One could also argue that the IT regime itself is endogenous with respect to the existence of the bond market. A small amount of evidence consistent with this is tabulated in Appendix Table A3. The determination of monetary regimes is notoriously difficult to model empirically; this multinomial logit model uses the default model of size, income, and polity developed in Table 8 of Rose (2013).