Bond Vigilantes and Inflation

Andrew K. Rose and Mark M. Spiegel*

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Abstract

This paper explores the relationship between inflation and the existence of a local, nominal, publicly-traded, long-maturity, domestic-currency bond market. Domestic bond markets have an unclear effect on inflation; they present issuing governments with the opportunity to inflate away their debt obligations, but also expose bond holders to capital losses through inflation, creating a potential anti-inflationary force. We ask whether the latter effect is apparent empirically. We use a panel of data, examining inflation before and after the introduction of a domestic bond market. Inflation-targeting countries with a bond market experience inflation at least three to four percentage points lower than those without one. This effect is economically and statistically significant; it is also insensitive to a variety of estimation strategies. In particular, we use a wide variety of political and fiscal instrumental variables to account for the potential endogeneity of domestic bond issuance. Moreover, we do not find a similar effect for indexed or foreign-currency bonds.

Keywords: empirical, panel, long, maturity, domestic, currency, risk, fixed, effect, nominal, debt.

JEL Classification Codes: E52, E58

Contacts: Andrew K. Rose, Haas School of Business,
University of California, Berkeley, CA 94720-1900
Tel: (510) 642-6609
E-mail: arose@haas.berkeley.edu
URL: http://faculty.haas.berkeley.edu/arose

Mark M. Spiegel, Economic Research,
Federal Reserve Bank of San Francisco, 101 Market St., San Francisco, CA, 94105
Tel: (415) 974-2168
E-mail: mark.spiegel@sf.frb.org

* Rose: B.T. Rocca Jr. Professor of International Business, Associate Dean, and Chair of the Faculty, Haas School of Business at the University of California, Berkeley, NBER Research Associate, CEPR Research Fellow, and ABFER Senior Fellow; Spiegel: Vice President, Finance and International Research, Federal Reserve Bank of San Francisco.

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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

Countries issue debt 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, we ask the question: does the very existence of such bond markets help keep inflation low and stable?

The answer is not obvious. On one hand, the existence of local currency bond markets gives issuing governments the incentive to raise inflation to lower the real value of outstanding nominal debt obligations. However, at the same time it creates a potentially formidable political force that benefits from low stable inflation, namely the holders of those same nominal bonds.

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 that are not protected from inflation, it can create a powerful constituency for low inflation.[2] The consequences of inflation become more concentrated when they are borne by the rich rather than the poor. The logic of collective action then implies that the political 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 domestic-currency bonds are held, as they are owned by a relatively small powerful interest group necessarily opposed to the redistributive consequences of inflation.[3] That is, inflation is likely to be lower when the consequences of the inflation tax are borne more by bond-holders and less by money-holders. This effect can also operate without any growth in the bond market relative to the money market, if the composition of government debt is transformed. Debt which is short-maturity, indexed, and/or

foreign-currency denominated does not provide the anti-inflation bulwark of long, nominal, local-currency bonds.

In the appendix of this paper, we present a theoretical model which formalizes our intuition. We consider a political-economy median voter model in which the issuance of domestic-currency bonds encourages the government to pursue a lower inflation rate. As entry into securities markets is costly and the distribution of wealth is skewed, only the rich hold securities; the poor hold only money and are thus always exposed to inflation risk. When exposed to inflation risk through nominal bonds, the rich lobby to induce the government to pursue a lower inflation outcome than it would have chosen on its own.[4] Under certain parameter conditions inflation drops, since the lobbying effect dominates the government incentive to inflate away its debt obligations. In this manner, rich households holding nominal assets and acting solely in their self-interest, can actually work to equalize the distribution of pre-tax wealth across households, since the poor benefit from lower inflation. That is, the anti-inflation lobbying efforts of the rich inadvertently and disproportionately benefit the poor.

There may be additional costs of inflating away nominal debt obligations, above and beyond those considered in our model. Increased inflation may weaken the local banking sector and firm balance sheets [e.g. Gennaioli, et al (2014) and Du and Schreger (2014)], potentially disrupting local financial conditions and adding to the costs of government-triggered default. This theoretical conjecture is shown to hold empirically for sovereign defaults by Du and Schreger (2016). Since our focus is empirical, we remain essentially agnostic on the underlying mechanism; we present a theory simply to provide one possible explanation for our empirical results.

Our main objective is to examine the implications of local currency nominal bond markets for inflation empirically. Our results demonstrate that the presence of a long, nominal, local-currency bond market is indeed associated with inflation that is at least three to four percentage

points lower, for inflation-targeting countries. We do this using an instrumental variables panel data approach, using country- and time-specific fixed effects, as well as other controls.

Causality could easily run in both directions between bond market development and inflation. A number of papers [e.g. Calvo (1996), Jeanne (2000) and Claessens, et al (2007)] argue that the currency composition of debt is endogenously related to perceived borrowing risk, implying that bond markets are determined at least in part by inflation. This is intuitive; partial default on nominal debt through inflation may be less costly than formal debt renegotiation. As such, this form of default may be attractive to a country facing financing difficulties, making it challenging for agents from such countries to issue domestic currency debt *ex ante*. Stable monetary conditions have been shown to be associated with greater shares of public and private domestic currency issuance [e.g. Claessens, et al (2007) and Burger and Warnock (2007)], as have expectations of more stable future monetary conditions [Hale and Spiegel (2012)].

We take it as given that inflation is likely a determinant of bond market development, and ask the converse question; does bond market development affect inflation? We account for simultaneity in a number of ways. First, we limit our sample to inflation-targeting countries, who have formally committed to avoiding inflation. Second, we control for other characteristics that may influence inflation or bond market creation. Finally and most importantly, we deal with this problem head-on by showing that a variety of plausible instrumental variables deliver similar results. (We also show that our results are robust to treatment effect estimation.) We use five sets of IVs, including different combinations of the size of government spending as a share of GDP, the time that has passed since national independence, measures of security effectiveness and legitimacy, the adoption of a democratic political system, and civil liberties. We show that these are strong instrumental variables, and that tests of over-identifying restrictions are not rejected at conventional significance levels. While we rely on our IV estimates most, we find that least squares, treatment effect, and instrumental variable estimates are similar; the introduction of a bond market seems to

cause inflation to fall by at least three percentage points and plausibly twice as much. Thus while the literature has already established that inflation affects bond markets, our value added is to demonstrate that the reverse is also present in both theory and practice.

2. Empirical Strategy and Methodology

Our objective is to investigate whether the presence of a domestic currency bond market is negatively correlated with inflation empirically. There are obviously other determinants of inflation, especially in the short run. As a consequence, our methodology is relatively low-frequency, relying on annual data for a broad panel of countries. We begin with a conventional panel setup:

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

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 nominal, long-term, domestic-currency bond market at time t, and 0 otherwise), X_{it} is a vector of controls linked to inflation via a set of nuisance parameters γ, $\{\delta_i\}$ and $\{\varepsilon_t\}$ are respectively country- and time-specific fixed effects, and η is a residual to represent all other influences on inflation. The coefficient of interest is β, the partial-correlation between a bond market and inflation. We use five covariates X_{it} to control for other inflation determinants unlikely to be affected by bond market existence: 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.[5] Since we include comprehensive sets of both time- and country-specific fixed effects, this can be interpreted as a difference-in-differences estimator.[6]

Why and when do local 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.[7] 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?

We try to handle this potential simultaneity problem in a few ways. First, we estimate (1) only for inflation-targeting regimes (hereafter "IT"). IT regimes have proven remarkably durable and consistently deliver inflation that is low and stable compared with alternate regimes. Thus we begin by restricting our attention to a set of countries that would already seem to have the necessary conditions to establish a domestic currency bond market. As a robustness check, we also consider other monetary 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 suffer less from endogeneity among IT regimes.

We also try two econometric strategies to deal with potential simultaneity. We 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. We also estimate (1) with instrumental variables, relying on a number of (mostly political) variables to construct instruments for bond market existence. We use a set of six default instrumental variables, and show that our results are insensitive to their exact nature, providing five different combinations of the IVs. Our IV results indicate an economically and statistically significant effect of a bond market on inflation for the inflation targeting countries, about twice the size of the effect estimated with least squares.

3. The Data Set

We are 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 and controls, we need

information on whether or not a country maintains an IT regime, and a domestic currency bond market. The most difficult information to obtain is whether a suitable bond market exists.

We begin with the GFDatabase from *Global Financial Data* (hereafter "GFD"). GFDatabase is advertised as providing data "spanning more than 200 global markets and extending coverage back to 1265."[8] We 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."[9]

In practice, bond data from GFD appear to be available for those bonds traded with sufficient liquidity to have prices quoted, typically over the counter, and often after an initial auction. We rely on series for government bonds, since the corporate analogues from GFD tend to follow government bonds in time. We are interested in long, nominal, local-currency bonds, since these are the most vulnerable to inflation. We begin with bonds which have a maturity of at least a decade. Ten years is an international benchmark, a maturity largely outside the horizon of current monetary policy, and a horizon sufficiently long that bond prices are quite responsive to (actual and expected) inflation. We also use GFD to construct series on shorter maturity, indexed, and foreign-denominated bonds, as robustness checks.[10]

While we begin with GFD, we have checked it extensively against other data sources, which typically seem less complete. 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 we have found is Dealogic, which covers 73 countries (and territories, such as Jersey and Puerto Rico). We have checked the GFD data for errors against all these sources (and others), and corrected some GFD errors and omissions.[11,12]

Other data series are more straightforward. We 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.[13] Dates for the start of inflation targeting regimes are taken from Rose (2013). We use polity2, which ranges from -10 (autocracy) to +10 (democracy), taken from the *Polity IV* project.[14] For hard fixed exchange rate regimes, we use the Reinhart-Rogoff (2004) data set, updated through 2010 by Ilzetzki, Reinhart and Rogoff.[15]

In all, we have annual data for over 200 countries between 1970 and 2012 (with gaps). However, most of our 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 domestic-currency, long, nominal, bond markets. Four IT countries do not have bond markets during the sample (Albania, Ghana, Guatemala, and Serbia). 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 our empirical approach.

Do IT countries with domestic currency bond markets seem to have lower and more stable inflation than those without bonds? Figure 1 provides some informal graphical evidence. In the pair of histograms at the left of the figure, we plot CPI inflation for IT countries with (below) and without (above) bond markets.[16] 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).[17] 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 CPI 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. We 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. The introduction of a long bond market in an inflation-targeting country seems to be associated with lower inflation. Inflation begins at approximately the inflation rate for IT countries without bond markets (marked with horizontal lines) and seems to converge towards that of IT countries with bond markets (also marked). But the event-study should not be over-interpreted. There are only 14 cases where inflation targeters introduced a bond market during the sample. Further, the event is the creation of the bond market; there appears to be a one-year anticipation of these events, which is perhaps unsurprising, given the issues involved with setting up such a market. Accordingly, it is appropriate to add more rigor to the empirics.

4. Results

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, we pursue instrumental variables estimation. We begin with a set of six instrumental variables: a) the log of the length of time since national independence; b) the size of government spending (relative to GDP); c-d) measures of security effectiveness and legitimacy; and e-f) measures of civil liberties and democracy.

More mature governments are likely to have the institutional capacity necessary to create a bond market. Governments that spend more are likely to have a greater need to create one. Security effectiveness is a measure of a nation's security and vulnerability to political violence provided by systemicpeace.org; security legitimacy is a measure of state repression. Violent and repressive political environments plausibly deter the creation or existence of a long bond market intrinsically concerned with repayment prospects.[18] Civil liberties is measured by Freedom House, and varies from 1 through 7.[19] We also use the democracy variable as measured by Freedom House.[20] It strikes us as plausible that freer and more democratic societies are more likely to engender far-sighted institutions like bond markets.

We are at pains to show that our results do not depend sensitively on the exact choice of instrumental variables, by considering different combinations of the six alternatives. We also take advantage of the fact that we have six instrumental variables to estimate a single coefficient to test the over-identifying restrictions.

Our benchmark estimates of (1) are recorded in Table 1. The top row presents results when all six of our instrumental variables are employed. The point estimates of β (in the "Coef." column) are -5.3 and -7.4 for CPI and GDP inflation rates respectively. Both estimates are economically large, indicating that inflation is over five percentage points lower when a long local bond market exists compared to economies without a bond market. Both estimates are also significantly different from zero at the .01 level (robust standard errors are recorded parenthetically).

Other columns in Table 1 provide evidence that bolsters confidence in the coefficient estimates. We tabulate the p-value for Wooldridge's score test of the null hypothesis of endogeneity (similar to a Hausman test, but without the requirement of iid errors, since we employ robust standard errors). We also provide the p-value for the F-test of weak instrumental variables in the first-stage, as well as a conventional test of over-identifying restrictions (we again use a test that does not require iid errors, such as Sargan's test). Curiously and comfortingly, there is little evidence of bond market endogeneity. We are reassured to see both that the hypothesis of weak instrumental variables is strongly rejected, and that the test of over-identifying restrictions is not.

Successive rows of Table 1 provide results when we alter the set of instrumental variables; we retain at least two so that a test of over-identifying restrictions is possible. The point estimates for the effect of the bond market on inflation remain consistently negative and are typically significantly different from zero at conventional levels (one of the ten estimates, for the second set of instrumental variables and the CPI inflation rate, is only significant at the .1 level). The results of the other diagnostic statistics twin with those of the top row; there is remarkably little evidence that bond market presence is actually endogenous, and the instrumental variables look strong. The over-identifying restrictions are not rejected with one exception (again, for the second set of instrumental variables and the CPI inflation rate, at the .05 significance level).[21]

The bottom row of Table 1 presents results when (1) is estimated with OLS. The coefficients estimates of β remain significantly negative but shrink in size by a factor of around two. The OLS estimates show that IT countries with a domestic currency 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. Our IV estimates are consistently higher in magnitude than the OLS estimates; to act conservatively, we choose to emphasize the lower (OLS) point estimates.

Different strategies to develop instrumental variables for bond market existence undoubtedly exist. For instance, one could imagine focusing on wars, private-sector financial development, and/or instability associated with previous inflations.[22] We leave further elaboration for future research. Still, we conclude that estimation with a number of different sets of reasonable instrumental variables delivers a negative effect of bond markets on inflation that is economically and statistically significant. That is, even though the literature leads us to believe that inflation influences bond market development, the reverse linkage is also apparent in the data.

Sensitivity Analysis

The evidence from Table 1 indicates that the existence of a long nominal local bond market is associated with lower inflation. Table 2 provides sensitivity analysis to show that this conclusion is insensitive to a number of features of the methodology. The default estimates of β from the top row of Table 1 are reproduced in Panel A of Table 2 for ease of comparison; successive panels provide analogous estimates when the methodology is changed in (sixteen) different ways.

Panel B shows that the key (β) coefficients are robust to changes in the precise data sample. We 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 <5 million/> 100 million); and d) outlier observations (those with residuals greater than 3 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. The bottom row of Panel B changes the sample more dramatically, using only observations for countries *not* engaged in inflation targeting. These last point estimates are dramatically different; the effect of a bond market in a non-IT regime is estimated to be positive, but with sufficient imprecision as to be insignificantly different from zero. That is, our bond market results only characterizes inflation targeters, not countries with other monetary regimes.

Panel C shows that the precise econometric technique does not seem to matter much. We successively: a) replace robust with conventional standard errors; b) drop the country fixed effects; c) drop the time fixed effects; and d) drop the control covariates (X in equation (1)). The effect of the bond market remains negative and statistically significant throughout these perturbations, though its size drops dramatically when country effects are dropped. Still, none of the perturbations in Panel C undermines our confidence in the basic result.

We check the robustness of the precise measure of the bond market in Panel D. First, we 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. Next, we substitute a five-year lag of the bond market in place of its contemporaneous variable. The effect of the bond market on inflation remains negative and statistically and economically significant through both of these checks for the CPI inflation rate. The results for GDP inflation are smaller and significantly different from zero at only the .1 level.

The final pair of checks, recorded at the very bottom of Table 2, is expected to fail. Our hypothesis is that only bond-holders significantly affected by domestic inflation can be expected to provide support for anti-inflationary policies. We test this by successively replacing our 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.[23] 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, and marginally significant. Thus, the drop in inflation appears to come from a particular type of bonds, not extra fiscal space in itself.

A simple placebo test is presented in Figure 3. For each IT country, we replace the actual date a bond market was created (if any, since four of our countries never have bond markets in the sample) with a date bootstrapped from our 32 inflation targeters, replace our bond dummy variable

with this artificially created one, and then estimate β from (1). We do this a large number of times, and display histograms for these bootstrapped coefficients in Figure 3. Most cluster around zero; our actual estimates are displayed and are out on the tail. Falsified bond market dates, even for IT countries, do not deliver our results.

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 at least three-four percentage points lower.

Treatment Effect Estimates

In Table 3, we 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, we 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.[24] 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 Tables 1-2. 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. We 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.

5. Conclusion

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

In a theoretical model we present in the appendix, we introduce a model that suggests that the answer may be positive. In this model, the numerous poor hold cash and are thus exposed to inflation, while the few wealthy initially hold foreign bonds. Our model suggests that when a domestic bond market is created, the rich find themselves holding assets exposed to inflation, and respond by lobbying to lower inflation. Our model is stylized and not meant to be taken literally. Still, it formalizes our contention that domestic financial market development can influence macroeconomic outcomes. By issuing debt that is not protected from inflation, the government creates a powerful political group opposed to inflation, and ends up choosing less inflation than it would otherwise.

Our empirical work supports this prediction: the very existence of a market for long maturity, nominal bonds denominated in local currency seems to lower inflation by at least 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 seems natural, and is consistent with the intuition provided by our theoretical model; countries with bond markets have a powerful interest group opposed to inflation, one that often has considerable influence. This result is more 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.

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

References

Acemoglu, Daron, Simon Johnson, Pablo Querubin and James A Robinson, "When Does Policy Reform Work? The Case of Central Bank Independence," *Brookings Papers on Economic Activity*, Vol. 2008 (Spring), 351-4.

Burger, John D. and Francis E. Warnock, (2006), "Local Currency Bond Markets," *IMF Staff Papers*, 53, 133-146.

Burger, John D. and Francis E. Warnock, (2007), "Foreign Participation in Local Currency Bond Markets," *Review of Financial Economics*, 16, 291-304.

Calvo, Guillermo, (1996), *Money, Exchange Rates and Output,* the MIT Press, (Cambridge, MA).

Chang, Roberto, and Andrés Velasco, (2006), "Currency Mismatches and Monetary Policy: A Tale of Two Equilibria," *Journal of International Economics,* 69, 150-175.

Claessens, Stijn, Daniela Klingebiel, and Sergio Schmukler, (2007), "Government Bonds in Domestic and Foreign Currency: The Role of Institutional and Macroeconomic Factors," *Review of International Economics,* 15(2), 370-413.

Deacon, Mark, Andrew Derry and Dariush Mirfendereski, (2004), *Inflation-Indexed Securities: Bonds, Swaps and Other Derivatives, 2nd ed* (Wiley, New York).

Doepke, Matthias and Martin Schneider, (2006), "Inflation and the Redistribution of Nominal Wealth," *Journal of Political Economy*, 114(6), 1069-1097.

Du, Wenxin and Jesse Schreger, (2014), "Sovereign Risk, Currency Risk, and Corporate Balance Sheets, Working Paper, Harvard University and Federal Reserve Board.

Du, Wenxin and Jesse Schreger, (2016), "Local Currency Sovereign Risk," *Journal of Finance*, 71(3), 1027-1070.

Eichengreen, B. and Hausmann, R. (1999) "Exchange rates and financial fragility" *NBER Working Paper* No 7418.

Fischer, Stanley, (1983), "Indexing and Inflation," *Journal of Monetary Economics* 12, 519-541.

Gennaioli, Nicola, Alberto Martin, and Stefano Rossi, (2014), "Sovereign Default, Domestic Banks, and Financial Institutions," *Journal of Finance*, 69(2), 819-866.

Hale, Galina B., and Mark M. Spiegel, (2012), "Currency Composition of International Bonds: The EMU Effect," *Journal of International Economics*, 88, 134-149.

International Monetary Fund (2002) "Chapter IV, Selected Topic: Emerging Local Bond Markets" in *Global Financial Stability Report*.

Jeanne, Olivier, (2000), "Foreign Currency Debt and the Global Financial Architecture," *European Economic Review,* 44, 719-727.

Pezzolo, Luciano (2005) “Bonds and Government Debt in Italian City-States, 1250-1650” in *The Origins of Value: The Financial Innovations that Created Modern Capital Markets* (Goetzmann and Rouwenhorst, eds: Oxford University Press).

Reinhart, Carmen M. and Kenneth S. Rogoff (2004) “The Modern History of Exchange Rate Arrangements” *Quarterly Journal of Economics* CXIX-1, 1-48.

Romer, David (1993) “Openness and Inflation: Theory and Evidence” *Quarterly Journal of Economics* 108, 869-903.

Rose, Andrew K. (2007) “A Stable International Monetary System Emerges: Inflation Targeting is Bretton Woods, Reversed” *Journal of International Money and Finance.*

Rose, Andrew K. (2013) “Surprising Similarities: Recent Monetary Regimes of Small Economies” *NBER Working Paper No. 19,632.*

Tirole, Jean, (2003), “Inefficient Foreign Borrowing: A Dual and Common-Agency Perspective,” *American Economic Review,* 93(5), 1678-1702.

Vries, Jan de and Woude, A Van Der (1997) *The First Modern Economy. Success, Failure and Perseverance of the Dutch Economy, 1500-1815* (Cambridge University Press).

Table 1: Instrumental Variables Estimates

Instrumental Variables	CPI Inflation				GDP Inflation			
	Coef. (se)	Endogeneity (p-value)	1st-stage (p-value)	Overident. (p-value)	Coef. (se)	Endogeneity (p-value)	1st-stage (p-value)	Overident. (p-value)
IV1, IV2, IV3 IV4, IV5, IV6	-5.3*** (1.9)	.13	.00	.16	-7.4*** (2.1)	.15	.00	.34
IV1, IV3, IV4	-4.1* (2.2)	.48	.00	.05	-7.1*** (2.4)	.26	.00	.14
IV2, IV5, IV6	-6.9** (2.8)	.17	.00	.82	-7.3** (3.2)	.38	.01	.35
IV4, IV6	-6.2** (2.7)	.17	.00	.68	-8.7*** (2.7)	.10	.00	.51
IV1, IV5	-7.2*** (2.3)	.06	.00	.72	-8.5*** (3.0)	.19	.00	.98
OLS	-2.9*** (1.0)	n/a	n/a	n/a	-4.4*** (1.1)	n/a	n/a	n/a

Instrumental variables estimates of effect of long nominal LCU bond market on inflation; IVs recorded in left column. IV1 is log of years of independence; IV2 is direct government spending (% GDP); IV3 is security effectiveness; IV 4 is security legitimacy; IV5 is civil liberties; IV6 is democracy. Coef. records coefficient for dummy variable (=1 if bond market exists, =0 otherwise); robust standard errors recorded parenthetically, coefficients significantly different from zero at .1/.05/.01 level marked with one/two/three asterisk(s). Endogeneity is p-value for Wooldridge score test of null hypothesis of exogeneity. 1st stage is p-value of null hypothesis of F-test for weak instruments. Sample restricted to inflation targeters. Overident. is p-value for Wooldridge score test of over-identifying restrictions. Comprehensive time- and country-specific fixed effects and five control covariates included but not recorded (a) polity; b) log real GDP per capita; c) log population; d) trade, %GDP; and e) GDP growth). Annual data for up to 32 IT countries, 1991-2012.

Table 2: Sensitivity Analysis: Effect of Presence of Long Bond Market on Inflation

A: Default

	CPI Inflation	GDP Inflation
Inflation Targeters	-5.3***	-7.4***
	(1.9)	(2.1)

B: Sample Sensitivity

Drop pre-1995	-5.3***	-7.4***
	(1.9)	(2.1)
Drop post-2006	-7.8***	-8.3***
	(2.2)	(1.9)
Drop Poor	-11.2***	-11.8***
(real GDP p/c < $10k)	(2.2)	(2.0)
Drop Rich	-5.3***	-7.2***
(real GDP p/c > $40k)	(1.9)	(2.1)
Drop Small	-5.1***	-7.2***
(population <5m)	(2.0)	(2.1)
Drop Large	-3.6*	-5.1**
(population > 100m)	(2.2)	(2.3)
Drop >|3σ| outliers	-5.3***	-7.4***
	(1.9)	(2.1)
Analogue for non-Inflation	29.8	15.3
Targeters	(29.3)	(26.5)

C: Estimator Sensitivity

Conventional standard errors	-5.3***	-7.4***
	(1.5)	(2.0)
Drop country effects	-3.1***	-2.9**
	(1.0)	(1.4)
Drop time effects	-5.9***	-7.3***
	(2.1)	(2.2)
Drop covariates	-5.4***	-7.7***
	(1.5)	(2.1)

D: Robustness of Bond Market Measure

5-9 year maturity bonds instead	-3.8**	-2.9*
of ≥10 years maturity	(1.5)	(1.6)
5-year lag of bond market, not	-4.1***	-2.7*
contemporaneous	(1.4)	(1.5)
Indexed/Adjusted instead of	-1.6	-2.7
nominal long bonds, OLS	(1.3)	(1.9)
Bonds denominated in foreign	1.1*	1.4*
exchange not LCU, OLS	(.6)	(.8)

Coefficients for dummy variable (=1 if bond market exists, =0 otherwise); robust standard errors recorded parenthetically. Instrumental variables estimates unless otherwise indicated, using 6 IVs (a) log of years of independence; b) direct government spending (% GDP); c) security effectiveness; d) security legitimacy; e) civil liberties; f) democracy). Coefficients significantly different from zero at .1/.05/.01 level marked with one/two/three 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: 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.

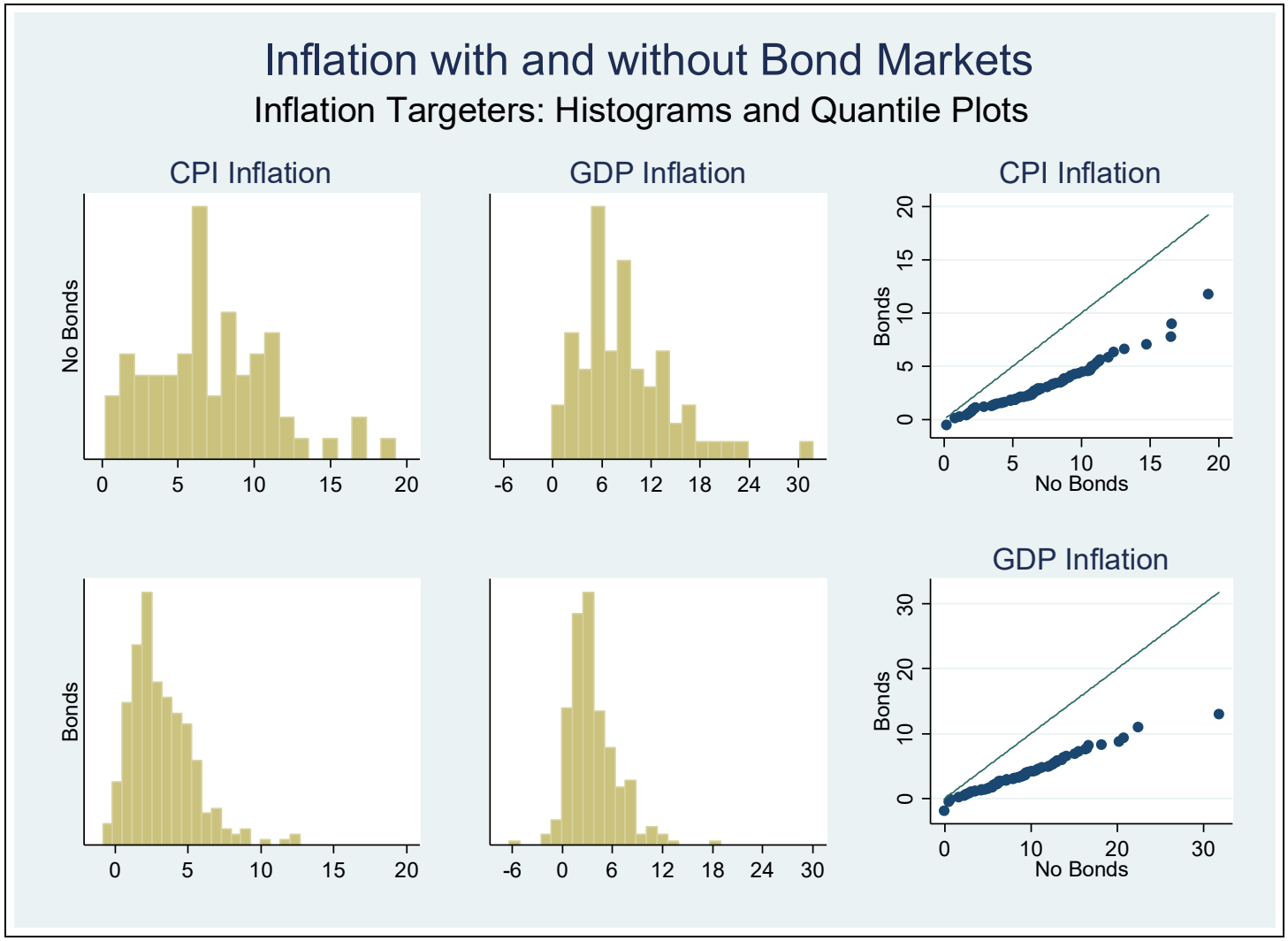

Figure 1: Descriptive Statistics

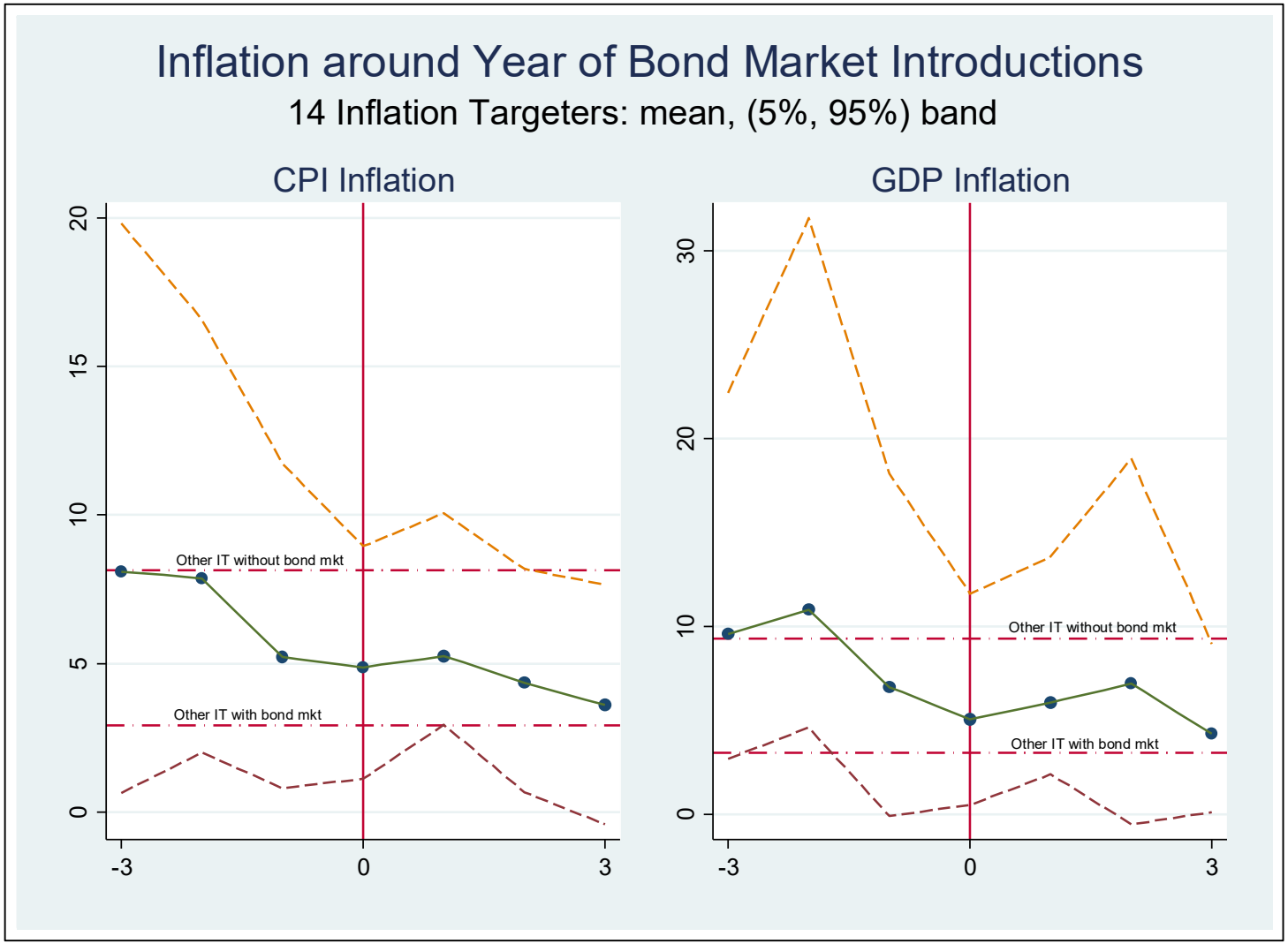

Figure 2: Event Studies

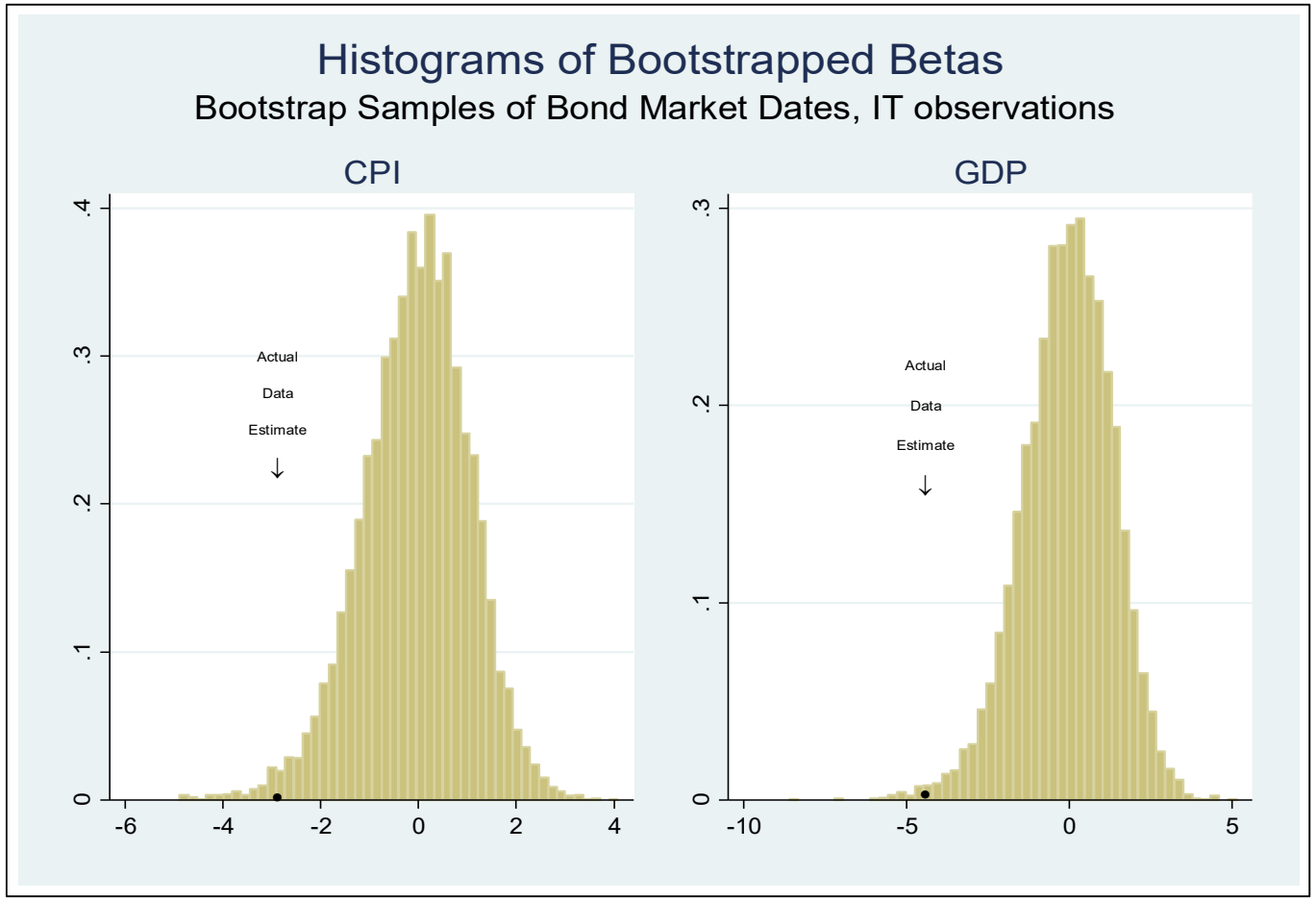

Figure 3: Placebo Tests

Appendix

Our study is related to earlier literature in which *ex ante* actions taken by the public or private sector can affect the severity of government moral hazard problems, and therefore *ex post* outcomes. A closely-related paper is Tirole (2003), in which the prevalence of domestic-currency denomination by private firms can discipline government behaviour. Similarly, Chang and Velasco (2006) demonstrate that private wage and debt contracts optimal for a given *ex post* exchange rate policy can change the payoffs to a benevolent government, inducing it to validate these contracts by pursuing a particular policy. An alternative strand of literature argues that low shares of domestic bond issuance may reflect "original sin," (e.g. Eichengreen and Hausmann, 1999); firms in emerging markets experience difficulties issuing debt in their domestic currencies along with greater macroeconomic instability *ex post*.

A1. A political-economy theory of bond market development and inflation

Consider a simple perfect-foresight one-period model of an endowment economy with domestic currency and inflation. There are three types of "agents": households, who are endowed with wealth at the beginning of the period, and invest in either cash or securities; the government, which finances its expenditures through debt issuance and services its debt through a combination of taxes and inflation; and an "inflation lobby" which acts on behalf of domestic bondholders – if such a market exits -- as a group, lobbying the government for lower inflation.

There are N atomistic households. Each household i is endowed with nominal assets w_i at the beginning of the period. Households are numbered from the household with the smallest endowment, 0, to those with the largest endowment, N.

Wealth can be held as cash, which yields no interest, or invested in securities. The government, has issued a total of G securities, denominated in either domestic or foreign currency.[25]

Markets are assumed to be segmented. There is an exogenous real fixed cost $\phi > 0$ of entering the securities market. After paying the fixed fee, households can purchase domestic or foreign bonds. Since international capital markets are open, interest parity requires that all bonds earn an expected return equal to one plus the real international rate of return, represented as r^*. We set the foreign inflation rate to 0 for simplicity. Domestic bonds pay an endogenous fixed nominal return, r, representing 1 plus the nominal interest rate in domestic currency.

The fixed cost of entering the securities markets implies scale economies. There is a marginal household, i^*, that is indifferent between entering the securities market and purchasing bonds, or holding cash. Wealthier households, $i \geq i^*$, all pay the fee and enter the bond market, while poorer households, $i < i^*$, hold cash. Without loss of generality, we assume that the median household $(i = N/2)$ is poorer than the marginal household, i.e. $w_m < w_{i^*}$. This requires a parameter restriction, which we determine below.

We assume that all households that purchase domestic securities also participate in lobbying. For simplicity, lobbying contributions are proportional to domestic bond holdings, with each bond holder contributing an amount λ times his bond holdings. λ is determined below.[26]

After paying the fixed fee to enter the securities market, households are free to choose between domestic and foreign securities. Interest rate parity ensures that ex ante

$$r = \pi^e r^* + \lambda^e \tag{2}$$

where X^e represents the expected value of variable X at the beginning of the period, and $\pi \geq 1$ represents 1 plus the rate of domestic inflation. In order to clear the market, the equilibrium nominal rate paid on domestic securities compensates asset holders for both expected inflation and the expected costs of political activity. All else equal, it is cheaper to issue domestic debt with lower expected lobbying activity.

At the end of the period, if the household does not enter the bond market its expected pre-tax real wealth satisfies w_i / π^e. Alternatively, if household i does enter the bond market (since expected securities returns are equalized), its expected pre-tax real wealth satisfies $r^*(w_i - \phi)$.

Let i^* represent the household that is indifferent between entering the securities market and holding cash, by (1), w_i^* satisfies

$$w_i^* = \frac{\phi}{\pi^e r^* - 1}. \tag{3}$$

The identity of the marginal household is a function of three arguments: First, i^* is increasing in ϕ; the more costly it is to enter the securities market, the larger a household's wealth needs to be. It is decreasing in r^* as increases in bond returns reduce the initial wealth needed to make entering the bond market profitable. Finally, i^* is decreasing in π^e, as higher expected inflation raises the expected returns from converting into inflation-protected (foreign) bonds.

The government issues debt with exogenous face value G and earns seigniorage on inflation. To allow for an interior solution, we specify real seigniorage revenues, R_π as increasing in inflation according to the function

$$R_\pi = \varphi_1 - \varphi_2 \pi^{-2} \tag{4}$$

where φ_1 and φ_2 are positive parameters. Note that $R_\pi'(\pi) > 0$ and $R_\pi''(\pi) < 0$.[27]

At the end of the period, the government is assumed to pay its debt obligations.[28] To balance its budget, its real tax revenues, T, must match the real value of its debt obligations minus its seigniorage revenue. To focus on the distributional impact of inflation, we assume that taxes are shared equally across all households, with each household's real tax burden being equal to T / N.[29]

We also assume that no household is insolvent, which requires that $\pi T / N \leq w_0$. The parameter constraint needed to satisfy this condition is derived below.

The government is interested in maximizing the utility of the median voter [e.g. Bowen (1943)], which is linear in the log of end of period wealth.[30] In addition, the government agent values the real value of transfers from the anti-inflation lobby, $\left(\pi^{-1}\right)\lambda G$ at par value. Let W_i reflect the end-of-period wealth. Since the median household holds cash, W_i satisfies

$$W_m = \frac{w_m}{\pi} - \frac{T}{N} \ .$$

The government loss function then satisfies:

$$U_g = \left[\frac{w_m}{\pi} - \frac{T}{N}\right] + \nu \frac{\lambda G}{\pi} \tag{5}$$

where ν is an exogenous constant term representing the relative weight the government agent puts on transfers from the anti-inflation lobby.

Case 1: No Domestic Bond Market

We first consider the case where no domestic bond market exists and the government issues all its debt in foreign currency. To distinguish this case, we designate endogenous values with a superscript f . The government's real debt obligation at the end of the period in domestic currency will be equal to r^*G. Its budget constraint then satisfies

$$T^f \geq r^*G - R_\pi^f\left(\pi^f\right) \tag{6}$$

As there is no inflation lobbying activity in this case, substituting the budget constraint into the government's utility function, the solution of the government satisfies

$$\underset{\pi^f}{Max} U_g = \left[\frac{w_m}{\pi^f} - \frac{r^* G - R_\pi^f\left(\pi^f\right)}{N} \right] \tag{7}$$

The first order condition for the government satisfies

$$\pi^f = \frac{2\varphi_2}{N w_m}. \tag{8}$$

The government chooses a higher level of inflation the greater is N, as an increase in the number of households reduces the impact of increased total taxes on the median household. It chooses lower inflation the larger is w_m, as higher inflation affects the marginal household more the wealthier it is that household.

We can now evaluate the needed parameter restriction on ϕ for the median household to hold cash. By (2), household initial wealth is decreasing in π^e. A sufficient restriction would be based on the highest inflation case, which is that under foreign bond issuance. By (2) and (8), our parameter restriction satisfies $N w_m \geq \phi - 2\varphi_2 r^*$, which we adopt.

Case 2: Domestic Currency Bond Market with Anti-Inflation Lobbying

We next consider the case where a lobby emerges to petition the government on behalf of the domestic bondholders.[31] We follow Acemoglu et. al. (2008) in assuming that the anti-inflation lobby makes a take-it-or-leave-it offer of a contract pair $\left(\lambda, \pi^d\right)$, which promises to pay the government a nominal transfer of λG in return for a promised inflation realization of π^d. The transfer is assumed to be financed by proportional contributions from all bondholders. As in Acemoglu, et al, we assume that the government can credibly commit to a lobbying contract, and that the domestic currency bondholders service the transfer to the government.[32] The lobby's

problem is then to choose a pair (λ, π^d) that maximizes the returns of domestic currency debt holdings, subject to: a) the government's budget constraint; and b) the constraint that the government is at least as well off as it would be in the absence of a lobbying agreement.[33]

Let $\bar{U}$ represent government utility and $\bar{\pi}$ inflation in the absence of an agreement. As nominal debt obligations rG are already determined, the maximization problem in the absence of lobbying activity satisfies

$$\underset{\pi}{Max}\, \bar{U} = \left[\frac{w_m}{\bar{\pi}} - \frac{rG}{\bar{\pi} N} + \frac{R_\pi(\bar{\pi})}{N} \right]. \tag{9}$$

The government's solution satisfies

$$\bar{\pi} = \frac{2\varphi_2}{N w_m - rG}\ . \tag{10}$$

Comparing equations (8) and (10), it can be seen that the government chooses a larger level of π in the presence of a domestic bond market without lobbying. In the absence of lobbying, the government chooses to decrease the real value of its liabilities through increased inflation.

Substituting (10) into (9)

$$\bar{U} = \frac{1}{N}\left[\frac{(N w_m - rG)^2}{4\varphi_2} + \varphi_1 \right] \tag{11}$$

We next turn to the problem faced by the anti-inflation lobby, which takes both $\bar{U}$ and r as given. We assume that the transfer from the anti-inflation lobby goes directly to the government official, and does not enter into the government budget constraint.

The inflation lobby maximizes net real returns to domestic currency bondholders, $(r - \lambda) G / \pi^d$, subject to the constraint of leaving the government as well off as it would be under

no lobbying $(U \geq \bar{U})$, where U is government utility in the presence of lobbying. The Lagrangian representing the maximization problem for the inflation lobby satisfies

$$\underset{\pi^d,\lambda}{Max}\, L = \left(\frac{r-\lambda}{\pi^d}\right)G + \theta\left(U - \bar{U}\right) \tag{12}$$

where in the presence of lobbying government utility satisfies

$$U = \frac{1}{N}\left[\frac{Nw_m}{\pi^d} - \frac{rG}{\pi^d} + R_\pi\left(\pi^d\right)\right] + \frac{\nu\lambda G}{\pi^d}$$

The first-order conditions for π^d, λ, and θ satisfy

$$\left(r-\lambda\right)G + \theta\left(\frac{1}{N}\left[\left(Nw_m - rG\right) - \frac{\varphi_2}{\pi^d}\right] + \nu\lambda G\right) = 0 \tag{13}$$

$$\theta = \frac{1}{\nu} \tag{14}$$

$$\frac{1}{N}\left[\frac{\left(Nw_m - rG\right)}{\pi^d} + \varphi_1 - \frac{\varphi_2}{\left(\pi^d\right)^2}\right] + \frac{\nu\lambda G}{\pi^d} = \bar{U} \tag{15}$$

By (14), we can eliminate θ from (13)

$$\pi^d = \frac{2\varphi_2}{\left(Nw_m - rG\right) + N\nu rG} \tag{16}$$

Comparing equations (8) and (16), it can be seen that the net impact of the introduction of the domestic currency bond market on inflation is ambiguous. This ambiguity is formalized in our first proposition:

PROPOSITION 1: *Realized inflation is lower with a domestic currency bond market relative to a foreign currency bond market if and only if* $N\nu \geq 1.$

The proof follows directly from equations (8) and (16). The intuition behind this result is straightforward. When $N\nu$ is sufficiently large, lobbying is effective enough that the introduction of

domestic bonds may result in lower inflation, even though domestic bond issuance encourages the government to inflate away its nominal debt obligations.[34]

To solve the model, note that under perfect foresight, substituting (2) and (11) into (15) and simplifying yields

$$\left(\pi^d\right)^2\left[\left(Nw_m - rG\right)^2 + 4\varphi_2 \nu NGr^*\right] - 4\varphi_2\pi^d\left[\left(Nw_m - rG\right) + \nu NGr\right] + 4\varphi_2^2 = 0 \qquad (17)$$

Combining (16) and (17) to eliminate π^d, r will be the positive root of

$$\left(N\nu + 2\right)Gr^2 - 2Nw_m r + 4\varphi_2 r^* = 0 \qquad (18)$$

Given r, π^d can be obtained directly from (16), and then λ can be obtained from (15).

By (6), (16), and (18), the necessary restriction to satisfy our parameter restriction that $T/N \le \pi^{-1}w_0$ is

$$w_0 \ge \frac{2Nw_m - 2\left[\left(Nw_m\right)^2 + 4\varphi_2 r^*\left(N\nu + 2\right)G\right]^{\frac{1}{2}}}{\left(N\nu + 2\right)} + \frac{2\varphi_2\varphi_1 - \frac{1}{2}\left[\left(Nw_m - rG\right) + N\nu rG\right]^2}{\left(Nw_m - rG\right) + N\nu rG} \qquad (19)$$

Implications for the distribution of wealth

We next consider the implications for the distribution of wealth. As taxes are distributed equally across households, it is sufficient to examine the implications for pre-tax end-of-period wealth.[35] Given that we are in the parameter space defined above where inflation falls, it follows by equation (4) that the creation of a domestic bond market will raise the initial wealth of the marginal household, as the gains from entering the bond market are reduced with lower inflation. Let i_f^*

represent the marginal household under foreign currency issuance and i_d^* under domestic currency issuance.

We have three ranges of households: The poorest, from 0 through i_f^* hold only cash under both foreign and domestic currency issuance; a middle group from i_f^* through i_d^* switches from entering the bond market under foreign currency issuance to holding cash under domestic issuance; and the rich, i_d^* through N, who always enter the bond market.

The poorest group's end-of-period pre-tax wealth is raised by the reduced inflation. In contrast, the richest group enters the bond market under both regimes and therefore its pre-tax end-of-period wealth remains unchanged. Finally, the middle group entered the bond market to protect their assets from inflation under foreign currency issuance, but with the reduction in inflation under domestic currency issuance holds cash. Their wealth must be higher as a result, since they could have left their wealth unchanged by continuing to enter the bond market.

The impact of the introduction of the domestic bond market is illustrated in Figure A1. Under foreign currency issuance, households 0 through i_f^* hold cash and have pre-tax wealth equal to $\left(\pi^f\right)^{-1} w_i$. Wealthier households enter the bond market, where their pre-tax wealth is equal to $r^*\left(w_i - \phi\right)$. With the introduction of the domestic currency bond market, households 0 through i_d^* hold cash and have pre-tax wealth equal to $\left(\pi^d\right)^{-1} w_i$, while households wealthier than this higher threshold continue to enter the bond market, and their pre-tax wealth is unchanged at $r^*\left(w_i - \phi\right)$. The introduction of the domestic bond market therefore raises the pre-tax wealth in the lower two ranges, but leads to no change in the pre-tax wealth of the richest range.

This leads to our second proposition:

PROPOSITION 2: *When the introduction of a domestic currency bond market reduces inflation, it leaves the distribution of end-of-period pre-tax wealth more equal if* i_f^* *is sufficiently close to* i_d^* *. In particular, a sufficient, but not necessary condition for wealth to equalize is* $i_f^* = i_d^*$.

To prove Proposition 2, we consider the Lorenz curves for pre-tax wealth under foreign and domestic currency bond issuance. This curve is calculated for each household i as the ratio of the cumulative wealth of all households $j \le i$ to total pre-tax wealth.

First, in the poorest segment 0 through i_f^* where households always hold cash, the height of the Lorenz curve for a household i satisfies

$$\left(L_i^k \left| 0 \le i < i_f^* \right.\right) = \frac{\sum_{j=0}^{i} \left(\pi^k\right)^{-1} w_j}{\sum_{j=0}^{i_k^*} \left(\pi^k\right)^{-1} w_j + \sum_{j=i_k^*}^{N} r^* \left(w_j - \phi\right)}; k = f, d \tag{20}$$

Given $N\nu \ge 1$, $\left(L_i^d \left| 0 \le i < i_f^* \right.\right) \ge \left(L_i^f \left| 0 \le i < i_f^* \right.\right)$ if the height of the Lorenz curve is decreasing in inflation within this range. Differentiating with respect to π^k, $\left(k = f, d\right)$ yields

$$\left(\frac{\partial L_i^k}{\partial \pi^k} \left| 0 \le i < i_f^* \right.\right) = -\frac{\sum_{j=0}^{i} w_j \sum_{j=i_f^*}^{N} r^* \left(w_j - \phi\right)}{\left[\sum_{j=0}^{i_f^*} w_j + \pi^k \sum_{j=i_f^*}^{N} r^* \left(w_j - \phi\right)\right]^2} < 0; k = f, d \tag{21}$$

It follows that $\left(L_i^d \left| 0 \le i < i_f^* \right.\right) \ge \left(L_i^f \left| 0 \le i < i_f^* \right.\right)$ in this range, i.e. the relative income share of the poorest households is increased by the introduction of domestic currency issuance.

We next turn to the wealthiest households in the range i_d^* through N who enter the bond market under both regimes. Households in this range experience no change in their pre-tax wealth, as they always earn $r^* \left(w_j - \phi\right)$. As such, their share of total wealth declines with the introduction of the domestic bond market, as total pre-tax wealth rises.

It would therefore appear that the introduction of the domestic currency bond market would lead to equalization of the distribution of pre-tax wealth. However, ambiguity is introduced through the middle group, i.e. households i_f^* through i_d^*, that switch back to holding cash when the inflation rate is reduced due to the introduction of the local currency bond market. This "middle" group may be either relatively wealthy or poor, depending on parameters, and therefore a restriction is required to demonstrate that the introduction of the domestic currency bond market equalizes the pre-tax distribution of wealth. In particular, if this middle group is not "too big," the wealth distribution will become unambiguously more equal.

We therefore prove Proposition 2 for the special case where the middle range group is of measure zero. Recall that for monotonically increasing in income households, the Gini formula for inequality satisfies

$$G^k = \frac{1}{N}\left\{N+1-2\left[\frac{\sum_{j=0}^{i_k^*}\left(\pi^k\right)^{-1} w_j\left(N+1-i\right)+\sum_{j=i_k^*}^{N} r^*\left(w_j-\phi\right)\left(N+1-i\right)}{\sum_{j=0}^{i_k^*}\left(\pi^k\right)^{-1} w_j+\sum_{j=i_k^*}^{N} r^*\left(w_j-\phi\right)}\right]\right\}; k=f,d \quad (23)$$

Letting i^* represent the marginal household, the introduction of the domestic currency bond market leads to more equality, $G^f > G^d$, if and only if

$$\left[\sum_{j=0}^{i^*}\left(\pi^d\right)^{-1} w_j\left(N+1-i\right)+\sum_{j=i^*}^{N} r^*\left(w_j-\phi\right)\left(N+1-i\right)\right]\left[\sum_{j=0}^{i^*}\left(\pi^f\right)^{-1} w_j+\sum_{j=i^*}^{N} r^*\left(w_j-\phi\right)\right]$$
$$>\left[\sum_{j=0}^{i^*}\left(\pi^f\right)^{-1} w_j\left(N+1-i\right)+\sum_{j=i^*}^{N} r^*\left(w_j-\phi\right)\left(N+1-i\right)\right]\left[\sum_{j=0}^{i^*}\left(\pi^d\right)^{-1} w_j+\sum_{j=i^*}^{N} r^*\left(w_j-\phi\right)\right] \quad (24)$$

Expanding and simplifying

$$\left[\left(\pi^d\right)^{-1}-\left(\pi^f\right)^{-1}\right]\left[\sum_{j=0}^{i^*} w_j\left(N+1-i\right)\sum_{j=i^*}^{N} r^*\left(w_j-\phi\right)-\sum_{j=0}^{i^*} w_j\sum_{j=i^*}^{N} r^*\left(w_j-\phi\right)\left(N+1-i\right)\right]>0 \quad (25)$$

As inflation declines, the first term is positive. This implies that the entire term will be positive if the bracketed term is positive. This term will be unambiguously positive according to our assumption that $i^* > i_m$, i.e. that the median wealth household does not enter the bond market. Given this condition, our results suggest that the wealthy bondholders, acting only in their self-interest by lobbying for lower inflation, unintentionally become a force for equality.[36]

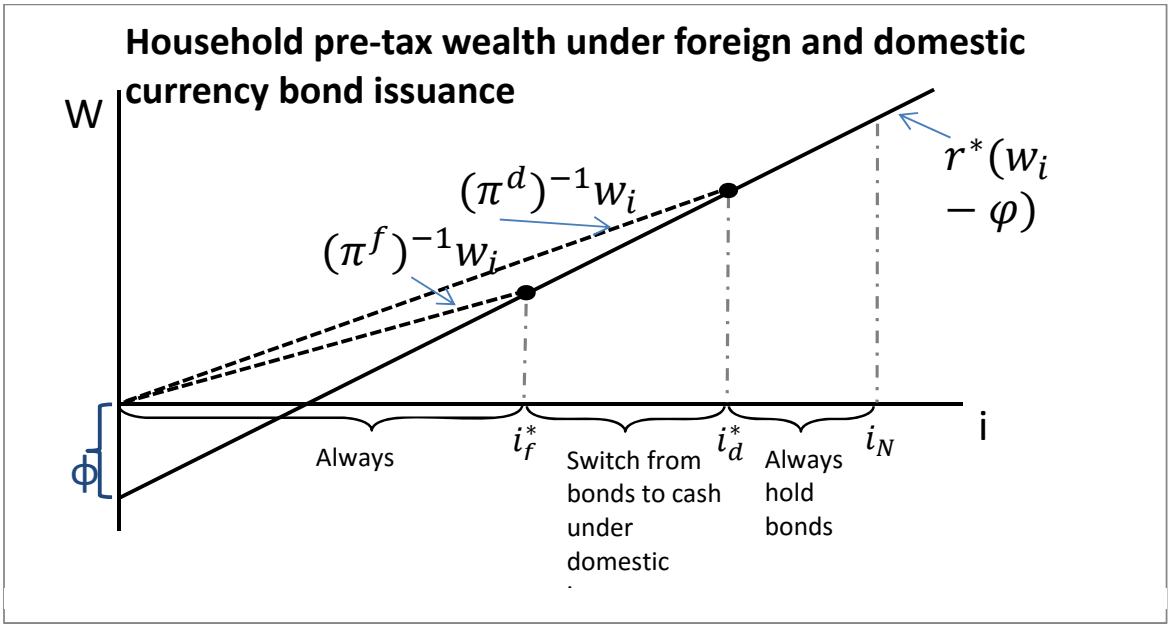

Figure A1: Implications of domestic currency issuance

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.

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] For example, Fischer (1983) notes that the will to fight inflation will be reduced by bond indexation, because the costs of inflation are reduced by indexing.

[4] Doepke and Schneider (2006) note that nominal debt holdings are a primary source of inflation exposure for rich households.

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

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

[7] 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.

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

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

[10] We also attempted to create a series using the share of domestic currency assets in total financial assets, as an alternative to our (admittedly crude) dummy variable for bond market existence. However, data limitations make this continuous series impossible. We lacked data on the value of total (public and provide) bonds which are not indexed, long-maturity, and denominated in local currency, at least for a set of inflation-targeting countries. Even after making heavy-handed assumptions to utilize BIS Debt Security Statistics data, our sample is still cut in half.

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

[12] In principle, it might be possible to improve on our measure of bond market presence. We use a simple dummy variable for the existence of publicly-traded market for long nominal local-currency bonds; a more continuous measure would be preferable. However, this continuous measure would be the fraction of wealth that is fixed in nominal terms; the numerator would include money as well as all bonds (private and corporate, publicly traded or not), and any other nominal obligations. Creating a complete set of these data for a full panel would not be trivial.

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

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

[15] Available at http://personal.lse.ac.uk/ilzetzki/data/ERA-Annual%20coarse%20class.xls ; we 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 we allow both Spain and Finland to be members of both hard fix and inflation target regimes during the run-up to EMU, we do not allow the Czech Republic to be classified as a hard fix after it begins inflation targeting.

[16] It is interesting to note that our sample includes deflationary observations.

[17] 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).

[18] Measures of security effectiveness, and legitimacy are available from 1995 through 2013 at http://www.systemicpeace.org/inscrdata.html. Both are annual quantitative measures available for 167 countries: "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. Three indicators are used to calculate each country's "residual war" score …" "Security legitimacy [is] a measure of state repression … [using data from] Political Terror Scale … [which] provides separate annual indicators drawn from U.S. State Department and Amnesty International Reports … coded on a five-point scale, from 1: "no repression" to 5: "systemic, collective repression." (http://www.systemicpeace.org/vlibrary/GlobalReport2014.pdf)

[19] "A country or territory is awarded 0 to 4 points for each of … 15 civil liberties indicators, which take the form of questions; a score of 0 represents the smallest degree of freedom and 4 the greatest degree of freedom… The civil liberties questions are grouped into four subcategories: Freedom of Expression and Belief (4 questions), Associational and Organizational Rights (3), Rule of Law (4), and Personal Autonomy and Individual Rights (4). A country or territory is assigned … ratings (7 to 1) … for civil liberties—based on its total scores for the … civil liberties questions. Each rating of 1 through 7, with 1 representing the greatest degree of freedom and 7 the smallest degree of freedom, corresponds to a specific range of total scores …" (https://www.freedomhouse.org/report/freedom-world-2014/methodology#.VFq48vnF8WJ)

[20] "[Freedom House] … assigns the designation "electoral democracy" to countries that have met certain minimum standards. In determining whether a country is an electoral democracy, Freedom House examines several key factors concerning the last major national election or elections. To qualify as an electoral democracy, a state must have satisfied the following criteria: 1. A competitive, multiparty political system; 2. Universal adult suffrage for all citizens (with exceptions for restrictions that states may legitimately place on citizens as sanctions for criminal offenses); 3. Regularly contested elections conducted in conditions of ballot secrecy, reasonable ballot security, and in the absence of massive voter fraud, and that yield results that are representative of the public will; 4. Significant public access of major political parties to the electorate through the media and through generally open political campaigning." (https://freedomhouse.org/report/freedom-world-2012/methodology#.VFq81fnF8WI)

[21] We provide a little further evidence on the plausible exogeneity of our instrumental variables in an online appendix, using one of the techniques of Conley, Hansen and Rossi (*The Review of Economics and Statistics* 2012).

[22] 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.

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

[24] We use three matches; results remain strong if the exact number of matches is varied. We match on the basis of the five control covariates used in (11).

[25] We assume that the law of one price holds, so that inflation is reflected perfectly in the nominal exchange rate.

[26] While lobbying contributions are modeled as transfers for simplicity, we consider them to be analogous to campaign contributions and other standard lobbying activity, rather than corruption. As such, we do not think that the effectiveness of lobbying activity would be influenced by a country's institutional quality.

[27] The functional form assumed for seigniorage facilitates our analytic solution, but is not necessary for our general results. We only require that seigniorage revenues are increasing and concave in inflation.

[28] Note that by assuming that the government services its debt obligations we are limiting its discretion.

[29] We consider more progressive tax systems below; these do not change results.

[30] As the data in our study demonstrate, there is a notable dispersion in inflation outcomes across inflation targeting countries. Presumably, this is due to differences in the preferences of government. As such, our theoretical analysis abstracts from the government's pursuit of a formal target, and instead examines its preferences over household welfare, which presumably is the root of the formal target chosen in inflation targeting regimes.

[31] There is certainly anecdotal evidence of this mechanism. For instance Deacon et al (2004, pp 67-68) write "Certainly, by providing [indexation] protection for bondholders a government is reducing the political lobby against inflation. It is interesting to note that for some years now the Israeli authorities have preferred to issue nominal bonds for precisely this reason: the belief that by expanding the group of agents with a vested interest in the maintenance of low and stable inflation, pressure will be brought to bear on the authorities to this end …"

[32] Acemoglu, et al (2008) motivate these assumptions by allowing for the possibility that the interaction between the government and the lobby and its constituents might be a repeated game.

[33] Given an interior solution, the equilibrium outcome will be one with positive lobbying efforts $(\lambda > 0)$ and the alternative outcome in the absence of an agreement represents off-equilibrium path activity, where the equilibrium contract derived below is anticipated, but not signed. This alternative outcome provides the threat point that ensures that the offer made by the lobby to the government is incentive compatible.

[34] As N represents the number of households in the economy, we would expect it to tend to be large. The parameter condition in Proposition 1 would therefore hold if ν is not de minimus. We would expected that to be the case, but ν is likely to be opaque in practice, reflecting, among other things, the level of corruption. Still, it seems unlikely that the weight the government puts on a dollar of personal revenues from the anti-inflation lobby would be minuscule, i.e. lower than $1/N$.

[35] The conditions that support decreased skewness in the end-of-period wealth would be robust to the introduction of a progressive tax system, as the increase in taxation required under decreased inflation would be predominantly borne by the rich. However, under a regressive tax system, further parameter restrictions would be required to conclude that the distribution of wealth became less skewed with domestic currency bonds.

[36] Our interest is in the distribution of income, and we do not evaluate welfare. In general, the distributional implications of the introduction of the domestic currency bond market leave overall welfare conclusions challenging. Nevertheless, as lobbying activity represents a deadweight loss for the economy as a whole, it is clear that overall wealth must decline. The implications of this decline for welfare depend on preferences concerning the distribution of wealth, as well as the technologies for lobbying and seigniorage, which are likely to vary across countries. On the other hand, our model also contains no explicit gains from the reduction in inflation, leaving scope for more favorable implications of lobbying activity in a richer model.