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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. Bond holders are exposed to capital losses through inflation and therefore represent a potential anti-inflationary force; we ask whether their influence is apparent both theoretically and empirically. We develop a simple theoretical model with heterogeneous agents where the issuance of such bonds leads to political pressure on the government to choose a lower inflation rate. We then check this prediction empirically using 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 approximately 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, including using political and fiscal variables suggested by theory to account for the potential endogeneity of domestic bond issuance. Notably, we do not find a similar effect for short-term or foreign-currency bonds.

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

JEL Classification Codes: E52, E58

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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? One might imagine so, since bond-holders are a potentially formidable political force who benefit from low stable inflation.

We have two objectives. First, we present a theoretical model in which the issuance of domestic-currency bonds encourages a flexible inflation-targeting government to pursue a lower inflation rate. As the distribution of wealth is skewed, assets of all types are held by the rich. 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. Second, we demonstrate empirically that the presence of a long, nominal, local-currency bond market is indeed associated with inflation that is approximately three-four percentage points lower, for inflation-targeting countries.

These findings seem 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 that are not protected from inflation, it creates 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. 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 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; we formalize this intuition in our theory.

Bonds issued in local currency could also have the opposite effect on inflation. As long-maturity, nominal, local-currency debt increases, so do the immediate government benefits (i.e., bond-holder losses) from inflation. Thus, one might expect countries with bond markets to have higher inflation. Indeed, a parameter restriction is required in our model below to unambiguously sign the effect.

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*.

Endogeneity issues arise here, as 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 causality in the opposite direction. Partial default on nominal debt achieved through inflation may prove less costly and disruptive than formal renegotiation of debt. 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 respond to these concerns in a number of ways. First and foremost, we limit our sample to inflation-targeting countries, who have formally committed to avoiding inflation for revenue raising purposes. Still, it is likely that investors may perceive the risk that a country abandons its inflation targeting commitment – either formally or informally – to vary across countries. We therefore use treatment effect estimation to control for other characteristics that may influence bond market creation. We show that our qualitative results are robust to treatment effect estimation. We also look to institutional characteristics as instrumental variables, primarily relying on the size of government spending as a share of GDP and the time that has passed since national independence or the adoption of a democratic political system. In practice, 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 around three percentage points.

After clarifying these linkages with a theoretical model, we then test our main implication with an empirical investigation.

2. Theory

In this section, we introduce a simple one-period model of an endowment economy with domestic currency and inflation. There are three types of agents: households, which are endowed with wealth and invest in either cash or securities; the government, which finances its expenditures through debt issuance and finances its debt service through a combination of taxes and inflation; and an "inflation lobby" which lobbies the government for lower inflation on behalf of domestic-currency debt holders.

Households

There are N atomistic households. Each household i is endowed with nominal assets w_i at the beginning of the period. Households differ in their wealth endowments, and are numbered from the household with the smallest endowment, 0, to those with the largest endowment, N. w_i is distributed on the interval $\left[\underline{w}, \overline{w}\right]$ with density $f(w_i)$, where $f'(w_i) \leq 0$; the density of w_i is non-increasing as w_i increases so that there are fewer rich households than poor ones.

Wealth can be held as cash, c_i, which yields no interest, or invested in securities. The government, discussed below, has issued a total of G securities, denominated in domestic and foreign currencies, with face values which are taken as given as $B \geq 0$ and $G - B \geq 0$ respectively (issuing all debt in foreign currency is feasible).

Markets are assumed to be segmented, in the sense that there is a real fixed cost $\phi > 0$ of entering the securities market. After paying the fixed fee, households can choose to purchase bonds denominated in foreign or domestic currency (if the latter exist). Since international capital markets are open, interest parity requires that bonds denominated in foreign currency yield an exogenous real return, with r^* representing 1 plus the foreign rate of interest. At the end of the period

domestic bonds pay an endogenous fixed nominal return, with r representing 1 plus the nominal interest rate in domestic currency.

The fixed cost of entering the securities markets implies scale economies to the expected returns in these markets. These scale economies imply that there is a marginal household, w^*, indifferent between entering the securities market and holding cash. Below, we determine the identity of the marginal household.

We assume that all households that purchase domestic securities also participate in lobbying, as discussed below. For simplicity, we assume that lobbying contributions are proportional to domestic bond holdings, with each bond holder contributing an amount λb_i, where b_i represents the face value of domestic currency securities issues held by household i, and λ represents the intensity of lobbying activity, which is endogenous and determined below.

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

$$r = E(\pi r^* + \lambda) \tag{1}$$

where $E(\bullet)$ represents beginning of period expectations, and $\pi \geq 1$ represents 1 plus the rate of 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. It is therefore cheaper to issue domestic debt in environments with less expected lobbying, holding realized inflation constant.

The budget constraint faced by household i satisfies

$$w_i \geq c_i + \left(1 + E\left(\lambda\right)\right) b_i + b_i^* - \phi_i . \tag{2}$$

where b_i^* represents foreign currency securities purchases of household i and $\phi_i = \phi$ if the household enters the market, and 0 otherwise.

At the end of the period, if the household does not enter the bond market its expected pre-tax real wealth satisfies

$$E\left(\overline{w}_i \middle| b_i = b_i^* = 0\right) = \left(E(\pi)^{-1} w_i\right), \tag{3}$$

where $\overline{w}_i$ represents the ex-post realization of w_i, while if household i does enter the bond market (since returns in both domestic and foreign securities are equal *ex ante* by (1)), its expected pre-tax real wealth satisfies

$$E\left(\overline{w}_i \middle| b_i + b_i^* > 0\right) = r^*\left(w_i - \phi\right). \tag{4}$$

In particular, by (1), (2), (3) and (4) for the marginal household w^* that is indifferent between entering the securities market and holding cash

$$w^* = \frac{E(\pi) r^* \phi}{E(\pi) r^* - 1}. \tag{5}$$

The identity of the marginal household is a function of three arguments: the share of households for which $w_i \leq w^*$, i.e. the share choosing not to enter the securities markets, is decreasing in ϕ, as the more costly it is to enter the securities market, the larger a household's wealth needs to be to make entering the securities market worthwhile. It is also increasing in the return on holding foreign securities, r^*, as interest rate parity ensures that this influences the returns on all assets. Finally, w^* is decreasing in the expected inflation rate, $E\left(\pi\right)$. The higher is the expected rate of inflation, the greater is the share of domestic households choosing to enter the securities market to obtain assets protected from inflation.

Government

The government has outstanding foreign debt with face value, $G - B > 0$, and outstanding domestic debt outstanding with face value B. It also earns seigniorage on inflation, designated as φ. For analytic tractability, we specify that seigniorage revenues increase in inflation according to the function

$$\varphi = \varphi\left(\pi^{-1}\right) > 0. \tag{6}$$

where $\varphi' \leq 0$. For simplicity, we assume that $\varphi'' = 0$.

At the end of the period, the government pays its obligations. To balance its budget, its tax revenues, T, must match the real value of its debt obligations minus its seigniorage revenue:

$$T \geq \pi^{-1} rB + r^*(G - B) - \varphi\left(\pi^{-1}\right). \tag{7}$$

Note that in addition to seigniorage revenue, the tax burden is reduced by inflation through the decreased burden of servicing domestic currency debt obligations.

We consider a reduced-form loss function for a consolidated government with an inflation target. As inflation eases the government's budget constraint, it consistently chooses an inflation rate that exceeds its target. We therefore specify government utility as a function of taxes, inflation, and transfers from the anti-inflation lobby, λB:

$$U = U(T, \pi^{-1}, \lambda B) \tag{8}$$

where U is decreasing in T and increasing in π^{-1} and λB, with cross-partial terms equal to 0 and $U''(\bullet) \leq 0$ for all three arguments.[3] Below, we consider the optimization decision of the inflation lobby, which makes a take-it-or-leave-it offer to the government subject to the constraint that

acceptable offers must leave the government as well off is it would be without a transfer from the lobby.

We therefore first evaluate the equilibrium when the government is isolated from lobbyists and determine U^A, government utility absent lobbying. The government decision problem is to maximize utility subject to satisfying its budget constraint or

$$U^A = \underset{\pi^{-1},T}{Max} U(T, \pi^{-1}, 0) + \psi\left[rB\pi^{-1} + r*(G-B) - \varphi\left(\pi^{-1}\right) - T \right] \quad (9)$$

In the appendix we demonstrate that government utility absent lobbying is decreasing in r.[4] We also demonstrate that the higher is the share of domestic bond financing, the higher would be the government's reliance on inflation. The intuition is that inflation directly reduces the government's budget burden by reducing the real value of its nominal outstanding debt obligations, and therefore, absent lobbying the government would choose a higher mix of inflation relative to taxes. This same channel is also operative under the inflation lobby's decision below; thus a parameter restriction is needed to obtain an unambiguous determination of the impact of increased domestic currency bond finance.

Inflation Lobby

Finally, the inflation lobby acts as an agent of the domestic currency bondholders. We follow Acemoglu et. al. (2008) in assuming that the inflation lobby makes a take-it-or-leave-it offer of a contract pair (λ, π), which promises to pay the government a transfer of λB in return for a promised inflation realization of π. 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 carrying out a lobbying contract, and that the domestic currency bondholders service the transfer to the government.[5]

The lobby's maximization problem is to choose the pair (λ, π) 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 left at least as well off as it is in the absence of lobbying, i.e. at welfare level $\widehat{U}(r)$. $\widehat{U}(r)$ is taken as given by the inflation lobby. We honor the government budget constraint by substituting for T from equation (7), as it is binding in equilibrium. As above, it is simpler to solve the maximization problem of the lobby in terms of the reciprocal of inflation. The Lagrangian representing this problem satisfies

$$\underset{\pi^{-1},\lambda}{Max}\, L = \pi^{-1}(r-\lambda) - \theta\left(U\left(T, \pi^{-1}, \lambda B\right) - \widehat{U}(r)\right) \tag{10}$$

We solve for the lobby solution in the appendix, which leads directly to our proposition:

PROPOSITION 1: *Realized inflation is decreasing in the share of domestic debt issues.*

We directly derive this result given that: a) government utility is increasing in inflation below its optimal inflation level absent lobbying, and b) government utility is increasing in lobby transfers at a greater than or equal to level than its disutility from taxation, as well as rational expectations on the part of households. The intuition behind this result is that an increase in the share of issuance in domestic currency creates a constituency for lower inflation among those with sufficient wealth to enter securities markets. These agents support increased lobbying activity, which lowers the level of inflation agreed to by the government.

Having provided a theoretical framework to formalize our intuition, we now proceed to an empirical examination of the data.

3. 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 least-squares panel estimator:

$$\pi_{it} = \beta Bond_{it} + \gamma X_{it} + \{\delta_i\} + \{\varepsilon_t\} + \eta_{it} \quad (11)$$

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.[6] Since we include comprehensive sets of both time- and country-specific fixed effects, this can be interpreted as a difference-in-differences estimator.[7]

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.[8] 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 (11) only for inflation-targeting regimes (hereafter "IT"). IT regimes that 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 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 suffer less from endogeneity among IT regimes. In the case of peggers, bond markets may be more likely to arise among lower nominal inflation regimes, leading to more severe endogeneity concerns.[9]

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 (11) with instrumental variables, relying on fiscal and political variables to construct instruments for bond market existence. We use the size of government spending in the economy and the age of the country as our instrumental variables, and show that our results are insensitive to their exact nature. Our IV results indicate an economically and statistically significant effect of a bond market on inflation for the inflation targeting countries, just like those estimated with least squares.

4. The Data Set

We are interested in estimating β in equation (11), 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."[10] 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."[11]

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 responsive to inflation. We also use GFD to construct series on shorter maturity and foreign-denominated bonds, as robustness checks.

We 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 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 omissions.[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 the 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.

Table 1 provides some descriptive statistics on inflation across bond markets and monetary regimes. Panel A shows that countries with domestic currency 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 center" 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 center are tabulated in the remainder of the panel.

Together, the panels of Table 1 paint a suggestive picture. IT countries with domestic currency 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 provides graphical evidence for inflation targeters with and without bond markets. 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. 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).[16] 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. This exercise is limited, since there are only 14 cases where inflation targeters introduced a bond market during the sample. Still, the introduction of a long bond market in an inflation-targeting country seems associated with lower inflation.

5. Results

Our benchmark results for (11) are recorded in Panel A of Table 2. This presents estimates of β from (11), along with robust standard errors (clustered by country). 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. 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 center.

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. 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 <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. We 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 (11)). Again, none of the perturbations in Panel D undermine confidence in the default estimate.

We check the robustness of the precise measure of the bond market in Panel E. First, we substitute a five-year lag of the bond market in place of its contemporaneous variable. Next, 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. 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. 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.[17] 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.

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.[18] 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. 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.

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 now pursue instrumental variables estimation. We begin with two instrumental variables: the size of government spending (relative to GDP), and (the log of) the length of time since national independence. The motivation for our 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. We also show that IV results do not depend sensitively on the exact choice of instrumental variables by considering six alternatives.

Table 4 presents evidence associated with instrumental variables estimation of (11). 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 controls in (11)). The p-value is low, indicating that the instrumental variables are significantly correlated with the bond market dummy variable. Two IV estimates of β are then tabulated, one for each measure of inflation, along with their standard errors. These are both economically larger – in the range of 8% – than their least squares analogues tabulated in the bottom row of the table for convenience – which are approximately 3-4%. However, the IV coefficients are estimated with worse precision, so that Hausman tests for equality between the IV and LS estimates of β are insignificantly different from zero; the t-ratios are recorded. We also add the IVs directly into equation (11) and test the hypothesis that both IVs can be excluded. The tabulated p-values are above .1, indicating that the IVs can reasonably be excluded from (11). Succinctly, it appears that plausible instrumental variables lead to the same conclusion as least squares estimation: the existence of a bond market lowers inflation significantly, even for countries already pursuing an inflation-targeting strategy.

The remainder of Table 4 shows that these results do not depend sensitively on the exact choice of instrumental variables. We consider six variants of our default IVs. First, we drop government spending, since this variable is only weakly correlated with bond market presence. Next, we replace government spending with measures of security effectiveness and legitimacy.[19] The third and fourth variants repeat the first rows but replace (the log of) years of independence with (log) years of democracy using the Acemoglu et al (2014) methodology. This series is only available for countries which have democratized recently (51% of the sample), resulting in a halving of the sample size. In the penultimate row we use civil liberties as measured by Freedom House, an

IV which varies from 1 through 7.[20] For the final perturbation we use a dummy variable for democracy as an IV, again as measured by Freedom House.[21]

The results indicate that our instrumental variable results are relatively insensitive to the exact choice of instruments. All the IVs we use seem to be strong in the sense that they are correlated with bond market existence; none seem to be directly correlated with inflation with a single exception (log years independence, when one measures inflation via the CPI). All the IV estimates are negative and economically larger than their LS analogues, though they are less precisely estimated. Ten out of fourteen IV estimates of β are also significantly different from zero at conventional significance levels. In no case does a standard Hausman test indicate a significant difference between IV and LS estimates.[22]

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.[23] We leave further elaboration for future research. Still, we conclude that estimation with reasonable instrumental variables does not weaken our results significantly.

Business Cycles and Output

The evidence presented above indicates that inflation is strongly affected by the presence of a domestic 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. Our theory suggests that the existence of a bond market discourages the use of inflation to ease the government budget constraint, but has no implication for the efficacy of counter-cyclical policy in the presence of such a bond market. In particular, while bond markets create a constituency for low inflation, those same bonds may face increased default risk in the presence of business cycle volatility.

Table 5 presents estimates that are analogous to those of (11), substituting a measure of the business cycle in place of inflation as the dependent variable. We estimate:

$$BC_{it} = \beta Bond_{it} + \gamma X'_{it} + \{\delta_i\} + \{\varepsilon_t\} + \eta_{it} \quad (11')$$

where BC_{it} is a measure of country i's business cycle deviation from trend at time t, and X'_{it} is a set of control covariates. To ensure the robustness of our results, we 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.[24] We estimate (11') after dropping real GDP growth from the covariate controls (X). Equation (11') 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, we re-run (11') 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 5. Still, the estimates of β in Table 5 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.[25]

6. 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?

We introduce a model that suggests that the answer may be positive. In our model, large numbers of poor households are forced to hold cash which is not protected from inflation, while wealthy asset-holders influence inflation outcomes. Our model suggests that when bond markets

are created, the rich find themselves holding assets exposed to inflation, and respond by acting politically 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 three to four percentage points; bonds that 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. Finally, and reassuringly, no effect of the bond market is apparent on real output.

This work could be improved in several ways. First, a more structural approach to the issue of simultaneity might prove fruitful. Second, it might be possible to improve on our measure of bond market presence. We 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.

We 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	421

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

A: Default

	CPI Inflation	GDP Inflation
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: 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 4: Instrumental Variables Estimates

			CPI Inflation			GDP Inflation		
Instrumental Variables	Obs.	Weak IV? (p-value)	β_{IV}	Hausman |t| for β	Excludable? (p-value)	β_{IV}	Hausman |t| for β	Excludable? (p-value)
Log Years Independence, Gov't Spending (% GDP)	353	.00**	-8.0** (3.0)	1.7	.12	-8.7** (3.7)	1.2	.23
Log Years Independence	353	.00**	-8.0** (3.0)	1.7	.05*	-8.4** (3.7)	1.1	.24
Log Years Independence, Security Effectiveness, Legitimacy	329	.00**	-4.1* (1.8)	.8	.11	-7.1** (2.4)	1.3	.14
Log Years Democracy, Gov't Spending (% GDP)	183	.01**	-4.4 (4.1)	.9	.61	-7.9* (3.8)	1.7	.14
Log Years Democracy	183	.00**	-4.4 (4.1)	.9	.36	-7.7* (3.8)	1.6	.06
Civil Liberties	353	.00**	-6.5* (2.6)	1.4	.12	-8.6* (4.3)	1.0	.30
Democracy	353	.01*	-7.9 (5.2)	1.0	.27	-5.8 (5.2)	.3	.78
Least Squares	353		-2.9** (1.0)			-4.4** (1.1)		

Instrumental variables estimates of (11); IVs recorded in left column. β_{IV} records coefficients for dummy variable (=1 if bond market exists, =0 otherwise); standard errors 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 β coefficient. Sample restricted to inflation targeters. 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 5: 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.

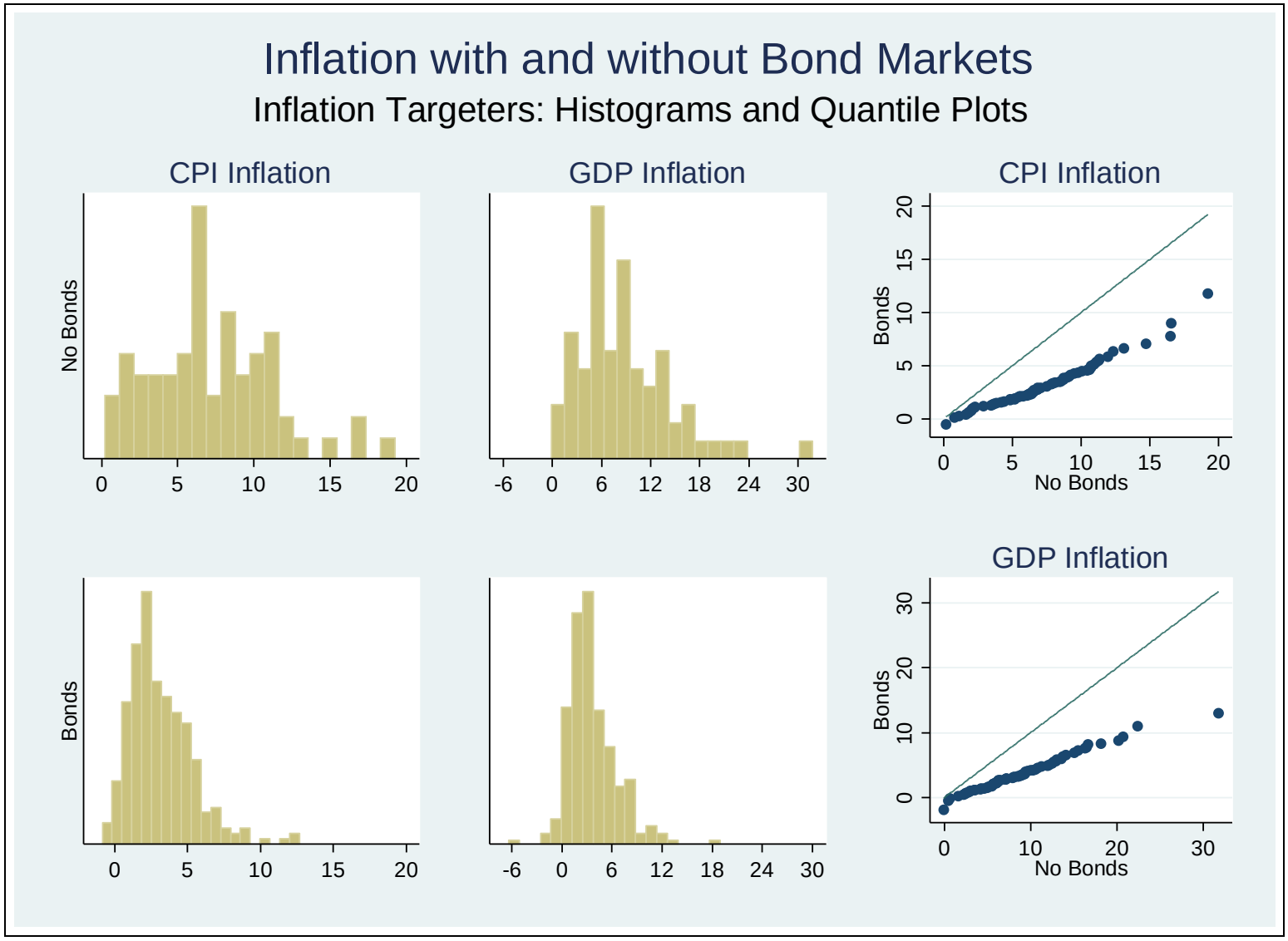
Inflation with and without Bond Markets
Inflation Targeters: Histograms and Quantile Plots
CPI Inflation
GDP Inflation
CPI Inflation
No Bonds
Bonds
0
5
10
15
20
-6
0
6
12
18
24
30
No Bonds
GDP Inflation
Bonds
No Bonds

Figure 1

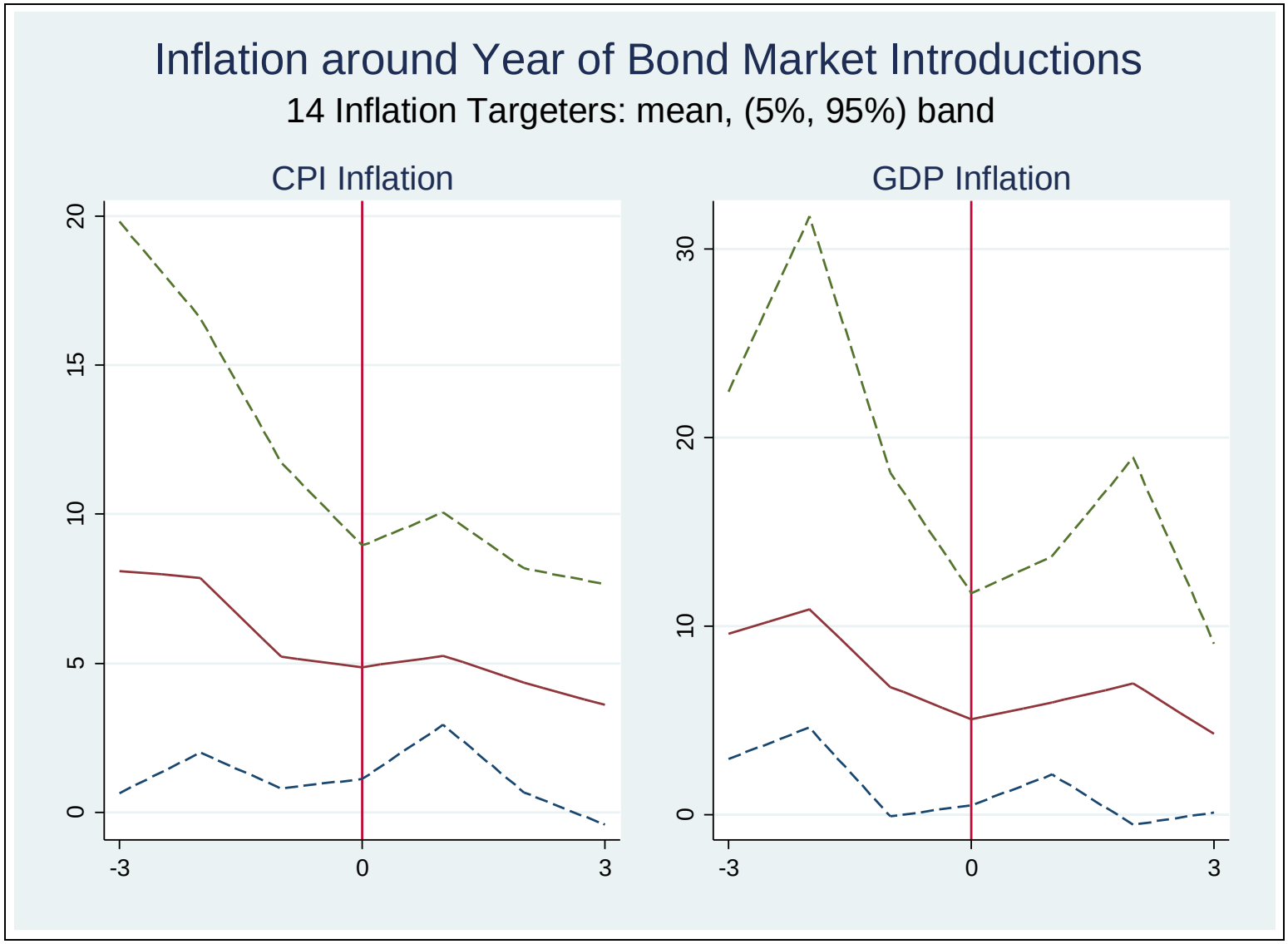
Inflation around Year of Bond Market Introductions
14 Inflation Targeters: mean, (5%, 95%) band
CPI Inflation
GDP Inflation
0
5
10
15
20
0
10
20
30
-3
0
3
-3
0
3

Figure 2

Theoretical Appendix

Government Decision in the Absence of Lobbying

Recall that the government decision problem in the absence of lobbying is to maximize utility subject to satisfying its budget constraint or

$$\widehat{U}(r) = \underset{\pi^{-1},T}{Max} U(T,\pi^{-1},0) + \psi\left[rB\pi^{-1} + r*(G-B) - \varphi\left(\pi^{-1}\right) - T\right] \tag{A.1}$$

The government's first order condition for π^{-1} satisfies

$$\frac{dU}{d\pi^{-1}}\Big|r \equiv \frac{\partial U}{\partial T}\left(rB - \varphi'\right) + \frac{\partial U}{\partial \pi^{-1}} = 0\,. \tag{A.2}$$

Note that r is determined at the point that this decision is reached. Totally differentiating (A.2) with respect to π^{-1} and r yields

$$\frac{d\pi^{-1}}{dr} = -\frac{B\left(\partial U/\partial T\right)}{\partial^2 U/\partial\left(\pi^{-1}\right)^2} \le 0 \tag{A.3}$$

Government utility in the absence of lobbying is then decreasing in r, as discussed in the text.

$$\frac{\partial \widehat{U}(r)}{\partial r} = \frac{\partial U}{\partial T}B\pi^{-1} + \frac{\partial U}{\partial \pi^{-1}}\frac{\partial \pi^{-1}}{\partial r} \le 0\,. \tag{A.4}$$

Totally differentiating (A.2) with respect to π^{-1} and B

$$\frac{d\pi^{-1}}{dB} = -\frac{r\left(\partial U/\partial T\right)}{\partial^2 U/\partial\left(\pi^{-1}\right)^2} \le 0 \tag{A.5}$$

also as discussed in the text.

Lobbying Solution

Recall from the text that the Lagrangian representing the lobbyist's problem satisfies

$$\underset{\pi^{-1},\lambda}{Max}\, L = \pi^{-1}\left(r - \lambda\right) - \theta\left(U\left(T,\pi^{-1},\lambda B\right) - \widehat{U}(r)\right) \tag{A.6}$$

The lobby's first-order conditions satisfy

$$\frac{\partial L}{\partial \pi^{-1}} = \left(r - \lambda\right) + \theta\left[\frac{\partial U}{\partial T}\left(rB - \varphi'\right) + \frac{\partial U}{\partial \pi^{-1}}\right] = 0\,, \tag{A.7}$$

where the bracketed term $[\bullet]$ can be signed as negative by the fact that inflation is lower under the inflation lobby agreement relative to the solution in the absence of lobbying (at which it is equal to zero). As such, utility is increasing in π and therefore decreasing in π^{-1},

$$\frac{\partial L}{\partial \lambda} = -\pi^{-1} + \theta B \frac{\partial U}{\partial \lambda B} = 0, \tag{A.8}$$

and

$$U\left(T, \pi^{-1}, \lambda B\right) - \widehat{U}(r) = 0. \tag{A.9}$$

We can eliminate θ

$$\frac{\partial U}{\partial \lambda B}\left(r - \lambda\right) + \frac{\pi^{-1}}{B}\left[\frac{\partial U}{\partial T}\left(rB - \varphi'\right) + \frac{\partial U}{\partial \pi^{-1}}\right] = 0 \tag{A.10}$$

We then close the model by noting that under rational expectations $E\left(\pi^{-1}\right) = \pi^{-1}$ and $E\left(\lambda\right) = \lambda$. By (1)

$$\pi^{-1}\left(r - \lambda\right) = r^*. \tag{A.11}$$

Substituting for r in (A.7) and (A.8)

$$\Lambda_1 \equiv \frac{\partial U}{\partial \lambda B} r^* + \frac{\partial U}{\partial T}\left(\pi^{-1} r^* + \left(\pi^{-1}\right)^2\left(\lambda - \varphi' B^{-1}\right)\right) + \frac{\partial U}{\partial \pi^{-1}} = 0 \tag{A.12}$$

$$\Lambda_2 \equiv U\left(\pi^{-1}\lambda B + r^* G - \varphi\left(\pi^{-1}\right), \pi^{-1}, \lambda B\right) - \widehat{U}\left(\left(\pi^{-1}\right)^{-1} r^* + \lambda\right) = 0 \tag{A.13}$$

We can now form a system in two unknowns, π^{-1} and λ. The comparative statics of the system satisfy

$$\frac{\partial \Lambda_1}{\partial \pi^{-1}} = \frac{\partial U}{\partial T}\left[\left(r^* + 2\pi^{-1}\left(\lambda - \varphi' B^{-1}\right)\right) - 2\varphi' \pi^{-1}\right] + \frac{\partial^2 U}{\partial\left(\pi^{-1}\right)^2} < 0 \tag{A.14}$$

$$\frac{\partial \Lambda_1}{\partial \lambda} = \frac{\partial^2 U}{\partial \lambda B^2} B r^* + \frac{\partial U}{\partial T}\left(\pi^{-1}\right)^2 < 0 \tag{A.15}$$

$$\frac{\partial \Lambda_2}{\partial \pi^{-1}} = \frac{dU}{d\pi^{-1}} + \frac{\partial \widehat{U}}{\partial r}\left(\pi^{-1}\right)^{-2} r^* < 0 \tag{A.16}$$

where $dU / d\pi^{-1}$ satisfies

$$\frac{dU}{d\pi^{-1}} \equiv \frac{\partial U}{\partial T}\left(\lambda B - \varphi'\right) + \frac{\partial U}{\partial \pi^{-1}} \tag{A.17}$$

which is of ambiguous sign. As above, we can sign this term as negative by appealing to the fact that at the lobbyist solution, inflation is below the government's optimum in the absence of lobbying, implying that utility is increasing in inflation, and therefore decreasing in π^{-1}.

$$\frac{\partial \Lambda_2}{\partial \lambda} = \left[\frac{\partial U}{\partial T}\pi^{-1} + \frac{\partial U}{\partial \lambda B}\right]B - \frac{\partial \widehat{U}}{\partial r} \tag{A.18}$$

Here, the bracketed term is of ambiguous sign, depending on whether government utility is increasing in the transfer it receives from the lobby. The ambiguity lies in the first term, which endogenizes r, noting that increases in transfers from the lobby raise the nominal rate paid on domestic bonds. In turn, this increases the government tax burden. As this increase in r also reduces the government's utility in the absence of lobbying, which also leaves minus the third term positive.

A sufficient, but not necessary condition for the entire term to be positive is that government utility is increasing in lobby transfers at a greater than or equal to level than its disutility from taxation

$$\left|\frac{\partial U}{\partial T}\right| \leq \frac{\partial U}{\partial \lambda B} \tag{A.19}$$

which we adopt. This merely implies that the government prefers contracts with greater transfers from the lobby, despite the fact that these transfers raise its tax burden. The determinant of the system is then unambiguously negative

$$D = \frac{\partial \Lambda_1}{\partial \pi^{-1}}\frac{\partial \Lambda_2}{\partial \lambda} - \frac{\partial \Lambda_2}{\partial \pi^{-1}}\frac{\partial \Lambda_1}{\partial \lambda} < 0\,. \tag{A.20}$$

We then solve for the comparative statics of the implications of changes in the stock of domestic bonds, B. Differentiating Λ_1 and Λ_2 with respect to B yields

$$\frac{\partial \Lambda_1}{\partial B} = \frac{\partial U}{\partial T}\left(\pi^{-1}\right)^2 \varphi' B^{-2} > 0 \tag{A.21}$$

$$\frac{\partial \Lambda_2}{\partial B} = \left(\frac{\partial U}{\partial T}\pi^{-1} + \frac{\partial U}{\partial \lambda B}\right)\lambda > 0 \tag{A.22}$$

again using our assumption in (A.19) that increases in government utility from transfers outweigh its disutility from its increased tax burden at the margin. The sign of the change in π^{-1} with changes in the share of domestic bonds then satisfies

$$\frac{\partial \pi^{-1}}{\partial B} = \left(-\frac{\partial \Lambda_1}{\partial B}\frac{\partial \Lambda_2}{\partial \lambda} + \frac{\partial \Lambda_2}{\partial B}\frac{\partial \Lambda_1}{\partial \pi^{-1}}\right) / D > 0. \tag{A.23}$$

which directly proves the proposition.

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 (1.7)	-1.2 (1.6)
Analogue for Hard Fixers	2.3 (3.4)	2.4 (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** (.35)	.71* (.36)	1.16** (.37)
Log Population	-.37** (.10)	-.43** (.10)	-.36** (.11)
Log Real GDP p/c	.05 (.14)	-.04 (.14)	.07 (.14)
Polity	-.05* (.02)	-.05* (.02)	-.05* (.02)
<u>Inflation Target</u>			
Bond Market	1.42** (.53)	1.03* (.44)	.70 (.51)
Log Population	.15 (.16)	.51** (.17)	.23 (.17)
Log Real GDP p/c	.29 (.25)	.89** (.28)	.51* (.26)
Polity	.21** (.06)	.24** (.08)	.24** (.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] If our model was stochastic, we would need our specification to explicitly consider the distance of inflation from the specified inflation target, π^*, from both directions. However, here our specification, which is expressed solely in terms of actual inflation, π, is sufficient because the government always chooses an inflation rate above π^*, implying that government utility is decreasing in inflation.

[4] The intuition behind this result is that an increase in r deteriorates the government budget, requiring a response in the form of higher taxes, inflation, or a combination thereof.

[5] 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.

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

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

[8] 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.

[9] As hard fixed exchange rate regimes have made no explicit low inflation commitment, they may differ in other dimensions that leave it difficult in our parsimonious specification to identify the impact of bond markets on inflation. For example, rapidly-growing pegged regimes may experience real exchange rate appreciation that manifests itself in the form of increased inflation, even as hard nominal pegs remain intact.

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

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

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

[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] 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).

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

[18] 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).

[19] 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)

[20] "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)

[21] "[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)

[22] Estimates for the equivalent of a reverse regression to (11) are presented in Appendix Table A2. Where (11) 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).

[23] 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.

[24] We use standard parameter values for our 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).

[25] Similarly negative results appear if one replaces the regressand with standard measures of fiscal policy, such as either the budget surplus/deficit or stock of central government debt (both expressed as percentages of GDP).