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**JEL Classification:** E31, E42, E58, E65

**Keywords:** Hyperinflations, monetary institutions, inflation, central banks.
LONG-TERM INFLATION OUTCOMES AFTER HYPERINFLATION: THEORY AND EVIDENCE (*)

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I. INTRODUCTION

Anecdotal accounts suggest that hyperinflations leave a long-lasting mark in people’s memories of the hardships introduced by run-away inflation. These memories, the story goes, lead central banks to adopt subsequent long-term monetary policies that are more conservative than the long-term monetary policy observed in the average country lacking a past of hyperinflation.

Most, but not all, of the anecdotal accounts refer to the German experience of the early 1920s and the subsequent long-term conservative stance of monetary policy followed by the Bundesbank, commonly attributed to the trauma caused by the 1923 hyperinflation (see some quotations in section two below). The importance of the episode is out of question, but even if one takes the story at face value, the doubt remains on how general the German results are. Concretely, has the German experience been repeated in other countries? Furthermore, and to the extent that some other countries have indeed repeated the German pattern, how general is the result? Does it survive in a wide cross-section of countries? These are the questions examined in the second section of this paper. The findings are both statistically and economically significant.

Why does hyperinflation lead to lower subsequent long-term rates of inflation? Moreover, what are the mechanisms at play? The third section of this paper proposes a model that suggests a rationale for the outcome: hyperinflations act by reducing the costs of collecting conventional taxes vis-à-vis the costs associated with the collection of the inflation tax. This is the main lesson that societies that lived through hyperinflation seemed to have learned and internalized: no matter how highly distorsionary conventional taxes may be, they are always preferable to the social costs imposed by the massive use of the inflation tax to finance the budget. Section four of this paper discusses the main rationale advanced by the model against available evidence from country case studies, in particular in regards to the key role that conventional taxation played in terminating hyperinflations, and it also discusses the role played by some critical assumptions of the model. Section five briefly concludes the paper.
II. WHAT THE EVIDENCE SAYS

This section reviews the evidence concerning the effect of past hyperinflationary experience on subsequent, long-term inflation outcomes. First, some anecdotal evidence on the German and Argentine experiences is reviewed. Next, the cross-country data after WWII are examined and discussed.

II.A. Scattered pieces of evidence from the cases of Germany and Argentina

When the issue of the legacy of hyperinflation in Germany is discussed, even the non-technical literature produces statements along the following lines:

“It (the collapse of the German currency) left a permanent mark on the psyche of the nation, with far reaching effects that the passing of time has not been able to eradicate completely. Thus, on various subsequent occasions, the mere fear of inflation which the trauma of the 1920s had implanted in the minds of the German people was responsible for policies and attitudes, sometimes for better, sometimes for worse. In 1924, for instance, it helped to create the spirit of restraint and self-denial needed to maintain the stability recently brought to the currency. Conversely, during the world economic crisis of the 1930s, it prevented the German authorities from applying even mildly inflationary policies, which might have made the recession less disastrous.” Guttmann and Meehan [1976, p. xi]

The issue is taught to undergraduate students taking the Money and Banking course in a similar way:

“The ghost of the inflation after World War I still frightens many Germans today” Meyer [1986, p. 41]

“Not surprisingly, given Germany’s experience with hyperinflation in the 1920s, Germans have had the strongest commitment to price stability as the primary goal for monetary policy”. Mishkin [2000, p. 457].

And a similar view is held in policy circles, as well:

“…the inflation of 1923 left a terrible legacy for the future fate of our country… The objective of stable money was and is deeply rooted in our society. It is based on a wide consensus in broad sections of our population. It is based on a culture of stability. That is why German public opinion --particularly in critical periods-- again and again proved a loyal ally of a stability-oriented monetary policy”. Tietmeyer [2001, pp. 7-12].

Sometimes, even quantitative comparisons are advanced:

“Germany has achieved a high degree of price stability. In that respect, the last 50 years have been in distinct contrast to the monetary upheavals of the first half of the twentieth century with
their calamitous political and social consequences. A comparison with inflationary developments in other countries during the past fifty years also testifies to how deeply stability awareness is anchored in Germany --something which is undoubtedly due to its specific past experience. The average annual rate of inflation in the UK over the past five decades --based on a broad index of consumer prices-- has been 6.4%, for example. By contrast, the corresponding German rate has been 2.8%. Even countries with a traditionally stronger anti-inflationary orientation, such as Switzerland and the United States, have recorded higher rates of monetary erosion than Germany --at 3% and 4.1% respectively". König [2001, p. 56]. (Italics added).

For clear and well-justified reasons, the Argentine hyperinflation of 1989-91 has not attracted as much attention. Nonetheless, there has been no lack of speculation on the legacy of hyperinflation. Reflections have gone along similar lines.

“The loyalty of Argentinians since 1991 to the Convertibility Plan…has been similar to the persistent loyalty of Germans to their anti-inflation commitment. Both are rooted in their countries’ bad histories of inflation. Many would argue that low inflation in Germany since 1950 and in Argentina since 1991 are owed to institutional commitments –the independence and legislated commitments of their central banks. But I suspect that such independence and commitments have survived only because of the support of public opinion that has its roots in historical memory”. Corden [2002, p. 181].

Even after the traumatic collapse of the Currency Board arrangements in January 2002 --involving an unprecedented institutional crisis that witnessed the resignation of two different presidents in a period of a month-- , not all professional economists agreed with the conventional wisdom of the times concerning the inevitability of a new hyperinflation:

“Many people think that we are headed toward hyperinflation. That can indeed happen, but it is not something inevitable. The inherited economic mess and the colossal policy mistakes of the Duhalde administration are not themselves sufficient to generate a new hyperinflation. Hyperinflation is a monetary phenomenon that depends on both the demand for and the supply of money. Up until this point (July of 2002) the demand for money has shown a striking resiliency. The stability of the demand for money is all the more surprising if we recall that the Peso has devalued by more than 70% (since January 2002)…Regarding the supply of money…the federal treasury has received only small transfers from the central bank. Memories of the 1989-91 hyperinflation have had a very positive influence via a huge ‘fear effect’.” Espert [2002, pp. 2-3]

II.B. Cross-country evidence on hyperinflation and subsequent long-term inflation

This subsection is devoted to analyzing the cross-country evidence on the effects of hyperinflation on subsequent inflation outcomes for the period 1949-2002.

II.B.1. Description of the data
The data are from the International Monetary Fund’s International Financial Statistics (IMF-IFS) database, and consist of averages through time for each country for the period 1949-2002. The main advantage of using averages over a long period of time is that the chance of capturing short-run dynamics (rather than the long-run behavior of inflation) is substantially diminished, if not completely eliminated.

Table 1 presents the summary statistics for the inflation data. From the information reported in Table 1, it is noteworthy that roughly 25% of the observations associated with countries that have not undergone hyperinflation correspond to average inflation rates above 12%, the maximum average inflation rate observed in the aftermath of hyperinflation. Indeed, for countries that have had hyperinflation, annual inflation rates range from roughly 2.5% in the cases of Macedonia and Germany, to 11.9% in the case of Nicaragua. On the other hand, the maximum rate of inflation for countries that have not experienced hyperinflation is 82.79%, corresponding to the case of Zambia (a clear outlier; more on this topic below). Remarkably, even if we concentrate our attention on OECD countries that have not experienced hyperinflation (that is, Germany and Austria are excluded from the OECD group), the average rate of inflation for this group is 8.19%, higher than the 7.07% mark characterizing the average inflation record in the post-hyperinflation period for the countries in the sample.

**II.B.2. Methodological Issues**

Table 2 lists the twenty one countries classified as having a hyperinflation and reports their subsequent average inflation outcome. Cagan’s conventional threshold of a rate of inflation of at least 50% per month was used to classify the hyperinflation experiences. Two questions arise at this point. First, what were the criteria that led to the inclusion of the twenty countries listed in Table 2? Second, how does the list compare to other relevant studies on hyperinflations? First, Serbia (Former Yugoslavia) was excluded from the sample for lack of data in the IMF-IFS database. The same is true of Tajikistan and Turkmenistan. These three countries were included by Fischer et al. [2002] in their study of hyper and high inflations. Second, Belarus was excluded
from the sample both because it is (still) living a situation --prevalent for the whole 1990s--,
reminiscent of high, chronic inflation, not of a hyperinflation and because its "market socialism",
coupled with authoritarian rule and inefficient state enterprises operating under soft budgets --
financed through the printing of money-- all within Soviet style planning arrangements, has
artificially delayed reform, preventing stabilization from taking place. Third, Congo (CDR) and
Angola, countries that experienced hyperinflation and for which data are available in the IMF-IFS
database were excluded because until very recently (up to the present day in the case of the CDR,
and until 2002 in the case of Angola) they continued to experience civil wars that prevented the
stabilization of inflation from taking place.

A second important methodological question is how to deal with countries that
experience hyperinflation more than once. When a country experienced hyperinflation at two
different points in time, the following criteria were used to record them:
a) If the two hyperinflations occurred before 1949, then the most recent one is considered. This is
the case of Hungary, with one hyperinflation occurring after WWI and another one after WWII.
b) If one happened before 1949 and another after 1949, then the less recent hyperinflation is the
one considered. This is the case of Russia, with one in the early 1920s and another one in the
early 1990s. c) If the two of them occurred after 1949, then the less recent one would be
considered (no case like this occurs in the sample, though). The above criteria were set with two
ideas in mind. First, to maximize the number of years spanning the post-hyperinflationary period,
so as to highlight the role of past hyperinflations on subsequent inflation outcomes, and second to
minimize the number of missing observations before 1949, the first year with data in the IMF-IFS
database.

II.B.3. Regression results

A simple univariate regression shows that a dummy variable for the existence of past
hyperinflation has a strong negative (and statistically significant) correlation with the actual
cross-country rates of inflation. (Given criticism related to the fact that Taiwan is not universally
accepted as a country, it was excluded from the regressions presented in this paper. Results are slightly better if Taiwan is included. The results including Taiwan are available upon request from the author and included in Guerrero, 2006b). Countries that experienced hyperinflation tend to have, on average, a rate of inflation 5 percentage points lower than the average rate of inflation for the countries that lacked the same experience. The result is statistically significant at the 0.1% level, with a t-statistic of -3.75 (The t-stat is -3.89 if Taiwan is included). Moreover, this result is relatively robust to the exclusion of sample outliers. If Zambia is excluded from the sample, the estimated coefficient falls, in an absolute value sense, from -5 to -4.39, the t-statistic falls (also in an absolute value sense) from -3.75 to -3.68 (from -3.89 to -3.80 if Taiwan is included), and the coefficient remains statistically significant at the 0.1% level. If all the countries displaying annual average rates of inflation higher than or equal to 50% (Zambia, Uganda, Indonesia, and Chile) are excluded from the sample, the estimated coefficient falls again, in absolute value terms, to -3.24 (-3.35 when Taiwan is included) but remains statistically significant at the 0.2% level, with a t-statistic of -3.21 (-3.35 if Taiwan is included). If, alternatively, all the countries with annual average rates of inflation higher than or equal to 40% (Zambia, Uganda, Indonesia, Chile, Uruguay) are excluded from the sample, the estimated coefficient is now -2.95 (-3.06 when Taiwan is included) and the statistical significance is still at the 0.3% level with a t statistic of -3.03 (-3.18 in the case Taiwan is included). Even if 6 more countries are deleted from the sample (Guinea Bissau, Turkey, Israel, Ghana, Mozambique and Yemen), so that only countries with average annual rates of inflation lower than or equal to 30% remain, the coefficient remains marginally statistically significant at the 5% level and reveals that countries that experienced hyperinflations display rates of inflation that are on average 1.5 percentage points lower than the one in the average country of the cross-section. (Results when Taiwan is included are as follows: t-statistic, -2.07; p-value, 0.04; coefficient, -1.66).

Table 3 presents the multivariate regression results for all but one of the countries in the sample: Zambia, a clear outlier among the countries that did not experience hyperinflation,
displaying an average rate of inflation of 82% (the results that include Zambia are marginally better and are reported in Guerrero, 2006b). The vector of control variables in Table 3 (and also in Table 4 and Table 5) is composed of the following. First, dummy variables for former colonies of Spain and France were included. As discussed in Barro [1997, pp. 113-16], former colonies of Spain tend to display relatively high cross-sectional rates of inflation whereas the converse is true for former colonies of France. Second, following McCandless and Weber [1995] and Lucas [1996], two proxies for the average growth of the money supply are alternatively included: the rate of growth of M2 and the rate of growth of Base Money. Third, given that initially richer countries could have had better institutions across the board, the natural logarithm of GDP per capita in 1950 is included to try to shut-off that channel of variation in the cross-sectional rate of inflation. Similarly, both the existence of armed conflicts and a low degree of prevalence of the rule of law can lead to poor inflation outcomes that are themselves independent of the existence of hyperinflation in the past. For that reason, proxies for both the degree of prevalence of the rule of law and the existence of wars were also included in the vector of control variables. In doing so, we follow Barro [1997] and Guerrero [2006a]. Finally, so as to avoid picking up the effect of globalization on global disinflation during the 1990s, a point stressed in Rogoff [2003], two alternative proxies for disinflation in the world were included as right-hand side regressors: (i) the absolute difference in the average rate of inflation between the 1990s and the 1980s for every country, and (ii) the relative (%) difference in the average rate of inflation between the 1990s and the 1908s for every country. Recalling that regressions are of a purely cross-sectional variety, these measures do not introduce a problem with the left hand side variable (the rate of inflation over the period 1949-2002 for every country, except for the ones suffering hyperinflation, for which the average rate of inflation in the post-hyperinflation period is considered).

The results in Table 3 are both economically and statistically important. Countries that experienced hyperinflation have subsequent rates of inflation that are 15 percentage points below
the rate of inflation of the average sample country that never experienced hyperinflation. This result is statistically significant at least at the 5% level across different specifications.

How sensitive to the elimination of outliers are the results shown in Table 3? In particular, what happens if all the countries with rates of inflation higher than or equal than 50% (Uganda, Indonesia, and Chile, in addition to Zambia) are removed from the sample? Table 4 provides the answer. Results stay statistically significant at the 5% level, but now the quantitative economic impact of a hyperinflationary experience is cut by a third to roughly 10 percentage points.

More challenging tests can be posed to the results displayed in Table 4. What happens, for instance, if all the countries with rates of inflation in excess of 40% (Zambia, Uganda, Indonesia, Chile, and Uruguay) are excluded from the sample? Results are displayed in Table 5. The quantitative effect of hyperinflation is roughly 8 percentage points, on average. Results for the hyperinflation dummy stay statistically significant at the 5% level. This last result is shown to survive even if the sample is reduced to countries that are members of the OECD. Unsurprisingly, given the loss of degrees of freedom involved in such an exercise, the statistical significance level is reduced to the 10% level in some specifications (though it remains at the 5% level for 50% the cases). The interested reader can find this and other robustness results in Guerrero [2006b].

III. A MODEL

This is an endowment economy where real per capita output, $y_t$, is given (and constant) at every instant: $y_t = y > 0 \ \forall t$. Population is constant and its size is normalized to unity for convenience. The economy is composed of two groups of individuals. A fraction $\gamma$ is composed of fully rational individuals endowed with perfect foresight (their behavior is fully described below in section 3.1.). A fraction $(1 - \gamma)$ is boundedly rational. In particular, their rationality is limited in regards to their understanding of the full consequences of inflation finance. Their
behavior is summarized in subsection III.B. below and the implications of their limited rationality
more fully discussed in section IV.

The remaining part of this section proceeds as follows. A standard representative agent
model is presented first, in section III.A., to describe the behavior of the $\gamma$-agents. Next, the
assumptions on the $(1 - \gamma)$ agents are summarized in sub-section III.B. Subsection III.C.
aggregates the behavior of the two types of agents and presents the macroeconomic equilibrium.
Subsection III.D. discusses the government finances and the political constraints to raise tax
collections. Subsection III.E. presents the main social tradeoff between increasing the collection
of conventional taxes versus increasing the collection of the inflation tax and subsection III.F.
models social preferences between conventional taxes and inflation in the aftermath of
hyperinflation.

III.A. Microeconomic optimization by the gamma-group representative agent

The $\gamma$-group representative agent is assumed to be infinitely lived, forward looking, and
endowed with perfect foresight. (S)he supplies labor inelastically, and maximizes:

$$
\int_0^\infty [u(c_t) + v(m_t)] e^{-\rho t} dt
$$

Where $c$ stands for consumption per capita, $m$ represents real money holdings per capita,

$$
m_t \equiv \frac{M_t}{P_t}, \quad M_t \text{ represents the nominal stock of money, the only asset the } \gamma \text{-group}
$$

representative agent holds at any instant } t, P_t \text{ represents the price level at any instant } t, u(\cdot) \text{ and
$v(\cdot)$ are known as the instantaneous utility functions (assumed to be strictly increasingly
concave), and the parameter $\rho$ is the rate of time preference, or the subjective discount rate,
which is assumed to be strictly positive and equal to the real rate of interest, for simplicity. The
index $\gamma$ that denotes the agent’s group has been dropped to keep notation as simple as possible,
and it will also be ignored in what follows, so long as there is no room for confusion.
It is also assumed that the instantaneous utility function \( v(.) \) adopts the following functional form:

\[
v(m_t) = m_t [A - B \ln (m_t)]; \quad A, B > 0
\]

The previously assumed functional form has been used before in studies of seigniorage during episodes of runaway inflation [i.e., Calvo and Leiderman, 1992] and it is also very convenient in the present context, since it will give rise to a generalized form of Cagan’s money demand (see below, equation (13), p. 15).

The maximization is made subject to the following constraints:

\[
\dot{m} = y - c_i - \pi m + x_i - \tau_i
\]

\[
\lim_{t \to \infty} \lambda m_i e^{-\rho t} = 0
\]

\[
m_t, c_i > 0 \quad \forall t \quad \text{and} \quad m_0 \text{ is given.}
\]

Equation (3) is usually called the evolution equation and acts as an intra-period budget constraint. In equation (2), \( \pi \) is the rate of inflation (so that the term \( \pi m \) represents the inflation tax on real cash balances), \( x \) denotes lump-sum government transfers per capita, and \( \tau \) denotes lump-sum taxes per capita (the last two are assumed to be taken as given by the \( \gamma \)-group representative agent when solving the maximization problem).

Equation (4) is the so-called transversality condition, a condition that guarantees the fulfillment of the lifetime budget constraint of the \( \gamma \)-group representative agent. Equation (4), sometimes also called no-Ponzi game or no-bubbles condition, guarantees that the real value of the individual’s assets does not explode as time passes by (recall that \( \pi \) was not formally restricted to be positive), thus acting as an intertemporal budget constraint in the optimization program. In equation (4), \( \lambda \) represents the shadow value of the \( \gamma \)-group representative agent’s lifetime wealth.
Last but not least, (5) describes the initial condition for the stock of money per capita, and the relevant non-negativity constraints.

Making use of Fisher’s parity condition, a condition that holds true in the present context of perfect foresight, the nominal interest rate can be linked to the real interest rate, $\rho$, and the inflation rate, $\pi$, as follows:

\[ i = \rho + \pi \]

The solution to the maximization problem is obtained by means of Pontryagin’s maximum principle. Setting up the current value Hamiltonian:

\[ J = \{u(c) + m_i[A - B \ln(m_i)]\} + \lambda_i[y + x_i - \tau_i - c_i - \pi_i] \]

Treating $c$ as the control variable and $m$ as the state variable (with $\lambda$ being the associated costate variable), gives the following first order conditions:

\[ \frac{\partial J}{\partial c} = u'(c) - \lambda_i = 0 \]

\[ \frac{d\lambda_i}{dt} \equiv \dot{\lambda} = -\frac{\partial J}{\partial m_i} + \lambda_i \rho = -(A - B - B \ln(m_i)) + \lambda_i (\pi_i + \rho) \]

Plugging equation (8) into (9) and considering a steady state where $\frac{d\lambda}{dt} \equiv \dot{\lambda} = 0$ gives:

\[ \ln(m_i) = \frac{A - B}{B} - [\rho + \pi_i] \frac{u'(c_i)}{B} \]

Taking antilogs to (10) yields:

\[ m_i = A e^{-\alpha(t) [\rho + \pi_i]} ; A \equiv e^{\frac{A-B}{B}} , \alpha(t) \equiv \frac{u'(c_i)}{B} \]

In other words, a generalized form of Cagan’s money demand (Cagan, 1956) is obtained for group $\gamma$-consumers.

III.B. Behavioral assumptions for the boundedly rational consumers
These agents also hold only one asset, money. How do they arrive to a well-defined demand for money? The answer has two parts.

(i) These agents understand the working of intra-period budget constraints like the one given by equation (3). However, they are not intertemporal maximizers. Instead,

(ii) They arrive to a heuristic version of the money demand equation given by (11). They do not obtain it through optimization, though, but rather through a mix of heuristics, empirical investigation (following in the footsteps of Cagan, 1956), and imitation of the behavior of the gamma consumers. Accordingly, their demand for money schedule involves a constant semi-elasticity of real money demand with respect to the rate of inflation, exactly as in Cagan [1956].

Formally:

\[ m_i = F e^{-\alpha \pi}; \quad F, \alpha > 0 \]

Finally, and with the purpose of facilitating aggregation (see section 3.3. below), it is also assumed that:

(iii) They consume all of their disposable income every period (their saving rate equals zero).

**III.C. Macroeconomic equilibrium**

A necessary step in transforming this setup into a macroeconomic model is to impose the relevant market clearing condition for a closed economy with no government spending:

\[ c_i = y_i = y \quad \forall t. \] Conceptually, macroeconomic equilibrium can only be achieved if aggregate spending equals aggregate supply at every instant.

Given both the aggregate market clearing condition just discussed and the fact that \((1 - \gamma)\) -consumers do not save, in equilibrium \(\gamma\) -consumers do not save either. Hence, we plug the condition \(c_i = y_i = y \quad \forall t\) back into equation (11) to see what it implies for the demand for money schedule of \(\gamma\) -consumers. After redefining the constant term \(A\) in such a way that the term involving the discount rate \(\rho\) is now a part of a new constant term, \(F\), gives the following closed-form solution for money demand for group \(\gamma\) -consumers:
Because $\alpha$, the semielasticity of money demand with respect to the rate of inflation, is now constant for the $\gamma$-consumers as well, from a macroeconomic perspective there is no difference between the money demand schedules characterizing both groups of agents. Hence, normalizing $F$ to unity, taking natural logs to (12) --either (12a) or (12b), since they are the same--, and solving for the rate of inflation $\pi_t \equiv \frac{d\hat{P}}{dt}$ yields:

$$
\frac{d\hat{P}}{dt} = \frac{1}{\alpha} [\hat{P} - \hat{M}]
$$

Where a hat sign over a variable denotes the natural log of that variable. Equation (13) is linear in the logs and can be solved using the integrating factor method. Rewriting (13) to express it in terms of the integrating factor and taking the integral yields:

$$
\hat{P}_t e^{-\left(\frac{1}{\alpha}\right)t} + K = -\frac{1}{\alpha} \int_0^t \hat{M}(s) e^{-\left(\frac{1}{\alpha}\right)s} ds
$$

Where $K$ is an arbitrary constant of integration, still to be determined.

At this point, modern day macroeconomists’ standard method of solution to the differential equation given by (14) follows a suggestion by Sargent and Wallace [1973], and proceeds by imposing a transversality condition that calls for the limit of the first term in the left hand side of equation (14) to vanish as $t$ approaches infinity. After that, equation (14) is evaluated for $t = 0$, and the constant of integration is thus endogenously obtained. The solution so obtained is indeed very appealing in contexts where the variable to be determined (typically the price of an asset) can be reasonably assumed to remain bounded from above. This is not the case in the present context of hyperinflation. There is no reason to believe that during hyperinflations the price level remains bounded from above. Indeed, the evidence clearly shows that this is not the case (see Cagan [1956, p. 26], Table 1, and Figures 1 through 7, pp. 28-40). Therefore, a terminal
condition as a way to determine the value of $K$ will not be imposed here. Instead, equation (14) is
directly evaluated for $t = 0$, which gives: $K = -\hat{P}(0)$. Furthermore, it is also assumed that $\hat{P}(0)$
is exogenously given as of time zero. The price level at time zero is thus determined outside the
model. This is not a problem in the present context. First, as is shown below, this method of
solution highlights the role that different monetary histories play in determining the current price
level, the main issue this paper investigates. Second, this method is clearly better than the
standard alternative in the present context, since the latter involves the assumption of an upper
bound for the price level during hyperinflations that is easily falsified by all existing empirical
evidence, as previously discussed.

Evaluating (14) for $t = 0$ and solving for the (log of) the price level as of time $t$ yields:

\[
\hat{P}_t = \hat{P}(0)e^{(1/\alpha)t} - \frac{1}{\alpha} \int_0^t \hat{M}(s)e^{-(1/\alpha)(t-s)} \, ds
\]

The first interesting feature worth mentioning about equation (15) is that the second term
of the right hand side represents the monetary history of the economy. Given an initial condition
for the price level and a value for $\alpha$, the semielasticity of real money demand with respect to the
rate of inflation, the first right-hand side addend implies an exponential trajectory for the price
level. Similarly, for given values of the money supply, $\alpha$, and the time periods $s$ and $t$, the
second right-hand side addend substracts a constant value from the first addend, and so the
‘wilder’ the monetary history of the economy (i.e., the more the money supply has been expanded
in the past), the higher the value that is substracted from the first addend. Note in passing that
when $s > t$, if the money supply grows at a rate lower than the one implied by the exponential
factor $\frac{1}{\alpha}$, the whole second term of the right hand side tends to vanish. Intuitively, the second
term of the right hand side is not relevant for countries with monetary histories involving “mild
enough” inflationary outcomes.

III.D. Government finances and the political constraints to raise taxes
Government transfers are assumed to be subjected to random shocks, some of which, occurring with non-negligible positive probability, imply very high realizations for the value of government transfers (a relevant historic example is given by the need to pay war reparations). Formally,

\[ x_t = \bar{x} + \varepsilon_t \]

Where \( \bar{x} \) stands for the “historic” or “normal” level of government transfers, and \( \varepsilon \) denotes the random shocks affecting government transfers.

It is assumed that tax collections are exactly enough to cover “historic” or “normal” levels of government transfers, whatever the value of those maybe. That is,

\[ \tau_t - \bar{x} \equiv 0 \]

Hence, if there is a positive shock to government transfers (say, because of the sudden need to pay war reparations), then the government has to run a budget deficit. Following the literature on hyperinflations that Cagan [1956] pioneered, it is also assumed that the government has exhausted its borrowing capacity and so it cannot issue new debt. Therefore, budget deficits have to be monetized, if more taxes cannot be collected. Almost every study about hyperinflation emphasizes the crucial role of seigniorage. What is less often emphasized in analytical studies of hyperinflation is that sudden increases in tax collections are not easy to achieve when a modern tax system is a missing institution, as was the case in the economies that lived through hyperinflation. Some brief examples can be drawn from history (See Bresciani Turroni, [1937, pp. 48-49] for the case of Germany, Makinen [1986, p. 796] for the case of Greece, and Heymann [1991, p. 115] for the case of Argentina). A representative quotation follows:

“The difficulty of increasing the income of the Reich was due…to the particular structure of the German financial system, which was founded on a tripartition of the income between the Reich, the State, and the Municipalities, which did not provide the Reich with an income capable of being expanded and easily adapted to increasing needs” (Italics added). Bresciani Turroni [1937, pp. 48-49]
This paper assumes that at any given time there is a maximum increase in tax collections that is socially tolerable and politically feasible. A large enough shock to government transfers --- requiring an increase in tax collections that hits the maximum socially tolerable level--- implies that the required increase in the tax rates will not be legislated, and so the resulting budget deficit will have to be financed through the inflation tax. To circumvent issues connected with the political game, a random draw from the toss of a coin is assumed to determine that the \((1 - \gamma)\) agents, those with a limited understanding of the full scale effects of inflation finance, constitute a majority in the economy, which is sufficient to deliver the result previously described. 5

Formally,

(i) There exists a well-defined \(\tau_{MAX}\), such that for any two time periods \(t, 0\) (with \(t > 0\)) and a given \(\tau_0\), there exists a finite achievable increase in tax collections:

\[
\Delta \tau_{tolerable} = (\tau_i - \tau_0)_{tolerable} = \Delta \tau \\
0 < \Delta \tau \equiv N < +\infty
\]

(ii) The required increase in tax collections needed to finance a random increase in government transfers is given by:

\[
\Delta \tau_{needed} \equiv (x + \varepsilon_i) - \tau_i \quad \text{when} \quad \varepsilon_i > 0
\]

Hence, if the required increase in tax collections exceeds the increase that is socially tolerable, the resulting budget deficit is financed through the inflation tax. Formally:

If \(\Delta \tau_{needed} \geq \Delta \tau_{tolerable}\) \(\Rightarrow\) \((x_i - \tau_i) = \pi, m_i\)

Establishing a well-functioning, modern tax system is socially costly, as shown by the evidence reported in Cukierman et al. [1992], and especially so for countries that live through a hyperinflation, since tax collections cannot increase in any easy way to cover a sudden increase in government transfers. For instance, Bomberger and Makinen [1983, pp. 804-806] show that for
all but 3 months during the Hungarian hyperinflation of 1945-46, less than 10% of expenditures were covered by legislated tax revenues and that figure fell to 5% for the final 2 months of the hyperinflation.

III.E. The social trade-off

The main public policy trade-off is between the costs of increasing conventional tax collections and the costs associated with seigniorage.

One way to formalize that trade-off in a very simple way is to assume that in order to overcome the costs of information gathering and processing associated with the direct tracking of the political processes that lead to decisions on the financing of the government’s budget, all agents take a short-cut and infer the social costs of increasing tax collections from the information embedded in the price level. In other words, it is assumed that the public observes a reduced-form of the political processes related to the financing of the government’s budget at zero cost: the price level; the higher it turns out to be, the higher the implied costs for the government of increasing tax collections, from the perspective of the agents.

Thus, the (log of) the cost of increasing tax collections is assumed to be proportional to the (log of) the price level. Formally:

(18) \[ \hat{C}_t = \beta \hat{P}_t \; ; \beta > 0 \]

Therefore, plugging (18) back into (15), we get the following expression for the cost of increasing tax collections:

(19) \[ \hat{C}_t = \hat{C}(0)e^{(1/\alpha)t} - \frac{\beta}{\alpha} \int_0^t \hat{M}(s)e^{-(1/\alpha)(t-s)} \; ds \]

Notice that according to (19), if the money supply has grown at a rate higher than the rate implied by the exponential factor \( \frac{1}{\alpha} \), then, given the negative sign preceding the second term on the right hand side of (19), the cost of increasing tax collections falls with the intensity at which the money supply has expanded in the past, a crucial insight when trying to rationalize why
countries that experienced hyperinflations display substantially lower rates of inflation than similar countries lacking the same experience: hyperinflations act by reducing the social costs of collecting more (conventional) taxes.

**III.F. Social preferences in the aftermath of hyperinflation**

An equivalent way to formalize the social trade-off is to assume that social preferences between conventional distorsionary taxes and the inflation tax can be represented by a standard quadratic loss function that a benevolent government tries to minimize. The loss function takes the following form:

\[ L_i = \frac{1}{2} \delta(H) \tau_i^2 + \frac{1}{2} \theta(H) \pi_i^2 ; \delta, \theta > 0 ; \delta'(H) < 0, \theta'(H) > 0 \]

Where \( H = \int_0^t \delta(s) e^{-s \alpha} \pi(s) ds \) is, as argued when discussing equations (15) and (19), the monetary history of the economy, \( \delta \) is the parameter that reflects aversion to taxation, and \( \theta \) is the parameter denoting inflation aversion. It is also assumed, following the discussion in the previous subsection, that \( \delta \) decreases with the intensity of the inflationary history of the economy and the opposite is true of \( \theta \). Finally, following equations (16) and (17), it is assumed that the period budget constraint of this benevolent government implies that transfers are financed by both distorsionary taxes and the inflation tax. Formally:

\[ x_i = \tau_i + \pi_i m_i(\pi_i^*) ; m^1(\pi_i^*) < 0 \]

Solving for taxes in (21), plugging the resulting equation back into (20), differentiating with respect to \( \pi_i \) (taking inflationary expectations as given), setting the first order condition equal to zero and solving for the rate of inflation gives the following government’s best response when acting in a discretionary fashion:

\[ \pi_i = \frac{\delta(H) m_i(\pi_i^*) x_i}{\theta(H) m_i^2(\pi_i^*)} \]
Note that both when $\delta \to +\infty$ and $\theta \to 0$, $\pi \to +\infty$.

Partial differentiation of (22) with respect to $H$ yields:

$$\frac{\partial \pi}{\partial H} = x_i (\delta \theta' - \theta' \delta) \frac{\theta'^2 m_i}{\theta^2} < 0$$

Hence, the long-term effects of hyperinflations on long-term inflation outcomes are present even for central banks acting under discretion (no commitment).

IV. DISCUSSION

The previous result is interesting because it shows that hyperinflations do not need to lead to radical institutional reforms (such as the adoption of a currency board in Argentina as of April 1st, 1991, for instance) in order to have an effect on long-term inflation outcomes. Guerrero and Heymann [2006] provide further discussion on this issue.

Three topics deserve further discussion. First, where are the political constraints to raise income or consumption taxes coming from? Why could the $(1 - \gamma)$ agents prefer the inflation tax vis-à-vis either an income or a consumption tax? Second, what is the role played by the assumption that the $(1 - \gamma)$ agents have a limited understanding of the full effects of inflation finance in achieving the result contained in equation (19)? Finally, the third issue is related to the practical relevance of the assumed trade-off between conventional tax collections and the inflation tax during hyperinflation episodes and the consequent need to raise tax collections to stabilize the price level.

Turning to the first issue, the $(1 - \gamma)$ agents’ opposition to the enactment of either income or consumption taxes stem (partly, at least) from the straightforward nature of these taxes. In both cases, it can easily be inferred what those taxes mean for welfare. Consider an income tax first. The intra-period budget constraint in this case becomes:

$$\frac{1 - \gamma}{1 - \gamma} y + x = c + \pi m$$
Opposition to the income tax only requires a rudimentary understanding of the intra-period budget constraint. By assumption, both groups of consumers fully understand this.

Turning to the consumption tax, a similar case arises. The intra-period budget constraint in this case becomes:

\[
y + x = (1 + t_c) e + \pi m
\]

The tax on consumption simply raises the effective price of consumption. Again, \((1 - \gamma)\) agents fully understand it, since it is a simple implication of the working of the intra-period budget constraint.

Unfortunately, the costs of the inflation tax are not so easy to grasp, and so inflation finance may be more appealing than conventional taxation for the \((1 - \gamma)\) group, at least before hyperinflation has occurred. Even when the inflation tax is clearly present in the period-budget constraint of \((1 - \gamma)\) agents, the logic of the costs of inflation finance are far more subtle to grasp than the costs of either income or consumption taxes. First, agents in the \((1 - \gamma)\) group should have to understand the relation between the use of the printing press and the associated increase in inflation. Unfortunately, there is a disconnection between the additional printing of money to cover government transfers and the increase in prices that reduce the purchasing power of money, the only part that the \((1 - \gamma)\)-agents are able to perceive through the inflation tax term in their intra-period budget constraints. Second, and even more subtle, is the idea that inflation tax avoidance requires economizing on the use of real money balances (and hence a decrease in welfare through increased transaction costs) on the part of all agents. This step involves not just an understanding of the instantaneous utility function \(v(m)\), which is not an explicit part of \((1 - \gamma)\)-agents’ decision-making processes, but also a conceptual comprehension of the meaning of equation (12) --the equation that describes the behavior of money demand, something fundamentally more difficult, and something that agents in the \((1 - \gamma)\) group derived by purely
heuristic methods. Agents in the \((1 - \gamma)\) group are quite sophisticated economic agents (they managed to arrive to a very similar money demand schedule as the one derived by agents in the \(\gamma\)-group, after all), but their failure to fully understand the consequences of inflation finance may force the economy through a hyperinflation, if they constitute a majority (or if they are in control of monetary policy). A historically relevant example of a typical \((1 - \gamma)\) agent is provided by Helfferich, the representative of the Chancellor of the Republic of Weimar in the Reichsbank in post World War I Germany (quoted by Bresciani Turroni [1937, p. 34]):

“The increase of the circulation has not preceded the rise of prices and the depreciation of the exchange, but it followed slowly and at great distance. The circulation increased from May 1921 to the end of January 1923 by 23 times; it is not possible that this increase had caused the rise in prices, which in that period increased by 344 times”.

An understanding of the sharp increase in the velocity of money (i.e. of the type of “flight from currency” embedded in equation (12)), and of the implied loss of welfare involved in that process is clearly absent in Helfferich’s thinking. Furthermore, Helfferich, a quite sophisticated individual who was not only a prominent monetary pundit but also the leader of the right-wing political parties in parliament, was not alone. His limited understanding of the effects of inflation finance was shared by Havenstein, the president of the Reichsbank, and a good part of the German press (see Bresciani Turroni, [1937, p. 50 and 45] respectively).

At this point, the reader should note that the assumption about a group of agents displaying a limited understanding of the full effects of inflation finance was added to motivate the previous discussion on what factors are behind the political constraints on raising conventional taxes. But the theoretical result contained in equation (19) is independent of the assumption of bounded rationality on the part of the \((1 - \gamma)\) agents. If the assumption of limited rationality by the \((1 - \gamma)\) agents is dropped, then (12b) becomes the relevant economy-wide money demand schedule. Equation (12b) is then integrated to get equation (15), and so long as the assumption embedded in equation (18) still holds true, the result in equation (19) follows.
Turning to the third issue raised at the beginning of this section, the need to raise conventional tax collections to stabilize the price level is well-documented, if not always stressed in analytical studies. A few illustrative examples follow.

Referring to the Greek stabilization plan of 1946, Makinen [1986, p. 802] says:

“Concluded on January 24, 1946, it gave top priority to arresting inflation through budget reforms that adjusted the specific tax rates, improved tax collection methods, and increased revenue from the sale of aid goods”

With regard to the Hungarian hyperinflation of 1945-46, Bomberger and Makinen [1983, p. 817] show in their Table 5 how tax receipts were more than doubled between the fiscal years 1946-47 and 1947-48, and referring to the fiscal reforms on the revenue side they add (Bomberger and Makinen, [1983, p. 816]):

“A comprehensive reform of the tax system was undertaken. Rates of taxation were raised considerably over those in force prior to the war. Income taxes were imposed at the rate of 2% on incomes exceeding F1,200 (about $100), rising to a maximum of 60% on income from work and 80% on income from property. The maximum rates applied to incomes exceeding F84,000. The gross rent on houses was subject to a tax ranging from 60 to 80 percent. The purchase tax was raised from the pre-war rate of 2-5 percent to 3-10 percent. The company tax had to be paid according to turnover, irrespective of profit. All taxes in arrears were subject to a monthly penalty of 10%”

Sargent [1982] shows a similar pattern for the cases of Austria, Poland, and Germany (See Sargent, [1982], Table 3.5., p. 83 for the case of Austria, Table 3.13, p. 93 for the case of Poland, and Table 3.22., p. 111, for the case of Germany).

For a more recent episode of hyperinflation, Bolivia 1984-85, Morales [1988, p. 326], Table 7.5.) shows that total tax revenues increased from 1.6% of GDP during the third quarter of 1895, when hyperinflation reached its peak, to 11.3% of GDP during the fourth quarter of 1985, when inflation was stabilized. Morales [1988, p. 318] also describes the reforms on the revenue side of the fiscal package introduced by the government to stabilize inflation. In a similar vein, Artana [2001, p. 21], Table 7, shows that in the case of Argentina, legislated revenues at the national level increased by 25% in real terms between the years 1991, when the currency board
was introduced, and 1992 (the first year inflation fell to low levels). At the provincial level, the increase was even more important: 33% in real terms during the same period. Commenting on these developments, Artana [2001, p. 19] adds:

“the inflation tax was replaced by consumption taxes and legislated revenues increased by 77% —in constant pesos of the year 2000—between the year 2000 (the year before the collapse of the currency board) and the average for the period 1985-90 (the years of the runaway inflation).”

V. SUMMARY AND CONCLUSIONS

This paper has shown evidence indicating that hyperinflationary experience is followed by long-term rates of inflation substantially lower than the ones prevalent in countries that lack the same experience. The quantitative effect depends on the composition of the control group of countries and the vector of control variables used, but it generally is economically and statistically significant.

There is more than one mechanism through which the long-term effects of hyperinflation may have an impact on long-term inflation outcomes. First, there are the psychological effects, through the long-lasting memories of the hardships introduced by hyperinflation. Second, there is the role of financial adaptation through “hysteresis” in the demand for money: since during hyperinflation agents learn to live with less real cash balances, the scope for financing subsequent budget deficits through the inflation tax in the aftermath of hyperinflation may be permanently reduced. This paper advanced yet a third, complementary channel: hyperinflations lead to low long-term rates of inflation because they change the “marginal rate of technical substitution” between conventional taxes, and the inflation tax.

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Association), Universidad Nacional de La Plata, and Concordia University (during the 2006 Annual Meetings of the Canadian Economic Association). All errors and omissions are my own.

UNIVERSITY OF NEVADA, RENO

REFERENCES


Translated from Spanish (Duhalde puede evitar la hiperinflación. Available on-line at:


<table>
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<tr>
<th>Variable</th>
<th>Observations</th>
<th>Mean</th>
<th>Std.</th>
<th>Min</th>
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### Table 2
Hyperinflation experiences and subsequent inflation

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<tr>
<th>Country</th>
<th>AVG Inflation</th>
<th>Period of</th>
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<tbody>
<tr>
<td>Countries After Hyper</td>
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<td></td>
</tr>
<tr>
<td>21</td>
<td>7.07%</td>
<td>2.68</td>
</tr>
<tr>
<td>-B/w 11.9% and 7.1%</td>
<td>9.10%</td>
<td>1.5</td>
</tr>
<tr>
<td>-B/w 7% and 6%</td>
<td>6.40%</td>
<td>0.2</td>
</tr>
<tr>
<td>-Under 6%</td>
<td>3.80%</td>
<td>1.3</td>
</tr>
<tr>
<td>All No Hyper Countries</td>
<td>117</td>
<td>12.19%</td>
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<tr>
<td>-Over 29%</td>
<td>11</td>
<td>44.10%</td>
</tr>
<tr>
<td>-B/w 12.1% and 29%</td>
<td>17</td>
<td>19.00%</td>
</tr>
<tr>
<td>-B/w 12% and 7.1%</td>
<td>35</td>
<td>8.70%</td>
</tr>
<tr>
<td>-Under 7%</td>
<td>53</td>
<td>5.10%</td>
</tr>
<tr>
<td>OECD countries, no Hyper</td>
<td>23</td>
<td>8.19%</td>
</tr>
<tr>
<td>-Over 29%</td>
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<td>36.93%</td>
</tr>
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<td>19.83%</td>
</tr>
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<td>3</td>
<td>8.85%</td>
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<td>-Under 7%</td>
<td>17</td>
<td>5.01%</td>
</tr>
<tr>
<td>Country</td>
<td>Post-Hyper</td>
<td>Hyperinflation</td>
</tr>
<tr>
<td>-------------</td>
<td>------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>11.88</td>
<td>1988-89</td>
</tr>
<tr>
<td>Ukraine</td>
<td>10.87</td>
<td>1993</td>
</tr>
<tr>
<td>Kazakhstan</td>
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</tr>
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<td>Greece</td>
<td>9.88</td>
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<tr>
<td>Bolivia</td>
<td>9.82</td>
<td>1984-85</td>
</tr>
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<td>Bulgaria</td>
<td>8.89</td>
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<td>China</td>
<td>8.16</td>
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<td>Peru</td>
<td>7.96</td>
<td>1988-89</td>
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<tr>
<td>Georgia</td>
<td>7.71</td>
<td>1993</td>
</tr>
<tr>
<td>Brazil</td>
<td>7.58</td>
<td>1993-94</td>
</tr>
<tr>
<td>Armenia</td>
<td>7.38</td>
<td>1994</td>
</tr>
<tr>
<td>Hungary</td>
<td>6.53</td>
<td>1945-46</td>
</tr>
<tr>
<td>Russia</td>
<td>6.49</td>
<td>1921-24</td>
</tr>
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<td>Poland</td>
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</tr>
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<td>Austria</td>
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<td>Germany</td>
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<td>Macedonia</td>
<td>2.43</td>
<td>1992</td>
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Avg Inflation: 7.07
Post-hyper
Table 3: Multivariate OLS Regressions—Whole Sample w/o Zambia
Dependent Variable is Inflation

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<thead>
<tr>
<th>Explanatory Variables</th>
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<th>(2)</th>
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<th>(4)</th>
<th>(5)</th>
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<tr>
<td>Constant</td>
<td>9.1 (6.24***</td>
<td>27.8 (3.21***</td>
<td>27.6 (2.93***</td>
<td>20.80 (2.28**</td>
<td>28.3 (3.14***</td>
<td>27.7 (2.82***</td>
<td>21.9 (2.35**</td>
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<td>Dummy Past hyperinflation</td>
<td>-15.1(-3.52***</td>
<td>-17.1(-2.49**</td>
<td>-17.6(-2.49**</td>
<td>-17.4(-2.42**</td>
<td>-15.7(-2.53**</td>
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<td>-15.17 (-2.42**</td>
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<td>French</td>
<td>-4.5 (-3.62***</td>
<td>-7.5 (-3.38***</td>
<td>-7.5 (-3.25***</td>
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<td>-7.8 (-3.36***</td>
<td>-7.6 (-3.13**</td>
<td>-8.1 (-3.09***</td>
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<tr>
<td>Spain</td>
<td>2.53 (0.77)</td>
<td>1.84 (0.48)</td>
<td>1.99 (0.49)</td>
<td>2.02 (0.46)</td>
<td>3.00 (0.71)</td>
<td>3.55 (0.84)</td>
<td>2.66 (0.60)</td>
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<td>% Growth of M2</td>
<td>0.25 (2.37**)</td>
<td>-1.74 (-1.52)</td>
<td>-1.75 (-1.55*)</td>
<td>-0.65 (-0.57)</td>
<td>-1.59 (-1.33)</td>
<td>-1.65 (-1.46)</td>
<td>-0.63 (-0.56)</td>
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<td>log initial (GDP/L)</td>
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<td>Rule of Law</td>
<td>-1.42 (-1.44)</td>
<td>-1.37 (-1.36)</td>
<td>-1.83 (-1.65)</td>
<td>-1.62 (-1.59)</td>
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<td>-0.31 (-1.10)</td>
<td>0.21 (0.07)</td>
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<td>% Growth of Base Money</td>
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<td>97</td>
<td>93</td>
<td>99</td>
<td>98</td>
<td>94</td>
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<tr>
<td>R-Squared</td>
<td>0.21</td>
<td>0.24</td>
<td>0.29</td>
<td>0.31</td>
<td>0.27</td>
<td>0.26</td>
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<td>F-Stat</td>
<td>6.66</td>
<td>4.69</td>
<td>4.2</td>
<td>4.58</td>
<td>4.61</td>
<td>4.06</td>
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<td>0.0002</td>
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<td>0.0002</td>
<td>0.0004</td>
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Alternative proxies

| Observations                        | 119                      | 97                       | 97                       | 93                       | 99                       | 98                       | 94                       |
| R-Squared                           | 0.21                     | 0.24                     | 0.29                     | 0.31                     | 0.27                     | 0.26                     | 0.28                     |
| F-Stat                              | 6.66                     | 4.69                     | 4.2                      | 4.58                     | 4.61                     | 4.06                     | 3.75                     |
| Prob > F                            | 0.0001                   | 0.0002                   | 0.0003                   | 0.0001                   | 0.0002                   | 0.0004                   | 0.0005                   |

Robust t statistics in parentheses; ***significant at 1%, ** significant at 5%, * significant at 10%
<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
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<td>Constant</td>
<td>8.7 (8.20***</td>
<td>25.3 (3.40***</td>
<td>23.5 (3.12***</td>
<td>15.5 (2.19**</td>
<td>25.2 (3.37***</td>
<td>23.1 (2.98***</td>
<td>17.3 (2.39**</td>
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<tr>
<td>Dummy Past hyperinflation</td>
<td>-11.2(-3.39***</td>
<td>-12.00(-2.28**</td>
<td>-12.3(-2.37**</td>
<td>-11.5(-2.39**</td>
<td>-10.6(-2.27**</td>
<td>-10.4(-2.24**</td>
<td>-10.4(-2.24**</td>
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<td>-6.9 (-3.75***</td>
<td>-6.7 (-3.64***</td>
<td>-7.55 (-4.09***</td>
<td>-7.2 (-3.84***</td>
<td>-6.7(-3.49***</td>
<td>-7.2 (-3.78***</td>
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<td>Spain</td>
<td>2.55 ( 0.93)</td>
<td>1.12 ( 0.37)</td>
<td>2.02 ( 0.70)</td>
<td>2.34 ( 0.80)</td>
<td>10.62 (0.50)</td>
<td>2.58 (0.84)</td>
<td>1.67 (0.54)</td>
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<td>% Growth of M2</td>
<td>0.18 (2.28**)</td>
<td>0.16 (2.06**)</td>
<td>-1.00 (-0.92)</td>
<td>-1.04 (-1.02)</td>
<td>0.29 (0.28)</td>
<td>-0.86 (-0.78)</td>
<td>-0.94 (-0.95)</td>
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<td>log initial (GDP/L)</td>
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<td>-1.04 (-1.02)</td>
<td>0.15 (1.96*)</td>
<td>0.12 (1.76)</td>
<td>-0.86 (-0.78)</td>
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<td>-2.36 (-3.11**</td>
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<td>-1.80 (-2.22**)</td>
<td>-1.80 (-2.22**)</td>
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<td>-4.52 (-2.08**)</td>
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<td>-3.76 (-1.67*)</td>
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<tr>
<td>% Growth of Base Money</td>
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<td></td>
<td>0.11 (1.77*)</td>
<td>0.09 (1.59)</td>
<td>0.07 (1.48)</td>
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<td>0.03 (0.89)</td>
<td>0.05 (1.57)</td>
<td>0.03 (0.38)</td>
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Observations: 116 94 94 90 96 95 91
R-Squared: 0.19 0.32 0.33 0.4 0.31 0.32 0.37
F-Stat: 5.48 4.97 4.37 5.16 5.21 4.3 4.24
Prob > F: 0.0005 0.0001 0.0002 0.0000 0.0001 0.0002 0.0002

Robust t statistics in parentheses; ***significant at 1%, ** significant at 5%, * significant at 10%
Table 5: Multivariate OLS Regressions-Countries with less than 40% inflation
Dependent Variable is Inflation

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<tr>
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<td>0.13</td>
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<tr>
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<td>(2.32**)</td>
<td>(2.08**)</td>
<td>(1.98*)</td>
<td>(1.76)</td>
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<td>(1.37)</td>
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<td>0.3</td>
<td>0.33</td>
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<td>F-Stat</td>
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<td>0.0002</td>
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</tbody>
</table>

Robust t statistics in parentheses; ***significant at 1%, ** significant at 5%; * significant at 10%
Endnotes

1 This led to the elimination of other well-known episodes of runaway inflation, like Diocletian’s inflation, the inflation during the French Revolution of the early 1790s, and the inflation in the US Confederacy in the early 1860s. See some evidence on the quantitative magnitude of those historic episodes left out here in Tayer Watkins’ homepage: http://www2.sjsu.edu/faculty/watkins/hyper.htm.

2 At this point, this is all that we need to know about this group of agents. More details about their limited understanding of the effects of inflation finance are provided in section four.

3 Sargent and Wallace proposed this solution in the specific context of models of money and capital (or money and growth models), not in the context of hyperinflationary paths for the price level, despite the fact that they used Cagan’s money demand to motivate their paper. Their use of Cagan’s money demand was a purely pragmatic choice to assure analytical tractability and simplicity, but it is worth recalling that Sargent and Wallace [1973] were not studying hyperinflationary paths.

4 Given the present continuous time setup, the price level is thus a predetermined variable. Further implications from this assumption are discussed in page 21.

5 The assumption that the gamma group is a majority is convenient, but not strictly needed. All that is needed is that individuals from that group are in control of inflation finance decisions, as, for example, was the case in post World War I Germany with Helfferich and Havenstein (see Bresciani Turroni, [1937, pp. 42-57]).