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The Success of Currency Reforms to End Great Inflations: An Empirical Analysis of 34 High Inflations

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Abstract. *The estimation of an ordered probit model for currency reforms attempting to end 31 hyperinflations and three huge inflations of the twentieth century shows that the introduction of an independent central bank and the adoption of a credibly fixed exchange rate are crucial for the success of a currency reform. In addition, currency reforms are demonstrated to be more difficult in centrally planned economies than in market economies.*

JEL classification: *B*31, *E*58, *E*65.

Keywords: Great inflations; currency reforms; central bank independence; fixed exchange rate.

1. INTRODUCTION

High inflations and even hyperinflations in Cagan's (1956) definition, i.e. of inflations rising to rates of 50% per month or more, are a recurrent phenomenon in the twentieth century. In fact, we have a wave of hyperinflations in several countries after the two world wars. More recently, we note a couple of hyperinflations in Latin America in the 1980s and in the transition countries resulting from the breakdown of the communist bloc in the 1990s. The circumstances of hyperinflation are mostly characterized by political disorder and financially weak governments that rely on money creation to finance its expenditures in difficult times. Bernholz (2003, pp. 65–113), Fisher *et al*. (2002) and Siklos (2003) provide an overview of these episodes of monetary chaos in economic history. However, it is interesting to note in passing that hyperinflations are not always preceded by strong increases in seigniorage, so that we have to ask ourselves why the economy did not stay in a 'mere' high-inflation steady state. This phenomenon can be explained

as a bubble equilibrium with a standard Laffer curve implying two rational equilibria for the same seigniorage level (Sargent and Wallace, 1987), as a consequence of bounded rationality and adaptive learning (Marcet and Nicolini, 2003) or as an effect of credit rationing with perfectly rational private agents (Gomis-Porqueras and Haro, 2007).

Whatever may be the causes of hyperinflations and very high inflations, the task to end them without causing severe economic disruptions has proved to be difficult. The government deficit is huge and increasing and mainly financed by creating money. Moreover, government and monetary authorities have lost all credibility. The public try frenetically to get rid of the national money and to substitute it by stable foreign or (formerly) gold or silver money. Thus, rates of inflation are surging ahead of the growth of the money supply, the real stock of the national money is far below its normal level and the exchange rate is strongly undervalued. Capital markets have fallen apart and the real economy is in a mess. The social consequences of differently falling real wages in the diverse sectors of the economy and of the elimination of the value of nominal assets are devastating. As a consequence, ruling politicians and often even political regimes are discredited, a fact that has led in most cases to a fall of the government or even to the emergence of authoritarian regimes (Paldam, 1994).

But in spite of these adverse conditions it has been possible in several cases to re-establish stable national currencies without severe increases of unemployment and with beneficial consequences for the real economy. This has been clearly shown by Sargent (1982) for four central European hyperinflations of the 1920s (compare also Makinen, 1984, for the Greek stabilization of 1946, and Bomberger and Makinen, 1983, for the Hungarian stabilization of 1946). On the other hand, quite a number of reforms ending hyperinflations have been far less successful than the four mentioned by Sargent. This raises the question as to which institutional reforms are necessary or even sufficient for successful reforms. According to Makinen (1992, p. 328; see also Cagan, 1992, p. 325):

> Experience has shown that successfully ending hyperinflations requires a public sector budget balanced by explicit taxes and an end to money finance. It also suggests that to enforce fiscal responsibility, monetary policy has to be constrained by actions such as those creating an independent central bank, restoring external currency convertibility, or submitting domestic policy to foreign supervision.

These are certainly correct observations, but leave open several questions. First, they do not answer the question under which conditions the reform may be politically feasible. Second, it does not address the problem as to how the seeming contradiction between the necessity to strongly increase the real stock of the national money, given its very low level, and the control of the money supply can be resolved by the reforms. And finally, it leaves the question open as to which of the factors mentioned are necessary and which are only supplementary conditions for the most successful reforms.

Bernholz (2003, pp. 166–193) and Végh (1995) give a qualitative comparative analysis of the attempts to end eight and 29 hyperinflations, respectively. This paper adds to this literature by providing a quantitative econometric analysis using an ordered probit model for a sample of all 31 hyperinflations that occurred until now in history and three additional high inflations. This paper is organized as follows: in Section 2, we give a brief description of the 34 high inflations and the data considered. The empirical results are presented in Section 3 and Section 4 concludes.

2. DESCRIPTION OF 34 HIGH INFLATIONS

Our empirical analysis is based on the data collected by Bernholz (2003, pp. 189ff.), which cover all the hyperinflations of history, and data of four failed additional reforms of relatively recent high inflations. He divided the attempted reforms of the hyperinflations (Table 1) into three categories depending on the remaining rates of inflation in the year following the reform. The first category of the *most successful reforms* comprised the nine historical cases in which the rate of inflation remained below 25%. The second category of *less successful reforms* with seven cases referred to remaining rates of inflation between 25% and 99%. And the last category of *least successful currency reforms* contained 14 cases in which the rate of inflation remained higher than 99% or that failed altogether. Since such a classification is somewhat arbitrary, we also checked the robustness of our result by using a 10% besides the 25% bound for the most successful currency reforms. For the subsequent quantitative analysis, we have added five additional cases of attempted currency reforms: first, the Moldavian hyperinflation of 1992 is included. Second, the Israeli reform of 1985 and the Argentine (plan Austral) and Brazilian (plan Cruzado) reforms in 1985 and 1986 are also considered. These three reforms attempted to end high inflations below the hyperinflation level. Third, in Greece two reforms were attempted to end the hyperinflation of World War II. The first effort in 1944 was not successful, whereas this was the case for the second reform in the beginning of 1946. Table 1 presents the highest monthly inflation rates reached in these 34 historical cases and also the annual rates of inflation remaining in the time following the attempted reforms.

Bernholz has attempted to explain the successes or the failures of the reforms to end the inflations in the three categories considered by comparing the differences in the institutional changes contained in them. We follow this approach, but substitute his verbal by a more compelling quantitative analysis. Table 2 presents the most important characteristics of the attempted reforms. It is mainly based on the description of the reforms provided by Bernholz (2003, Tables 8.2, 8.4, 8.6 and 8.7). For a detailed discussion, the reader is referred to the source. In our analysis, we consider five qualitative institutional indicators that may be important for the success of a currency

Table 1 All hyperinflations and three other twentieth-century high inflations

Country	Year(s)	Highest inflation per month	Annual inflation in the year after reform
Austria	1921/22	124.27	3.83
Argentina	1985/86	30.64	50.9
Argentina	1989/90	196.6	84
Armenia	1993/94	438.04	177.78
Azerbaijan	1991/94	118.09	322.2
Belarus	1999	59.5[a]	161
Bolivia	1984/86	120.39	19.4
Brazil I	1985/86	21.83	72.8
Brazil II	1989/90	84.32	84.38
Bulgaria	1997	242.7	2.93
China	1947/49	4,208.73	11,248,955
Congo (Zaire)	1991/93	124.3	598.37
France	1789/96	143.26	235.44
Germany	1920/23	29,525.71	− 1.68
Georgia	1993/94	196.72	163
Greece I	1942/44	11,288	464.93
Greece II	1944/46	126.02	1.27
Hungary I	1923/24	82.18	− 6.33
Hungary II	1945/46	1.295E + 16	40.91
Israel	1984/85	21.7	21.26
Kazakhstan	1994	57	177.01
Kyrgyzstan	1992	54.17[a]	383.77
Moldova	1992	170.98[a]	83.3
Nicaragua	1986/89	126.62	3.5
Peru	1989	104.14	73.33
Poland I	1921/24	187.54	24.48
Poland II	1989/90	77.33	62.22
Serbia	1992/94	309,000,000	100
Soviet Union	1922/24	278.72	− 0.5
Taiwan	1945/49	398.73	82
Tajikistan	1995	78.1	234
Turkmenistan	1993	62.5	179.6
Ukraine	1991/93	249	376
Yugoslavia	1990	58.82	110.15

Notes: [a] Geometric average of quarter. Serbia with Montenegro: New Yugoslav Republic.
Not in all cases could the annual rate of inflation after reform be calculated for a full year. Moreover, in cases in which the inflation surged further in the second year after the reform efforts, the figure for this year has been taken.

reform for theoretical reasons. The first two indicators cover the existence of domestic and foreign credits to replace money financing of the government budget, the third indicator refers to the introduction of central bank independence and the fourth indicator shows the existence of limited credit

Table 2 Institutional characteristics of currency reforms

Country	Domestic credit	Foreign credit	CB independence	Budget finance rule	Fixed exchange rate
Austria	Yes	Yes	Yes	Yes	Yes
Argentina I	No	No	No	No	No
Argentina II	Yes	Yes	Yes	Yes	Yes
Armenia	Yes	Yes	Yes	No	No
Azerbaijan	Yes	Yes	No	No	No
Belarus	Yes	Yes	No	No	No
Bolivia	No	No	No	No	No
Brazil I	Yes	No	No	No	No
Brazil II	Yes	Yes	No	No	No
Bulgaria	Yes	Yes	Yes	Yes	Yes
China	Yes	No	No	No	No
Congo (Zaire)	Yes	No	No	No	No
France	Yes	No	No	No	No
Germany	No	Yes	Yes	No	Yes
Georgia	Yes	Yes	No	No	No
Greece I	Yes	Yes	No	No	No
Greece II	No	Yes	Yes	No	Yes
Hungary I	Yes	Yes	Yes	Yes	Yes
Hungary II	Yes	Yes	Yes	No	No
Israel	Yes	Yes	No	No	No
Kazakhstan	No	Yes	No	No	No
Kyrgyzstan	Yes	Yes	Yes	No	No
Moldova	Yes	Yes	No	No	No
Nicaragua	No	Yes	Yes	No	Yes
Peru	Yes	No	Yes	Yes	No
Poland I	Yes	No	Yes	No	Yes
Poland II	Yes	Yes	No	No	No
Serbia	No	No	No	No	No
Soviet Union	Yes	No	Yes	No	No
Taiwan	No	No	No	No	Yes
Tajikistan	Yes	Yes	Yes	No	No
Turkmenistan	Yes	Yes	No	No	No
Ukraine	Yes	Yes	No	No	No
Yugoslavia	Yes	No	No	No	No

lines of the government at the central bank. The adoption of a fixed exchange rate is the fifth indicator. Moreover, we added a sixth qualitative indicator for the economic system that takes the value of one for a centrally planned economy and zero otherwise. This variable is included because many aspects of controlling inflation are different in a centrally planned economy compared with a market economy. First, there exists a monetary overhang at the beginning of the reforms. Second, prices have been mostly fixed

by government agencies below the level of market equilibrium. With the beginning of the reforms, these regulations are mostly abolished, and, together with the monetary overhang, lead to substantial price increases. Third, the tax system is not well developed in a centrally planned economy, since in this system the government mainly finances itself by taking what it needs directly from the mostly state-owned enterprises. With the beginning of the transition process, it thus takes time to establish an adequate tax system. This usually leads to strong initial pressures to finance the budget deficit by money creation. The inflationary developments resulting from these factors may in turn lead to inflationary expectations, which increase the velocity of money and worsen further the prospects for a successful currency reform (Bernholz, 1992).

We should mention that we use the term central bank independence in a wide sense that differs from the meaning of the term in the literature on political business cycles and (moderate) inflation bias of a discretionary monetary policy. What is important in our context is only the legal safeguard that does not allow the central bank or the monetary authority to finance a government budget deficit except within narrow limits. Therefore, we do not attempt to differentiate the degree of central bank independence among the countries included. Independence of central banks in our paper means in all cases that the government could not exert any influence on the extension of the monetary base. But this was secured very differently and some examples illustrate these differences:

- *Austria and Hungary in the 1920s*: Secured by control through the League of Nations.
- *Argentina and Bulgaria 1990s*: Secured by the Currency Board allowed only to issue M0 by buying foreign exchange; but in this case the rules for Argentina were somewhat weaker, which perhaps explains why the reform was less successful.
- *Germany 1920s*: The new central bank, the Rentenbank, was made independent by law. This was a safeguard strong enough to allow it to flatly reject a secret demand by the government to be granted a higher credit than the very limited credit line provided by the law.
- *Greece 1940s*: The independence was secured by international treaty with Britain and the United States, giving their representatives a majority in the controlling commission.
- *Poland 1920s*: Independence established by law.
- *Soviet Union 1920s*: Independence of new State Bank established by decree.
- *Hungary 1940s*: Article 50 of the Statutes of the central bank stemming from the 1920s revalidated. This weaker safeguard under the unstable conditions in 1946 perhaps explains that the reform was less successful.
- *Peru 1990s*: Central bank autonomy by law or decree.

In this last case (less successful reform) and much more in those of Armenia (by law), Kyrgystan ('relatively high independence') and Tajikistan ('only

effective from July 1997', i.e. seven months after the law) in the 1990s, it is rather doubtful whether real independence was present, given the unstable institutions of these countries. In China of the 1940s, the purportedly independent central bank was even controlled by a government committee. All these cases belong to the group of least or unsuccessful currency reforms.

Similar to central bank independence, the introduction of regimes of credibly fixed exchange rates as a measure of currency reform has been established in different ways. Austria and Hungary introduced fixed rates in the 1920s controlled by the League of Nations. They were therefore quite credible as was also shown by the fact that subsequently the gold standard was reintroduced at the same parity and maintained until the Great Depression. Germany and Poland established fixed exchange rates by law in the 1920s and also went back to the gold standard at the respective parities. Greece introduced gold convertibility with gold coins in 1946, overlooked by the commission in which the representatives of the United Kingdom and the United States held a majority. This parity was maintained until 1950, although in 1947 an exchange certificate with a lower value in foreign exchange markets was introduced. Bulgaria introduced a strictly fixed exchange rate implied by the currency board in the 1990s. The Soviet Union in the 1920s and Nicaragua in the 1990s introduced fixed exchange rates by decree and by law, respectively. In the former case, this probably had only a psychological importance, since foreign trade was fully controlled by the government. The rate was, however, maintained for several years until 1928. Similar remarks as for the Soviet Union apply to the reform ending the second Hungarian hyperinflation in 1946. The fixed exchange rate introduced had even less meaning, since full exchange controls were maintained and a planned economy was introduced.

Argentina introduced a fixed exchange rate implied by the currency board in 1992, for which, however, as mentioned, some of its strict characteristics were missing. This presumably also made the fixed exchange rate less credible.

France introduced a fixed exchange rate to landed property, a rather ridiculous step. Similarly, the fixed exchange rate introduced by China in 1948 had no credibility since the council of ministers was responsible in the midst of the civil war against the communists. Yugoslavia in 1989 and Serbia in 1994 also introduced fixed exchange rates, but were presumably not very credible, since they already had to be given up or changed in the fourth quarter of 1990 and in November 1995, respectively. The last two cases to be mentioned in which exchange rates were legally fixed are Taiwan in 1949 and Poland in 1990. In both cases, these measures were more credible than in those just mentioned, although the rates also had to be devalued after some time, for instance in Poland in May 1991. The exchange rate regime in Taiwan was more credible, since the country soon received sizeable American support because of the outbreak of the Korean War.

Not much can be said on the credibility of limitations of domestic credit by the central bank to the government. In all those cases where the independence of the central bank or of a regime of fixed exchange rates was credibly introduced, the limitations by law or decree on domestic credit also obtained credibility. Foreign loans were always limited by their nature, and usually used by the creditors to require measures to further the chances of success for the reforms. But it is important to realize that the conditions imposed by the League of Nations on Austria and Hungary in the 1920s were more successful because of their design and control than those of the International Monetary Fund on Latin American countries since the 1980s and on successor states of the Soviet Union in the 1990s.

Finally, we have to motivate the omission of fiscal indicators as budget deficit and public debt as a share of GDP. First, budget deficits show no relevant variation over our hyperinflations since they were always very large. Second, public debt was no longer relevant at the peak of the inflation because the latter reduced the real value of these nominal obligations of the government to about zero.

3. ECONOMETRIC RESULTS FROM AN ORDERED PROBIT MODEL

This section presents the results of an application of an ordered probit model to the dataset described in Section 2. This model is used instead of a standard regression model since the target variable of the reform (the inflation rate in the post-reform period) is very high for some unsuccessful reforms. These outlying observations would probably have a strong influence on the regression estimates. The ordinal variable to be explained is the variable y taking the value 2 for a fully successful reform, 1 for a less successful reform and 0 for a least successful or a completely unsuccessful reform, respectively. Six dummy explanatory variables are considered: $x_1 = DCD$ (limited domestic reform credit 1, otherwise 0), $x_2 = DFC$ (foreign reform credit 1, otherwise 0), $x_3 = DCB$ (independence of central bank 1, otherwise 0), $x_4 = DB$ (no government finance by money creation 1, otherwise 0), $x_5 = DFIX$ (credibly fixed exchange rate 1, otherwise 0) and $x_6 = DS$ (centrally planned economy 1, otherwise 0),[1] respectively.

The ordered probit model is based on a regression model for one underlying non-observable variable y^* with a normally identically and independently distributed error term. If the observable ordinal variable y

1. The centrally planned economies in our sample are: the successor states of the Soviet Union contained in our sample (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova Takijikistan, Turkmenistan and Ukraine) as well as Poland II, Serbia and Yugoslavia. The results are, however, robust with respect to the exclusion of Serbia and Yugoslavia.

takes the value s, this indicates that the latent y^* lies between two unknown bounds that have to be estimated jointly with the regression coefficients:

$$y_i^* = \sum_{j=1}^{k} \beta_j x_{ji} + \varepsilon_i$$

$$y_i = s, \text{ if } \gamma_{s-1} < y_i^* \leq \gamma_s, \quad s = 0, 1, \ldots, M-1$$

$$\gamma_{-1} = -\infty, \ \gamma_M = \infty$$

An increase in one of the regressors increases the probability of observing a higher value of y (i.e. a greater success of the reform) if the corresponding regression coefficient is larger than zero. The estimation results obtained with our dataset are reported in Table 3. We show the results for the alternative definition of a most successful reform (with a post-reform annual rate of inflation less than 10%) as well as for a restricted variant of the model including only statistically significant indicators.

Table 3 indicates that three indicators are statistically significant at the 10% level for the degree of success of a currency reform, namely central bank

Table 3 Estimates of an ordered probit model for 34 hyperinflations; standard errors (Huber/White QML) in parentheses

$$y_i^* = \beta_1 DCD + \beta_2 DCF + \beta_3 DCB + \beta_4 DB + \beta_5 DFIX + \beta_6 DS + \varepsilon_i$$

	Most successful inflation <10%	Most successful inflation <10%	Most successful inflation <25%	Most successful inflation <25%
β_1	−0.4399	–	−0.5363	–
	(0.5377)		(0.4279)	
β_2	−0.0071	–	0.3196	–
	(0.6447)		(0.6797)	
β_3	0.9473*	0.7816**	0.8315*	0.7235*
	(0.6069)	(0.4643)	(0.6176)	(0.4658)
β_4	−0.2752	–	0.2260	–
	(0.5768)		(0.5812)	
β_5	1.1309**	1.1574**	0.8183**	1.2386**
	(0.6213)	(0.5427)	(0.4739)	(0.5565)
β_6	−1.1251**	−1.0268**	−1.1351*	−1.0935**
	(0.6580)	(0.5130)	(0.7287)	(0.5008)
γ_0	−0.5191	−0.1236	−0.4391	−0.1659
	(0.5191)	(0.3779)	(0.3461)	(0.3884)
γ_1	0.6801	1.3281***	1.0302*	1.002**
	(0.5671)	(0.4445)	(0.7287)	(0.3884)
Pseudo-R^2	0.3242	0.3056	0.3196	0.3127

*,**,***Statistical significance (one- sided) at the 10%, 5%, 1% levels, respectively.

independence, fixed exchange rate and, with a negative sign, the centrally planned economy indicator. All other indicators are clearly insignificant and we obtain statistical significance at the 5% level for the three apparently important indicators if we exclude the insignificant ones. The coefficient for the fixed exchange rate is usually the largest in absolute value and implies that the adoption of a credibly fixed exchange rate is highly relevant for successful currency reforms. Indeed, the magnitude of the estimates indicates that the adoption of a credibly fixed exchange rate pushes the latent variable over the second limit point in the region with full success in a market economy. In a centrally planned economy more safeguards are required in the sense that according to our restricted estimates we need both measures *DCB* and *DFIX* to arrive at a successful currency reform.

4. CONCLUSION

The estimation of an ordered probit model for currency reforms of 31 hyperinflations and three huge inflations of the twentieth century showed that the introduction of an independent central bank and the adoption of a fixed exchange rate are statistically significant indicators for the success of a currency reform. The provision of domestic and foreign credits for government-budgeted finance has no statistically significant effect on the success of a currency reform. This indicates that the provision of credits to the government may raise doubts about its intention to solve its budget problem in a sustainable manner. Most interestingly, legal restrictions on budget financing do not seem to be relevant when the legal status of the central bank and the exchange rate regime are controlled for. Finally, currency reforms are more difficult in formerly centrally planned economies than in market economies.

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