The Transition from Hyperinflation to Stability: Some Evidence

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INTRODUCTION

The nature, characteristics, and functioning of monetary regimes is central to monetary economics. Special interest has often focused on the type of regime that produced the world's episodes of hyperinflation and on changes to bring about successful stabilization of prices. (Sargent [8], Bomberger and Makinen [3], and Makinen [7]).

This paper attempts to adduce some evidence of these regime changes from data on money and prices. Specifically, it demonstrates on the basis of changes in the Granger causal ordering of the data that the monetary regimes existing before stabilization did indeed come to an end. In this way, the paper follows up on the work of Sargent and Wallace [10] in which causation tests on hyperinflation data provide statistical undergirding for the qualitative descriptions provided in the historical accounts of the stabilizations.

In this century, hyperinflation has occurred in European countries seven times: in Germany, Austria, Hungary, Poland, and Russia following the first world war, and in Greece and Hungary at the end of World War II. All of the episodes have been the subject of research. In the most famous of studies of hyperinflations, Cagan [4] hypothesized that each was the result of a regime in which governments attempted to extract by means of money creation amounts of real resources that could only be obtained through accelerating inflation.

In a paper whose primary purpose was to explore circumstances under which adaptive expectations are rational, Sargent and Wallace demonstrated that such a regime will be one in which causation in the sense of Granger [6] runs from inflation to money. Since the creation of money to pay for resources generates inflation, each subsequent effort by the government to secure resources by means of note issue will require still larger quantities of notes—and, hence, greater inflation. As a consequence, note issue comes to depend on previous price increases; that is, inflation "causes" money growth. If expectations are rational, prices will be raised in anticipation of future note issue. Since the note issue is determined by the inflation rate, the past history of prices provides market participants the information required to set new prices. Money drops out of the chain of causation so that money ceases to "cause" inflation.

This hypothesis is well suited to a Granger-Sims style causation test. If the Sargent and Wallace hypothesis is correct, then the past history of prices should predict money. On the other hand, the past history of money should be expected to add little or nothing to the ability of past values of prices to predict current prices. Granger-causation is precisely this. If lagged values of prices and money explain current values of money better than past values of money alone, prices are said to Granger-cause money. If lagged values of money and prices fail to explain current

prices better than lagged prices alone, then money does not Granger-cause prices. These two results would indicate unidirectional influence of prices on money; no feedback from money on prices would occur.

Testing for causation along the lines suggested by Sims [11], Sargent and Wallace find support for their reasoning in the results for Germany, Austria, and Hungary I (see their tables 1 through 5). Results for Greece suggest that causality is two-way—both from inflation to money and money to inflation.[1] For the remaining three cases, Poland, Russia, and Hungary II, their evidence suggests that there is neither causality from inflation to money nor from money to inflation. However, Bomberger and Makinen [3] have recently furnished evidence that the Cagan data set for money compiled for Hungary II, used by Sargent and Wallace, commingles indexed and nonindexed deposits. Given Sargent and Wallace's explanation for their causality findings, one would expect them to want to use only nonindexed money for the purposes of their test. When only non-indexed money is used, Anderson, Bomberger, and Makinen [1] show that the results for Hungary II are consistent with Sargent and Wallace's principal findings: causality runs from inflation to money. Using an alternative money series for Greece, they reached the same conclusion.

These econometric results, and the behavioral model which predicts them, are consistent not only with a regime in which a fixed quantity of resources is being extracted by means of money creation, but also a monetary authority following a real bills doctrine [Sargent, 9]. In the real bills case, an effort to discount private paper at a below equilibrium interest rate leads to over issue of currency. The resulting inflation will increase the nominal quantity of money that the private sector wishes to borrow at a given real interest rate. If this demand is satisfied by the central bank, an even larger note issue is generated. Again, the rate of inflation "causes" money growth.

Whether a real bills regime or a regime in which the government is attempting to secure resources for its own use by means of inflation, we know that in terms of our conventional notion of causality, it is money growth that is causing inflation. We can say this because controlling money growth is a prerequisite for controlling inflation. In Sargent's words this conventional definition of causation is "invariance with respect to intervention," that is money causes inflation because, regardless of the institutional rules determining money growth, "the stochastic process for inflation is an invariant function of the stochastic process governing money creation."

Granger causality is merely defined by whether money is of any use in predicting inflation. Where money growth is endogenous, and dependent on past inflation, it does not predict or "cause" inflation in the Granger sense, even though halting the money growth would halt the inflation. This is why Granger causality is so well suited to determining the existence of a certain institutional setting or regime, and why changes in the Granger causal ordering can tell us if that regime has changed.

The institutional reforms that successfully stabilized these hyperinflations were (1) the recreation of an independent central bank with sufficient autonomy to refuse the government's request for notes on the basis of unsecured credit, i.e., the central bank was no longer obliged to provide the monetary wherewithal to allow the government to command a more or less constant fraction of real resources, and (2) reform of government's fiscal practices to sufficiently increase tax revenue and reduce expenditures to bring the budget to near balance and reduce the need for money financing.[2] Where these reforms were implemented, they should have severed the linkage between past inflation and new money issue and, therefore, changed the Granger causal ordering of the data. Although tests of Granger causality were conducted by

Sargent and Wallace on the hyperinflation data, none have been undertaken for the post stabilization periods. Such follow-up tests, however, would provide statistical support for the hypothesis that it was indeed the endogenous money supply regime that generated the hyperinflations and that it was the termination of these regimes that brought stability.

METHODOLOGY

In many studies of Granger causality (including the Sargent and Wallace study), the researchers have chosen to use the Sims version of the test. Sims shows that the Granger formulation is equivalent to estimating the following two equations:

$$(1) \qquad x_t = \sum_{i=-n}^{n} z_i m_{t-i} + e'_t$$

$$(2) \qquad m_t = \sum_{i=-n}^{n} h_i x_{t-i} + e''_t$$

where m and x are the growth rates of money and prices respectively. These are the equations estimated by Sargent and Wallace for the German episode.

If money Granger-causes prices, then future prices will significantly add to past prices in explaining current money. Similarly, if prices Granger-cause money, then future money will add to the ability of past money to explain current prices. By subjecting the leads to joint tests of significance in each equation, the null hypothesis of no causation can be rejected. Sargent and Wallace, whose study supported the hypothesis of unidirectional causation of money by prices, used 4 leads and 6 lags in each equation.

For our study we have chosen the same lead-lag specification as Sargent and Wallace in order to maximize the comparability of the results.[3] Thus, we follow their example by estimating equations (1) and (2). Rates of growth of prices and notes are used. The equations are estimated OLS and corrected for serial correlation using "quasi differenced" values (i.e., they are first estimated by least squares and then the data are multiplied by $(1 - \rho)$, where ρ is the least squares estimate of the first order autoregressive parameter—again, the same technique used by Sargent and Wallace). F statistics are computed for the leads in each equation.

The time series used covering the post stabilization periods are: Austria, September 1922–December 1925; Germany, December 1923–October 1926; Greece, January 1946–March 1948; Hungary I, January 1924–December 1926, Hungary II, August 1946–December 1948; and Poland, January 1924–December 1926.[4] We aimed for three years of data for each country where possible.

Our most significant departure from Sargent and Wallace is in the use of note issue for our money variable. Sargent and Wallace included deposits in their measure (making it akin to M2). We view the use of notes as more appropriate to the Cagan hypothesis. If the government is trying to claim a fixed amount of resources by means of inflation, it can do so only through the creation of base money. Money created within the banking system will not add to the government's claim on resources.[5] While the government may issue bonds to claim more resources, and while these bonds might be purchased by banks as part of the deposit expansion process, they would only have been so in lieu of lending to the private sector, and would not increase the size of the money supply. Hence, only note issue can truly represent the claim placed on the real resources by the government through an inflation tax.

While an end to the causal nexus from prices to money can be expected as a consequence of stabilization, it should not be expected that a money-to-price causal link will reappear. Successful stabilizations are accompanied by rapid remonetizations of the economy. This permits a large increase in the money supply without a resulting price increase as agents increase their holdings of real balances.[6] This fact suggests another limitation of Granger-Sims style testing. Relationships between variables such as money and prices can too easily be overwhelmed by third factors—in this case by the effect of revised inflation expectations on money demand.

Yet, limitations imposed by data availability prevent the use of more complete tests, such as the development of money demand functions that could accommodate the rapid change in desired real balances and reveal the relationship between money and prices. Similarly, series on real interest rates, which would provide further statistical evidence on the nature of the monetary regimes before and after stabilization, are impossible to construct. Lacking these, Granger causality tests are the best econometric approach we can think of to use to investigate the nature of these regimes, in spite of their limitations.

RESULTS

Our overall results are summarized in Table 1.[7] In five of the six cases we cannot reject either the hypothesis that inflation does not cause money or that money does not cause inflation. In other words, our results indicate an absence of an influence running from inflation to money or from money to inflation. In the single exception, the case of Hungary II, we are left with a somewhat ambiguous result analogous to that obtained by Sargent and Wallace for Greece. At the 5 percent level of significance, the critical value of the F statistic is such that the results would suggest that causality runs from inflation to money. However, at the more demanding 1 percent level, the Hungary II results conform to the others.

The near uniformity of our results are in accord with salient characteristics of the various stabilizations noted in the descriptive studies of these episodes. A central conclusion of these studies is that the stabilizations were successful because they were accompanied by or produced by a regime change that altered the behavioral rules of conduct of central banks. When our results are compared with Sargent and Wallace's (see their tables 1 through 5) we can confirm that the behavior of the central bank did change in Germany, Austria, Hungary I, and Greece. No longer were these central banks the handmaidens of the respective fiscal authorities supplying high powered money on demand.

Each stabilization had as a central tenet the reconstruction of an independent and

TABLE 1
F-Statistics (X versus M)

Country	X Regressed on M	M Regressed on X	Degrees of Freedom	Critical Values of F .05	.01
Germany	.25	.77	4/10	3.48	5.99
Austria	1.78	1.03	4/15	3.06	4.89
Hungary I	.83	4.12	4/11	3.36	5.67
Poland	.36	1.80	4/11	3.36	5.67
Hungary II	14.66	.125	4/4	6.39	15.98
Greece	.96	.165	4/2	19.25	99.25

autonomous central bank. As such, the reform legislation enjoined the central bank from advancing notes to the fiscal authorities (government) on an unsecured basis, i.e., on the basis of treasury bills. In all cases, the respective central banks lived within this legal restraint for at least the period of our study.[8]

The one anomolous result—that for Hungary II—tempts us to find an explanation. Admittedly, any such explanation, *ex post,* amounts to a rationalization. But it is hard to pass up the opportunity to discuss the Hungary II experience in more detail, since certain unique aspects of its stabilization program can explain this result.

The econometric evidence would suggest no change in regime. Yet the descriptive evidence presented by Bomberger and Makinen [3] indicate a regime change. Except for an initial overdraft, the government was forbidden to borrow from the central bank. An inspection of the weekly balance sheets of the Hungarian National Bank (the central bank) for the post stabilization period confirms that the government lived within this legal prohibition. This suggests an inconsistency between the econometric results and descriptive treatment of the stabilization.

The answer may lie in the operation of monetary policy following stabilization. In any regime, some mechanism must exist to help authorities determine how much money to create. In a regime in which stability of the price level is the primary goal, but in which the economy must be remonetized, the central bank faces a dilemma about the rate of note issue. Money creation must be restricted to hold prices steady, yet the reduction in inflationary expectations resulting from stabilization requires a rapid expansion of the monetary base. A constant money growth rate is not very useful at such an early stage in the stabilization program; it would likely be disastrous.

Insofar as the post World War I stabilizations were concerned, exchange rates provided a target for policy. Those episodes took place concurrently with the reconstruction of the international gold (or gold exchange) standard. Indeed, these programs were an integral part of the establishment and maintenance of fixed exchange rates.[9] In Greece, the third and successful effort at stabilization in January 1946 involved the central bank setting a fixed exchange rate for the drachma in terms of dollars and pound sterling, and using open market operations in gold sovereigns to prevent any divergence between the market and the official rate. Such central bank behavior was identical to that of the central banks in the four World War I stabilizations discussed by Sargent [8].

It was really only in Hungary II that this was not an option. The August 1, 1946 stabilization was accompanied by the introduction of a new unit of account, the forint. The forint was given a gold content but was not itself convertible into gold or foreign currencies. Indeed, in the economic chaos in Europe following World War II, during which Hungary was not yet a Soviet satellite, little foreign trade was carried on outside carefully arranged official agreements. In this environment, maintaining a fixed exchange rate had no meaning since a free market in foreign exchange did not function. However, the Hungarian central bank was intent on stabilizing the internal price level. While it continued to maintain real interest rates at low levels, it allocated credit carefully, and adhered to ceilings set on the monthly issue of notes. If the Bank used the behavior of the price level as a guide to setting these ceilings, it could explain the anomalous econometric results of causality in Hungary II.

In all the other episodes, the targeting procedures used would have made note issuance dependent on variables other than the price level, and based on movements (in foreign exchange rates or sovereign prices) that could be monitored on a weekly and even daily basis. But if the

price level was the criterion for setting money growth targets, causality from monthly observations of prices to money would result. It merely would shift from a direct to an inverse relation.

Inspection of the coefficient signs (not shown) in the Hungary II causation tests indicates that this may, indeed, be what happened. In the equation with money as the dependent variable, all of the lagged inflation rate coefficients are negative. This is also the case for the first and largest of the lagged lead note coefficients in the equation with inflation as the dependent variable.

While the descriptive accounts of the other stabilizations explicitly address the means by which monetary policy was conducted, and confirm that the exchange rates and the sovereign price did function as targets, we cannot find any information on how policy was conducted in Hungary II. We know that monthly ceilings on note issuance were set with an aim to controlling inflation. We also know that the initial issuance of money was calculated to yield a particular price level in accordance with what was known about the Hungarian economy. But we do not know how the monthly ceilings were determined in the absence of any market indicators such as were available in the other episodes.

This suggests a line of further research on the conduct of the second Hungarian stabilization. But it also raises the possibility that the anomolous Hungary II result is the exception that proves the rule. Given the alternative targets available to the Hungarian authorities for determining money growth, it is quite possible that prices were used, so that the regime change was uniquely one from a positive inflation-to-money-growth connection to a negative one.

CONCLUSION

Overall, the econometric evidence presented in this paper is in close conformity with three descriptive treatments of the end to some of the most turbulent episodes in monetary history.

The Cagan hypothesis that the great hyperinflations were generated by government's attempt to garner revenue through money creation has specific implications for causality between money and inflation. Sargent and Wallace adduce evidence that is largely consistent with this hypothesis. Our research further confirms this hypothesis by showing that the implied causality disappeared after the monetary regime changed. In addition, the comparative results for Hungary II versus the other episodes provides hints concerning the methods used by the monetary authorities for gauging the proper rate of monetary expansion during the stabilization.

APPENDIX

Data Sources

The money supply series selected is confined to the notes of the central bank for several reasons. Some countries used only currency as deposit banking was in its infancy. In others, the hyperinflation led to the almost exclusive use of currency (for an explanation of this phenomenon see Bomberger and Makinen [2]) and, in the post stabilization period, deposit banking was slow to revive. In one instance deposit data are present, but not for a long enough period (we desired a minimum of 36 observations).

Austria

Notes for 1922 and 1923 were taken from Sargent [8]; for 1924, 1925, and 1926 from issues of *Regelmathige Jahressitzung der Generalversammlung der Oesterreichischen National Bank,* Vienna. Wholesale prices were taken from *Statistische Nachrichten,* vol. 4, Austria, 1926, and *Memorandum sur les Monnaies et les Banques Centrales, 1913–1925,* vol. II, Societes des Nations, Geneva, 1926.

Germany

For the post stabilization period in Germany various note issues are available. In particular, those of the Rentenbank, an intermediate step in the reconstruction of an autonomous central bank. Thus, the money series is a combination of Reichbank and Rentenbank notes, coin, and other energency note issues (generally by state-owned enterprises). Notes and wholesale prices were gathered from the *Report of the Reichbank,* Statistishes Reichsamt *(Wirtschaft und Statistik), Vierteljahrshefte Zur Konjunkturforschung,* Herausgegeben vom Institut fur Konjunkturforschung 1926, Berlin, and *Memorandum on Currency and Central Banks, 1913–1924,* League of Nations, vol. I, Geneva 1925.

Greece

The note issue and price data were taken from Delivanis and Cleveland [5]. Private deposits, while present, were unimportant until 1949. Alternative price indices are available. Because they contained commodities and services whose prices were either frozen or subject to state control, we chose the market price of the gold sovereign, the principal alternative to commodities as an inflation hedge, as our price index.

Hungary I

Notes were taken from the annual reports of the National Bank of Hungary for 1926 and 1927 and wholesale prices for these years were gathered from *Annuaire Statistique Hungrois.*

Hungary II

Notes and wholesale prices were taken from the monthly bulletins of the National Bank of Hungary for 1946, 1947, and 1948. Deposit data are available for only a part of this period—1946 through mid-1948. They lack complete coverage (deposits ranged in size relative to notes from 23 percent in August 1946 to 76 percent in June 1948).

Poland

The money series consists both of the note issues of the Bank of Poland and the Polish Treasury (both were legal tender). Money and wholesale prices were compiled from *Rocznik Statystyki Rzeczypospolitej Polskiej* (Bank of Poland); *Compte Rendue des Operations de la Banque de Pologne* 1924, 1925, and 1926, Bank Polski: *Memorandum sur les Monnais et les Banques Centrales, 1923–1925,* Societe des Nations, Geneva, 1926; and *La Banque de Pologne et la Monnaie Polonaise,* Jan Dziewanowski, Paris 1933.

FOOTNOTES

1. The Greek evidence is mixed. At a 5 percent level, two-way causality is present. However, at the 1 percent level the evidence is consistent only with the hypothesis that causality runs from money to inflation.
2. These studies have concentrated on the lessons relevant for stabilization in market oriented economies and thus have not included the stabilization in Soviet Russia.
3. Limited experimentation with other lead-lag patterns failed to alter our conclusions.
4. While these time intervals comprise the periods from which our observations are taken, the actual regressions are run over somewhat shorter periods because the regression equations use leads and lags.
5. For the most part, very little deposit money existed by the end of the hyperinflations. Considerable time passed before the revival of deposit banking occurred after stabilization. Only in Germany were deposits a significant fraction of the money supply.
6. Our data show the following relationship between the rise in high powered money and the price level for each country respectively, 36 months after stabilization: Germany (141.7%, 2.9%), Austria (290.7%, 5.9%), Hungary I (309.2%, 77.3%), Poland (485.8%, 65.4%), Greece (556.8%, 54.1%), and Hungary II (692.22%, 22.5%).
7. Detailed results for individual countries are available on request.
8. To be more precise, in the case of Germany, Poland, and Hungary II, the governments were allowed an initial overdraft at the central bank of a fixed amount in order to finance expenditures until the new taxes imposed as a part of the fiscal reforms yielded sufficient revenue.
9. We do not mean to suggest that a gold standard or fixed exchange rate system will always produce price level stability. Our interpretation of our results is made in the context of a particular historical setting. In some other setting, the gold standard could be compatible with inflation or even deflation. Moreover, one could envision other monetary regimes that would be conducive to price level stability and an absence of findings of causality from money to inflation or from inflation to money.

REFERENCES

[1] Anderson, Robert B., Bomberger, William A., and Makinen, Gail E., "The Demand for Money, the 'Reform Effect', and the Money Supply Process in Hyperinflations: The Evidence from Greece and Hungary II Re-examined," (forthcoming).
[2] Bomberger, William A. and Makinen, Gail E., "Indexation, Inflationary Finance, and Hyperinflation: The 1945–46 Hungarian Experience," *Journal of Political Economy,* 88 (June, 1980), 550–556.
[3] _____, "The Hungarian Hyperinflation and Stabilization of 1945–46," *Journal of Political Economy,* 91 (October, 1983), 801–824.
[4] Cagan, Phillip, "The Monetary Dynamics of Hyperinflation," in M. Friedman ed., *Studies in the Quantity Theory of Money* (Chicago: University of Chicago Press, 1956).
[5] Delivanis, D. and Cleveland, W., *Greek Monetary Developments 1939–1948,* Bloomington: Indiana University Press, 1949.
[6] Granger, C.W.J., "Investigating Causal Relations by Econometric Models and Cross Spectral Methods," *Econometrica,* 37 (July, 1969), 424–438.
[7] Makinen, Gail E., "The Greek Stabilization of 1944–46," *American Economic Review,* 74 (December, 1984), 1067–1074.
[8] Sargent, Thomas J., "The Ends of Four Big Inflations," in R. Hall, ed., *Inflation: Causes and Effects* (Chicago: University of Chicago Press, 1982).
[9] _____, "The Demand for Money During Hyperinflations Under Rational Expectations: I," *International Economic Review,* 18 (February, 1977), 59–82.
[10] _____, and Wallace, Neil, "Rational Expectations and the Dynamics of Hyperinflation," *International Economic Review,* 14 (June, 1973), 328–350.
[11] Sims, Christopher A., "Money, Income, and Causality," *American Economic Review,* 62 (September, 1972), 540–552.