Expectations in an open economy hyperinflation: evidence from Germany 1921-23

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Abstract

We reconsider the Beladi et al. (1993) technique to measure expectations in hyperinflation episodes by allowing money to be substitutable with foreign assets as well as goods. We determine new correctness conditions for adaptive and rational expectations formation in this context and show that, taking into account these conditions, the data for the German hyperinflation of the 1920s is consistent with rational expectation formation.

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1. Introduction

Expectations formation plays a crucial role in hyperinflation episodes. The prevailing explanations of hyperinflation episodes employ money demand functions in which expectations formation is assumed a priori to be either adaptive (AE) or rational (RE), and are almost always measured ex-post using a time series approach, as in Cagan (1956) and Sargent and Wallace (1973), or a market based approach, as in Frenkel (1977) and Webb (1986).[1] One of the few contributions in which an attempt is made to determine ex-ante the type of expectations present in hyperinflation episodes is due to Beladi et al. (1993) who employ Chow's (1989) method to establish the correctness conditions for the presence of AE or RE expectations in the demand for money. They then test the conditions of the two expectations hypotheses with reference to the 1920's hyperinflations in Germany, Poland and Hungary. In their empirical analysis, Beladi et al. (1993) use a Cagan (1956)-type demand for money function in which money is substitutable only with goods and report that in the case of Germany the data is consistent with the AE hypothesis. The Cagan demand for money is consistent with the so-called fiscal view, according to which German hyperinflation was due exclusively to money financing of huge government deficits. However, as shown by Holtfrerich (1960), German hyperinflation was fed also by large capital outflows. In this paper, we show that if the demand for money function allows money to be substitutable with foreign assets in addition to goods—i.e., the open economy case—the correctness conditions of the AE and RE hypotheses change and the results of empirical estimates of the German hyperinflation of the 1920s support the RE hypothesis.

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[1] See Blinder (2016).

2. The correctness conditions in a Cagan-type demand for money

In their approach to expected inflation in hyperinflation episodes Beladi et al. (1993) used a Cagan (1956)-type demand for real monetary balances of the following form:

$$m_t - p_t = \alpha - \beta(p^e_{t+1} - p_t) \tag{1}$$

where m is the logarithm of the money supply, p the logarithm of the price level, and p^e the logarithm of the expected price level. Defining $\delta = \beta(1 + \beta)^{-1}$, equation (1) can be expressed as follows:

$$p_t = -\alpha(1 - \delta) + (1 - \delta)m_t + \delta p^e_{t+1} \tag{2}$$

Under the RE hypothesis: $p^e_{t+1} = p_{t+1} + \varepsilon_{t+1}$ where ε_{t+1} is a random error with zero mean and constant variance. Therefore, in the case of rational expectations, equation (2) becomes:

$$p_t = -\alpha(1 - \delta^{-1}) + \delta^{-1}p_{t-1} + (1 - \delta^{-1})m_{t-1} - \varepsilon_t \tag{3}$$

From this equation they get the correctness conditions of the RE hypothesis reported in part A of Table 1.

According to the (AE) hypothesis: $p_{t+1}^e - p_t^e = \theta(p_t - p_t^e) + \varepsilon_t$, where, as before, ε_t is a random error. Solving eq. (2) for p_{t+1}^e and p_t^e, and using them into the AE equation, the price level becomes:

$$p_t = (1 - \delta\theta)^{-1}\{-\alpha\theta(1 - \delta) + (1 - \theta)p_{t-1} + \theta(1 - \delta)m_{t-1} + (1 - \delta)(m_t - m_{t-1}) + \delta\varepsilon_t\}$$

(4)

The correctness conditions of the AE hypothesis are given in panel A of Table 1. Using equations (3) and (4) Beladi et al. (1993) found that in the German hyperinflation the demand for money was informed by the AE expectations.

3. Correctness conditions when money is substitutable with both goods and foreign assets

Several scholars (e.g., Abel et al., 1979; Dornbusch et al., 1990; Taylor, 1991) have pointed out that the demand for money put forward by Cagan (1956) and developed by Sargent and Wallace (1973) and Sargent (1986) refers to a closed economy. This implies that in a context of hyperinflation a country's currency is replaced exclusively with goods. In reality, in a context of perfect capital mobility, the exchange rate plays an independent role in the demand for money. Therefore, as argued by Abel et al. (1979) and Taylor (1991), the demand for money becomes:

(1') $m_t - p_t = \alpha' - \beta'(p_{t+1}^e - p_t) - \gamma'\sigma_t$

where to the terms of equation (1) has been added the premium (discount) of the forward exchange rate on the spot exchange rate (σ_t). Using equation (1'), equation (3) and (4) become respectively:[2]

$$(3') \; p_t = \delta'^{-1}p_{t-1} - \alpha'(1 - \delta'^{-1}) + \gamma'(1 - \delta'^{-1})\sigma_{t-1} + (1 - \delta'^{-1})m_{t-1} - \varepsilon_t$$

and

$$(4') \; p_t = \frac{1}{1-\theta\delta}\{-\alpha'\theta(1 - \delta) + (1 - \theta)p_{t-1} + (1 - \delta)(m_t - m_{t-1}) + \theta(1 - \delta)m_{t-1} +$$

$$+\gamma'(1 - \delta)(\sigma_t - \sigma_{t-1}) + \gamma'\theta(1 - \delta)\sigma_{t-1} + \varepsilon_t\}$$

The correctness conditions that refer to eq. (1') are given in panel B of Table 1.

4. Empirics

4.1. Instrumenting for money and exchange rate

Because of possible endogeneity issues in estimating the price level, we instrument the money supply and the exchange rate. In the estimate of equation (4) we used an instrumental variable $\widehat{m}_t$ estimated as:

$$(5) \; \widehat{m}_t = \vartheta_0 + \sum_{i=1}^{3} \vartheta_{1i}m_{t-i} + \sum_{i=1}^{2} \vartheta_{2i}p_{t-i}$$

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[2] Where, as before, $\delta' = \beta'(1 + \beta')^{-1} < 1$.

while in the estimate of equation (4'), the open economy case, we use an instrumental variable $\hat{\sigma}_t$

estimated as:

(6) $\hat{\sigma}_t = \zeta_0 + \sum_{i=1}^{3} \zeta_{1i}\sigma_{t-i} + \sum_{i=1}^{2} \zeta_{2i}p_{t-i}$

and, taking account of eq. (1'), an instrumental variable for money demand specified as:

(5') $\hat{m}_t = \vartheta_0 + \sum_{i=1}^{4} \vartheta_{1i}m_{t-i} + \sum_{i=1}^{2} \vartheta_{2i}p_{t-i} + \sum_{i=1}^{2} \vartheta_{3i}\sigma_{t-i}$

The estimates of equations (5) and (5') are reported in Table 2, in which columns 1 and 2 report

results employing the narrow definition of money, and columns 3 and 4 report results employing

broad money. Column 5 reports the result for eq. (6) related to the exchange rate.

4.2. Expectations and hyperinflation

Table 3 report IV estimates of the two expectations hypotheses for German hyperinflation during

May 1921 to August 1923, the same sample period employed by Beladi et al. (1993). Prices are

measured using the wholesale price index; the money supply is measured alternately by notes and

coin in circulation (narrow money) and notes and coin plus bank deposits (broad money); and the

exchange rate is the monthly average rate against the US dollar.[3]

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[3] The money supply data and price data are from Sargent (1986) and Bresciani and Turroni (1937) and the exchange rate data is from Holtfrerich (1986).

Columns 1 to 3 of the table report results in which the narrow money supply is the independent variable in the price estimate and columns 4 to 6 report results in which the broad money supply is the independent variable. Column 1 reports the result from estimating equation (4) where the result is consistent with the correctness conditions of the AE hypothesis (set out in panel A of Table 1) being fulfilled and is in line with the result reported by Beladi et al. (1993). Column 2 reports the result for the open economy case (represented by the exchange rate) where the lack of statistical significance of the coefficient on the lagged change in the money supply, $\hat{m}_t - m_{t-1}$, means that the correctness conditions of the AE hypothesis are not fulfilled. Column 3 reports the estimate for the RE hypothesis in an open economy; in this case, the correctness conditions of the hypothesis (as set out in panel B of Table 1) are met, which suggests that the RE hypothesis is more consistent with the German hyperinflation data in the case of narrow money. The results change somewhat when the broad money supply is used as an independent variable. In the result reported in column 4 the correctness conditions of the AE hypothesis are not met given that the coefficient on p_{t-1} is greater than 1 and the coefficient on $\hat{m}_t - m_{t-1}$ is not statistically significant. Column 5 reports the result for the AE hypothesis in the open economy case, as for narrow money, the correctness conditions are not met because the coefficient on $\hat{m}_t - m_{t-1}$ is not statistically significant and the sign on the coefficient is negative. Finally, column 6 reports the estimate for the RE hypothesis in an open economy where the sum of the coefficients on m_{t-1} and p_{t-1} is equal to 1 and the sign on the coefficient of σ_{t-1} is negative, consistent with the correctness conditions for the hypothesis. Overall, the results employing either a narrow or broad definition of money in estimates of the German hyperinflation appear to support the RE hypotheses.

5. Conclusions

This paper builds on the contribution by Beladi et al. (1993) to determine the conditions of correctness of the adaptive and rational expectation hypotheses. However, unlike these scholars, we make reference to a demand for money in which money is substitutable not only with goods, as in Cagan (1956), but also with foreign financial assets and we redefine the correctness of the adaptive and rational expectation hypotheses accordingly. Our empirical results based on the restrictions determined in this manner suggest that, contrary to the findings reported by Beladi et al. (1993), inflation expectations in 1920s German hyperinflation were rational as opposed to adaptive.

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Table 1

Correctness conditions for adaptive and rational expectations formation

Panel A: Cagan (1956)-type demand for money

Rational expectations	Adaptive expectations
$p_{t-1} > 1$ $p_{t-1} + m_{t-1} = 1$	$0 < p_{t-1} < 1$ $p_{t-1} + m_{t-1} = 1$ $m_t - m_{t-1}$ significant $0 < m_t - m_{t-1} < 1$

Panel B: Demand for money in an open economy

$p_{t-1} > 1$ $p_{t-1} + m_{t-1} = 1$ $\sigma_{t-1} < 0$	$0 < p_{t-1} < 1$ $p_{t-1} + m_{t-1} = 1$ $m_t - m_{t-1}$ significant $\sigma_t - \sigma_{t-1}$ significant $0 < m_t - m_{t-1} < 1$ $\sigma_t - \sigma_{t-1} > 0$ $\sigma_{t-1} > 0$

Table 2
Instrumenting for the money supply and the spot exchange rate

	Narrow money supply		Broad money supply		Exchange rate
Intercept	-1.172***	-0.911***	4.215***	2.127	-15.573***
	(0.314)	(0.290)	(1.460)	(2.493)	(6.201)
m_{t-1}	0.891***	0.930***	0.822***	0.718***	
	(0.134)	(0.131)	(0.192)	(0.223)	
m_{t-2}	0.572**	0.327	-0.397	-0.271	
	(0.214)	(0.235)	(0.248)	(0.287)	
m_{t-3}	-0.194	0.008	0.046		
	(0.147)	(0.153)	(0.181)		
p_{t-1}	1.264***	1.205***	-2.284	-1.245	10.408
	(0.127)	(0.115)	(1.709)	(2.059)	(9.716)
p_{t-2}	-1.436***	-1.548***	4.329**	5.188**	-5.568
	(0.157)	(0.155)	(2.020)	(2.407)	(9.551)
σ_{t-1}		-0.007		-0.336	0.059
		(0.018)		(0.332)	(0.433)
σ_{t-2}		-0.051***		-0.224	-0.645
		(0.018)		(0.310)	(0.394)
σ_{t-3}					-0.050
					(0.433)
R2-adj	0.99	0.99	0.94	0.95	0.78

Notes. Standard errors in parenthesis below the estimated coefficients

Table 3

Adaptive v rational expectations in the German hyperinflation, 1921-1923—dependent variable p_t

	Narrow money supply as independent variable			Broad money supply as independent variable		
	1	2	3	4	5	6
Intercept	-0-603	-0.046	-0.409	0.512**	0.879***	0.129
	(0.603)	(0.580)	(0.795)	(0.268)	(0.262)	(0.282)
p_{t-1}	0.886***	0.447*	1.127***	1.367***	0.721**	1.303***
	(0.132)	(0.221)	(0.221)	(0.105)	(0.314)	(0.170)
m_{t-1}	0.179	0.188	0.083	-0.070**	-0.032	-0.033*
	(0.161)	(0.142)	(0.204)	(0.031)	(0.030)	(0.022)
$\hat{m}_t - m_{t-1}$	0.889***	0.343		-0.109	-0.026	
	(0.225)	(0.276))		(0.065)	(0.063)	
σ_{t-1}		0.141**	-0.016		0.142*	-0.023
		(0.059)	(0.048)		(0.071)	(0.047)
$\hat{\sigma}_t - \sigma_{t-1}$		0.102**			0.0119***	
		(0.037)			(0.032)	
Ad. R^2	0.99	0.99	0.98	0.98	0.99	0.98
Wald test: null hypothesis: $p_{t-1} + m_{t-1} = 1$						
t-statistic:	1.22	-1.94	1.28	3.90	-1.07	1.68
p-values:	0.23	0.06	0.21	0.00	0.30	0.11

Notes. IV estimates with standard errors in parenthesis below the estimated coefficients.