Israel 1983:
A Bout of Unpleasant Monetarist Arithmetic

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Abstract

This paper claims that anticipations of a massive future government bailout of owners of fallen bank shares suddenly caused a big jump in inflation in Israel in October 1983. That month, the government promised that four or five years later it would compensate people for the fall in the value of their bank shares. We reason that the public believed that promise, that it understood that the public debt must jump, and further that the public anticipated that the government would finance that debt via an eventual monetary expansion. That sparked an immediate jump in inflation via the unpleasant monetarist arithmetic of Sargent and Wallace (1981).

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1. Introduction

This paper presents what we regard as a telling example of the 'unpleasant monetarist arithmetic' of Sargent and Wallace (1981), according to which an anticipated future monetary expansion triggers an immediate rise in inflation coming from a negative dependence of money demand on expected inflation and the public's expectations about the future path of the money supply. From 120%, around which it had hovered during the previous five years, inflation in Israel suddenly jumped to 400% in October 1983. It fluctuated around that new level until July 1985 when a comprehensive fiscal reform caused it to fall suddenly and dramatically. We shall argue that the July 1985 reform could not have been anticipated in October 1983, but that other and very different prospective monetary and fiscal events were, and it was those anticipations that caused the 1983 explosion of inflation.

Because it was not accompanied by any significant *contemporaneous* rise in the government deficit or in government expenditures, the sudden upward jump of inflation in October 1983 has puzzled observers.[1] We claim that the October 1983 jump in inflation was caused by another event in October 1983, namely, the announcement of a massive bailout of bank shares by the government of Israel. Large Israeli banks had surreptitiously but successfully manipulated the market prices of their shares for some years, but by 1983, their shares were significantly overvalued and the banks had exhausted their means of supporting them, so share prices plummeted. In October 1983,

[1] We believe that the Lebanon War, which began in June 1982, could also not be responsible for the jump in inflation because its cost was not high and it did not raise defense expenditures significantly.

the government promised to reimburse shareholders for the high values their shares had fallen from, but only after four or five years. That promise increased the government debt overnight by 5.5 billion dollars, about a quarter of GDP. Because the banks still had some intrinsic value, not all of that was an increase in net government debt. But the public still appropriately viewed the promise as calling forth a very large increase in net debt.[2] We shall argue that even if the public had already anticipated some chance of a bailout earlier, the announcement of the bailout in October 1983 significantly increased the probability that a bailout would occur and that it would be accompanied by substantially higher rates of money creation, and that caused an immediate jump in inflation.[3]

The paper begins with a presentation of the salient facts of the Israeli inflation and with an exposition of the main puzzle in Section 2. Section 3 tells the story of the bank shares bailout. Section 4 presents a simple model that shows how the bailout announcement could have triggered a jump in inflation of approximately the same magnitude as occurred in 1983. Section 5 briefly discusses some alternative explanations to the jump in inflation in 1983. Section 6 concludes.

2. The Israeli Inflation: A Story of Three Plateaus and One Deficit

Inflation began to rise in the early 1970s. After 1973 it reached a plateau around 40% and remained there until 1978. In 1979 inflation jumped again and stabilized at 120% annually. That remained the average rate until October 1983, when inflation jumped to a

[2] The commitment to pay the public the value of the bank shares was not formally written as public debt.
[3] In their history of monetary policy in Israel, Barkai and Liviatan (2007, p. 167) mention the bank shares bailout as one possible explanation for the jump in inflation in 1983, but dismiss it in favor of other explanations.

very high rate of 400% and fluctuated around it. In July 1985 the government implemented a comprehensive stabilization that reduced the rate of inflation to 20% annually and ended the fiscal crisis. See figure 1 for annual data on Israeli inflation over the period of interest.[4]

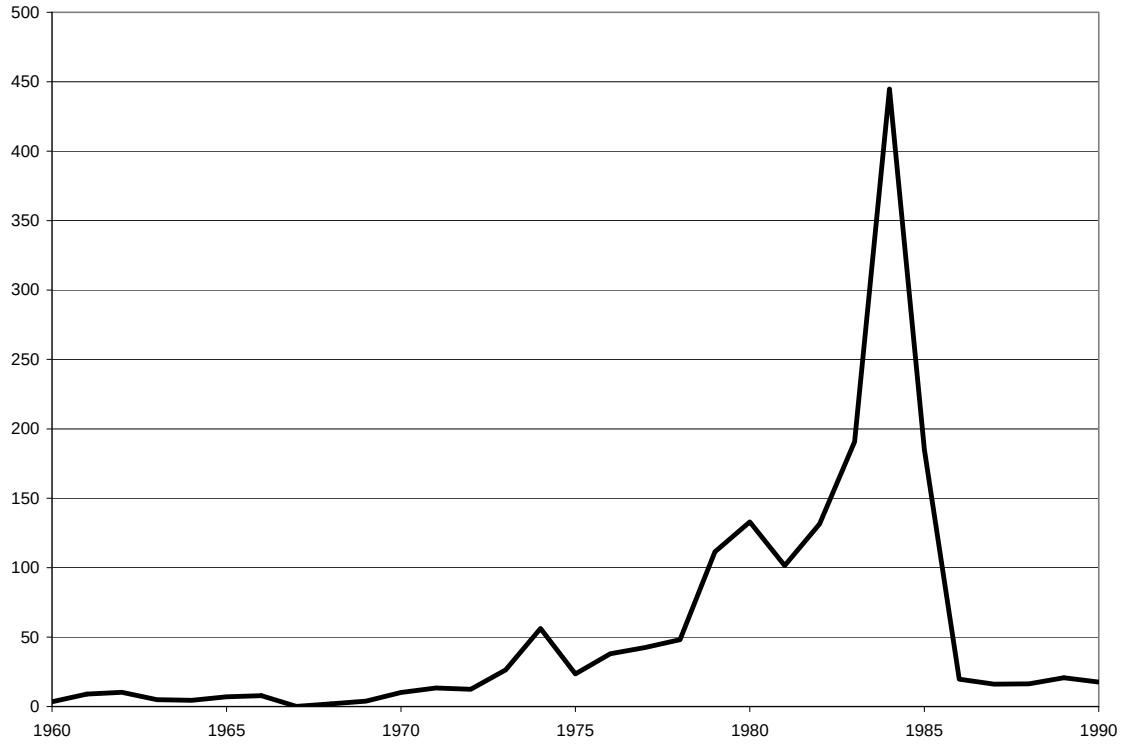

Figure 1: Annual Rate of Inflation: 1960 – 1990

What caused the inflation and its three upward jumps? We believe that the answer to this question lies in the effects of anticipated fiscal and monetary policy as interpreted within a basic inflation tax model. After briefly indicating explanations for the first two jumps in inflation that occurred in 1973 and 1979, we turn to our purpose, which is to explain the jump in October 1983.

[4] Actually, Figure 1 includes years when inflation changed significantly in midyear, like 1983 and 1985. Monthly rates of inflation indicate that the highest plateau began in October 1983.

Figure 2 describes fiscal policy in Israel in the years 1960-1990, where the three curves depict expenditures, including interest payments, receipts and surplus (minus deficit) of the public sector in Israel.[5] While the public sector was around 30% of GDP in the early 60s and the government was in surplus, after 1967 expenditures increased significantly and after 1973 they reached an average level of 75% of GDP until 1985. Public revenues increased as well during this period, but the rise in expenditures was larger and so a deficit opened up. Between 1973 and 1985 it reached around 15% of GDP.

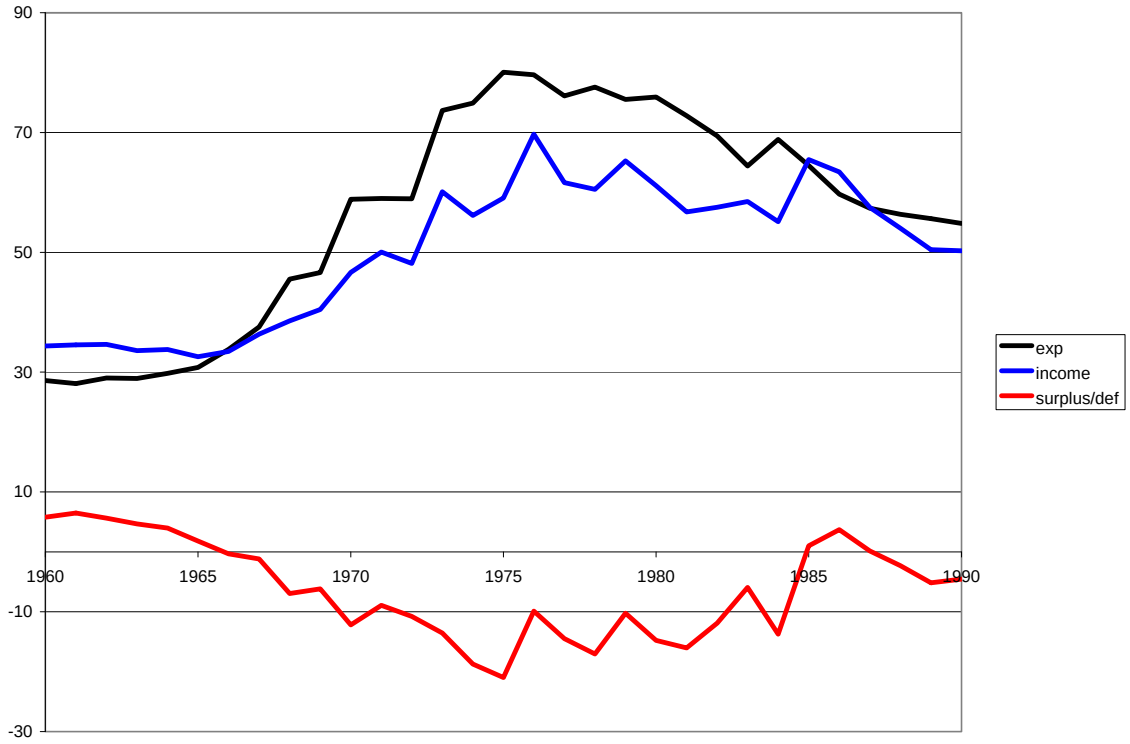

Figure 2: Public Sector Expenditures, Receipts, and Deficits (% of GDP) – 1960-1990

[5] The public sector in Israel includes the central government, social security (the National Insurance Institute), local municipalities, hospitals and universities, and the Jewish Agency.

During this period, how much of the deficit was monetized? We use two sources of evidence that can help answer this question. First, we shall look directly at estimates of additions to the stock of high powered money. After that, we adduce indirect evidence by using a steady-state calculation to estimate a rate of monetization that would have been consistent with the inflation of 40%-50% observed during the first inflation plateau.

Year	Change in M0	Public Sector Injection	Foreign Exchange Purchases by Public
1977	3.4	7.1	-4.8
1978	1.8	5.7	-2.1
1979	0.6	3.1	-5.8
1980	2.0	4.4	-4.6
1981	2.0	6.6	-2.4
1982	2.3	5.7	-1.5
1983	1.9	9.7	-5.7
1984	3.0	8.8	-5.2

Table 1: Changes in M0 as % of GDP, 1977 – 1984. Source: Bank of Israel, 2008.

Table 1 presents changes in high-powered money and its main components, expressed in percentages of GDP. It shows that high powered money M0 increased annually.[6] The average change in high powered money over the years 1977 – 1984 was 2.1% of GDP and it seems to have been fairly stable over these years. But Table 1 also

[6] Data are available only from 1977 on. We present data only until the last year of the high inflation, 1984.

shows that the creation of money by the public sector (labeled 'injection') was much higher, an average of 6.4% of GDP over the entire period. The actual change in high powered money was smaller since the central bank sold foreign reserves to the public at an average annual amount of 4% of GDP.

Table A1 in Appendix II presents the size of public net debt relative to GDP during the inflationary years and the annual changes in public debt relative to GDP. Table A1 shows that in 1974-1984 the average annual increase in government debt was 9.8% of GDP. Hence, debt financed around two thirds of the deficit. The missing third of the deficit that had to be financed matches the estimate of injections of the public sector from Table 1.

The data from Table 1 raise the question of what is the more pertinent concept of money creation as a determinant of inflation, the net change of high powered money or the amount of injection by the government. To answer this question, we look at the first inflation plateau and interpret it in terms of an inflationary steady state in which money grows at the same rate as does nominal output. Let us denote, as is common, the amount of high powered money in period t by M_t, real output by Y_t and the price level by P_t. Denote by ng_t the rate of growth of nominal output, namely of P_tY_t. The change in high powered money relative to GDP should therefore have been equal to:

$$(1) \qquad \frac{M_t - M_{t-1}}{P_tY_t} = \frac{M_{t-1}}{P_{t-1}Y_{t-1}}\left(\frac{ng_t}{1+ng_t}\right).$$

Using data on high powered money relative to GDP and on the rate of growth of nominal output, we calculated the right side of (1) for the `first plateau' years 1974 – 1978 and found that given the rate of inflation at the time, the change in high-powered money

should have been around 5.5% of GDP.[7] Hence, in terms of this steady-state calculation, the observed rate of inflation better fits the rate of injection by the public sector, column 3 in Table 1, than the net growth of high powered money, column 2 in Table 1.

We leave behind these steady state calculations and turn our attention to the 'unpleasant monetarist arithmetic' that states that it is not the contemporaneous rate of money growth that matters for inflation, but instead the amounts of future government deficits that the public expects to be monetized. According to the inflation rate in the first inflation plateau years 1974 – 1978, this monetized deficit was between 5% and 6% of GDP, about a third of the public deficit. This outcome is consistent with the view that the public believed that the public debt would not be fully monetized, so that the public seems to have expected that the government had additional room to roll over future routine additions to its debt and retire it, if ever, only in the distant future. Note that the rise in public expenditures and the deficit was initiated by the intensification of the Israeli-Arab conflict during and after the wars of 1967 and 1973.[8] Hence, it is at least plausible that the public could have expected this rise to be long, but temporary.

This interpretation imputes the Israeli inflation to a government deficit of more than 15% of GDP between the years 1973-1985, of which around one third was monetized. While this story is quantitatively consistent with the outcomes observed during the first inflationary plateau at a rate of 40%-50%, how can we explain the jumps of inflation in 1979 to 120% and in 1983 to more than 400%? According to Table 1, there were no significant changes in fiscal policy in those years and there was no change in the fraction of the deficit that was monetized. Sussman (1992) attributed the jump in

[7] It was 11.6% in 1974, 8.7% in 1975, 4.8% in 1976, 5.5% in 1977 and 5.6% in 1978.
[8] Defense expenditures rose from 7% of GDP before 1967 to more than 30% of GDP after 1973. Other defense related costs increased as well (Berglas, 1986).

1979 to the liberalization of access to foreign currency that occurred in October 1977. Freer access to foreign currency led to a reduction in the demand for money, reduced the base of inflation tax, and thereby raised the rate of inflation. A number of studies carried out by the Bank of Israel have shown that indeed there was a significant reduction of the demand for domestic money in 1978 and 1979 (see Offenbacher (1986)). As for the jump in inflation that occurred in October 1983, we think the bailout of bank shareholders unleashed a chain of public perceptions that triggered unpleasant monetarist arithmetic.

3. The Banks' Shares Debacle

3.1. Manipulation

During the 1970s, major Israeli banks manipulated the prices of their own equity by executing trades through various subsidiaries like mutual funds and provident funds.[9] Sometimes banks used other banks to manipulate their share prices.[10] Bank Hapoalim began doing so already in 1972 and it was soon joined by most large banks. In testimonies to the Baisky Investigation Committee (1986) the bankers said that high inflation in Israel had made their nominal balance sheets grow significantly, so they needed to increase capital to satisfy international capital requirements. Therefore, they sought ways to make their equity more attractive to the public, especially because their equity had to compete with the government's popular indexed bonds for a place in investors' portfolios. Initially, the banks manipulated their share prices with the aim mainly to reduce volatility of returns. Using their own widely used financial advisory services, they marketed their shares to the public as a safe asset. Bank officers promised

[9] The Israeli banks controlled most of the channels of financial intermediation in Israel: mutual funds, provident funds, investment banking, etc.
[10] The Hebrew name given to this activity, probably by the banks, was 'visut', namely regulation.

the public that, because they were supported by the banks themselves, banks share prices would not fall. Those promises motivated banks to arrest threatened falls in their share prices and implemented what amounted to a Ponzi game. Their use of illegal methods finally led to the bankers' disgrace when they were hauled before the Baisky Committee in 1986.[11] The banks' CEOs later faced criminal charges and some were convicted. Although the government ultimately became aware of the banks' share-price manipulations, aside from mild protests, until October 1983 it did almost nothing to stop them.

Why did the government let the bank share price support process continue for as long as it did? Was it possible that some of the revenues from the public offerings by banks went to the government to finance its deficit? Did bank shares serve implicitly partly as government bonds? Because these questions are relevant for our main argument, we address them in some detail. There is no evidence that bank revenues went to the government directly, and to a large extent indexed government bonds and bank shares actually *competed* for space in investors' portfolios in the high inflation Israeli economy. It is true that of the four main manipulating banks, three were public (Leumi, Poalim, and Mizrahi), while only one (Discount) was private.[12] But these banks were public only nominally, as the public bodies that controlled them did not intervene in their management and all three banks were run by very dominant CEOs, who were virtually independent.

At the time, two reasons were mentioned for the government's complicity with, or at least toleration of, the manipulation. One was that the government needed the large banks

[11] Most of the information in this section is taken from the Baisky Report, Investigation Committee (1986).
[12]Formally Bank Leumi was controlled by the Zionist movement, Bank Hapoalim by the Histadrut, the national labor union, and Bank Hamizrahi by the religious national party.

and their good foreign contacts to facilitate borrowing abroad. As mentioned above, the banks claimed that they needed the manipulation to enable public offerings to meet international capital requirements. The other reason was that the government wanted to help the public protect its savings from inflation and viewed bank shares as good assets for that purpose.

In the end, the banks were trapped by their own webs of manipulation. They successfully marketed their shares as almost risk-free assets, so the demand for banks' shares increased significantly. The early 80s were boom years for the Tel-Aviv Stock Exchange in general and this put extra pressure on banks to raise their share prices further. The annual real rate of return on bank shares rose from 9.7% between 1975 and 1979, to 40.6% in 1980, 32.5% in 1981, and 28.3% in 1982. In January 1983 the Tel Aviv Stock Exchange (TASE) crashed. The banks succeeded in keeping their shares from crashing, but the public still lost confidence in these stocks and increasingly turned to foreign currency. In the first nine months of 1983, the banks succeeded in maintaining a real rate of return of 9% on their shares, but it began to cost them dearly. The value of banks shares held by the banks themselves increased sharply from 200 million dollars during 1982, to more than 400 million dollars in May 1983, and to more than 600 million dollars in the beginning of October. In October 6 this amount reached 920 million dollars and was around 12 percent of the outstanding value of bank shares altogether. The banks had already been borrowing abroad for some time to finance purchases of their own shares, but now the required finance became unsustainable.

3.2. Bailout

In early October 1983 the banks realized that they faced a crisis and turned to the government for support. On October 6, 1983, bank shares collapsed and the stock exchange was closed for two weeks, during which an agreement of bailout was formed between the government and the banking system. It was called "The Bank Shares Arrangement" (Hesder Hamenayot Habankaiot), or in short, the "Hesder" (Arrangement).

The main elements of the "Hesder" were that the banks should stop manipulating the prices of their shares and that the government would be responsible for the shares of the manipulating banks that were held by the public, excluding shares held by bank executives. The "Hesder" offered share holders two main options. The first was to keep the shares tradable, but to be able to sell them to the government in October 1988 at their pre-Hesder value of October 6th, 1983, indexed to the US dollar with cumulative interest of 4% over the 5 years.[13] The second alternative was to hold the shares as non-tradable and sell them to the government in 1987, at the value of October 6th, 1983, indexed to the US dollar and with cumulative interest of 12% over the whole 4 years. The government promised that those who would continue to hold the bank shares for 6 or 8 years would get even higher interest rates. Pensioners could redeem their shares after only 2 years.

Most of the public chose the option of holding the shares tradable for 5 years, indicating to us that perhaps people did not fully trust that the government would be able to deliver on its promise to bailout the share holders. But we argue later in this section that the public still expected that the bailout would be implemented with a probability around 60%. We also show in Section 4 that even this 60% probability was sufficient to increase the rate of inflation by 300%.

[13] Actually the government calculated the value of the shares at the exchange rate that prevailed after October 6th, namely at 20% less, as there was a large devaluation of 23% on that night.

Although we think that it could not have been forecast in October 1983, in July 1985 inflation was stabilized. And as previously promised, the government bailed out bank share holders. But instead of financing the required payments by increased money creation, it financed them by issuing bonds.[14] It purchased shares from the public at 1 billion New Israeli Shekels (NIS) in October 1985 (from pensioners), 2 billion NIS in October 1987, 5.6 billion NIS in October 1988, .85 billion NIS in October 1989 and finally 3.4 billion NIS in October 1991.

3.3 Implications

The economic implications of the bank shares bailout agreement were far-reaching. The government of Israel acquired 7 banks, among them the largest four, Leumi, Poalim, Discount and Mizrahi. Privatizing these banks took a long time, and even today, in 2010, one of the largest banks, Leumi, has not yet been fully privatized. But the main focus of our paper is not the implications of the bailout for the banking sector but rather for fiscal and monetary policy. By committing to purchase the shares at a specific future date, the government, albeit implicitly, increased its debt overnight. The putative value of the shares being bailed out was 6.8 billion dollars. Even after the erosion of their dollar value due to the 23% exchange rate devaluation on the night of October 6, the government increased its obligations by the huge amount of 5.53 billion dollars. GDP in 1983 was about 24 billion dollars**.**

By 1991, when the bailout finally ended, its cumulative cost was 16 billion NIS at 1991 prices.[15] This is equivalent to $6.9 billion in 1991 prices. Formally the government increased its obligations but also its assets, as it became owner of the banks' shares. But

[14] See Bank of Israel (1989).
[15] See Bank of Israel (1992).

the public knew that the market value of the bank shares was truly much lower than their value on the eve of the scandal. The market value of the shares dropped significantly following the bailout arrangement. By the end of 1983 it had declined to 48% of its September value. Note that even this value reflected a positive probability of bailout. Another way to estimate the intrinsic value of the banks shares at the time is to examine the actual proceeds from the future sales of the banks. Up to July 2005 the government had received only 5.13 billion dollars from the privatizations of the banks. The present value of these sales, discounted to 1983 is 1.98 billion dollars. Hence, if we accept this estimate for the value of banks, the net cost of the bailout was $3.55 billion in 1983 prices, which is 15% of GDP.[16]

3.4. Two important qualifications

The bailout was announced in October 1983, but it might have been anticipated ahead of time. Also, it could still have been doubted by the public after the "Hesder" had been announced. Interestingly, we can learn about those expectations from rates of return on bank shares after the arrangement. The ex post rate of return of these banks shares, which were like dollar indexed bonds, was quite high. The average rate of return from December 1983 to the end of 1984 was 17%.[17] Alternative safe dollar denominated assets had a rate of return of 8.8%.[18]

[16] This is clearly an underestimate of the net cost of the bailout, since future sales of the banks benefited from future economic developments in Israel, like the Russian immigration, which could not be anticipated at the time.

[17] The rate of return was 12.4% in November 1983 and reached 17% at December 1983. During 1984 it remained approximately at that level. See the Bank of Israel Annual Report 1984 (1985).

[18] This was the dollar rate of return on liquid deposits, while the rate of return on illiquid deposits of the same maturity was around 12%.

Next we conduct a simple calculation designed to impute to the public the probability that the bailout would indeed be implemented by the government. As a first approximation, our calculation ignores the risk premium. If we denote the probability of bailout by Q, and remember that according to the above estimates, in case of no bailout the value of one dollar of bank shares would be 1.98/5.53, we get:

$$\frac{1.04}{1.17^5} = \frac{Q(1.04) + (1-Q)\frac{1/98}{5.53}}{1.088^5}. \tag{2}$$

The left hand side of (2) is the present value of the stock if redeemed, discounted by the rate of return of the stocks. The right hand side of (2) is the present value of the future expected value of the stocks, discounted by the dollar rate of return. Solving (2) yields that by the end of 1983 and during 1984 people held a probability Q = 54% that indeed the bailout would be implemented. Adding a risk premium on these risky assets contributing to the estimate might raise the probability of a bailout after the announcement to 60% or higher.

We view the sudden increase in anticipated financial obligations of the government as offering a promising explanation for the rise of inflation in October 1983. We show in Section 4, provided that the bailout was expected to be financed through monetization, that a plausible magnitude of the probability of a bailout was sufficient to raise inflation to a high annual rate of 400% and more.

Why do we believe that the public expected the bailout to be financed by money creation? Unlike other public debt, which in principle could be rolled over to later periods, here was an obligation to pay within a short period of four to five years, making it more likely to be monetized.

Note that we are not imputing perfect foresight to the public because the great stabilization of July 1985 completely upset the October 1983 expectations that we are attributing to the public. As a result of the July 1985 stabilization, the bailout was *not* monetized. The main reason that we think that the stabilization was not anticipated by the public in 1983 is that the substantial changes in the political landscape that eventually facilitated the 1985 disinflation could not have been foreseen in October 1983. The 1985 reform was managed by the unity government of Likud and Labor that came to power in September 1984 after elections held one year earlier than had generally been anticipated.[19] In October 1983, we can recall no one who could foresee the emergence of the broad coalition of September 1984 (97 seats in the Knesset out of 120).[20]

4. A Model and Calibration

In this section, we simulate a calibrated model of a monetary economy with a public that for dates $t < 0$ assigns a lower probability of a bailout than it does after a government announcement at time $t = 0$ of a promised bailout at date $T > 0$. Thus, in our model, at dates $t < 0$, the public suspects that a bailout might happen, but it has no specific information about *when* the bailout might occur. We model this by imputing to the public a constant probability q that the bailout might occur next period. In period 0, the government announces that it will pay the bailout in period $T > 0$. The public does not fully believe the government, so it imputes probability Q to a bailout actually occurring at

[19] The elections were moved up in response to a gradual worsening of the military situation in Lebanon and higher inflation.

[20] Actually, the government in October 1983 looked weaker than ever, especially with respect to economic management. In 1983 Begin resigned the premiership and Shamir assumed it. The Likud government looked weak, especially after replacing its finance ministers almost every year. It seemed unlikely that this government could carry out major fiscal reforms needed to bring inflation down.

T and probability 1-*Q* to it not occurring at *T*. If there is no bailout in period *T,* then things return to the initial situation in which the public attaches a constant probability *q* to a bailout next year for each year after *T*. We think that this simple structure of beliefs can adequately capture the history of the public's expectations before and after the "Hesder" in 1983.

4.1. The Model

Consider a closed Ramsey economy with a single physical good that is produced by labor only. The population consists of a continuum of size 1 of consumers with infinite horizons. Each individual produces 1 unit of the good in each period. There are two assets, loans and money. Loans are for one period, are indexed for inflation, and pay a real interest rate r_t.[21] The government issues high powered money.[22] Continuation utility of a consumer at time *t* is

$$U_t = E_t \sum_{s=t}^{\infty} \frac{\log c_s + \gamma \log(m_s / P_s)}{(1+\rho)^{s-t}}, \tag{3}$$

where c_t is consumption in period *t*, m_t is the consumer's stock of money at the end of the period, and P_t is the price of the physical good in terms of money in period *t*.

The government purchases an amount *G* of the good each period and collects a lump-sum tax *TA*, where $TA < G$. The deficit $D = G - TA$ is financed by issuing new money. Note that $G < 1$ so that it is smaller than output. For simplicity, assume that public debt is zero. The bailout is modeled as a possible future transfer to the public of a

[21] Indexed bonds were the most common asset at the time in Israel. The model could be solved with nominal bonds just as well, with the same results.
[22] Ironically, there are no banks in this model.

real size B, which we assume to be financed by a single monetary expansion at the time of the bailout.[23] Therefore, monetary policy in periods of no bailout is:

$$M_t - M_{t-1} = P_t D. \tag{4}$$

If there is a bailout in period t, monetary policy will evolve according to:

$$M_t - M_{t-1} = P_t D + P_t B. \tag{5}$$

4.2. Equilibrium Conditions

We first present the consumer's budget constraint in periods with no bailout, where e denotes the amount of indexed loans:

$$e_{t-1}(1+r_t) + \frac{m_{t-1}}{P_{t-1}}\frac{P_{t-1}}{P_t} + 1 - TA - c_t - \frac{m_t}{P_t} - e_t = 0. \tag{6}$$

If a bailout occurs in period t, the budget constraint also includes a windfall of size B:

$$e_{t-1}(1+r_t) + \frac{m_{t-1}}{P_{t-1}}\frac{P_{t-1}}{P_t} + 1 - TA + B - c_t - \frac{m_t}{P_t} - e_t = 0. \tag{7}$$

Maximizing expected utility (2) subject to the budget constraints (5) and (6) we get first order conditions that take the form of the Euler condition

$$\frac{1+\rho}{c_t} = (1+r_{t+1})E_t\left(\frac{1}{c_{t+1}}\right), \tag{8}$$

and the portfolio condition

$$\frac{\gamma P_t}{m_t} = \frac{1}{c_t} - \frac{1}{1+\rho}E_t\left(\frac{\frac{P_t}{P_{t+1}}}{c_{t+1}}\right). \tag{9}$$

[23] Another possibility is to finance the payment by debt, and then finance the interest on this debt by money issuing. This alternative method of finance yields the same outcomes.

The equilibrium condition in the money market each period is $m_t = M_t$ and the equilibrium condition in the loans market is $e_t = 0$ in each period. Together with the budget constraints and the printing money conditions it follows that in each period: $c_t = 1 - G$. As a result, (8) implies that the real interest rate is equal to ρ in each period. From (9) we get

$$\frac{\gamma P_t}{M_t} = \frac{1}{1-G}\left[1 - \frac{1}{1+\rho} E_t\left(\frac{P_t}{P_{t+1}}\right)\right]. \tag{10}$$

To describe the dynamics of the model, denote real balances by $L_t = M_t / P_t$. Then (10) becomes:

$$\gamma(1+\rho)(1-G) = (1+\rho)L_t - L_t E_t\left(\frac{P_t}{P_{t+1}}\right). \tag{11}$$

4.3. Dynamics After the Bailout

Note first that once the bailout takes place, there is no uncertainty and (11) holds with certainty. Note also that from then on the monetary policy rule is given by (4), so the dynamics of real balances are described by:

$$L_{t+1} = D + L_t \frac{P_t}{P_{t+1}}. \tag{12}$$

Substitute this condition into (11) to get:

$$L_{t+1} = L_t(1+\rho) + D - \gamma(1+\rho)(1-G). \tag{13}$$

Hence, the rational expectation equilibrium implied by (13) is constant real balances and a constant rate of inflation. Real balances from the time of the bailout are

$$L^* = \gamma \frac{1+\rho}{\rho}(1-G) - \frac{D}{\rho}. \tag{14}$$

We denote the rate of inflation by π, namely:

$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}} = \frac{P_t}{P_{t-1}} - 1.$$

Calculating the rate of inflation from the period following the bailout leads to leads to the following long-run rate of inflation:

(15) $$\pi^* = \frac{D}{L^* - D}.$$

4.4. Dynamics Prior to the Announcement

Note first that prior to the announcement at time $t = 0$, all prices and quantities just repeat themselves, since the probability q of a bailout is constant over time. Denote the equilibrium real balances prior to the time $t = 0$ announcement by L_P. If there is no bailout in period $t + 1$, then the dynamics are given by (12), so that:

$$L_t \frac{P_t}{P_{t+1}} = L_{t+1} - D = L_P - D.$$

If there is a bailout in $t + 1$, the dynamics of real balances follow (5) so that:

$$L_t \frac{P_t}{P_{t+1}} = L_{t+1} - D - B = L^* - D - B.$$

Hence, expected inflation satisfies:

$$L_t E_t\left(\frac{P_t}{P_{t+1}}\right) = qL^* + (1-q)L_P - D - qB.$$

Substituting into (11) and remembering that $L_t = L_P$, we get that real balances prior to the announcement are:

(16) $$L_P = L^* - \frac{q}{q+\rho} B.$$

The rate of inflation prior to the announcement is therefore:

(17) $$\pi_P = \frac{D}{L_P - D}.$$

4.5. Dynamics after the Announcement

An announcement of a bailout in period T occurs in period 0. Let's work backwards from date T. At date T, it is realized whether or not there actually is a bailout. If there is a bailout, real balances are L^* from period T onward and inflation is π^* from $T + 1$ onward. If there is no bailout real balances are L_P from T onward and inflation is π_P from $T + 1$ onward. We next want to know the rate of inflation in period T and earlier. Due to (4), if there is no bailout, inflation at T is given by:

$$\frac{P_{T-1}}{P_T} = \frac{L_P - D}{M_{T-1} / P_{T-1}}.$$

Due to (5), if there is bailout, inflation in T is:

$$\frac{P_{T-1}}{P_T} = \frac{L^* - D - B}{M_{T-1} / P_{T-1}}.$$

Calculating the ex-ante expectations of inflation $E_{T-1}(P_{T-1} / P_T)$, by use of the probability Q of a bailout and $1 - Q$ of no bailout, and substituting into equation (11), we get:

(18) $$L_{T-1} = L^* - \frac{QB + (1-Q)B\dfrac{q}{q+\rho}}{1+\rho} = L^* - \frac{B}{1+\rho}\frac{q+Q\rho}{q+\rho}.$$

Note that after $t = 0$ but before period $T - 1$ people do not expect any bailout in the next period and so condition (13) holds with certainty. It can be rewritten by use of (14) as

(19) $$L_t = \frac{\rho L^* + L_{t+1}}{1+\rho}.$$

Applying this dynamic condition recursively backward to the size of real balances from (18) on, we can calculate the size of real balances in every period. Thus, real balances N periods before the possible bailout equal

$$L_{T-N} = L^* - \frac{B}{(1+\rho)^N}\frac{q+Q\rho}{q+\rho}. \tag{20}$$

The rate of inflation N periods prior to T is therefore

$$\pi_{T-N} = \frac{D + \rho B(1+\rho)^{-N-1}(q+Q\rho)(q+\rho)^{-1}}{L^* - D - B(1+\rho)^{-N}(q+Q\rho)(q+\rho)^{-1}}. \tag{21}$$

In particular inflation in year 1, the year after the announcement, is

$$\pi_1 = \frac{D + \rho B(1+\rho)^{-T}(q+Q\rho)(q+\rho)^{-1}}{L^* - D - B(1+\rho)^{-T+1}(q+Q\rho)(q+\rho)^{-1}}. \tag{22}$$

Inflation at the time of the announcement is derived from equations (4), (16) and (20):

$$\pi_0 = \frac{L_P - L_0 + D}{L_0 - D} = \frac{D + B[(q+Q\rho)(1+\rho)^{-T} - q](q+\rho)^{-1}}{L_P - D - B[(q+Q\rho)(1+\rho)^{-T} - q](q+\rho)^{-1}}. \tag{23}$$

4.6. Simulation

We calibrate this model in order to check whether a plausible probability of bailout after the announcement of the "Hesder" was sufficiently large to have induced a jump in inflation from 120% to around 400%. For this calculation we fit numerical values for the following parameters and variables: the rate of discount ρ, the size of monetized deficit D, the rate of inflation prior to the announcement π_P, real balances prior to the announcement L_P, and the net cost of the bailout in 1988, namely B. Note that because we have normalized output to 1, all real variables G, D, B, and L can be thought of as shares of GDP.

First, assume that the subjective annual discount rate ρ is 0.05, although real interest rates in Israel at the time were higher than usual, probably due to a high risk premium, caused by the large public debt. The average rate of inflation prior to the shares bailout, in the years 1980-1982 was 122%, hence we set $\pi_P = 1.22$. The ratio of high powered money to output prior to 1983, in the years 1980-1982, was on average 4.37%. Hence we set $L_P = .044$.[24]

We next estimate the net cost of the bailout predicted for 1988. As mentioned above, the value of the bailout was 5.53 billion dollars in 1983. Since it was indexed to the dollar with an accumulated interest of 4% over the 5 years, its value in 1988, the year of the bailout, was supposed to be 5.75 billion dollars. The inherent value of the bank shares to the government is estimated by their future sale value, discounted by the US interest rate to 1988, and is equal to 2.7 billion dollars.[25] Hence, the net cost of bailout anticipated in 1988 was 3.05 billion dollars. Since Israel's GDP in 1988 was 44 billion dollars, B should be 6.9% of GDP, or .069.

Next, we turn to estimate the size of the monetized deficit D. Our estimates of D in Section 2 for the first period of inflation, 1974-1978, were around 5% of GDP. According to Bank of Israel (1984) its size was 2% on average in the years 1980-1982. Bental and Eckstein (1988) estimate it to be higher, around 2.5%. Interestingly, calculation of D using equation (16) yields a result which is very close to Bental and Eckstein (1988): $D = 0.0242$.

Evidently, the public had anticipated a bailout of the banks shares even before the "Hesder," though at a low probability. The problem is that we cannot estimate this

[24] This figure is calculated using the most recent data published by the Bank of Israel on these years, Bank of Israel (1999).
[25] As explained in footnote 16, this is an overestimate of the value of the banks.

probability, as we observe inflation and real balances prior to the announcement, where this probability already affects these variables, as shown by Equation (16). Because we do not know L^*, which would have appeared only after the bailout, we cannot calculate the initial probability for the bailout. But we can use the following relationship, which is derived from (16)

$$L^* = L_P + \frac{qB}{q+\rho}.$$

We do not observe the probability q but we can try a few reasonable values of it, namely the probability that the government will bailout the banks within a year, prior to the "Hesder." Figure 3 describes the size of inflation in period 1, π_1, as a function of the probability of a bailout Q, for a few values of q.

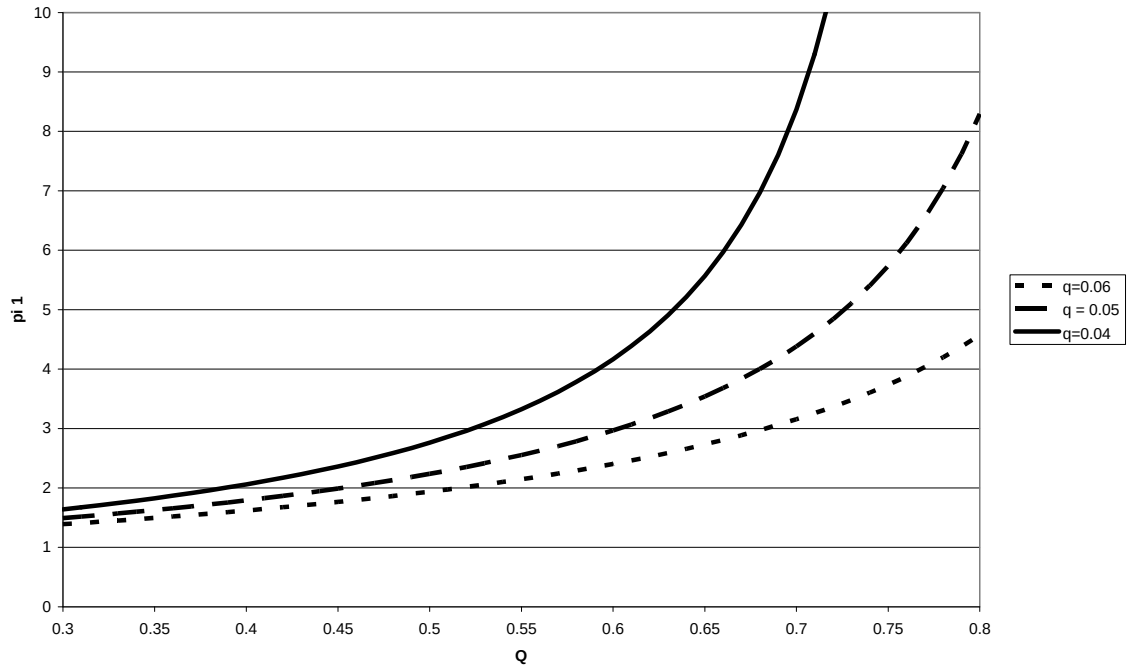

Figure 3: Rate of Inflation in Period 1 as a Function of Q

Figure 3 shows that the probability of a bailout after the Hesder, which was estimated in Section 3 to be more than 60%, can explain a jump of inflation to over 400%, if the initial probability of a bailout next year was 0.04 and even 0.05. Hence, we can deduce that our story of unpleasant monetary arithmetic can account for a large jump in inflation and even to most of the jump, which was experienced in October 1983. Figure 4 presents the rate of inflation in the year of the Hesder, π_0, as a function of the probability that the bailout will take place, Q. It also shows that if this probability is above 60% inflation can jump to a high level.

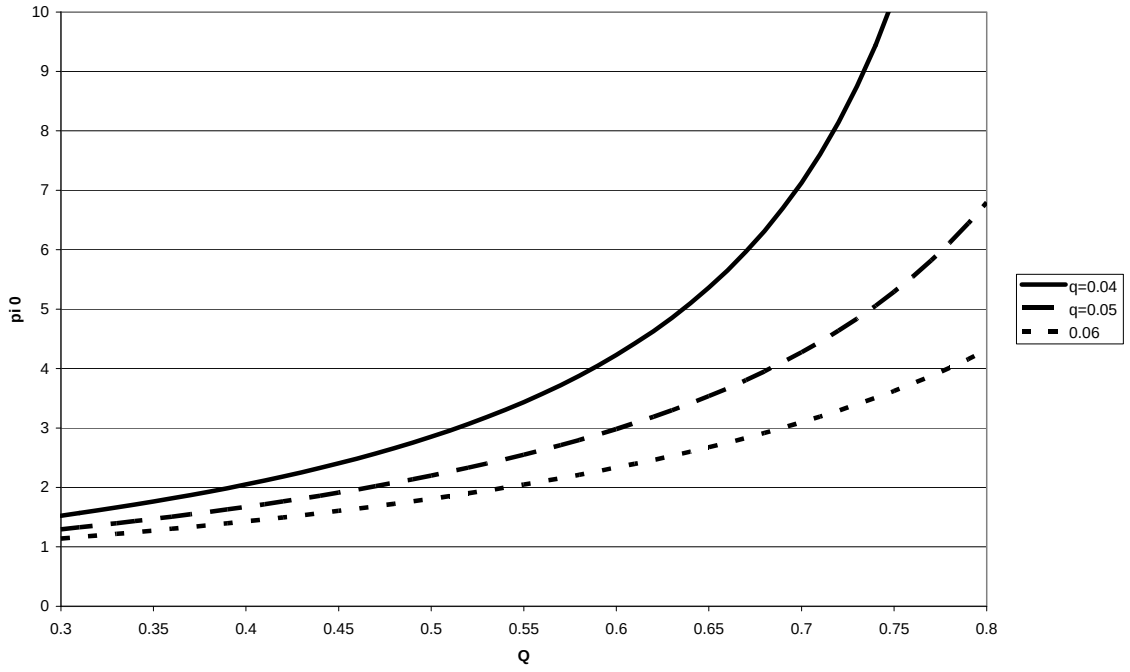

Figure 4: Rate of Inflation in Period 0 as a Function of Q

4.3. Robustness

Our calculations above are based on a number of assumptions. First we assume that the probability of bailout in the coming year, before the announcement, was in the range 4%-6%. This assumption means that prior to the announcement the probability of a bailout in the next 5 years was between 18.5%, if q = 4%, to 26.6%, if q = 6%. Since we estimate that the probability of a bailout in 5 years after the announcement was around 60%, a probability of 20-25% for a similar period of time prior to the announcement seems to be reasonable.

Another assumption we made is that if in period T the government does not bailout the banks, the public returns to the previous probability of a bailout. If we assume instead that in this case the public believes that the government will *ne*ver bail the banks out thereafter, the main results of the simulation are not changed significantly. The results show that a jump to a rate of inflation of 400% is still possible if the probability of a bailout prior to the announcement, q, is around 2% and the probability that the bailout will happen, Q, is 60%.

Another assumption is the size of the bailout. Our estimate is 6.9% of GDP. As mentioned above in footnote 16, we regard this as a lower bound, since in 1983 the banks could not have been expected to be sold at the high prices they ultimately attained. But it might be argued against our story that, even granting that the amount of the bailout was high, not all of it had to be financed by money printing at precisely the time that the bailout funds were to be paid out to bank stockholders. This argument strikes us as problematic, since circa October 1983 expectations that those payouts would be financed

via debt issues would probably then have been accompanied by expectations that eventual printing of money had just been postponed, with impacts on inflation in 1983 that would have been much the same. This is of course the basic logic of 'unpleasant monetarist arithmetic' and Appendix I shows that it prevails in our model.

Perhaps it could be argued that in October 1983 people expected that the bailout would have no fiscal or monetary consequences at all, because people simply anticipated that the bailout would be accompanied one-for-one either with reductions in other public expenditures or increases in tax collections. We believe that it would be a mistake to impute such anticipations to informed citizens of Israel who, in 1983, had just lived through ten years of a deficit of 15% of GDP. The government that was in power in 1983 was viewed as especially weak and increased fiscal discipline at the time seemed very unlikely.

Nevertheless, we examined the results of the simulation in the case that the size of the bailout is 0.05, which is much smaller than our estimation. We find that the inflation can still jump to 400%, if the probability of the bailout Q is 60% and if the probability of a bailout prior to the announcement was 2.5%. This probability that the government will bailout the banks next year, is not implausible. Hence, even if the size of the bailout had been smaller, the jump in inflation could still have been the result of the announcement, under fairly plausible assumptions.

5. Discussion of the Literature

This paper provides a new explanation for the dramatic October 1983 rise in inflation in Israel that has been difficult to account for previously. This jump was not accompanied

by any observable contemporaneous rise in public expenditures or in the government deficit and was therefore quite puzzling and ignited a number of attempts to explain it. Our explanation uses a standard theory of the inflation tax, but points at future government deficits, as intermediated through the public's expectations, as the cause of the contemporaneous jump of inflation in 1983. There are at least four prominent alternative explanations of the 1983 jump in inflation.

Two of the explanations deviate from the standard theory of inflation. Liviatan and Pitterman (1985) claim that the 1983 jump was caused by an accommodating monetary policy in conjunction with a large devaluation, associated with a balance of payments crises, and that acted as a price shock. We have substantial doubts about whether this explanation hangs together because it requires that inflation should be inertial and Zeira (1987) shows that if inflation is inertial, it has a unique long run rate that is not altered by temporary price shocks, only by permanent changes in real costs of production. A second explanation offered by Bruno and Fischer (1990) appeals to multiple equilibria. Noting that the two equilibria of an inflation tax model, one high, one low, could both be stable under some kinds of dynamics, Bruno and Fischer posited that a shock could push the economy from the low-inflation equilibrium to a high-inflation one. However, the least squares learning models of Marcet and Sargent (1989), Sargent, Williams, and Zha (2009), as well as the classic adaptive expectations model used by Bruno and Fischer (1990), make this argument tenuous because their dynamics typically render the high rational expectations equilibrium inflation rate unstable.

In addition to these explanations, two other explanations are based on the standard theory of inflation tax and rational expectations and also allude to unpleasant monetarist

arithmetic. One was hinted at by Drazen and Helpman (1987) in a theoretical paper that refers to the same inflationary jump that we study.[26] During 1983 the Israeli government followed a policy of reducing the rate of depreciation of the dollar through a version of the infamous "Southern Cone Disinflation." The policy restricted the rate of devaluation to a monthly rate of 5%, while prior rates of devaluation were around 7%. This policy was supported by increasing the public debt, or sales of foreign reserves, which increased anticipated monetary expansions and thus caused inflation to rise immediately. This is an interesting channel, but quantitatively its effects seem not to have been large. Reducing the monthly rate of inflation from 7% to 5% would have increased the public debt during the year of this policy (and in October 1983 it was clear that the policy ended) by less than .5% of GDP.

A second explanation based on future expectations is offered by Bental and Eckstein (1990), who study an inflationary economy with constant public deficits that anticipates a future stabilization of inflation. They show that under some conditions, inflation might rise prior to stabilization. Indeed, the Israeli inflation was stabilized in July 1985. But we have doubts whether the situation in Israel indeed fits the conditions in their model. For example, the Bental and Eckstein result holds only if the post-stabilization demand for real balances is smaller than before the stabilization. This was not the case in Israel.

5. Conclusions

[26] The references to the Israeli episode were more extensive in earlier versions of the paper.

A challenge to using rational expectations models to interpret historical episodes is the need to recover the mindsets and information sets possessed by decision makers at the time being studied. Assuming perfect foresight would usually be mistaken because shocks can intervene to move outcomes away from paths that had earlier seemed most likely. This is surely the case for our episode. Sargent and Wallace's (1981) unpleasant monetarist arithmetic was cast in terms of a nonstochastic model in which rational expectations amounted to perfect foresight. In practice, uncertainties associated with the unfolding of monetary and fiscal policy mean that what George Eliot called the "dim lights and tangled circumstances" of the real world obscure manifestations of unpleasant monetarist arithmetic. We have spun our tail by definitely backing off of perfect foresight – for otherwise the July 1985 stabilization would completely subvert our story – and doing our best to put ourselves into the shoes of Israeli bank share holders listening to the promises being made by the government in October 1983. We regard the 1983 Israeli episode to be an unusually clear instance of unpleasant arithmetic because the promised jump in the future deficit was so large and because we think that the public could reasonably have attached a high enough probability to it to give substantial force to that arithmetic.

Appendix I: The Bailout is Financed by Debt

Here we change one assumption in the model by assuming that while the bailout is financed by debt, the future interest payments on the debt are to be monetized. Hence, if there is bailout in period T, from period T+1 on the government prints more money to pay for the deficit and the interest payments of the debt:

(A.1) $$M_t - M_{t-1} = (D + r_t B)P_t.$$

Hence, under such finance of the bailout, inflation is higher after the actual bailout. Next we show that prior to the bailout inflation is the same as in the case that the bailout is financed by a one time monetary expansion. To save space this is shown only for periods after the announcement of the arrangement.

It can be shown that if there is a bailout, the new steady state real balances from period T on are equal to

(A.2) $$L^* - B,$$

where L^* are the real balances after a bailout, and are given by equation (14) in the text. Since monetary dynamics until period T are described by (4), the rates of inflation in the cases of bailout and of no bailout can be calculated to be

$$\frac{P_{T-1}}{P_T} = \frac{L^* - D - B}{L_{T-1}}$$

and

$$\frac{P_{T-1}}{P_T} = \frac{L_P - D}{M_{T-1}/P_{T-1}},$$

respectively. From these two values we can calculate the expected rate of inflation in T, substitute it in equation (11), and get the following value for real balances in period T-1:

(A.3) $$L_{T-1} = L^* - \frac{B}{1+\rho}\frac{q+Q\rho}{q+\rho}.$$

This is precisely equal to equation (18). Hence the dynamics of inflation under our alternative financing scheme are the same prior to the bailout, even though they differ after the bailout.

Appendix II: Net Public Debt in Israel

Year	Net Public Debt	Change in Net Debt
1974	92.1	13.8
1975	109.4	20.7
1976	122.8	15.1
1977	124.2	3.9
1978	135.8	16.5
1979	131.4	1.7
1980	131.7	4.9
1981	130.2	4.3
1982	134.0	5.6
1983	131.8	1.2
1984	149.5	20.5

Table A1: Net Public Debt and Changes in Public Debt, in % of GDP.

Source: The Research Department in the Bank of Israel.

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