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THE DETERMINATION AND CONTROL OF MONEY SUPPLY
IN AN OIL EXPORTING COUNTRY:
THE IRANIAN EXPERIENCE

by

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1. Introduction

The impact on the economies of the oil importing nations of the late 1973 oil price increase and its consequent international payment imbalances has been the subject of a great deal of research.[1] But relatively little emphasis has been placed on the severe problems that the resulting capital inflows have created for the economies of oil-exporting countries. Most of these countries have experienced severe inflation and economic disparities since 1974. The neglect of this area of research is rather unfortunate, as a better understanding of the role of oil revenues on the domestic economy of these countries can provide useful guidelines for better management of these economies and as a result provide more stability in the world oil market.

In this paper our objective is to analyze the role of oil revenue in the determination and the controlability of money supply in Iran. In particular we will pursue the double objectives of analyzing the degree to which the Central Bank has been able to influence the determination of money supply and the types of monetary instruments used in its effort to control money supply. Since the oil revenue is paid in terms of foreign currency and directly accrues to the government, it affects both the government budget and the balance of payments. Viewed from the point of view of money supply determination, the oil revenue affects the domestic and external component of monetary base adversely. Any change in oil revenue will change the foreign reserves holdings of the Central Bank and at the same time, given the level of government expenditure, will affect the claims of the Central Bank on the government. This dual feature of

oil revenue in Iran, seems to us to be a key element in understanding the mechanism of the money base determination and hence has constituted the core of our theoretical analysis.[2]

The study is set out in four sections. In the next section a theoretical model is presented within which the various factors influencing the growth of money supply are analyzed. By integrating the balance-of-payments constraint and the government budget constraint, an equation is derived which explains the change in monetary base as a function of oil revenue and government expenditure. Section Three contains the empirical analysis. First it presents quantitative information on the sources of growth of money supply in Iran for the period 1961-1974; secondly, it presents some regression results on the determinants of money base, and thirdly, it discusses the issue of sterilization policy in Iran and tries to separate the part of sterilization which has been automatic due to the nature of oil revenue from the part which has been due to the conscious actions of the Central Bank. Section Four concludes the paper with a brief summary and some important conclusions.

2. THE ANALYTICAL FRAMEWORK

2.1. <u>The Monetary Base and Its Determinants</u>. The monetary base is broadly defined as the net monetary liability of the government to the banks and non-bank public. It, therefore, consists of currency in circulation and the legal and sight deposits of the banks with the Central Bank.[3] More specifically the monetary base can be derived by consolidating the balance sheets of the government and the Central Bank.

From the liability side of this consolidated balance sheet one can obtain an equation describing the use of monetary base, B, as:

$$B = CRP + LRB + ERB \qquad\qquad (1)$$

where CRP = currency in the hands of the public,
LRB = the legal reserve of the banks and ERB represents

their excess reserves.

Correspondingly, from the asset side of the consolidated balance and by a proper rearrangement of some of the items we obtain an equation describing the sources of monetary base:

$$B = FRC + GNAC + BAC + EAC \qquad\qquad (2)$$

where   FRC =   foreign assets held by the Central Bank less the loans and
                credits received from abroad,

        GNAC = claims on the government less the government deposits with
                the Central Bank,

         BAC = Central Bank's advance and rediscounts to the banks,

         EAC = a term containing other items on the asset side less the
                import registration deposits of the private sector,
                contingent liabilities, and others.

A more detailed analysis of the Central Bank's balance sheet is presented in Appendix 2. However, it is important to note here that the items of the balance sheet have been rearranged in such a way that the source components reflect the main separate mechanism of the supply of the monetary base. In this regard it is important to distinguish between the external sources, determined by the conditions in the balance of payments and the internal sources which depend on the government's budgetary position and the banks borrowing from the Central Bank.

The external source component of the monetary base can be identified with the net Central Bank's foreign asset holdings, FRC, which consists mainly of the holdings of foreign currencies, the special drawing right and the gold trading position with the IMF, the subscription and shares to international agencies, and the stock of official gold. Changes in the foreign assets of the Central Bank depend essentially on the evolution of the balance of payments and reflect the transactions in both the current and capital accounts. Under the system of fixed (or pegged) exchange rates the balance of payments acts as a constraint on the supply of monetary base. The exact way in which the situation in the balance of payments affects the changes in the foreign assets of the Central Bank is described in equation (3).

$$\Delta FRC = CAB + \Delta (FLB - FAB) + \Delta (FLG - FAG) \qquad (3)$$

where CAB denotes the current account balance, (FLB - FAB) represents the net foreign liability of the banks, (FLG - FAG) is equal to the net foreign government debt and Δ is the difference operator defined as

$$\Delta x_t = (x_{t+1} - x_t).$$

It is important to note that embedded in our representation of the balance-of-payments constraint in equation (3) is the assumption that the non-bank public in Iran does not hold foreign assets or incur foreign liabilities. Especially it is assumed that the private corporations do not issue securities or bonds to foreigners. This assumption is indeed justifiable in the case of Iran where the capital markets are not fully developed nor integrated with the foreign markets.

The balance on current account, CAB, is equal to the total exports of goods and services minus the imports of goods and services. In the Iranian situation where oil is the major export and due to the predominant influence of oil revenue on the national income determination and consequently the level of imports, it is assumed that:

$$CAB = \lambda OR + \beta \qquad (4)$$

where OR denotes the oil revenue and λ and β are constant parameters.

The internal source component of the monetary base can in turn be identified with the government debt to the Central Bank, GNAC, and the banks borrowing from the Central Bank, BAC. The changes in net claims on the government depend mainly on government current budget deficit and the manner in which the deficit is financed. In the case of Iran where the public participation in the government bond market is insignificant, the government deficit has to be financed mainly by increases in the government debt with the Central Bank, GNAC, and by placing government securities either abroad (FLG - FAG) or with the banks (BLG - BAG), that is:

$$GDF = \Delta GNAC + \Delta (FLG - FAG) + \Delta (BLG - BAG) \qquad (5)$$

where GDF denotes government deficit.

In equation (6) we express the amount of government securities purchased by banks as a linear function of government deficit, that is:

$$\Delta (GLB - GAB) = \mu GDF + \alpha \qquad (6)$$

Government deficit itself is equal to government expenditure, GEXP, minus government revenue, where government revenue is composed of oil revenue, OR, and non-oil revenue, NOR.

$$GDF = GEXP - OR - NOR \tag{7}$$

To see more precisely how the oil revenue affects the monetary base in Iran, we must first define the adjusted monetary base, BA, according to the following equation.

$$BA = B - (FLB - FAB) - BAC - EAC \tag{8}$$

It is important to note that, according to equation (8), BA is defined to consist only of those components of the monetary base which are not influenced by the behavior of the banks.

By substituting for B from equation (2) we obtain a new expression for the adjusted monetary base which is,

$$BA = FRC + GNAC - (FLB - FAB) \tag{9}$$

By applying the difference operator Δ to the both sides of equation (9) and then by substituting for FRC and GNAC from equations (5) and (3) and by means of the equation (4), (6) and (7) we obtain an equation whichexpresses the change in the adjusted monetary base as a function of oil revenue and government expidenture. The result is equation (10).

$$\Delta BA = (\lambda - (1 - \mu)) OR + (1 - \mu) (GEXP - NOR) + \beta - \alpha \tag{10}$$

It follows from equation (10) that the way that the oil revenue affects the change in the adjusted monetary base depends on two parameters λ and μ . In the case that $\lambda > (1 - \mu)$ then the oil revenue has a positive influence on the change in the monetary base, otherwise it has a negative influence.

2.2. The Money Supply Function. The second step in our analysis requires the specification of a multiplier function to relate the stock of money to the monetary base. For this purpose a narrow definition of money is adopted, namely:

$$M = CRP + DD \tag{11}$$

where M denotes money stock, CRP the currency in circulation outside the banking sector and DD the demand deposits.

Recent research by Metzler and Brunner[2] has emphasized the point of view that the determination of the multiplier function should be viewed as the outcome of the optimization behavior of the public and banking sector on one hand, and the monetary authorities on the other hand, under the various constraints imposed upon them. The behavior of the public can be described by a set of equations determining the allocation of its total financial assets among a set of competing assets. Given the fact that in Iran the public holdings of government bonds are insignificant and that trade in any further type of securities is not considered here, the public portfolio behavior can be described as

allocating its financial assets between currency (CRP), demand deposits (DD), and saving and time deposits (SD). In this context two ratios are defined to express the public portfolio behavior, they are:

$$C = \frac{CRP}{M} \tag{12}$$

$$S = \frac{SD}{DD} \tag{13}$$

where C and S are respectively the ratio of currency to money supply and saving deposits to demand deposits.

In the same fashion the behavior of the banking system can be described by means of two ratios expressing their legal and excess reserve positions. That is,

$$RR = \frac{LRB}{(DD + SD + GD)} \tag{14}$$

$$RE = \frac{ERB}{(DD + SD + GD)} \tag{15}$$

where RR and RE are the legal and excess reserve ratios respectively and GD is the government deposits with the banks. Furthermore GD can be related to DD by means of the following ratio:

$$G = \frac{GD}{DD} \tag{16}$$

where G is the ratio of government deposits to the public's demand deposits.

Substituting (13) and (16) into (14) and (15) yields:

$$LRB = RR (1 + S + G) DD \tag{14.a}$$

$$LER = RE (1 + S + G) DD \tag{15.a}$$

Again substituting (14.a) and (15.a) in (1.a) yields:

$$B = CRP + (RR + RE) (1 + S + G) DD \qquad (17)$$

By dividing both sides of (17) by M and substituting for DD/M from equations (12) and finally solving it for M yields:

$$M = m (\quad . \quad) B$$

$$\text{where} \qquad m = \frac{1}{C + (RR + RE) (1 + S + G) (1 - C)} \qquad (18)$$

is the monetary multiplier.

Finally by taking the natural logarithm of (18) and differentiating with respect to time, we obtain an equation expressing the growth rate of money as a function of growth rate of monetary base and the rates of change of monetary ratios. That is:

$$\frac{\dot{M}}{M} = \frac{\dot{B}}{B} - (1 - (RR + RE)) (1 + S + G) \frac{dc}{dt} - (1 + S + G) (1 - C)$$

$$\frac{dRR}{dt} - (1 + S + G) (1 - C) \frac{dRE}{dt} - (RR + RE (1 - C) \frac{dS}{dt} - (RR + RE)$$

$$(1 - C) \frac{dG}{dt} \qquad (19)$$

3. EMPIRICAL ANALYSIS

3.1. The Sources of Growth of Money Stock. Table 1 displays the annual percentage rate of growth of money stock and money base in addition to the annual percentage change of monetary ratios for the period 1962-1975. An interesting feature of this table is the increasing trend observed in the growth rate of money stock, especially after 1971. While the average annual growth rate was about 10.4 percent over the period 1962-1970, it sharply rose to about 36.2 percent for the period 1971-1975. The growth of money stock reaches its peak of 61.4 percent in 1974. This is clearly the result of the phenomenal oil price increase of October 1973 which gave the Iranian economy its unprecedented boom.

Equally interesting is the observation that the growth of monetary base closely follows the growth of money supply. The closeness of this relationship is striking as it can be revealed by the correlation coefficient of .933 between the two growth rates. This indeed is an interesting finding as it can be used as a basis for projecting the growth of money supply from the knowledge of the growth of the monetary base. However, before pursuing this issue it is essential to have some quantitative knowledge about the contribution of other determinants of money stock. This knowledge is provided in Table 2 where it reports the absolute and relative contributions of the average rates of change of monetary base and the monetary ratios to the average rate of change of money stock for different time periods. The relative contributions are derived by dividing the absolute contributions by the average growth rate of money stock.

Table 1

The Annual Rate of Growth of Money Supply and
Money Base, and the Annual Change of Monetary Ratios

(1962-1975)

Year	M	B	C	S	RR	RE	G
1962	9.7	6.8	2.4	32.0	-3.2	-3.5	0.5
1963	11.8	11.9	.9	20.1	-0.5	-2.3	7.0
1964	10.0	1.6	-2.0	5.7	0.0	-3.9	-0.9
1965	11.8	18.5	-2.0	0.7	3.2	-0.1	7.7
1966	10.7	9.0	-1.1	7.3	0.0	-0.9	0.3
1967	15.4	13.5	-1.1	8.3	-0.6	-0.3	-1.7
1968	14.0	20.5	-1.2	18.8	1.4	0.4	-5.4
1969	2.8	13.3	2.3	52.4	0.1	-0.6	14.0
1970	7.7	19.0	0.9	28.4	2.6	-0.5	2.3
1971	20.1	20.8	0.4	20.9	-1.1	-0.7	19.8
1972	35.6	31.7	-0.5	-4.9	-0.2	-0.2	-10.8
1973	27.7	33.0	0.8	8.5	1.5	0.1	-6.8
1974	61.4	65.4	-2.3	-12.7	-0.8	1.6	14.7
1975	36.4	33.9	0.8	7.9	0.3	-1.3	-2.2

Coments: The annual changes in the monetary ratios have been calculated
by the formula:

$$\bar{x}_t = (x_t - x_{t-1}) * 100$$

Source: Annual Report of the Central Bank of Iran, various years.

An examination of the observations contained in Table 2 reveals some interesting features of the Iranian monetary system. To begin with, one is immediately struck by the predominant contribution of the monetary base to the growth rate of the Iranian money stock during the period 1961-1975.[5] An idea of the relative significance of the monetary base in the determination of the money stock can be gained on the basis of the observation that the growth of monetary base accounts on average for about 188 percent of the growth of money stock during the period 1961-1975. Also, the observation that the growth rate of monetary base exceeds that of money stock over most of the time periods under consideration.

Table 2

Absolute and Relative Contribution to the Growth

Rate of the Iranian Money Stock by the Money Base
And the Monetary Ratios,[a] for Selected Periods 1961-1975

Period	Average Growth Rate of M per year	Absolute Contributions by					
		B	C	S	RR	RE	G
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1961-1964	10.5	6.7	-0.2	-0.34	3.1	5.6	-0.3
1964-1967	12.6	13.6	1.0	-0.7	-2.9	0.8	-0.3
1967-1970	8.16	17.6	-0.2	-0.45	-3.3	0.4	-0.4
1970-1973	27.8	28.5	-0.04	-1.0	-0.1	0.5	-0.08
1973-1975	48.9	49.5	0.1	0.3	0.5	-0.2	-0.7

Notes:

(a) Annual percentage rate of charge

(1) M = currency and demand deposit

(2) B = monetary base as defined in the text

(3) C = currency - money ratio

(4) S = Saving deposit - demand deposit ratio

(5) RR = legal reserve ratio

(6) RE = excessive reserve ratio

(7) G = government deposit - private demand deposit ratio

Table 2 (continued)

Absolute and Relative Contribution to the Growth
Rate of the Iranian Money Stock by the Money Base
And the Monetary Ratios,[a] for Selected Periods 1961-1975

Period	Total Change of M (b)	Relative Contributions in percent by					
		B	C	S	RR	RE	G
1961-1964	100	63.8	-1.9	-32.38	29.52	53.33	-2.85
1964-1967	100	107.93	7.93	-5.55	-23.01	6.34	-2.38
1967-1970	100	215.68	-2.45	-55.14	-40.44	4.90	-4.90
1970-1973	100	102.51	0.143	-3.59	-0.359	1.79	-0.287
1973-1975	100	101.22	0.204	0.163	1.02	-0.408	-1.43

Comment:

(b) Because of approximation errors the sum of the contributions
of the money base and the monetary ratios may not be equal to
the total change in money stock. This is true especially for
the period 1967-1970.

An important implication drawn from this phenomenon leads one to the realization that the multiplier function has acted mostly as a restraining element rather an expansionary element in the formation of money supply in Iran. This is most visible during the time period 1967-1970 where the growth rate of money base exceeds that of the money supply by more than 200 percent. This high rate of growth in money base was mainly offset by a sharp increase in the legal reserve ratio and the shift of private assets from demand deposits to saving and time deposits. The legal reserve ratio increased from a value of .111 in 1967 to a value of .152 in 1970 resulting in an increase of about 136 percent during these years. Also the increase in the saving-demand deposit was very noticeable, from a value of 1.45 in 1967 to a high value of 2.44 in 1970.

It is interesting to note that this predominance of monetary base in the process of money supply determination does not hold for all time periods considered here. The time period 1961-1964 exhibits a pattern which differs markedly from other time periods. During this time period, the share of the rate of growth of money stock explained by the growth of monetary base amounts only to 64 percent. This leaves about 36 percent to be explained by the changes in the monetary ratios. Turning to Table 2 we realize that the expansionary task was mainly performed by the banking sector. Both the legal and excess reserve ratios declined during this period, therefore allowing the banks to expand credit to private and public sector. This, once again, confirms the view that the banking sector in Iran has been an effective channel through which the Central Bank has controlled the supply of money.[6]

3.3. Oil Revenue and the Monetary Base. An important conclusion

emerging from our inquiry into the sources of growth of the Iranian money

stock in th previous section was the significant contribution of the

monetary base to the growth of money stock. A better understanding of

the process of money supply determination in Iran, thus, necessitates the

knowledge of factors determining the growth rate of monetary base. In

this section of our study we undertake an examination of the determinants

of monetary base in Iran.

Table 3 reports our estimate of monetary base and its source

components for the Iranian economy for the period 1961 through 1975. An

important aspect of the supply of money base in Iran is the behavior of

foreign reserves. Its contribution to the supply of monetary base

fluctuates from a minimum value of -9 percent in 1970 to a maximum value

of 163 percent in 1974. Until 1967 it exhibits a rather stable pattern

contributing on the average 48 percent to the monetary base. This

stability is then disturbed by the shortage of foreign exchange in 1970

and by its abundance brought about by the oil price increase of October

1973.

The amount of bank borrowing from the Central Bank shows a

relatively stable pattern, contributing on the average about 17 percent

to the monetary base.

The government component of the monetary base which is in fact the

net claims of the Central Bank over the government, displays a trend

which is the mirror image of the foreign component. During the years

1974 and 1975 when the foreign reserves exceed the monetary base, the

government component is negative, implying that government deposits

exceed the stock of government securities held by the Central Bank.

Table 3

The Sources of Money Base in Iran

Year	Money Base b. of R	External b. of R	Sources (%)	Government b. of R.	Comp. (%)	Bank Borrowing b.of R (%)		Others b.of R. (%)	
1961	30.8	12.7	(41)	15.8	(51)	4.8	(15)	-2.5	(-8)
1962	33.0	16.9	(51)	14.9	(45)	4.5	(13)	-3.3	(-10)
1963	36.8	18.4	(50)	16.6	(45)	5.1	(13)	-3.3	(-9)
1964	37.3	26.2	(70)	7.8	(21)	10.1	(27)	-6.8	(-18)
1965	44.0	21.7	(49)	23.1	(52)	8.7	(19)	-9.5	(-21)
1966	48.0	19.4	(40)	29.3	(61)	11.2	(23)	-11.9	(-24)
1967	54.8	20.9	(38)	41.0	(75)	7.6	(13)	-14.7	(-26)
1968	66.3	14.0	(21)	54.3	(82)	11.2	(17)	-13.2	(-20)
1969	75.1	7.1	(9)	67.6	(90)	15.0	(29)	-14.6	(-19)
1970	91.6	-8.8	(-9)	101.5	(114)	15.3	(17)	-16.4	(-18)
1971	108.7	29.6	(27)	84.4	(78)	14.5	(13)	-19.8	(-18)
1972	141.4	70.3	(49)	82.4	(58)	20.6	(14)	-31.9	(-22)
1973	188.3	142.7	(75)	51.9	(27)	45.2	(24)	-51.5	(-27)
1974	310.8	508.1	(163)	-109.2	(-35)	38.1	(12)	-126.1	(-40)
1975	419.6	506.6	(121)	-40.3	(-9)	99.6	(23)	-146.2	(-35)

Source: Central Bank of Iran Annual Report, various years. For exact
definitions of the components see the text.

During these periods the Central Bank became a net debtor to the government. This is indeed a reflection of the fact that oil revenue affects both the domestic and external components of the money base. Any changes in oil revenue will change the government revenues, thereby changing the net position of the government with the Central Bank. At the same time because oil revenues are received in foreign exchange this will change the foreign reserves of the Central Bank as well.

To gain some insight into the exact way in which oil revenue affects the monetary base we follow our theoretical arguments of Section 2. In that section we derived an equation expressing the change in monetary base as a function of oil revenue and the government expenditure. Rewriting that equation, we have:

$$\Delta BA = (\lambda - (1 - \mu) \; OR + (1 - \mu) \; (GEXP - NOR) + \beta - \alpha \qquad (10.a)$$

According to this equation the effect of oil revenue on the change in adjusted monetary base depends on the two parameters λ and μ. If $\lambda <$ $1 - \mu$ then we expect the oil revenue to exert a negative impact on the change in adjusted monetary base. Estimating equation (10.a) over the period 1961-1975 produced the following results:[7]

$$\Delta BA = -22.79 - .576 \; OR + .847 \; (GEXP - NOR)$$
$$(1.01) \quad (2.29) \quad (2.44)$$

$R^2 = .395$, t - statistics are in the parenthesis. (10.b)

The estimates indicate that the oil revenue has a negative impact on the changes in monetary base. This appears at first sight to be rather

strange and therefore requires some explanation. To seek some reasons behind this apparently paradoxical result we obtain the estimates of λ and μ . From equation (10.b) we obtain a value of .153 for μ and a value of .271 for λ . These estimates of λ and μ appears to be quite reasonable in light of equations (4) and (6). According to equation (6), μ can be interpreted as the proportion of the government deficit which is financed by commercial and specialized banks, and due to the underdeveloped stage of the government bonds market we expect to observe a low value for μ . Similarly from equation (4), λ can be interpreted as the marginal impact of oil revenue on current account balance of payments, and due to the significance of oil revenue in the determination of the Iranian national income and high marginal propensity to imports in Iran, we indeed expect a relatively low value for λ . Some further justification for this finding might be sought on the ground of interpreting the negative influence of oil revenue on the change in monetary base as an indication of the action of monetary authorities in sterilizing the impact of foreign reserves in monetary base. To illustrate this point of view further it is of interest to analyze more precisely the behavior of the Iranian monetary authorities in their attempt to offset the impact of foreign reserves on monetary base. An estimate of the degree to which the monetary authorities adjust the domestic component of monetary base to changes in the external component can be obtained from the following regression analysis.

$$\Delta(BA - FRC) = \alpha_1 + \alpha_2 \Delta FRC \qquad (20)$$

$$\Delta(B - FRC) = \beta_1 + \beta_2 \Delta FRC \qquad (21)$$

The coefficients α_2 and β_2 are the measures of the degree to which the monetary authorities attempt to sterilize the impact of foreign reserves on the adjusted monetary base and monetary base respectively. The estimates of α_2 and β_2 are, thus, expected to be negative and significant with the absolute value of β_2 exceeding the absolute value of α_2. Estimating these equations over the period 1961-1975, the results are:

$$\Delta(BA - FRC) = 7.04 - .514 \ \Delta FRC, \quad R^2 = .96 \quad (20.a)$$
$$ (2.43) \quad (17.94)$$

$$\Delta(B - FRC) = 17.64 - .713 \ \Delta FRC, \quad R^2 = .86 \quad (21.a)$$
$$ (2.15) \quad (8.76)$$

According to these estimates the Iranian monetary authorities on the average adjust the domestic component of the monetary base by about 71 rials and the domestic component of the adjusted monetary base by about 51 rials out of each 100-rial change in foreign reserves. These results clearly indicate that the Iranian monetary authorities have been relatively successful in sterilizing the movements in foreign reserves on the domestic component of monetary base.[7] In this regard, however, it is to be noted that part of the negative impact of the variation in foreign reserve on domestic component of monetary base can be attributed to the fact that the oil revenue, by nature, affects the domestic and external components of the monetary base adversely. As already indicated, any increase in the oil revenue increases the foreign reserves held by the Central Bank, while at the same time, given the level of government expenditure, it is more likely to decrease the claims of

Central Bank over the government. This automatic process of sterilization policy in Iran is of utmost importance in understanding the nature and the mechanism of monetary policy in Iran. However, it cannot be denied that the conscious actions of the Central Bank mainly through the exercise of its control over the commercial banks, such as changes in legal reserves requirements, changes in advance and discounts to the banks and so on, have been quite effective in offsetting the movements of foreign reserves on the domestic component of monetary base.[8] The higher estimate obtained

for β_2 than for α_2 in equation (20.a) and (21.a) clearly attests to the truth in this statement. As can be shown, the difference in the estimates of β_2 and α_2 is mainly due to the fact that the amount of banks' borrowing is included in the definitions of monetary base, while it is excluded in the definitions of the adjusted monetary base.

4. CONCLUSION

In this paper we carried out an investigation of the process of money supply determination in Iran, and tried to see to what extent the Central Bank has been able to control the stock of money. By analyzing the sources of growth of money supply for the period 1961-1975 we came to the realization that the growth of monetary base contributed significantly to the growth of money supply, accounting on the average for about 118 percent. This then led us to an interesting conclusion regarding the role of the multiplier function in the formation of money supply in Iran, namely, that it has acted mostly as an restraining rather than expansionary element.

Our empirical analysis of the supply of monetary base in Iran indicated that the oil revenue had a negative and significant and the government expenditure a positive and significant impact on the change in money base. This, indeed, pointed to a distinguishing feature of the process of money base determination in Iran or any other OPEC country. Due to the fact that the oil revenue accrues directly to the government and is paid in foreign exchange, it affects both the internal and external components of monetary base. This dual feature of oil revenue results in a partial automatic sterilization of foreign reserves. The autonomous and total sterilization coefficients were estimated to be .51 and .71 respectively.

APPENDIX I

Derivation of Monetary Base

Writing the asset side of the Central Bank's balance sheet we have:

$$\text{Asset side} = FAC + GAC + BAC + OAC \qquad (A.1)$$

The liability side can be written as:

$$\text{Liability side} = CRP + CRB + BLLC + BLSC +$$
$$GLC + FLC + TMLC + GLC_1 +$$
$$MLC + KAC \qquad (A.2)$$

From the identy (A.1) = (A.2) and by transferring the terms, FLC, GLC, GLC_1, MLC, KAC, and IMLC from the liability side to the asset side we have:

$$B = (FAC - FLC) + (GAC - GLC - GLC_1) + (OAC - MLC - KAC - IMLC + BAC$$
$$(A.3)$$

where the terms in parentheses represent the net position of the Central Bank with the government and with the foreigners. Rewriting it we have:

$$B = FRC + GNAC + BAC + EAC \qquad (A.4)$$

APPENDIX II

Alphabetical List of Variables

B	Monetary base
BA	Adjusted monetary base
BAC	Liability of banks to Central Bank
BAG	Government's deposits with the banks
BLLC	Legal deposits of banks with Central Bank
BLG	Government securities in the hands of commercial and specialized banks
BLSC	Sight deposits of banks with Central Bank
C	Currency-money ratio
CAB	Current account balance of payment
CRB	Currency holding of banks
CRP	Currency in the hand of non-bank public
DD	Demand deposits
EAC	Exogenous terms in the asset side of the balance sheet of Central Bank.
ERB	Excessive reserve of banks
FAB	Foreign assets of banks
FAC	Foreign assets of Central Bank
FAG	Foreign assets of government
FLB	Foreign liability of banks
FLC	Foreicn liability of Central Bank
FLG	Foreign liability of Central Bank
FRC	Net foreign assets of Central Bank
GAC	Government securities in the hands of Central Bank

APPENDIX II

(continued)

GD	Government deposits with the banks
GDF	Government deficit
GEXP	Government expenditures
GLC_1	Advance payment on letters of credit of the government sector
GNAC	Net claims of Central Bank over Government
IMLC	Import registration deposits of the private sector
KAC	Capital account of Central Bank
LRB	Required reserve of banks with Central Bank
M	Money multiplier
M_1	Money stock
MLC	Miscellaneous terms on the liability side of the Central Bank's balance sheet
NOR	Non-oil revenue of the government
OAC	Customers' understandings re credits, guarantees and acceptance
OR	Oil revenue
RE	Extensive reserve ratio of banks
RR	Required reserve ratio of banks
S	Saving and time deposits - demand deposits of banks
SD	Saving and time deposits

NOTES

1. See for example Fried and Schultze (1975) for a collection of papers on the impact of oil price increase of late 1973 on industrial countries.

2. This is indeed a distinguishing feature of OPEC economies from other open economies where the private sector is the main receipient of export earnings in the form of foreign currency. In this case and under the system of fixed exchange rates, any change in the foreign assets of the Central Bank - in the absence of any sterilization policy - has a direct and equal impact on the supply of bank reserves and hence on the supply of money. See for example Brunner (1973) and Herring and Marston (1977a, 1977b) for a discussion of this point. However, in the case of OPEC economies where the government is the main recipient of export earnings such a direct link between the change in the foreign reserves of the Central Bank and the change in money supply does not exist. This point has been noted by McNown and Wallace (1977) as well.

3. Our concept of monetary base for the Iranian economy is essentially close to the one adopted by the Federal Reserve Bank of St. Louis for the United State's economy. For a discussion concerning the definition of monetary base and its empirical measurement see Anderson and Jordan (1968), Jordan (1969) and Balbach and Burger (1976).

4. In studies by Cagan (1965) for US by Jonung (1976) for Sweeden and by Thygesen (1971) for Denmark, it was also found that the growth of money base contributed significantly to the growth of money supply. For example it was found that the growth in the money base contributed about 81 percent to the growth in the money stock during the period 1946-1971 in Sweeden and by about 91 percent during the period 1875-1955 in the United States.

5. To see more clearly how much control the Central Bank has exercised over the banks we have expressed money-multiplier as a function of monetary ratios. Estimating this equation by OLS we found

$$\frac{\Delta m}{m} = .704 - .586 \ c - 1.73 \ RR - 2.41 \ RE$$
$$(.62) \quad (.79) \quad (3.64) \quad (4.4)$$
$$-.167 \ S - .127 \ G$$
$$(2.3) \quad (1.55) \qquad\qquad R^2 = .908$$

From this equation we realize that the most significant variable in determing the growth rate of money-multiplier is the change in excess reserve ratio of the banks. Second to this is the change in legal reserve ratio of the banks.

6. We used OLS for estimating all the equations reported in this paper.

7. By estimating a similar equation as (21) Williams (1971) obtained an estimate of - .86 for Germany. This indicates that the German monetary authorities have been more successful in neutralizing the impact of foreign reserves on change in money base than Iranian monetary authorities.

8. From the estimates of equations (19) and (20) the coefficient of the "exogenous" sterilization policy of Central Bank can be estimated to be .2. This is the difference between β_2 and α_2 .

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