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INTEREST RATES AND INFLATION IN THE LEONTIEF - SRAFFA FRAMEWORK

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Abstract

The traditional theories define the real interest rate as the difference between the nominal interest **rate and the inflation** rate, which holds true in the case of demand pull inflation. Analysing interest rates **and inflation in** the Leontief - Sraffa framework, the definition of the real interest rate differs. More **precisely, the** real interest is given by the production technology for the prevalent wages in such a way as **to ensure price** stability. Thus, **in** a state of cost push inflation the monetary policy of increasing the **nominal** interest **rate** is **not** the appropriate remedy. Such a policy will results in increasing the inflation **rate, which in its turn will** lead to the increase of unemployment rate as well (JEL C67, E43).

1. Introduction

Up to the second World War economists knew one kind of inflation. It was defined as "more money chasing fewer goo" or "the effective demand being more than the supply at constant prices". This is called in current parlance as demand pull inflation. Keynes taught us that until there is no full employment in the economy, the higher demand will increase employment. Only after full employment is reached, this demand will result in inflationary pressures (Keynes, J. M. 1964, Book IV).

After the second World War it" was discoverd that there was inflation coupled with unemployment, which led to the theory of cost push inflation. That is the prices for many commodities will rise if their production cost has risen. This cost push inflation was primarily concerned with the increase in the nominal wages giving rise to the point of view that an overall increase in the nominal wages will keep the real wages the same. Sush a consideration is in consonance

with the traditional economy with full employment. However for the economy having unemployment, this is true only on the assumptions of the cost push theory of inflation.

Similar cost push inflationary effects are produced when the nominal interest rate exceeds the real one. But there is one crucial difference between the cost push inflation generated by the increase in the nominal wages and that by the increase in the nominal interest rate. The former results in increasing prices once until the time labour unions are again able to increase their money wage rate. The latter is cumulative as the same nominal interest rate goes on applying even when prices have already risen in the previous round.

The above two types of inflation are the consequences of two different market adjustment mechanisms to bridge the gap between supply and demand. The traditional method of adjustment is through the changes in prices. If the supply of goods is larger than the demand, prices will decrease until the lower prices will increase the demand and reduce the supply sufficiently to make them equal, and vice versa. Hicks has christened it as flex price system (Hicks J. R. 1965, part II). On the other hand instead of reducing prices, producers may reduce their output and thus equalise their supply to the effective demand. This is termed as fix price system (Hicks J. R. 1965). In this system the price of a commodity is fixed according to the production cost, and the production adjusts to the demand. Most manufacturers follow the fix price system while agriculture, cottage industries et.c. depend on the flex price mechanism to dispose of their total production. Attempts by various governments to stabilise the agricultural prices by buffer stock management can be termed as trying to move the agricultural commodities from the flex price system to the fix price one.

On the basis of the aforementioned, the demand pull inflation seems to be connected with the flex price system whereas the cost push inflation with the fix price one. In this paper it is first described the traditional interest theory, where the increase in the nominal interest rate decreases prices, and then examined its opposite effect in the fix price system of Leontief - Sraffa framework of production.

2. Interest Rate Effects in Terms of demand Pull and Cost Push Inflation

Within the Scholastic system, interest was simply considered as the price for the use of money. But when, under Smith's Influence, Bardons's analysis began to prevail, according to which interest was that part of business gains that

accrued to the surveyor at physical capital, the analysis was centred on the relation between this interest and the interst in the market of money loans. Smith argued that the loan rate in the money market represented the shadow of the profit rate on real capital while the quantity of money had nothing at all to do with it. This point of view remained the dominant one throughout the 19th century in spite of Wicksell's and Thornton's contributions to the relation among money, prices and the real rate of interest (Schumpeter J. A. 1954, pp. 720-723).

Thornton maintained that the loan rate (money interest) tends to be equal with the expected marginal profits of investment (marginal efficiency of capital). Nonetheless there does not exist, within the logic of credit mechanism itself, any restriction that will prevent bank credit from exceeding the limit beyond which it will cause an inflationary increase in prices, and that the practice of lending on good security does not constitute such a restriction. An expansion of loans unless accompanied by a compensating reduction of expenditure of people, will increase the money incomes and, hence, the demand for commodities and services. Such an expansion of loans can be induced by the offer to lend at a rate below the expected marginal profits. An increase in the loans beyond the equilibrium amount will eventually results in increasing prices, and if the interest rate continues to be kept at its old level, further borrowing will continue to be profitable at the new level of prices. Thus, a new expansion of credit will follow an so on eithout any assignable limit representing the Wicksellian cumulative process. Thornton, however, realised that bank loans which add to the mean of payment may stimulate output rather than raise prices if they are exercised in a developing economy.

In accordance with the Wicksellian cumulative process if banks keep their loan rate below the real one, they will put a premium on the expansion of production and especially on investment in durable plant and equipment. Prices, of course will rise and if banks refuse to raise their bank rate even then prices will go on rising cumulatively without any assignable limit (Schumpeter J. A. 1954, p. 1118).

Out of the above definitions, Myrdal's third as well as Marshall's can not be taken as definitions. They are simply the result of theoretical considerations. In these one can find out the natural rate only after the event. Furthermore it may not give a unique natural rate, if there is price stability for a range of interest. And as realised by Thornton before, if there is unemployment in the economy it may be price stability with the money rate less than real one. One the other hand,

Mydral's second definition is based on the classical theory, which assumes that both savings and investment depend on the rate of interest. However, either or both may be independent of the rate od interest. The propensity to save may mainly depend on income and slightly only, if not a all, on the rate of interest. Similarly, amount of investment may be completely exogenous. Thus, the only remaining definition of the real rate of interest is the one making it the ratio between the expected rate of return on the new investment and its cost of production. Warlas introduced in his system just one rate of interest implying that the money rate of interest is not only equal to this rate of net return in equilibrium but identical with it.

Given the positive elasticity of savings and the negative elasticity of investment with respect to the interest rate, Myrdal's second definition follows that the natural rate of interest equalises savings with investment in the economy. And further, given the independence of monetary and real economy Marshall's or Fisher's definition of the real rate as the nominal rate adjusted to price level changes may be derived. But both of these definitions are of doubtful validity. Nevertheless, both have become the pillars of monetary theory. Whenever there is an inflation, the suggested remedy is to increase the nominal rate of interest in order to reduce investment and make it equal to savings thereby controlling the rise in prices. There are two steps in this causal link. The famous Oxford study, done in late thirties, showed that the business men do not respond to the interest rate in their investment decisions (Klein L. R. 1966, p.65). On the other hand, econometric studies since then, in various countries, have not given any clear conclusion. A study done by Marwaha for India gave the puzzling result of investment increase with the increase in the interest rate (Klein J. R. 1966, p. 251).

Price increases with increasing interest is theoretically indicated only in an economy with full employment. It is only when the existing resources cannot support extra production that investment more than savings may result in price inceases meaning demand pull inflation. Otherwise, according to Keynes, it will lead to extra production rather than to price increases. In the developed economies this situation will usually arise only in the state of full employment. In the developing economies, however, there might be other resources that might become constraints to increased production even before the full employment of labour force is achieved. For instance there might be bottlenecks of capacity (inadequate capital), foreign exchange, energy and most important of all wages goods necessary to employ the available labour force.

On the basis of the previous analysis, it seems that interest rates do not do always the job assigned to them of either checking inflation or stimulating investment. However, in times of demand pull inflation they can be used to contract speculative hoardings and thus price increases.

3. Nominal Interest Rates in the Leontief - Sraffa System

When Leontief formulated the input - output analysis, he found out that not only the increase in the wages but also the increases in any item of the value added results in increasing prices. Moreover, the price increases differ depending on the input - output structure of commodities. Given the interest rate, the equilibrium solutiuon for the price structure and wages on Sraffa's system is based on the assumption that the stocks held by a firm are equal to its inputs requirements in one period. Sraffa, like Walras, did not distinguish between the nominal and the real rate of interest. At this point it is worth noting thar Sraffa's system not only determines the price structure and wages given the interest rate but also given the wage rate it determines the price structure and interest. In other words, in Sraffa's system either the interest rate or the wage rate can be independently determined. Once one is given, the other is determined by the technological constraints themselves.

Sraffa's system is a simple set of equations, one for each commodity stating that the price of a commodity should be equal to its cost of production. The cost of production, in its turn, consists of:

(a) The cost of all commodity inputs, where the cost of one commodity input is equal to its quantity used in the production multiplied by its price.

(b) The wage cost, which equal to the number of the effective labourers multiplied by the wage rate.

(c) The interest cost, which is represented by the interest charges on the values of all the stocks held in for production purposes. As noted above, for Sraffa stocks are equal to the inputs of one period. Again, each individual stock is valued as the quality of the stock multiplied by its price.

Given that the structure is static in conception, the price of a commodity is taken the same irrespective of its use as input, output or stock. If the interest rate is given from outside, viz. by monetary authorities (or monetary consideration), the system becomes a system of linear equations in prices and wage rate. As there are as many prices as many commodities, the number of unknown

becomes one more (wage rate) that the number of commodities. However, as the system is homogeneous of degree one, one commodity can be considered as numeraire. Therefore, on solving the equation system, the values of prices and wage rate are taken in terms of numeraire.

A basic problem with such system of simultaneous equations is to ensure that the solution will have an economic meaning. Namely it is necessary that all the values of prices and wage rate that come out as solution are positive or at least non-negative. Provided that the economy is feasible (Miller, R. E. & Blair, P. D. 1985, pp. 35-39), if the interest rate is zero, all the prices and wage rate will be positive. With a slight increase in the interest rate, the non-negativeness of all these will remain. However, the wage rate will decline. This will go on until the wage rate is reduced to zero. The interest rate at which the wage rate is zero represents the maximum interest rate. Thus, for ensuring economic feasibility the given interest rate should be between zero and the technologically given maximum interest rate. Once this interest rate is fixed, the corresponding wage rate is given by technological considerations.

Similarly, if the wage rate is zero, all the prices and interest rate will be positive. Increasing the wage rate, all the prices will remain positive for a diminishing interest rate until a maximum wage rate is reached which will imply a zero interest rate until a maximum wage rate is reached which will imply a zero interest rate. If a wage rate is exogenously determined between zero and the maximum wage rate, the interest rate will be uniquely determined by technological considerations.

In Leontief s dynamic input-output system the stocks need not to be the same as the inputs of one period. In fact, they include both fixed assets as well as working capital. Inventories for different commodities may be sufficient for different periods. Hence, the whole system becomes much more realistic. And as soon as the nominal interest rate is taken as distinct from the real one, the whole system becomes dynamic.

Such a system determines the nominal prices rather than the relative ones whereas the prices of the initial year are historically given. The cost of intermediate inputs are determined by them. Similarly, wages are also given and their real value is determined at the historically given prices. The value of stocks is also determined at the prices of the initial period. Therefore, given the nominal rate of interest exogenously, the total cost of production is determined at the initial price and wage structure. For an industry not to run at loss it is necessary that the value of output should be equal to this cost of production is determined

at the unitial price and wage structure. For an industry not to run at a loss it is necessary that the value of output should be equal it this cost of production. Consequently, the minimum price of a commodity will be equal to the unit cost of production at the price-wage-nominal interest structure in effect at the initial period.

As seen above, given a wage rate, the interest rate keeping prices stable is uniquely determined by the prevalent technology. This mean that the prices of inputs are the same as those of outputs Nevertheless, if the nominal or money interest rate is more than that determined by the technology, the prices of commodities will increase. If it is less, the prices will decrease provided, of course, that the price structure at the initial period was the one of non-inflationary (non-deflationary) situation. Thus, if R is the nominal interest rate and r is the real interest rate, then the new price of a commodity will be more than the old price by (R - r) multiplied by the value of stocks at the prices of the initial period. This can be deduced by the fact that the initial price is equal to the cost of inputs plus wages plus the value of stocks multiplied by r. So if r is changed to R, the additional cost is (R - r) multiplied by the value of stocks.

As the size of stocks will be different for different commodities the price increases will be different. Subsequently, the inflation will differently effect different commodities. A theory based on a common rate of inflation for the economy will be wide of the mark. The rate of inflation is not an analytically concept, it is a descriptive one in the sense of an average. At this point it is worth mentioning that only in a rare case the value of stocks will be equal to the cost of production, which means that the rate of inflation will not be equal to the difference between the nominal and the real rate of interest.

The above formula is applicable only to the first round when the initial prices corresponded to equal nominal and real interest rates. This will become more and more complicated with the increase of rounds, as the price increase are not proportionate even in the first round. Therefore, the disproportionate price structure will determine the cost of inputs in the next round. This will result in different price increases of the same commodity in different rounds, even when the difference between the nominal and the real interest rate remains the same.

4. Definition of Real Interest Rate

It may have been noticed that another definition of real rate of interest is introduced. Namely that the real interest rate is that rate which in a given

technology corresponds to the prevalent wages in such a way that no commodity price need change in order to make the value of output of every commodity equal to its production cost at the initial prices.

Consequently, the real interest rate not only depends on the technology of production but also on the prevalent real wage rate. With changes in the real wage rate the real interest will also change. Similarly, with changes in the technology of production it will change. Further, it is not maintained that if the nominal interest rate is equal to the real one, prices will remain stable. There may be other factors effecting prices in general, like the demand pull inflation or the prices of particular commodities in the case of distress sales etc. It is only that in such a situation prices need not change to become equal to the cost of production.

This definition of the real interest rate is different from that given by Marshall and Fisher. For them it is simply a difference betweeen the nominal interest rate and the inflationary rate. Their definition is the one designed to keep unchanged the real value of advances by creditors in an inflationary state, and therefore should be classed as a monetary definition of the real interest rate. It has nothing to do with technological conditions or production or the distribution of the product in the economy. This concept is linked with the quantity theory. If the inflation is due only to the increasing quantity of money in relation to total transactions in the economy and if the relative prices depend only on the real factors rather than on monetary factors, like the nominal interest rate, then the inflation will lead to only proportionate increases in the commodity prices. On the other hand, the nominal interest rate should be such as to keep the purchasing power of money investment creditors. In such a system, if prices, income as well as nominal interest rate are corrected for inflation, money does not matter nor the complications that arise in analysing a dynamic economy due to differential changes in the commodity prices.

The aforementioned conditions may prevail when demand pull inflation in ranging. However, they hardly represent the ordinary business life when cost push is the prime mover owing to attempts by the labour force to keep their standard of living and, sometimes, to increase it in conjunction with the misdirection of competent authorities to increase the nominal interest rate for keeping inflation under control. This results in increasing the commodity prices at different rates as well as in unemployment generated by the closing down of the firms unable to keep up with the changes in the economy. In other words, it is the classic condition of inflation coupled with unemployment.

5. Conclusions

The traditional interest rate theories define the real interest rate as the difference between the nominal interest rate and the inflation rate. Thus, it equalises savings and investment in the economy. If the nominal interest rate is lower than the real one, it will increase the propensity to invest and decrease the propensity to save from what it would have been in monetary equilibrium. Therefore, it will go on increasing the price level until the interest rate is not adjusted. As the inflation is due to the total demand for resources being more than the supply, to control this demand pull inflation, the best way is to increase the nominal interest rate which may reduce investment and increase savings to bring about the equilibrium. When there is mordinate expenditure of government by means of deficit financing, its immediate effects are similar to the increase of investment expenditure and similar remedies are advocated. In the Neo-Classical system, the relative prices are supposed to be determined independently of the absolute prices. Subsequently, the demand pull inflation does not effects them. Money is neutral.

When the cost push inflation is rampant, as in most of the past war world, it is not the exogenous investment demand which is higher than savings, but it is the increasing factors costs which push up prices. In this case, for the prevalent wages, the relevant real rate of interest is given by the production technology in such a way as to ensure price stability. If the nominal rate of interest is higher than this real rate of interest, it will push up the cost of production and hence prices. Thus, in a situation of cost push inflation, higher interest rate increases prices rather than dimimishes them as in a state of demand pull inflation. The price increase will be different for different commodities depending on their imput and capital structure. Therefore, this inflationary push will also change the relative prices. Cost push inflation is not neutral.

In the case of cost push inflation, the traditional definition of the real rate of interest does not only become wrong but also analytically misleading. When prices increase owing to the production cost, it is natural that the demand may be reduced, reducing in its turn both production and employment, hence, paradoxically, both inflation and unemployment will coexist. In such a situation, the monetary policy of increasing interest will lead to the increase of the rate of inflation.

6. Mathematical Appendix

a. Real interest rate in Sraffa's system. In this system

$$\mathbf{p} = pA + rpA + wl \tag{1}$$

where p is the price row vector, A is the input coefficient matrix, r is the real interest rate, l is the labour coefficient row vector, and w is the wage rate. This gives:

$$p - pA - rpA = wl$$

$$p\,(I - A - rA) = wl$$

$$P\,[\,I - (I + r)\,A] = wl \tag{2}$$

$$p = wl\,[\,I - (I + r)\,A\,]^{-1}$$

Obviously, the highest value of r is given when w is zero.
Then (2) becomes:

$$p\,[\,I - (I + r)\,A\,] = 0$$

$$p\left[\,\frac{I}{I + r} - A\,\right] = 0 \tag{3}$$

Implying that

$$\det\left[\,\frac{I}{I + r} - A\,\right] = 0 \tag{4}$$

However, only the highest characteristic root of (4) is real and positive (Mathur P. N. & Bharadway R. 1960).

Thus among the n values of r given by (4) only the smallest one is relevant.

If the real wage is fixed, w can be written as the wage index of labourers given by pc, where c is the vector of weights for the wage index. Then (1) becomes:

$$p = pA + rpA + pcl$$

$$p - pA - rpA - pcl = 0$$

$$p\,(l - cl - A - rA) = 0$$

$$p\,(I - cl - A)\,[\,I - r\,(I - cl - A)^{-1}\,A] = 0$$

$$p\,(I - cl - A)\left[\,\frac{I}{r} - (I - cl - A)^{-1}\,A\right] = 0$$

Implying that

$$\det\left[\,\frac{I}{r} - (I - cl - A)^{-1}\,A\right] = 0 \qquad (5)$$

Again, only the highest characteristic root of (5) is real and positive meaning that the smallest value of r given by (5) is relevant.

b. Real interest rate in Leontief's system. In this system:

$$p = pA + rpB + wl \qquad (6)$$

where B is the capital coefficient matrix of the economy. Using similar arguments as above, (6) can be written.

$$p = pA + rpB + pcl$$

$$p - pA - rpB - pcl = 0$$

$$p\,(I - cl - A - rB) = 0$$

$$p\,(I - cl - A)\,[I - r\,(I - cl - A)^{-1}\,B\,] = 0$$

$$p\,(I - cl - A)\left[\,\frac{I}{r} - (I - cl - A)^{-1}\,B\right] = 0$$

consequently

$$\det\left[\,\frac{I}{r} - (I - cl - A)^{-1}\,B\right] = 0 \qquad (7)$$

Implying that r is given as the eigen value of the matrix $(I - cl - A)^{-1}\,B$ by contrast with the matrix $(I - cl - A)^{-1}\,A$ in the case of Sraffa's system.

Out of all values of r given by (7), the smallest one is relevant and represents the real interest rate. In addition (7) gives the price structure corresponding to stable prices.

(c) Effects of Difference in real and nominal interest rate.

For the analysis of this aspect it is considered only the system of Leontief which is more general. Sraffa's system, on the other hand, can be easily derived by substituting B by A.

Let R, p, and p^t stand for the nominal interest rate, the stable price vector when R = r, and the price vector prevailing t years after the period of price stability respectively. Thus:

$$p^t = p^t A + Rp^t + B + wl$$

$$= pA + rpB + wl + (R - r)\, pB$$

$$= p + (R - r)\, pB$$

therefore,

$$p^t - p = (R - r)\, pB \tag{8}$$

which gives the price rise as the difference in the interest rates multiplied by the capital cost for each commodity.

If the economy is in a situation of non-equilibrium price structure, then the price vector of next period is given by

$$p^* = p^* A + Rp^*B + wl$$

$$= p^* (A + RB) + wl$$

$$= p^1 (A + RB) + wl + (p^* - p^1)(A + RB)$$

$$= p (A + RB) + wl + (p^* - p)(A + RB) + (R - r)\, pB$$

$$= p + (p^* - p)(A + RB) + (R - r)\, pB$$

where p^1 and p^* are the price vector of the current and the next period respectively. Subsequently,

$$p^* - p = (p^* - p)(A + RB) + (R - r)\, pB \tag{9}$$

Which emphasises that the inflation rate does not only depend on the difference between the nominal and the real interest rate but also on the initial price structure.

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