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Inflation, capital markets and the supply of beef

Claudio Sapelli
World Bank, Washington, DC, USA

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ABSTRACT

This paper puts forward an explanation for the negative elasticity of supply of beef found in many LDC's. As is explained by Jarvis (1974), the elasticity of supply of beef may be negative in the short run due to the dual role of cattle as both a capital and a consumption good. But in some LDC's, and especially in Latin America, one may find a long-run negative association between slaughter and prices, that cannot be explained by assuming shocks to slaughter are causing changes in prices. It is no coincidence that Jarvis' hypothesis itself was developed to explain developments in Argentina, a country with chronic high inflation. The paper argues that this long-run relationship cannot be explained by the Jarvis hypothesis, and offers an alternative hypothesis based on the demand for cattle as a hedge against inflation.

The long-run negative association between slaughter and prices has been found in high inflation countries. High inflation combined with excessive regulation of capital markets cause the well known phenomenon of desintermediation. It is argued here that cattle plays a role in the inflation hedged portfolio that is then demanded. Therefore, with imperfect capital markets the supply of beef is affected by the demand for cattle as an asset, and this demand, in turn, is affected by inflation. This paper will only attempt to prove the link between imperfect capital markets and the supply of beef. The way inflation in a repressed capital market leads to an imperfect capital market is not addressed here, for reasons of brevity. The paper will develop a model that in the context of imperfect capital markets results in a negative elasticity of supply. The model will then be tested with Uruguayan data. Uruguayan data are very adequate to test the hypothesis because they cover both a period without inflation and a period of high inflation. The results support that cattle was used as an alternative to money holdings when inflation signified a big tax on the latter. Inflation therefore affected the demand for cattle, or, conversely, the supply of beef.

Correspondence to: C.N. Sapelli, World Bank, 1818 H Street N.W., Washington, DC 20433, USA.

1. INTRODUCTION

This paper is concerned with the long-run negative elasticity of supply of beef found in many LDC's [1]. The elasticity of supply of beef in developed countries is positive within a year [2]. A negative short-run elasticity is found in developed countries, which is explained by Jarvis' (1974) capital/consumption good dichotomy. But, as will be argued below, the long-run negative association of slaughter and prices found in some LDC's (and especially in Latin America) cannot be explained by the Jarvis hypothesis. This paper proposes an alternative hypothesis [3], i.e. that it is due to a link between inflation and cattle markets, through the capital market. The present paper will only address one of the links in this chain: how imperfect capital markets affect the supply of beef. The link between inflation and imperfect capital markets is not developed here [4]. The core of this link is that highly repressed financial markets, in the context of high inflation rates, severely restrict the options open to investors, making attractive the demand for cattle as an asset. The paper first explains why the Jarvis hypothesis does not explain the phenomenon we are addressing, then presents the alternative hypothesis, which is then developed formally and finally tested with Uruguayan data. A conclusions section closes the paper.

2. CAPITAL/CONSUMER GOOD DICHOTOMY

A negative supply elasticity was found by Jarvis in Argentina and justified by the fact that cattle are both a capital and a consumer good. But in this explanation there are a lot of ifs that have not been duly stressed. A short-run negative elasticity of supply will exist *if* the price increase is unexpected and *if* producers think the price increase is permanent. In that case, the price increase will lead to a change in the optimal size of the herd and so farmers will retain cows (decrease slaughter) so to increase the herd and be able to increase slaughter in the future. If the increase were transitory, then supply will increase immediately. If it were expected, then supply will also increase (as the herd would have been increased in anticipation). Jarvis' hypothesis is crucially linked to expectations. A long run negative association between prices and slaughter can only be explained with this model if farmers are constantly being surprised by the price changes and always think these surprises are permanent. This clearly is not an appropriate explanation [5].

Even if we argued that price changes were unexpected due to government policy surprises, the issue of why producers would expect all changes to be permanent remains to be explained. The farmers' behavior in Latin

America can be described as irrational from this perspective. Producers sell when prices are low and hoard when prices are high. They behave as if they constantly were extrapolating prices into the future, and so a lower price leads to herd depletion, and so more supply; and higher prices lead to herd increases, and so lower supply. Producers do not learn from their mistakes. This is a naive adaptive expectations model, that we know generates systematic mistakes. But this is the expectations mechanism that is needed to explain the data with Jarvis' hypothesis. Therefore, the latter must be complemented with some other explanation.

3. IMPERFECT CAPITAL MARKET HYPOTHESIS

In LDC's the capital market consists mostly of the banking sector and the stock exchange. If government policy prevents financial innovation, inflation reduces the size of the banking system and the volume of trade in the stock exchange [6]. As the real interest rate on deposits becomes negative and there is a negative return on holding money (because of inflation), the assets that are normally used to save and dissave have to be substituted. If foreign exchange controls prevent a widespread use of foreign currency, commodities will be used for that purpose. But commodities are illiquid, and farmers, who have a highly variable income, have a great demand for a liquid asset to save and dissave. The paper argues that cattle are one such asset. Cattle will be part of the inflation hedged portfolio. It is important to keep in mind that the importance of cattle in this portfolio is not the issue, but only the fact that cattle may be part of such a portfolio. Let us now examine the case for such a demand for cattle.

Cattle are extremely liquid [7], they are homogeneous and divisible (small sums can be saved or dissaved). That gives cattle several of the characteristics of cash, or deposits. Cattle generate a return: a calf. And, as all commodities, cattle are a good hedge against inflation. Being so liquid, cattle are clearly one of the most adequate commodities to be used in a portfolio where a liquid hedge is required. This is exactly what farmers need. But there is a problem. Farmers may not find this asset profitable. A farmer needs to sell the asset when income is low, i.e. when prices of cattle are low. But if cattle are such an asset, then at that time its value will be low. This means that this commodity will have a low rate of return if it is used as an asset in which to save and dissave, i.e. there is an opportunity cost. This cost depends on the price difference between peak and trough, which in an open economy is basically exogenous.

The advantages of using cattle as an asset increase with the rate of inflation and with the degree of repression of capital markets. If we assume the degree of repression is given, then the higher the rate of inflation (i.e.

the higher the cost of holding financial assets with fixed nominal returns), the more willing a farmer will be to pay the opportunity cost of using cattle as an asset, i.e. as a store of value. The key issue is that the alternative liquid assets are worse hedges against inflation (something that may depend on the exact nature of the financial repression).

The farmer loses profits by keeping cattle as a store of value, but gains utility by being able to have in his portfolio an asset with very desirable characteristics. This is a rational decision, though it may not be a profit-maximizing decision. If capital markets are imperfect, then the separation between consumption and production decisions is broken down. It is no longer possible to produce to maximize profits and then use the capital market to decide the intertemporal consumption pattern that maximizes utility. With imperfect capital markts the production market will perform a dual function, as income will have to be predominantly consumed in the period it is generated. Production and consumption would become basically the same decision, and decisions in the product market will be made in order to maximize utility, and not profits. In the next section it will be shown that for a quite general family of utility functions, the lack of a capital market will generate a production pattern in which the elasticity of supply is negative. The rationale behind this result is quite intuitive. When goods are used as a store of wealth (i.e. when purchasing power is transferred from one period to the other through goods and not financial assets), then it is not reasonable to sell (dissave) when prices are high. When prices are high, if supply increases, the marginal utility of income will be low. With no capital market, selling is done to equalize the marginal utility of money (consumption) across periods. So less is sold when prices are high, and more when prices are low. When prices rise, the demand for cattle as a store of wealth increases (as the marginal utility of income diminishes), and supply is reduced with respect to what it would be if capital markets were not repressed or inflation were not high. In the extreme case of hyperinflation, were money disappears, there will be a negative elasticity of supply, as is proved by the following model.

4. MAXIMIZATION PROBLEM

The problem is to maximize utility in a two-period world, with a fixed endowment. The use of a fixed endowment replicates quite well the case of a cattle owner, as production can be considered to be a certain percentage growth of the existing stock of cattle. We are not concerned here with the production decision, but with the supply decision, which at the margin is deciding if cows should be slaughtered or kept to breed more cattle. This is a decision on what to do with the stock of existing cows.

In this model, farmers do not consume the good they produce, but a second good. The relative prices of both goods in periods 1 and 2 are p_1 and p_2. Production is q, C is consumption and y is the endowment. The lack of capital markets (an extreme assumption that will be relaxed later) forces the production and consumption decisions to coincide, as seen in the second and third constraints. Since $q_2 = y - q_1$, q_2 is the only degree of freedom. A Stone–Geary utility function was selected to obtain a minimum consumption requirement in each period. If it were possible to postpone or anticipate all consumption then we would not get a negative elasticity of supply. All consumption would be done in the period with the highest price.

$$\max_{q_1, q_2} U = f(C_1, C_2) = (C_1 - Z_1)^a (C_2 - Z_2)^b$$

q_1, q_2

subject to

$q_1 + q_2 = y$

$C_1 = p_1 q_1$

$C_2 = p_2 q_2$

Maximizing with respect to q_1 and transforming the FOC, we obtain the following supply function:

$$q_1 = Ay - Az_2/p_2 + Bz_1/p_1$$

where

$A = a/a + b$

$B = b/a + b$

$$\mathrm{d}q_1/\mathrm{d}p_1 = -Bz_1/p_1^2 < 0$$

$$\mathrm{d}q_1/\mathrm{d}p_2 = Az_2/p_2^2 > 0$$

As can be seen, optimizing behavior means a reversal of the usual signs of the supply function. A higher expected price (p_2), decreases future supply but increases current supply. A higher current price lowers current supply. These results are not affected if the endowment appreciates at a certain rate, i.e. if the herd is increasing due to births.

This result can be intuitively understood through the following argument. If the future price increases, the farmer is richer, and would want to increase consumption in all periods. With capital markets, he will sell when prices are higher, and use credit to consume more in other periods. Without capital markets, the only way to enjoy more consumption today, if the price will be higher tomorrow, is to sell more today (and less tomorrow).

In this way he distributes his consumption power so to equalize the marginal utility of consumption across periods. He is able to consume more today due to the higher supply, and more tomorrow due to the higher price. This utility maximizing strategy implies a negative supply elasticity: selling more at the lower price.

We can now relax the assumption of complete absence of capital markets, and introduce a second endowment good in which purchasing power can be transmitted across periods: money (M). One starts with two endowments: money and cows, but now money reserves can be run down when prices are low so to be able to increase supply when prices are high. The introduction of money should, therefore, increase the elasticity of supply. Is it still possible in this case to have a negative elasticity of supply?

Money has rate of appreciation r (the real interest rate). With high inflation, the real interest rate can be negative. We will assume that M has to be positive. If we were to relax this assumption, we would be in the perfect capital market case.

There are two decision variables now: how many cows to sell in the first period and how much money to spend in that period. Conversely, how much money and cows to store for the second period. The higher the inflation rate, the lower will the money holdings be, so the higher the inflation rate the more will this case resemble the previous one in which money holdings were zero.

The introduction of money adds two interactive terms to the supply function of beef, between the money stock and both the current and future prices. The derivatives of this supply function with respect to prices are:

$$\mathrm{d}q_1/\mathrm{d}p_1 = -Bz_1/p_1^2 + BM_1/p_1^2 + B_2q_1/p_1 \gtrless 0$$

$$\mathrm{d}q_1/\mathrm{d}p_2 = Az_2/p_2^2 - AM_2/p_2'^2 - a_2q_2/p_2' \gtrless 0$$

where

$$p' = p/(1+r)$$

and

$$M_1 + M_2/(1+r) = M + p_1q_1 - C_1$$

The first term is the same as was obtained before. But now the signs of the derivatives are ambiguous. They depend on the size of the additional two terms. As was argued above, the higher the money stock, the more probable it is that the signs will be the normal ones. But it is still possible for the elasticity to be negative.

This model will now be tested, with the exact specification shown above, with Uruguayan data. The specification used is:

$$q_1 = f(y, 1/p_2, 1/p_1, M/p_2, M_1/p_2, M_2/p_2)$$

Predicted signs of coefficients: $+, -, +, +, -, -$, respectively.
The three last terms are added due to the interaction of the capital market with the supply of beef. The key issue is if these terms are significant or not.

5. EMPIRICAL RESULTS AND CONCLUSIONS

As can be seen in Table 1, all but one coefficient are significant at the 95% level of confidence, and all the signs have the expected signs. These results confirm a strong interaction between the capital market and the supply of beef. A note of caution is due, given the fact that proxies were used for the flow and stock of money, both key variables. As it stands, both the flows and stock of money were found to affect the supply of beef. Therefore, the elasticity of supply of beef is, among others, a function of the stock of money, and indirectly, of inflation (as an argument in the demand for money function) and all regulations that repress the capital market.

6. CONCLUSION

The existence of an imperfect capital market can lead to a negative elasticity of supply, in the long run. More importantly, repressed capital markets induce a behavior in farmers that, though it is utility maximizing, is clearly not profit maximizing. This means a lower level of income and welfare for the farmer and a lower level of exports and foreign exchange for the country in question.

The comparative statics of the model says that an increase in the money stock (due either to a reduction in inflation or a relaxation of regulations of the capital market) will (unambiguously) permanently increase the supply of beef. Besides this effect on the mean level of supply, the timing of the supply will change in such a way as to increase slaughter when prices are the highest, which will further increase national income. High inflation coupled with repressed capital markets significantly lower the welfare of farmers and the overall income level. Decisions that seam to be irrational from a profit maximizing perspective, are not irrational but simply utility maximizing. Cattle is used as a store of wealth in a context in which the assets that usually perform this function are being heavily taxed. But this

TABLE 1

Explaining the supply of cattle in Uruguay (1983–1986)

	Coefficient	*t*-statistic	Level of significance (%)
Constant	1194.0	12.7	1
Inverse of expected price [a]	−121860.2	−15.2	1
Inverse of current price	123603.2	23.4	1
Size of herd	0.017	2.16	5
Stock of money divided by expected price [b]	48686.7	1.59	20
Change in the stock of money divided by the expected price [c]	−0.64	−12.5	1
Change in the stock of money divided by the current price	−0.24	−4.35	1
Adjusted *R*-square	0.97		
Durbin–Watson	1.92		
F-statistic	233.7		
AR(1) coefficient	−0.249 (−1.79)		

Sample: 1936–1986, annual data.

Dependant variable: Total slaughter of cattle, measured in heads.

Estimation method: OLS. The use of TSLS did not alter the results, basically due to the fact that the price is exogenous.

[a] Expected price obtained from the prediction of the ARIMA model followed by the price series (for the last 20 years) up to that year. The justification for the use of an ARIMA model and not rational expectations can be found in Sapelli (1985) based on the arguments given by Nerlove, Grether and Carvalho (1979) for the use of quasi-rational expectation models. Prices used are a weighted average of the prices of the different types of cattle (weighted according to their participation in slaughter).

[b] The stock of money is measured as M3 over GDP. M3 is currency plus time and savings deposits both in domestic and foreign currency. Domestic currency holdings are reduced due to inflation and capital market regulations (interest rate caps, etc.); foreign currency holdings – a possible substitute – are diminished by capital market regulations (exchange controls, etc.). The correct variable would be the stock of money used by the producers of beef; we considered the national stock of money to be an adequate proxy. We used GDP as the deflator as this would indicate the command of goods that the stock of money represents, and prevents the problems caused by using the CPI at times were price controls were widespread.

[c] Dissavings of money is defined as the difference between expected ('permanent') income (expected price times average slaughter) minus actual ('transitory') income (current price times current slaughter).

use of cattle lowers utility with respect to what it would be in a world with a cheaper store of wealth, a role played by money in low-inflation countries.

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NOTES

[1] See, for example, Nores (1972), Barros (1973), Lattimore and Schuh (1979). Estimates made in Sapelli (1985, pp. 41–44) show that for Uruguay, in 1956–78, the elasticity of supply with respect to current price was −1.41 and the elasticity of supply with respect to expected price was −3.72. During this period, supply elasticities were negative for all categories (steers, cows, bulls and calves), though the size varied. Conversely, as is argued below, when inflation was low (period 1939–1955), current price elasticities of supply were positive (except for calves).

[2] See Wicks and Dillon (1978) and Ospina and Shumway (1979).

[3] Technology probably has something to do with the fact that in LDC's the positive reaction does not occur within a year in LDC's. The weight gain function is different and means that

it takes longer to fatten in LDC's. But the problem is not that instead of having a positive response in 12 months, one may have it in 18. The problem is that price changes in the countries we are concerned with (in particular Argentina, Brazil, Chile and Uruguay) are always associated with herd-modifying decisions, not only weight gaining decisions. And herd increases always take much longer than weight changes. If all price changes were related to herd-size changes in a developed country, it would also have a long run negative elasticity of supply.

[4] But see chapter 3 of my thesis for extensive evidence of the association of inflation with the thinning of the Uruguayan stock market, the disappearance of long-term papers and the reduction of deposits to less than 10% of their peak value. A key role in this process is government regulation of the capital market: interest rate regulation, etc. Inflation, plus a repressed capital market is the context in which our hypothesis is developed.

[5] The long-run negative association between prices and quantities could be attributed to the fact we are tracing the demand curve. In a closed economy, shocks to the supply curve would lead to a negative association of prices and quantities. It is important to note that most of the countries where this long run negative elasticity has been found are important exporters of beef, and therefore the price of beef is exogenously fixed by the international market.

[6] See Sapelli (1985) for references and evidence on Uruguay.

[7] Although this is not necessarily true for all countries, it is true in Uruguay, where there are active and fluid local markets, due to the high domestic consumption of beef and all farmers are integrated to the money economy.