A MODIFIED ARBITRAGE CONDITION FOR COMMODITY MARKETING

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Abstract

Commodity arbitrage condition equates expected commodity prices to nominal interest rates plus storage costs. Any risk premium is normally subsumed in storage costs. Such an arbitrage restricts commodity marketing to speculative activities. This is an oversimplification of all the activities undertaken in commodity marketing. Studies dating from the 1940s have demonstrated that commodities are often stored even when their carrying costs are negative. Such an observation imply that there is more than speculation in commodity marketing. This paper attempts to incorporate the role of convenience stocks in commodity marketing. The intrinsic value of carrying convenience stocks referred to as convenience yield is incorporated in the commodity arbitrage.

Uittreksel
'n Aangepaste arbitrasie benadering in die bemarking van kommoditeite

In 'n gearbitreerde situasie is verwagte kommoditeitspryse gelyk aan nominale rentekoste plus opbergingskoste. Risiko premies word gewoontlik ingesluit by opbergingskoste. Die voorgenoemde is egter 'n oorvereenvoudiging van die aktiwiteite vereis in kommodoteitsbemarking. Studies vanaf so vroeg soos 1940 dui egter daarop dat kommoditeite baie keer waar drakoste negatief is. Dit impliseer dus dat kommoditeits bemarking meer as suiwer spekulasie behels. In hierdie artikel word gepoog om die rol van gemaksvoorrade ("convenience stocks") in kommoditeits bemarking te illustreer asook om 'n intrinsieke waarde daaraan te koppel.

1. Introduction

The impacts of monetary policy on U.S.agricultural commodity prices have received substantial attention since Schuh's article on macro-linkages. Initial studies investigated the effects of exchange rates on U.S. agriculture (Schuh, 1974; Chambers, 1984; Chambers and Just, 1980). However, Dornbusch's (1976) article opened the door for evaluating how monetary policies are transmitted to different goods with varying degrees of price flexibility. His model related monetary policy to exchange rate changes through an arbitrage condition that linked the domestic interest rate to a foreign interest rate plus expected exchange rate appreciation. Frankel (1986) borrowed the same concept to develop a commodity price adjustment path for a closed economy. Frankel (1986) applied an arbitrage condition that linked commodity price changes to the nominal interest rate less storage cost.

The role of the arbitrage condition in both models was very critical in establishing each adjustment path. The arbitrage condition in both models provided the means by which traders could shift from one investment portfolio to another. In the case of an exchange rate portfolio, traders could move from domestic interest bearing bonds to foreign bonds, and vice versa. In the case of commodity arbitrage, traders could move out of commodities into money denominated assets namely, fixed bank deposits. In these models, the arbitrage condition provided the mechanism for market clearance.

Frankel's (1986) arbitrage condition has received criticism from theoretical and empirical points of view. First, Gordon (1987) argued that the parallelism between Dornbusch's (1976) arbitrage and Frankel's (1986) arbitrage condition is misleading (Gordon, 1987). He argued that commodity arbitrage, referred to as the interest parity condition (IPC), needs to incorporate both speculative and non-speculative activities. Secondly, empirical estimates by Kitchen and Denbaly (1987) were not consistent with the theoretical framework proposed in Frankel's work.

The purpose of this paper is to develop a more comprehensive arbitrage condition that incorporates non-speculative activities. Thus, the arbitrage condition will encompass not only commodity speculation, but also non-speculative objectives of storage through the convenience yield. Convenience yield is defined as the intrinsic value of carrying convenience stocks.

2. Arbitrage condition

To analyze the impacts of monetary policy on different goods/commodities one has to work with two components of the economy: the money market and the goods market. In the money market, the arbitrage condition provides an important mechanism for selecting an investment portfolio. It specifies the relationship between the interest rate and implied asset price dynamics such that risk neutral investors are indifferent between holding a financial asset and holding an alternative asset (possibly a commodity). If the interest parity condition (IPC) is a characterization of market behavior, a systematic violation of the IPC would provide for relatively risk free profits and the market would be inefficient (Kitchen and Denbaly, 1987). The arbitrage condition forms the basis of linking storable commodities to the general economy through interest rates. A well formulated arbitrage condition provides a trade off

between interest bearing assets and storable commodities, ensuring market clearance.

Arbitrage maintains equilibrium between two markets. Any disequilibrium will be offset by investing in assets with relatively risk free profit opportunities. The exchange rate arbitrage condition expresses arbitrage in terms of the interest rate and exchange rate. In equilibrium, one country's interest rate is assumed equal to another country's interest rate plus the expected exchange rate appreciation.

$$r = r^* + \Theta(E - e) \quad (1)$$

where r is the domestic interest rate, r^* is the foreign interest rate, e is the exchange rate defined as the price of foreign currency per unit of domestic currency, Θ is an adjustment parameter which incorporates expectations and E is the long-run exchange rate. Any differences between interest rates and expected currency appreciation induce investment in the country with higher profit opportunities. Such an arbitrage maintains equilibrium in interest rates between the two countries.

In general terms, commodity arbitrage establishes parity between the interest rate, expected commodity price and storage cost.

$$i = p_c^e - sc \quad (2)$$

where p_c^e is the expected change in price, (i) is the domestic nominal interest rate and sc is the storage cost. The risk premium is subsumed in the cost of storage, an assumption carried on in this study.

Theoretically, the arbitrage condition has to fulfill two conditions. One, whenever the right hand side (RHS) is greater than the left hand side (LHS), opportunities for making relatively risk free profits prevail. Equally, whenever the LHS exceed the RHS, opportunities for making relatively risk free profits must prevail. In the case of exchange rate arbitrage, traders can move out of domestic bonds into foreign bonds whenever there is a disequilibrium in capital markets. Thus, exchange rate arbitrage is locational, i.e., one can borrow from one country and invest in another. Such a market assumes existence of perfect capital mobility. Unlike the exchange rate arbitrage, commodity arbitrage does not always fulfill these two conditions. Whenever $i < p_c^e - sc$, then opportunities for relatively risk free profits exist. Investors can borrow money at the lower interest rate (i) and invest in commodities. Traders can sell short to minimize risks and at maturity of the contract deliver the commodities, repay the loan and earn relatively risk free profits. However, whenever $i > p_c^e - sc$, these conditions are violated and opportunities for making relatively risk free profits cease to exist. Thus the commodity arbitrage condition is not as effective as the exchange rate arbitrage. Putting it in Gordon's (1987) terminology, the symmetry between exchange rate and commodity arbitrage breaks down. Commodity arbitrage is not a zero sum game.

The theory of storage cost, as developed by Working (1949) and Kaldor (1939), implies non-correspondence between commodities and financial assets. They concur that storage does exist even when the expected price differential (carrying charge) between the future price and the spot price is negative. Thus there are non-speculative motives that lead market participants to hold stocks. This may render arbitrage forces ineffective in bringing the system to equilibrium. They argued that theory must explain why storage is undertaken when carrying charge is negative. Among the factors attributed to storage whenever the carrying charge is negative are: some producers may not be interested in hedging so they store regardless of the future prices, and some activities undertaken by producers necessitate storage to enhance a smooth processing or merchandizing of commodities. The latter concept has been recognized as storage for "convenience yield". Existence of a convenience yield for commodities may drastically affect their pricing and, subsequently, the arbitrage condition.[1]

A change in monetary policy may cause interest rates and/or the general price level to change in order to equilibrate money supply and demand, ceteris paribus. Through arbitrage conditions, investors adjust their portfolios either by investing in commodities or money assets depending on the effects of monetary changes on interest rates and the price level. Specifically, if there is an increase in expected economy-wide inflation (due to monetary expansion), investors move from money to commodities. This causes an increase in demand for commodities with subsequent increases in commodity prices. On the other hand, an increase in interest rates beyond expected inflation (i.e., an increase in real interest rates due to a fall in money supply or a change in fiscal policy), induces portfolio adjustment favoring purchases of interest bearing assets. This puts downward pressure on commodity prices.

To maintain commodity and asset market equilibrium, market participants are assumed to have access to both markets. In addition, market participants are assumed to be indifferent between holding commodity assets and money denominated assets (given the same return). Thus, there exists perfect market conditions that enhance opportunities for maximizing profits. However, there are additional non-speculative activities in commodities that may influence the commodity price adjustment. These latter activities, namely storage for convenience, are hypothesized to impact the commodity price adjustment path, contrary to the model developed by Frankel.

As alluded to earlier, a rise in the interest rate would put downward pressure on commodity prices due to a shift by investors from commodity assets into money denominated assets like common stocks and bonds. Low commodity prices may would lead to less need for convenience stocks, thus lower convenience yield. Theoretically, lower levels of convenience stocks lead to higher levels of commodity stocks released into the market. Higher levels of commodity stocks in the market would lead to an accelerated fall in commodity prices. Conversely, higher commodity prices due to a fall in interest rates would lead to higher levels of convenience yield and an accelerated rise in commodity prices due to withholding of commodities for convenience purposes as mentioned earlier. Thus, an arbitrage condition must incorporate the effects of convenience yield on commodity price dynamics to capture all forces working in commodity markets.

To improve the commodity arbitrage condition, Gordon (1987) advocates incorporation of convenience yield. This yield determines the value of carrying stocks for non-speculative purposes. Thus the arbitrage condition becomes:

$$i = p_c^e - sc + cy \qquad cy \geq 0$$
$$\text{or } p_c^e = i + sc - cy \quad (3)$$

where cy is the convenience yield and all other variables are as defined.

Convenience yield is affected by all those factors that may cause the spread (expected future price minus cash

price) to fall below the interest rate plus physical storage cost, such as the level of inventory, cost of storage, expected future demand and supply of a commodity and interest rate. The interest rate is the opportunity cost forgone in carrying stocks, while the cost of storage is the physical cost, such as the rental cost, cost of loading and off-loading. Basically, convenience yield may be expressed as:

$$cy = f(i,/\pi) \qquad \blacktriangle cy/\blacktriangle i < 0 \qquad (4)$$

Where: cy = convenience yield
i = interest rate
π represents all other variables.

Convenience yield varies both directly and indirectly with interest rate. Indirectly, low interest rates due to easy monetary policies lower production costs of commodities, hence increasing supply. Increased supply would lead to more stocks and a decrease in convenience yield. To be precise, these indirect effects may be referred to as production effects. Directly, interest rate changes lead to tradeoffs between commodities and interest bearing assets. Lower interest rates would lead to commodity purchases and higher commodity prices, putting pressure on inventories, resulting in a higher level of convenience yield. These direct effects may be referred to portfolio effects. These direct (portfolio) and indirect (production) effects of interest rates on convenience yield may render adjustment of commodity prices somewhat ambiguous when monetary policies change (Gordon, 1987).

However, the assumption for this study is that the direct relationship dominates, especially for short-run price dynamics. For agricultural commodities, the interest rate at the time production is planned may be different from the interest rate at marketing. The short-term market clearing interest rate, as used in the arbitrage condition, may differ substantially from the interest rate at planting time. To maximize profits, investors make their decisions on whether to invest in commodities or money denominated assets based on the current short term interest rate, not preceding short term interest rates. This means that direct (portfolio) effects , due to tradeoffs between commodities and money denominated assets, are the dominant influence, such that the interest rate is negatively associated with convenience yield.

Incorporating the convenience yield in the arbitrage condition will improve the reactions of commodity prices to changes in monetary policies. Above all, the arbitrage condition will incorporate factors which explain why commodity stocks are held when the interest rate exceeds the price spread adjusted for the cost of storage.

Convenience yield varies inversely with interest rate. As the interest rate increases, traders adjust their portfolio in favor of holding money-denominated assets rendering a decrease in commodity prices with a subsequent increase in convenience stocks and a decrease in convenience yield. On the other hand, a fall in interest rate makes traders adjust their portfolio in favor of holding commodities. This creates pressure on commodity prices with a subsequent decrease in convenience stocks and increase in convenience yield. Convenience yield, as defined in equation (4), is specified in equation (5) as a linear function of the interest rate, holding other variables constant:

$$cy = \phi - \delta i \qquad \delta > 0 \qquad (5)$$

where ϕ is the autonomous level of convenience yield that is not affected by changes in commodity prices. Thus, changes in interest rates do not affect this level of convenience yield.

Substituting the value cy in equation (5), omitting the autonomous level in the arbitrage condition in equation (3) and rearranging the terms, we can express the change in expected price as:

$$p_c^e = i(1 + \delta) + sc \qquad (6)$$

Equation (6) expresses the modified arbitrage condition. Thus the modified arbitrage condition expresses the expected change in commodity price in terms of the nominal interest rate, convenience yield and storage cost.

The parameter δ incorporates the effects of changes in convenience yield into the arbitrage condition whenever there is a change in interest rate due to a change in monetary policy. Changes in commodity prices due to changes in monetary policy induce traders to adjust their convenience stocks. These adjustments would accelerate overshooting of commodity prices. Thus, the incorporation of convenience yield into the commodity arbitrage condition would influence overshooting/undershooting of commodity prices due to monetary changes.

3. Conclusion

The major contribution of this paper is the clarification of the ambiguity of the effects of interest rate on convenience yield. The tradeoff between commodity assets and interest bearing assets like bank deposits is established as the significant influence between interest rate and convenience yield.

The commodity arbitrage condition was modified by incorporating non-speculative activities of commodity marketing through convenience yield. Thus, the adjustment of convenience stocks due to changes in monetary policy becomes an important factor in developing commodity arbitrage condition. Carrying of these convenience stocks have some intrinsic value that may explain the reasons that make traders carry commodity stocks while price spreads is less than storage costs. Incorporation of convenience yield, is hypothesized to influence commodity price dynamic path due to monetary changes. Research in commodity price dynamics as done by Frankel (1986) may have different results if convenience stocks via convenience yield are incorporated in the model.

Note

1. Model assumes a short-run supply response. Short-run is defined as a duration of time such that only one period's production is allowed in the analysis. That is production in prior period does not enter into analysis. Thus supply elasticity is not infinite neither perfectly inelastic.

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