The Investment Response to Temporary Commodity Price Shocks

WPS/98-14

Richard Mash

1998

Centre for the Study of African Economies, University of Oxford and St Antony’s College

Direct dial telephone number: +44-1865-274553

Abstract:

The paper is concerned with the investment response to temporary trade shocks when capital in the commodity and import-competing sectors is irreversible once installed. Previous literature has argued in general terms that investment is likely to rise in response to sharp relative price movements because the return to capital in one of the sectors will increase. A rigorous model of investment under uncertainty in the two-sector commodity price shocks context is developed and used to investigate this issue. It is shown that investment booms in response to commodity price shocks are likely but not certain to occur and a boom at the end of the shock may also be expected. The predictions of the theory are shown to be consistent with the evidence from a small sample of countries during the late 1970s coffee/cocoa boom.
Introduction

This paper is concerned with the investment response to temporary commodity price shocks when capital is sector specific and irreversible once installed. It makes use of the insights of the irreversibility and investment literature to develop a rigorous two sector model of the optimal investment response to a temporary price shock. The model is simulated across a range of possible parameter values and the output compared with the actual investment responses of a small sample of countries to the late 1970s coffee/cocoa boom.

That boom has stimulated a substantial literature on trade shocks but formal work within it has tended to focus on the consumption/saving (rather than investment) response to price shocks and policy questions. These issues are extremely important, both because a key policy question has been whether the private sector savings response to a temporary shock would be appropriate (and hence if so there would be no need for government to play a custodial role by taxing the windfall from the boom), and also because the general policy responses have often been regarded as severely sub-optimal. Hence this literature has tended not to emphasise the investment response to relative price changes which is the focus of the current paper. This shift of emphasis is also natural because relative price effects were often small or absent in the 1970s (as we show below) because the great majority of developing countries stabilised domestic producer prices of commodities. With almost all price stabilisation schemes and marketing board arrangements abolished from the late 1980s, relative price effects are likely to be much more important in the future. The trade theory literature has also examined the effects of terms of trade changes on a number of variables but also without examining the combination of sector specific irreversibility and uncertainty that is the focus of the current paper.

Hence the key contribution of the current paper is its modelling of investment dynamics in response to relative price changes in the presence of uncertainty about the duration of the current price and irreversibility of capital at the sectoral level. The analysis is intended to improve our understanding of when investment booms are likely to occur as commodity prices (or the terms of trade) fluctuate. Bevan, Collier and Gunning (1990) provide the key intuition in that a sizeable increase in the relative commodity price, a "trade shock", will greatly increase the return to capital in the commodity sector and thus stimulate investment. If non-tradeable capital goods are important in production that investment boom will translate into a non-tradeable capital goods ("construction") boom also. Equally a large fall in the commodity price will give rise to the same effects in reverse with increased investment in the import-competing sector. This paper goes both much further and less far than that argument. It goes further in that formal modelling of the investment responses of both sectors allows for a much more precise prediction of when investment booms will occur and their possible size. An important point here is that when the favoured sector expands in response to a price change the other sector will allow its capital stock to depreciate. If depreciation is at a plausible (low) rate the combined capital stock increases but the change in aggregate investment is ambiguous: compared with before the price shock the favoured sector is investing more but the other sector will no longer be undertaking replacement investment. The net effect of these changes depends on the size of the investment response in the favoured sector (which in turn will depend on expectations about the duration of the boom and the severity of the losses from irreversibility that would occur if or when the boom is reversed), the relative size of the two sectors, and their capital intensities. The paper does not, however, include non-tradeable capital goods and hence its predictions concern investment...
booms rather than construction booms in particular, and while we draw general conclusions on
the latter these are not based on formal analysis.

It may be noted that analyses of this type assume that commodity price changes may be
characterised by relatively large infrequent swings so discrete shock episodes may be identified.
This is an entirely plausible procedure in relation to the coffee and cocoa price shocks of the late
1970s but in general it might be argued that other commodity prices may be better characterised
by ongoing volatility in which price changes are frequent and less readily divided into discrete
episodes. It is clear that there is no distinct dividing line between these two descriptions of price
movements but the results developed below are based on the assumption of a discrete shock with
defined start and end dates. Hence the model is less informative about investment dynamics in
response to higher frequency volatility except in so far as the typical price innovation has
persistent effects whereupon its results will carry over to some extent.

While the investment responses outlined above are the main focus of the paper we also analyse
their implications for three related issues as follows.

First the relationship between investment and the terms of trade has been difficult to establish
in empirical work with different studies finding different signs to the relationship (see Serven,
1997 for a recent overview). The paper shows why this may be so, in particular by showing that
investment is driven as much by changes in the terms of trade as in its level.

Second, we examine in a very stylised way possible feedback effects onto world commodity
prices from the supply response, partly driven by investment, to exogenous changes in those
prices. The model clarifies how the supply response is likely to vary during a commodity price
boom and also shows that prices after a shock may be lower than their steady state values as a
result of the irreversibility of capital acquired during the boom: investment during the boom
raises the capital stock and this stock remains higher (and hence prices are lower) for some time
after the shock until depreciation allows a new steady state to be reached. Hence irreversibility
implies that a temporary price shock may have long-lasting supply effects and this may help to
explain part of the serial correlation in commodity prices that has otherwise been difficult to
rationalise (see Deaton and Laroque, 1995, for a recent discussion).

Third our formal model assumes access to a perfect world capital market (a natural, if
unrealistic, benchmark case) but the investment dynamics that it predicts may readily be
compared with what would occur if investment had to be financed from internally generated
funds. This area is complex and there are a number of different modelling approaches that may
be taken but we show that financing constraints, while still important, do not prevent sizeable
investment responses to relative price swings. This reflects the fact that the “invest in good
times, allow the capital stock to depreciate in bad times” nature of optimal irreversible
investment decisions means that times when unconstrained investment would be positive tend
to correlate with times when internal funds are higher than usual.

The paper is structured as follows. Section 1 outlines the model while Section 2 simulates it in
order to generate different scenarios and possible results for the investment dynamics in response
to commodity price shocks. This constitutes the core of the analysis but we also compare the
results with the actual investment data for a small sample of countries during the late-1970s
coffee and cocoa boom. The model simulations also show why the empirical links between the
terms of trade and investment may be difficult to pin down and suggests possible alternative specifications. Sections 3 and 4 look at the feedback effects on world prices and the role of financing constraints discussed above. Section 5 concludes.

1. The Model

It is assumed that there are two competitive sectors with physical output $X$ and $M$ of the commodity and import-competing goods respectively. These outputs are produced using Cobb Douglas technology given by (1) which we assume for simplicity to be symmetric in the $\alpha$ and $\beta$ parameters. The notation is $l_i$ for labour in sector $i$, $K_i$ for the sectoral capital stock and $F_i$ a further fixed factor in each sector (discussed below).

$$X = l_x^\alpha K_x^\beta F_x^{1-\alpha-\beta}$$

$$M = l_m^\alpha K_m^\beta F_m^{1-\alpha-\beta}$$

The labour force in the economy is fixed but labour is assumed to be fully mobile between sectors so the wage rate in each will equalise in each period. Without loss of generality we normalise the aggregate labour endowment to unity so $l_m=1-l_x$.

Capital goods are sector specific and all imported. They are assumed to be available in elastic supply from the world market at constant prices $P_{k_x}$ and $P_{k_m}$ (non-linear adjustment costs are not considered) but irreversible once installed so the rates of depreciation, $\delta_x$ and $\delta_m$, represent the upper limit on the speed with which the sectoral capital stocks may shrink. These assumptions imply a major asymmetry between the upward and downward flexibility of the sectoral capital stocks which strongly drives the dynamics of the investment responses to price changes. Two further assumptions are that the capital goods are used in production and neither stored nor scrapped, and that there is a delivery or time to build lag between the decision to invest and the new capital goods becoming productive. In the simulations below we set this lag at one and four years in turn, the former corresponding approximately to equipment-type goods and the latter to tree crops where new trees take some time to mature before becoming productive.

We also assume that the economy has access to a perfect world capital market with (real) interest rate, $r^*$. This assumption, together with the absence of non-tradeable consumer goods, separates production and consumption decisions in the economy and makes risk neutrality an appropriate assumption such that investment decisions will depend solely on expected returns. Hence the structure of the model is focused tightly on the investment response to changes in the sectoral returns to capital in the presence of uncertainty about the continuation of the price shock. The motivation for this is that these factors are missing from the current literature.

It is assumed that there is free entry to each sector which, in relation to irreversibility and investment models, means that there is no option value of waiting since if the irreversibility constraint is not binding expected present value net returns (carefully specified to include future states in which it may bind and losses occur) will be driven to zero. Irreversibility still matters, however, since there is an entry asymmetry between good and bad states of the world for the return to capital. In a good state firms may enter without any barriers but in a bad state not only will there be no new entry but existing firms cannot exit due to irreversibility. This asymmetry is incorporated in the equilibrium condition for the capital stock by means of taking into account the future entry of new capital in good states when calculating expected returns.
The third factor of production in each sector, given by \( F_x \) and \( F_m \) in (1), is assumed to be entirely fixed, both by sector and over time. Given the international mobility of capital this factor is necessary to avoid complete specialisation and may be interpreted as being sector specific human capital or natural resources in inelastic supply (at least over the timeframe of a few years considered here). For agricultural commodities this fixed factor may be interpreted as being land. For simplicity we choose units so \( F_x = F_m \) to avoid their ratio cluttering the expressions below.

The remaining notation comprises \( P_x \) and \( P_m \) for the pre-shock world prices of \( X \) and \( M \) respectively. We make the \( M \) good the numeraire and hence \( P_m = 1 \) and all other prices are relative to this price. When the shock occurs the relative price of the commodity rises to \( P_x(1+s) \), where \( s \) is the proportionate size of the shock, and falls back to \( P_x \) when the shock is reversed. The output prices determine the economy’s position on its production possibility frontier while the prices of capital goods, \( P_{Kx} \) and \( P_{Km} \), together with the other parameters determine the position of that frontier given that the sectoral capital stocks are endogenous to the model rather than being fixed endowments. We assume that the prices of the capital goods are constant and in the simulations for simplicity we set them equal to each other, \( P_x \) being varied to change the initial conditions at the start of the shock.

Given (1) we have the following standard results for the return \( (r_i) \) and cost \( (c_i) \) of capital by sector. We include the term \( (1+s) \) though note that \( s \) is set to zero before and after the shock.

\[
\begin{align*}
    r_x &= \frac{P_x (1+s) \beta_l^x I_x F_x}{K_x^{1-\beta}} \\
    c_x &= P_{Kx} (r_x + \delta_x) \\
    r_m &= \frac{P_m \beta_l^m F_m}{K_m^{1-\beta}} \\
    c_m &= P_{Km} (r_m + \delta_m)
\end{align*}
\]

(2)

(3)

Given that labour is assumed fully mobile between the two sectors the wage rate, \( w \), will equalise so \( w_x = w_m \) and it is straightforward to show that:

\[
\frac{l_x}{l_m} = \frac{P_x K_x^\beta}{P_m (1+l_m) K_m^\beta}
\]

(4)

It is convenient to derive results relative to the values that obtained before the shock (given by superscript 0 corresponding to period 0 in the simulations) and we also want \( l_x \) and \( l_m \) separately so it is helpful to change (4) to give \( l_x = (1-l_m) \) in (5) by making use of (1) to (3).
Having laid out the core components of the model we specify the pre-shock situation, the response to the shock and the subsequent adjustment when shock reversal occurs. For simplicity we assume that the shock is not anticipated (while commenting later on the implications of changing this assumption) and that the pre-shock value of \( P_x \) has been in place long enough for the sectoral capital stocks to adjust such that the return to capital is equal to its cost in each case.

The commodity price shock takes the form of \( P_x \) changing to \( P_x(1+s) \). By assumption investment involves a lag (of initially one period, the case we outline in the discussion) so the sectoral capital stocks in the first period of reform are pre-determined. By contrast labour is fully mobile and hence an immediate labour reallocation towards the export sector will take place shown by (5). The shock implies an immediate reduction in the return to capital in the import competing sector and the loss of labour exacerbates this. The gain of labour in the export sector has the opposite effect on the return to capital there. In this first period investment decisions are taken to determine the sectoral capital stocks in the following period.

If the shock were permanent the path of these capital stocks over time would be that \( M \) sector capital would depreciate gradually down to its pre-shock value and \( X \) sector capital would expand upwards to its new steady state, at each point earning a zero net return, the size of \( K_x \) being determined by this condition combined with the rate at which the \( M \) sector releases labour as \( K_m \) depreciates.

Turning to a temporary trade shock, defined by agents perceiving a probability of shock reversal at each point, we anticipate increases in \( K_x \), the key issue being by how much given the risk of an excessively large capital stock in place after the end of the shock due to irreversibility. Decreases in \( K_m \), following the reduction in its return to capital during the shock, will occur gradually through depreciation until it reaches a steady state (assuming that reversal has not already taken place). \( K_x \) will face a binding irreversibility constraint if reversal occurs and hence the magnitude and probability of the losses that would result must be taken into account in forward looking investment decisions while reform continues. We adopt the simplifying assumption that shock reversal (with the relative commodity price returning to its pre-reform value) is, or at least is perceived to be, permanent. If reversal does take place the roles of the sectoral capital stocks are reversed in that \( K_x \) will depreciate gradually back to its pre-reform level and \( K_m \) will expand to its equivalent point, the expansion path being determined by a zero profits condition on \( K_m \) and the gradual reallocation of labour back to the \( M \) sector as \( K_x \) depreciates. Hence the post-reversal outcome is relatively simple and it is this, combined with the probability of it occurring, which determines the equilibrium expansion of \( K_x \) while reform continues.
More formally, at a given time, s, following reform but before any reversal and assuming that the initial value of $K_x$ is low enough for the irreversibility constraint not to bind, the desired and actual capital stock in the X sector (assuming risk neutrality) will satisfy:

$$E_{s-1} \left[ \sum_{t=s}^{\infty} \left[ (r_s(K_x') - c_x) \left( \frac{1-\delta}{1+r^s} \right)^{(t-s)} \right] \right] = 0 \quad (6)$$

This is the standard equilibrium condition by which the expected present value of net returns to a unit of capital invested at some time $s$ (the decision to invest having been taken at $t=s-1$) is equated to zero. The terms $r_s(.)$ and $c_x$ give the return and cost of a unit of capital and hence the term $(1-\delta)(t-s)$ appears because this gives the amount of an initial unit of capital left after $s-t$ periods. It is helpful to separate out period $s$ from (6) which gives:

$$E_{s-1} \left[ \sum_{t=s+1}^{\infty} \left[ (r_s(K_x') - c_x) \left( \frac{1-\delta}{1+r^s} \right)^{(t-s)} \right] \right] = 0 \quad (7)$$

This shows that the expected net return for period $s$ (which depends on $K_x$ at that time) depends on the expected net return in the periods that follow it in order that the expected net present value as a whole is zero to reflect free entry at time $s$. At this point the effect of the entry asymmetry discussed earlier becomes important. If reform continues at $s$, free entry means that equilibrium condition (6) will be repeated and hence seen from the perspective of time $s-1$, the expected present value of net returns if reform continues must be zero. On the other hand if reform is reversed, irreversibility implies that net returns will become negative for a number of periods before depreciation reduces $K_x$ to the point where net returns are zero once again. This asymmetry implies that a zero should be inserted within the summation of the second line of (7) for future scenarios where reform continues. Only future losses with reform reversal, together with their associated probability, need appear. Denoting $T^*_x$ as the number of periods when losses are made post reversal and making use of these arguments means that (7) may be transformed to:

$$E_{s-1} \left[ \sum_{t=s}^{s+T^*_x} \left[ (r_s(K_x') - c_x) \left( \frac{1-\delta}{1+r^s} \right)^{(t-s)} \right] \right] = 0 \quad (8)$$

In (8), $p$ is the perceived probability of reform reversal each period (which we take to be constant) and the $K_x$ term within the summation sign is given in relation to $K_x$ at time $s$ and the number of periods of depreciation because net losses are being made during the interval $s$ to $s+T^*_x$ and investment in the X sector will be zero.

Equilibrium condition (8) shows that investment will take place for time $s$ to the point where the capital stock gives an expected net return in that period equal to the present value of the losses that would be incurred after that period if liberalisation is reversed at $t=s$, weighted by the probability of that event. As the capital stock expands for time $s$, the period $s$ return will fall and the size of future losses will rise because a higher $K_x$ will be inherited at the time of reversal. Forward looking investment behaviour will balance the period $s$ return if reform continues.
against expected losses if it is reversed which implies that the current period return will not be
driven to zero as would be the case if the liberalisation was fully credible.

Hence (8) confirms the intuitive idea that an expectation of reversal must weaken the investment
response to reform though it also highlights the fact that an improved current period return
following the shock will encourage commodity sector investment. Given the assumption that
reversal entails a return to the pre-shock value of \( P_x \), (8) implies that the investment response in
the X sector must be positive because there is an increased current period return and the worst
outcome in the future is the same as before the shock. As noted above, however, a positive
investment response in the X sector will not necessarily lead to a positive aggregate investment
response given that investment in the M sector will be zero during the transition after reform and
lower in the steady state than its initial value. In turn a higher \( K_x \) and lower \( K_m \) implies that real
income will increase with liberalisation whatever the perceived probability of reversal.

In order to facilitate numerical simulations we transform (8) by assuming Cobb-Douglas
technology outlined above and also express \( K_x \) while reform continues relative to its credible
free trade value.

\[
\frac{K_x}{K_x^0}^{1-\beta} = \frac{(1+s) \frac{l_x^t}{l_x^0}^{\gamma_x} + p \sum_{t'}^{\infty} (1-\delta_x^{t'}) \frac{l_x^s}{l_x^0}^{\gamma_x} \frac{(1-\delta_x^s)^{\beta}}{(1+r^s)}^{1-s}}{1 + p \frac{(1-\delta_x^s)}{(r^s + \delta_x^s)} \left[1 - \frac{1-\delta_x^s}{1+r^s}\right]^{1-s}} 
\]

(9)

The system is completed by the labour allocation given by (5) and the value of \( K_m \) which is
given by its depreciation path from its initial value until it reaches its post reform steady state
value, \( K_m^{ss} \) given by (10) which is derived straightforwardly from a zero expected net return
condition given the one period investment lag.

\[
(1-p)[r(K_m^{ss})|_{s-x} - c_m] + p[r(K_m^{ss})|_{s-0} - c_m] = 0
\]

(10)

Which for Cobb-Douglas technology may be expressed by:

\[
\frac{K_m^{ss}}{K_m^0} = \left[ (1-p) \frac{l_m^s}{l_m^0}^{\gamma_m} + p \frac{l_m^0}{l_m^0}^{\gamma_m} \right]^{\frac{1}{1-\beta}} 
\]

(11)

After reversal (5) continues to hold, \( K_x \) depreciates down to its initial pre-shock level and \( K_m \)
increases to its pre-shock value, the pace of expansion being determined by a zero profits
condition combined with the depreciation path of \( K_x \) which affects the return to \( K_m \) through the
release of labour.

The discussion and expressions above have assumed that the delivery or time to build lag before
new investment becomes productive is one year. The extension to the four year lag for the
commodity sector (we assume that the lag for the M sector remains one year) is straightforward.
The structure of equations (6)-(9) remains the same but we replace \( (1-p) \), the probability of a
continued shock next period, with \( (1-p)^4 \) which is the probability of a continued shock in four
periods time. In turn this means that we replace p in the expressions with \[1-(1-p)^4\]. The longer lag reduces the probability of a favourable shock state at the time that this period's investment becomes productive and hence the investment response to the shock is much smaller. This is partly a reflection of the assumption that the \(K_m\) lag remains unchanged (since a longer lag there would slow down the post-reversal \(K_m\) expansion which reduces the return to X sector capital but even if this was allowed for the lower probability of a favourable post-lag \(P_x\) would still reduce the investment response.

Before simulating the model above we briefly note the implications of the trade shock being anticipated. Given that the shock increases the return to capital in the X sector and reduces it in the M sector, a positive perceived probability of reform will tend to increase \(K_x\) and reduce \(K_m\) prior to reform. In turn this implies a faster post-reform adjustment to the steady state but will not affect the latter since it depends solely on the probability of reversal.

2. The Investment Response to a Trade Shock

This section reports the core results of the paper concerning the aggregate investment response (based on the underlying sectoral responses) in response to a temporary trade shock. Models of the type set out above unfortunately do not readily generate tractable solutions and hence simulation is necessary. For this we use the parameter assumptions set out in the Appendix and present the results in Figures 1-3 below. The probability of shock reversal is set at 0.25 per period while the shock continues and hence the initial expected duration of the shock is four years. Figure 1 shows the path of aggregate investment and the commodity price assuming that shock reversal does take place after four years while Figures 2 and 3 assume two and six year shock durations. In each figure the left hand charts assume a one period lag in the X sector while the right hand charts extend this to four years. In addition the top pair of charts assume that before the shock the X sector capital stock is relatively large compared with the initial M sector capital stock, the middle pair of charts imposes symmetry between them while the lower charts assume that the X sector is relatively small before the shock. In addition the axes across all three figures are standardised to facilitate visual comparisons. It may also be noted that we show investment expenditure taking place straightaway even though the new capital goods will become productive only after the lag of one or four years.

We first consider Figure 1, which assumes a shock duration of four years, from which it may be noted that the aggregate investment series show spikes or jumps as well as more gradual changes. These reflect the absence of adjustment costs in the model which gives rise to rapid capital adjustments if desired though more gradual changes are also present following the shock and its reversal since after an initial adjustment the favoured sector (X during the shock, M after its reversal) expands more slowly as the other sector's capital stock gradually depreciates. If adjustment costs were included the rapid adjustments would be smoothed but we may anticipate that the overall profile of the series would not otherwise change.

It is clear from the charts, particularly Figure 1(c), the symmetric short lag case which is a natural benchmark, that aggregate investment tends to respond to both the occurrence of the shock and its reversal. It may be recalled that after a change in relative prices the favoured sector expands its capital stock relatively rapidly to take advantage of the new conditions (though as argued above less so than if the shock were permanent) while the other sector stops replacement investment in order to allow its capital stock to depreciate. The net effect of these
is shown to be positive in the first period of the shock since the upward adjustment in the favoured sector is initially large but subsequently the lower investment in the non-favoured sector dominates and aggregate investment is lower than before the shock or shock reversal. This chain of events is present after a large upward or downward movement in the relative commodity price since there is one favoured sector and one non-favoured sector in each case. Hence a potential investment boom is predicted by the theory both at the start and the end of the shocks modelled here. In Figure 1(c) we impose symmetry on the initial sizes of the capital stocks and there is an investment boom of comparable magnitude in periods 1 and 5 which correspond to the start and end of the shock.

Figure 1(a) and 1(e) show that the relative size of the capital stocks is important in determining the presence and relative size of these investment booms. In Figure 1(a) the X sector is relatively large and hence its expansion during the shock dominates the fall in M sector investment while that capital stock depreciates, and in turn at the end of the shock the zero investment in the X sector (to allow its capital stock to depreciate to its new post-shock steady state) dominates the expansion of investment in the M sector such that there is no post-shock investment boom. In Figure 1(e) the relative sizes are reversed and the investment boom at the start of the shock is smaller and that at the end of the boom much larger.

The right hand charts in Figure 1, which assume a four year investment lag, share this pattern of the relative sizes of aggregate investment at the beginning and end of the shock but also show very strongly that the initial aggregate investment response is at most zero and often negative. This reflects the much smaller expansion in $K_x$, due to the long lag such that the probability of the shock continuing at the time that new capital becomes productive is greatly reduced. This factor does not alter the post-shock expansion of $K_m$, both because we assume that its investment lag remains at one year and also because the reversal of the shock is assumed to be permanent.

Figures 2 and 3 show how things change if the shock in fact lasts for two or six years respectively. A similar pattern of possible investment booms at the start and end of the shock and the role of sector sizes is seen but in addition the post-shock investment boom is smaller for the two year shocks and much larger for the six year shocks. This results from the amount of time the M sector capital stock has had to depreciate during the shock. The steady state during the shock (assuming that it continues) is reached only after five to seven years and up to that time $K_m$ will continue to depreciate and hence investment in that sector will be larger at the end of the shock the longer the shock duration.

Hence these simulations have broadly confirmed the prediction of the trade shocks literature of an investment boom in response to a commodity price shock (and with it the likelihood of a construction boom if non-tradeable capital "construction" goods are present) though they have clarified a number of points. First that similar investment booms may be anticipated at the end of a shock and these may be larger than the initial boom depending on the relative size of the two sectors and the duration of the shock. Second that an investment boom at the start of the shock is not certain (even in the absence of damping effects from adjustment costs) because the increase in X sector investment may be dominated by the reduction in M sector investment (to zero) at that time, particularly if a long delivery lag is present because that reduces the desired expansion of the commodity sector.
FIGURE 1: AGGREGATE INVESTMENT, 4 PERIOD SHOCK

LARGE INITIAL $K_x/K_m$

a) 1 period X sector delivery lag

b) 4 period X sector delivery lag

SYMmetric INITIAL $K_x/K_m$

c) 1 period X sector delivery lag

d) 4 period X sector delivery lag

SMALL INITIAL $K_x/K_m$

e) 1 period X sector delivery lag

f) 4 period X sector delivery lag
FIGURE 2: AGGREGATE INVESTMENT, 2 PERIOD SHOCK

LARGE INITIAL $K/K_m$

a) 1 period X sector delivery lag

b) 4 period X sector delivery lag

SYMMETRIC INITIAL $K/K_m$

c) 1 period X sector delivery lag
d) 4 period X sector delivery lag

SMALL INITIAL $K/K_m$

e) 1 period X sector delivery lag

f) 4 period X sector delivery lag
FIGURE 3: AGGREGATE INVESTMENT, 6 PERIOD SHOCK

LARGE INITIAL $K_x/K_m$

a) 1 period X sector delivery lag

b) 4 period X sector delivery lag

SYMMETRIC INITIAL $K_x/K_m$

c) 1 period X sector delivery lag
d) 4 period X sector delivery lag

SMALL INITIAL $K_x/K_m$

e) 1 period X sector delivery lag
f) 4 period X sector delivery lag