The method of short period analysis in the General Theory seems to incorporate at least two distinct ideas. The first is to identify an economic activity (e.g., investment) that forces adjustment in other economic variables (e.g., the level of economic activity), but meanwhile the plans regarding itself remains unrevise. The second is to select that particular activity in such a way that the adjustments generated by it get completed in a finite and perhaps a relatively short calendar time. The principle of effective demand incorporates both these ideas: investment is identified as the activity, plans regarding which remain unrevised until the rest of the activities in the economy have time to get adjusted accordingly. Also, in the mechanism described in the General Theory, a less-than-unity marginal propensity to consume guarantees that the adjustment process, consequent upon investment, terminates in a finite time.

We are going to develop and use a method where this method of tracing out the short-period equilibrium is repeated. Each equilibrium, when attained, defines the stimulus (i.e., the investment level) for the next period's

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1. This is true, notwithstanding Keynes' emphasis on the volatile nature of investment. This latter is due to sudden changes in the "state of the news" and the state of expectations, which are completely exogenous.
adjustment process, in this method; and thus the long-period path is traced as a succession of short-periods. As a result the basic requirements for specifying any framework of long-period analysis by this method are firstly, that investment decisions are taken to be bunched together at the conclusion of each short-period flow equilibrium process and, secondly, that the specification of this flow equilibrium process should guarantee its own convergence.

If on the contrary, for example, investment plans are supposed to get revised as the Keynesian multiplier process works itself out, the short-period income determination of the General Theory may become intractable. Similarly if we specify a process of adjustment following investment, that does not conclude in a finite time, due to peculiarities in technical or behavioural specifications, the short period equilibrium also becomes intractable. In both these cases, it becomes impossible to use a method of repeating the Keynesian short-period analysis to generate a long-period path.

2. This clearly delimits the types of short-period adjustment hypotheses that can be worked upon in the framework being described. It is possible, for example, that the kind of short-period adjustment hypothesis suggested by empirical observation in a particular situation, is an

1. See for example J.R. Hicks: The crisis in Keynesian Economics: (Basil and Blackwell, 1975), Ch.I. If there is "induced investment", Hicks argues, induced by the very process of the working out of the multiplier rounds, then the short-period equilibrium becomes difficult to trace without detailed knowledge about stock adjustment behaviour and initial stock position.
unstable or non-convergent process, and in the particular framework under discussion there may be no way to construct the long-period path for the system. This point can be illustrated by an example of the following type.

To illustrate the point, let us first recapture the usual Keynesian quantity adjustment story in a two-sector framework. Denote by $x_1$ and $x_c$ the outputs of investment goods and consumption goods respectively. Let $w$ be the wage rate in units of consumption goods, $l_1$ and $l_c$ the labour units required to produce unit quantity of $x_1$ and $x_c$. The usual multiplier story can be described by taking a fixed real wage rate $w$ in terms of consumption goods.\(^1\)

Given a certain amount of investment goods output $x_1$, if the wage requirement (of consumption goods) for that sector exceeds the surplus output of the consumption good sector, then the consumption goods output adjusts itself to ultimately wipe out this excess demand. This process can be captured by the following differential equation, assuming, for simplicity, that there is no consumption good demand from non-wage income\(^2\):

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1. Keynes himself, however worked with a given money wage rate and not real wage rate. But the assumption of a proportionality between money wage rate and the general level of prices (which first appeared in his "A Treatise on Money") kept the effective real wage rate constant. This strict proportionality assumption, which Hicks called the "Wage Theorem" (see The Crisis in Keynesian Economics, Ch.2.), also provided Keynes with a powerful device of measuring variables in "wage units" to trace real movements of variables, abstracted from movements of prices.

2. This amounts to assuming that all profits are saved.
\[ \dot{x}_c = w_{11} x_1 - (1 - w_{1c}) x_c \] ............................... (1)

For a given \( x_1 \) this is a differential equation path for \( x_c \). The stability of the process is guaranteed by the condition:

\[ (1 - w_{1c}) > 0 \]

or \( w_{1c} < 1 \) ............................... (2)

This is just a variant of Keynes' requirement that the marginal propensity to consume be less than unity. Given this condition, the equilibrium level of \( x_c \) for a certain given level of \( x_1 \) is attained in a finite time. This whole time period can be taken as the unit period for the long-period analysis.

The equilibrium configuration corresponding to the given \( x_1 \) in this model is:

\[ x_1 = \text{output of investment goods}, \]
and \( x_c = \left( \frac{w_{11}}{1 - w_{1c}} \right) x_1 = \text{output of consumption goods}. \]

If we postulate an investment function that completely defines the investment level for the next period on the basis of this equilibrium configuration, we can begin to string together the unit periods for describing a long period path.

4. Suppose now we alter the specification of the short period adjustment process, and suggest as a hypothesis that the gap between supply of and demand for consumption
goods leads to a rise in consumption goods prices, proportional to the gap. If we denote the money wages by \( W \) and the price of consumption goods by \( p \), we can write:

\[
\dot{p} = K \left[ \frac{W}{p} \cdot 1_{\leq 1} \right] \left( 1 - \frac{W}{p} \right) \ x_c \] \quad \text{(3)}
\]

or

\[
\dot{p} = K \left[ \frac{W(1_{\leq 1} + l_c x_c)}{p} \right] - x_c \] \quad \text{(4)}
\]

Where \( K \) is a constant and \( 0 < K < 1 \).

For a given money wage rate \( W \) and given values of \( x_1 \) and \( x_c \), equation (4) is the differential equation path for \( p \). The path is stable and converges to the value

\[
p = \frac{W(1_{\leq 1} + l_c x_c)}{x_c} \quad \text{if} \ (1_{\leq 1} + l_c x_c) > 0.
\]

Since \((1_{\leq 1} + l_c x_c) > 0\) in any meaningful situation, the price adjustment following a particular level of investment \( x_1 \) (given the output of consumer goods) will eventually terminate.\(^1\)

If we postulate an investment function such that the equilibrium price together with other known data completely defines the investment level for the next period, then we can arrange the short-period processes in succession to trace the long period path.

5. However, this method may fail if we allow for several types of complications in the short period adjustment to a new investment rate. As an example, suppose we assume

\[1. \text{If } K < 0, \text{ the adjustment shown by equation (4) would not converge. For a difference equation formulation, the condition for convergence of the process would be } |K| < 1.\]
that the wage bargaining is such that after every rise in the price of consumption goods, the money wage rate is advanced by a certain proportion. To make the exposition simpler, we will now use a difference equation formulation and will use an adjustment equation involving proportions rather than differences. Suppose the price adjustment mechanism is now written as:

\[
\frac{P_{t+1}}{P_t} = K \left( \frac{(1_{x_1} + 1_{x_c}) \frac{W_t}{P_t}}{\frac{X_c}{P_t}} \right) \quad \text{.......................... (5)}
\]

where \( K \) is a constant and \( 0 < K < 1 \).

The numerator and the denominator of the expression in parenthesis in the right hand side of equation (5) denote the demand for and the supply of consumer goods, respectively. The subscripts refer to the value of the variable at the beginning of the corresponding period.

About adjustment of the money wage rate, let us suggest:

\[
W_t = L \cdot P_{t-1} \quad \text{.......................... (6)}
\]

where \( L \) is a positive constant.

Substituting (6) in (5) and upon manipulation, we have:

\[
P_{t+1} = K \cdot L \left( \frac{1_{x_1} + 1_{x_c}}{\frac{X_c}{P_t}} \right) \cdot P_{t-1} \quad \text{.......................... (7)}
\]

The difference equation (7) describes the behaviour of consumption goods price for the given level of \( x_1 \) and \( x_c \) production, under our specified set of assumptions. It is
clear\textsuperscript{1} from equation (7) that the price of consumption goods keeps shooting up from period to period if
\[
K.L \left| \frac{1_{c}x_{t} + 1_{c}x_{c}}{x_{c}} \right| > 1,
\]
and it keeps going down period after period if
\[
K.L \left| \frac{1_{c}x_{t} + 1_{c}x_{c}}{x_{c}} \right| < 1.
\]

For any given supply-demand disproportion of consumption good, i.e., \(W\left(\frac{1_{c}x_{t} + 1_{c}x_{c}}{p \cdot x_{c}}\right)\), and a given speed of price adjustment \(K\), we can always work out the speed of wage adjustment \(L\), that makes the outcome inflationary or deflationary. But the model does not have a convergent path unless we have fortuitously:
\[
K.L \left| \frac{1_{c}x_{t} + 1_{c}x_{c}}{x_{c}} \right| = 1,
\]
when prices and money wages remain stationary from the very beginning.

It is clear that such a hypothesis can not be handled in the particular framework we have in mind. Suppose initially the supply of consumer goods and its demand at the going price-money wage configuration were in balance, i.e.,
\[
p \cdot x_{c} = W\left(1_{c}x_{t} + 1_{c}x_{c}\right)
\]

1. The solution for equation (7) can be written as:
\[
\left(A_{1} - A_{2}\right) \left| L \cdot K \left(\frac{1_{c}x_{t} + 1_{c}x_{c}}{x_{c}}\right)^{t/2}\right|
\]
where \(A_{1}\) and \(A_{2}\) are constants determined by initial conditions.
investment, the resulting price change and money-wage change will follow a so-called spiralling path. As a result, in terms of our framework, the short period adjustment will never come to an end, to redefine the level of investment for the next short-period.

6. Several additional analytical problems arise if the adjustment in the short period is postulated to occur through changes in more than one variables. If investment decision is assumed to be based on the equilibrium values of both these variables, then it is necessary that both the variables settle down to their respective equilibrium values precisely at the same time. This needs that the two variables should not only have a convergent short period dynamics (in response to a given investment level), but also that proportional speed at which the divergence of these variables from the equilibrium values is corrected should also be the same.

This is quite a serious restriction and restricts the choice of short-period adjustment hypothesis rather severely, in case we choose to postulate it in terms of adjustment in more than one variable. An interesting illustration of this kind of restriction on the choice of hypothesis can be provided from the literature on the dual dynamics

1. In other words, in equal calendar time each variable should correct the same fraction of its extent of divergence from the equilibrium value, so that both variables converge to their equilibrium values after the lapse of the same length of calendar time.
of prices and quantities. One interesting result in this literature is the so-called Dual Stability Theorem, first formulated by Solow\(^1\) and later developed by Jorgenson,\(^2\) which describes a price-and-a-quantity-dynamics, the stability of each of which precludes that of the other. As a result, the particular set of hypotheses underlying the price-and-the-quantity-dynamics of the dual stability theorem, can not be combined together to formulate a model of simultaneous price and quantity adjustment, in a manner that would lead to the eventual convergence of both.

On the other hand there is a seemingly opposite result in this literature, which follows from an extension of Hicks'\(^3\) analogy between the static price-and-the-quantity-systems to their respective dynamics as developed by Bhaduri.\(^4\) This latter result demonstrates that the stability property of both the price-, and the quantity-dynamics is guaranteed by the exactly same technological condition. In a situation as captured by Bhaduri's formulation, it is perhaps possible to combine the two types of adjustment - the price-, and the quantity-dynamics, to describe a single process where both variables

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3. J.R.Hicks: Capital and Growth: (Oxford 1965); Chapter 12.
are adjusting and are ultimately converging to some equilibrium configuration.

It has often been observed that a short-period adjustment postulated entirely either in terms of quantity adjustment or in terms of price-adjustment is an oversimplifying view of the economy; and a more realistic picture should emerge from a combination of both. To highlight the analytical difficulties presented by such a procedure, we will examine the two apparently contradictory results in the literature on the dual dynamics of prices and quantities, a bit more elaborately.

7. The simplest way to capture the essential difference between these contrasting models is to set them within the familiar framework of a two-sector fixed coefficient growth model. Solow's discussion of the price system, around which the dual stability argument centres, uses a competitive price formation hypothesis, where unit cost on the one hand is taken to get equated, through competition, to price plus capital gains on the stock held for unit production. Using consumption goods as the memeraire and denoting by $p$, $w$ and $r$, the price of machines, wage rate in terms of the consumption goods and the rate of profit, Solow's price equations appropriate for a two-sector framework can be written as:

---

\[ p = l_1 w + a_1 r_p - a_1 p \]
\[ l = l_c w + a_c r_p - a_c p \]

...(8)

\[ l = l_0 + a_r \] \[ a_r \] \[ a \] \[ 1 \] \[ 0 \]

\[ a_1 \] and \( a_c \) stand for machine requirement for unit production of the machine and the consumption good sector, while \( l_1 \) and \( l_c \) are the corresponding labour requirements.

On eliminating \( w \) from (5) we get:

\[ \frac{\dot{p}}{p} = r - \frac{l_1 - l_c}{p} \]

(9)

where \( Z = a_0 l_1 - a_1 l_c \) is a measure of the difference in capital intensities between the two sectors. Since \( r \), the rate of profit, is taken to be equal to an exogenously given interest rate, equation (9) describes the determinate path for the price of machine goods.

Bhaduri's formulation of price dynamics is based on the movement of capital goods prices (relative to consumption goods) in response to a difference between saving and investment. If \( M \) is the stock of machines, and assuming that all profits, no wages and no capital gains are saved, the product market equilibrium conditions can be written as

\[ \frac{d}{dt} (pM) = rpM \]

yielding:

\[ \frac{\dot{p}}{p} + \frac{\dot{M}}{M} = r \] ................................. (10)

Bhaduri takes \( \frac{\dot{M}}{M} \), the physical rate of investment as

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1. The mechanism is close to that of Keynes in the "A Treatise on Money."
captured by the growth rate of machine stock, \( g \), as autonomously given. It is then natural to study the price dynamics for:

\[ g = n \]  

(11)

where \( n \) is the natural rate of growth of the labour force, i.e., a price dynamics corresponding to the full-employment growth path along the natural rate. Secondly, he uses the competitive price formation equations, where price equals unit cost without any capital gains terms to express the rate of profit as a function of the relative prices, as originally formulated by Hicks. These price equations can be written as:

\[
\begin{align*}
    p &= l_1 \cdot w + a_1 \cdot r \cdot p, \\
    l &= l_c \cdot w + a_c \cdot r \cdot p.
\end{align*}
\]

(12)

which yield:

\[ r = \frac{l_1 - l_c \cdot p}{pZ} \]  

(13)

Equations (10), (11) and (13) yield Bhaduri's price dynamics which can be written as:

\[ \frac{\delta \pi}{\delta} = -n + \frac{l_1 - l_c \cdot p}{pZ} \]  

(14)

The contrast between the two formulations about price dynamics comes out most dramatically if we now compare equations (9) and (14), describing the two price-paths. Both are linear first-order equations with the same coefficients but opposite signs (note that \( n \) in equation (14)

and \( r \) in equation (9) are both positive constants.) Hence the stability conditions for the two equations are exactly opposite; while Solow's formulation as simplified in equation (9) needs \( Z < 0 \), that of Bhaduri in equation (14) needs \( Z > 0 \) for stability. This also underlies the conflicting nature of the two formulations, since for both of them the convergence of the quantity dynamics is assured by the same condition \( Z > 0 \).

3. The above discussion serves to illustrate an extreme logical possibility in our present context, namely that by altering the specification of the adjustment hypothesis, prices and quantities can be made to move in same as also in the opposite direction. As a result, a short-period adjustment of savings to given level of investment can not be written at will by simply assuming that the savings is a function of both a price and a quantity variable. To include such an equation in a type of framework that we are suggesting, it is necessary to state the dynamics within the short-period explicitly, and ensure that both the variables converge simultaneously.

As already mentioned, the requirement of simultaneous convergence of both variables, is an extremely demanding requirement. We can easily see that even if the stability of both the price and the quantity dynamics is guaranteed

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1. That is to say, when Solow's formulation is simplified to suit our two-sector framework. In his multisectoral formulation, Solow has stock-coefficients as well, in his equations. Strictly speaking, therefore, the conditions relating \( Z \) are necessary but not sufficient for the stability of the systems discussed in the dual stability hypothesis.
by the same set of technological or behavioural conditions, it does not by any means guarantee that the two variables attain equilibrium values at the same point of time. But unless this latter condition is fulfilled, it is not possible to obtain the equilibrium values of both variables at the same point of time to define the level of investment for the next short-period process.¹

9. While the above discussion focuses in particular on treating both price and quantity as variables in a dynamic model, we should remind ourselves that Keynes had developed an interesting way of handling this problem in a limited way necessary for his own purpose in the General Theory. He was measuring output and its various aggregative components in terms of the wage-unit.² As a result, when he was discussing a change in output, it was not necessarily a change in output in the usual physical sense in which a quantity adjustment formulation is mostly used in the current literature. A change of output measured in terms of the wage unit remains invariant to a proportionate change in the money wages and the price level. Since Keynes' own understanding of the wage-bargaining situation led him

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¹ Even in the case of the price and quantity adjustment hypotheses used by Bhaduri, where both converge given the same condition \( z > 0 \), the proportional speed of correction of the extent of divergence from equilibrium is in general different for the two variables. See Amit Bhaduri: On the analogy between the quantity and the price traverse: Oxford Economic Papers, Vol.27, No.3, Nov.1975.

² See General Theory: Chapter 3, and footnote 1 on page 23 above.
to assert that the prices and money wages mostly move together, for his own purpose, the measurement of output in wage units meant a technique by which an adjustment in physical volume of output abstracted from changes in prices (with attendant proportionate change in money wages) can be analysed.

10. We shall use a second alternative method of handling the problem. Whenever we postulate a short-period adjustment in terms of two distinct variables, we shall use an additional relationship between these two variables, which will be assumed to be true at every instant of time. In that case, if we have a suitable hypothesis assuring the convergence of one of the two variables, the second variable (which continuously follows the first by virtue of the said relation) automatically stabilises also at the same time.

A variant of the same procedure will be to postulate a continuous functional relationship between the proportional adjustment speeds of the two adjustment variables, in such a way that when the speed of one becomes zero, that of the other also follows suit. Both these variants incorporate the same idea, namely that the two adjustment variables have an independent relation which is true at every instant of time. Depending on the particular adjustment variables, the method may become sometimes a good approximation and at some other times quite untenable. We will use both the variants in course of our discussion in the later chapters. But it should be emphasized that the use of such
a relation can be justified only when the context of the problem independently suggests such a relation between the two variables.

II. With these observations in view, we will process in the next two chapters to develop a few illustrative models of the long-period path, by using the particular framework we have suggested. The steps followed in all these models will be to postulate:

(i) An equilibrium condition, postulating the short-run behaviour of the system in the face of a given investment level.

(i)(a) Dynamics underlying the attainment of this short-period equilibrium will be taken as convergent. As a result, the parametric or other conditions ensuring this convergence will be stated, and their implication will be noted.

(ii) An investment function (or some variant, e.g. an ex-ante growth-rate function), relating investment to the equilibrium values of the short-period adjustment variables will be postulated.

(iii) In case we have two adjustment variables, we will postulate either a relation between the two valid at every instant of time, or a relation between their proportional adjustment speeds.

While we will discuss the nature of the paths following from these models, at some length, together with the models themselves, a detailed discussion of the methodological implication of the procedure adopted is reserved for the concluding chapter of the work.