Accumulation and the rate of profit: regulating the macroeconomy

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Abstract. In this paper we argue that as models of profitability and growth within the Marxist tradition have become more formal, they have relied increasingly upon assumptions of equilibrium. An alternative single-region, single-commodity model is proposed in which output, demand, and capital accumulation are independently determined and therefore potentially in disequilibrium. In the short run this means that profitability can be rising or falling, depending upon the rates of growth of demand, supply, and net exports, the rate of capital accumulation, the rate of change of unit costs of production, and the initial starting position of the economy. In the longer run, though, output is limited by the capacity of capital to produce and by the size of the labour force, and demand cannot exceed supply. These constraints place an upper bound on the rate of profit and its growth, a bound that depends on the rate of change in the unit costs of production and on the rate of growth of the labour force. In the longest term, net exports cannot continue to grow, and certain regulatory conditions are deduced: if those conditions are met as equalities then the rate of profit is constant; if they are met as inequalities, the rate of profit falls.

Can capitalist economies enjoy continued uninterrupted growth? The history of capitalist accumulation suggests that growth has continued now for a couple of centuries but that periods of rapid expansion are limited. In the neoclassical view, balanced growth with full employment of resources is an equilibrium state of an unfettered capitalist economy, so crises result from external shocks: rapid commodity price changes; wars; and market imperfections, especially government interference. By contrast, some Keynesians and Marxists argue that economic expansion is checked by forces internal to the capitalist mode of production.

Since the slowdown of growth in the industrialised nations during the 1970s, Marxist theories of accumulation and crisis have become prominent in attempts to explain the decline and restructuring of industries (Holmes, 1983; Mahon, 1984; Massey, 1981), regions (Bluestone and Harrison, 1982; Carney et al, 1980; Dunford et al, 1981; Massey and Meegan, 1982; Webber, 1986), and even the global economy (Henderson and Castells, 1987; Lipietz, 1986; MacEwan and Tabb, 1989; Peet, 1987). Marx's theory of the falling rate of profit provides the foundation on which many of these accounts rest. Yet the internal consistency of the theory of the falling rate of profit has repeatedly been denied. Such denials threaten the value of accounts of economy restructuring that posit declines in profitability as the progenitor of change.

The various views about profitability also motivate different understandings of the historical economic geography of the postwar world. For some, such as Gibson and Horvath (1983) and Mandel (1978), the period of more or less sustained growth in the 1950s and 1960s was derailed when contradictions inherent to the capitalist mode of production lowered the rate of profit. For others, such as Aglietta (1979), Lipietz (1987), and Piore and Sabel (1984), growth slowed once certain stability conditions
broke down. In brief, we seek in this paper to provide a model with which to understand the possible answers to the question. Still today, the main lineaments of the argument about profitability and growth are hotly contested (Moseley, 1990; van Parijs, 1980; Shaikh, 1980). We argue that the variety of positions in that debate reflect different and partial models of the growth process, all of which insist that growth follows equilibrium characteristics.

We begin the paper by reflecting on the various theories of profitability and growth and then we turn more explicitly to the theory of the falling rate of profit. The equilibrium character of that theory is explained and criticised. A more general macro model of the dynamics of capitalist economies is explained and presented; the microeconomic foundations of individuals' and corporations' decisions remain unexamined. In the major part of the paper we examine the dynamics that are implied by this model. Our central argument in the paper is this. A whole variety of paths of growth are possible, depending on the values of particular parameters, and in this sense it is not surprising that the relations between technical change, profitability, and growth have proved so contentious. However, if growth is off equilibrium, then the possible growth paths are constrained by certain fundamental economic inequalities—for example that demand cannot exceed supply, or that the labour force cannot exceed the supply of labour, or that output cannot exceed the capacity of the system to produce. The growth paths interact with the inequalities to produce constraints on growth; regulation theorists' accounts of Fordism (as for example in Aglietta, 1979, Lipietz, 1987) identify special cases of those constraints. In the long run, continued growth requires that economic conditions be regulated within certain defined limits.

There then remains the question of the slowdown in observed OECD growth rates after the early 1970s. Did the slowdown occur because economic conditions were no longer regulated within those defined limits? In the conclusions, some general calculations are provided to indicate the particular path followed by the OECD economies since the second world war; the regulatory constraints were never in fact operating and never formed a basis for the period of rapid growth. This evidence suggests that the regulatory conditions identified by the regulationists' accounts of Fordism were never in fact important.

1 Profitability and growth
Several broad groups of theories have driven attempts to understand why growth is faster or slower. These are:
the neoclassical theory of economic growth, usually following and embellishing the formalisation of Solow (1957);
the ideas collected together under the general heading of theories of endogenous economic growth (Grossman and Helpman, 1991; Lucas, 1988; Romer, 1994, all provide overviews of this literature);
Marxist economic dynamics, in the form of (or drawing upon) the falling rate of profit (Dumenil and Levy, 1994; Harvey, 1982; Mandel, 1978) and in the form of attempts to understand more general aspects of the experience of economic life under capitalism (Sheppard and Barnes, 1990; Webber, 1989; 1996; Webber and Rigby, 1996).

In its most stark form, neoclassical theory predicts that long-run rates of growth of output (say, GDP) in a country depend on the rate of saving and the rate of population growth. Mankiw et al (1992) use an equation of the form

\[
\ln \frac{Y_t}{L_t} = \ln A_0 + gt + \frac{a}{1-a} \ln s + \frac{a}{1-a} \ln(n + g + d),
\]

where \(Y_t\) and \(L_t\) denote national income and labour force, respectively, at time \(t\),
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\( a \) denotes the marginal product of capital, \( A_0 \) denotes the level of technology at time 0, \( s \) denotes the share of output that is invested (the rate of savings), \( n \) is the rate of population growth, \( g \) is the rate of increase of \( A \) (the exogenous rate of technical change), and \( d \) is the rate of depreciation. More developed models subdivide capital into human capital and physical capital (as do Mankiw et al, 1992); subdivide physical capital into machinery and equipment on the one hand and structures on the other (de Long and Summers, 1991); and add a variety of variables to hold other things constant (Barro, 1991). Such models predict differences in levels of per capita income between countries well, particularly when capital is subdivided in some way, but the addition of variables to enhance the statistical explanation is not robust (Levine and Renelt, 1992); for more trenchant criticism, see Grossman and Helpman (1994). Such thinking would ascribe rapid rates of growth primarily to high rates of saving (or high rates of investment in machinery and equipment), high human-capital investment, and to rates of technical change. Although the growth in total factor productivity has certainly slowed since 1973 (Englander and Mittelstadt, 1988; Fischer, 1988), the slowdown in growth after 1973 is more commonly ascribed by neoclassical growth theorists to the effects of the OPEC oil price rises of the 1970s (Fischer, 1988; Griliches, 1988).

Endogenous growth theory comprises a collection of models. Their development has been motivated by a number of failings of the neoclassical model. The first and most obvious of these is the fact that technical change is actually endogenous. Recent growth theory has been motivated by the observations that output has expanded faster than populations since the industrial revolution and that different countries have remained on seemingly disparate growth paths for long periods (Grossman and Helpman, 1994). Endogenous growth theory responds to this observation by positing external economies in the leading role (Lucas, 1988; Romer, 1986; Young, 1991) or by modelling the improvements in technology that lie behind the observation (Grossman and Helpman, 1991; Romer, 1990). A second feature is incorporated in such models: in contrast to the smoothly competitive world assumed in neoclassical theory, individuals and firms do, in fact, have market power and earn monopoly rents on discoveries (that is, some technical advances are partially excludable, even if they are also nonrival). To endogenous growth theorists, the critical variables in explaining the slowdown in the OECD are investment in physical and human capital and in research and development, but investment is a minor source of the slowdown in output (Maddison, 1987): the changes in research and development have not been large (Griliches, 1988), and in countries—like Japan—where research and development has continued to grow, the rate of growth of output has also fallen (Pack, 1994). In sum, endogenous growth theories offer intellectual appeal but—as yet—little substantive empirical backing (Pack, 1994).

In neoclassical and endogenous growth theories the role of profitability is implicit. In both theories, investment—in productive facilities, research and development, or education—is a primary determinant of changes in output (and, in endogenous growth theory, of changes in technology). There is evidence of a correlation between investment and growth (summarised in BIE, 1992, pages 45–53). In turn, investment depends on income (in the perfectly competitive world of the neoclassical models) or profitability (in the imperfectly competitive world of new growth models). The evidence seems to be that aggregate rates of profit are correlated with rates of investment in the long run, but not in the short run nor between regions (Webber, 1997). By contrast, the rate of profit forms a central variable in Marxist accounts of economic dynamics (Dumenil and Levy, 1994; Harvey, 1982; Mandel, 1978) and the history of changes in the rate of profit since the war apparently correlates with the history of rates of growth (Dumenil and Levy, 1994; Webber and Rigby, 1986; 1996). Despite this evidence, in Marxist approaches the theoretical link between profitability and growth remains implicit (though see Webber, 1986).
Marx regarded accumulation as a defining feature of the capitalist mode of production (Marx, 1967, volume 3, 244–245). Although the possibility of balanced growth, or accumulation without crisis, was recognized, Marx argued that the process of capital accumulation was subject to a series of checks and contradictions, internal barriers to the self-expansion of capital:

from underconsumption (see Sweezy, 1970; and the applications of this model by Aglietta, 1979, Devine, 1988);

from a squeeze on profits associated with a change in the distribution of income in favour of the working class (Glyn and Sutcliffe, 1972; and the applications by Boddy and Crotty, 1975; Goldstein, 1985; Hahnel and Sherman, 1982; Henley, 1987; Moseley, 1990; Sherman, 1990; Weisskopf, 1979; Wolff, 1986); and

from the rising technical composition of capital, itself the foundation for early debates on the theory of the falling rate of profit (Hodgson, 1974; Sweezy, 1970; Yaffe, 1973). Since the work of Okishio (1961), however, attention has focused on whether cost-reducing technical changes can reduce the rate of profit (Laibman, 1982; van Parijs, 1980; Roemer, 1977; 1978; Shaikh, 1978).

We take as our starting point debates over technology and rates of profit. The three different theoretical traditions regard profitability as an important determinant of rates of growth, a view reinforced by some long-run evidence. However, it is within Marxist theory of the falling rate of profit that the dynamics of profitability are most explicitly modelled. We briefly review debates over the dynamics of profitability to motivate the developments in this paper.

2 The theory of the falling rate of profit
To establish the tendency of the rate of profit to fall Marx claimed: first that competition between capitalists inexorably leads to increases in the technical composition of capital and the productivity of labour; second that the rising productivity of labour leads to an increase in the organic composition of capital; and third that increases in the organic composition of capital result in the tendency for the rate of profit to fall. This is not a claim that the rate of profit will necessarily fall, for Marx recognised that other pressures tend to raise it.

Assuming a two-department economy, the aggregate rate of profit for a single period is

\[
\pi = \frac{S}{V} \frac{C}{V + 1} = \frac{1 - \lambda_2 D}{\lambda_2 D} \left( \frac{\lambda_1 K}{\lambda_2 DL} + 1 \right),
\]

where

- \(S\) is the surplus arising in production,
- \(C\) is the total value of the aggregate capital good used up in production (\(C = \lambda_1 K\)),
- \(V\) is the value of labour power used in production (\(V = \lambda_2 DL\)),
- \(\lambda_1\) is the unit value of the aggregate capital good,
- \(\lambda_2\) is the unit value of the aggregate consumer good,
- \(K\) is the physical number of units of capital employed in production,
- \(L\) is the amount of labour employed in production,
- \(D\) is the real wage, the number of units of the consumer good received by labour as compensation for work.

Early debate about the theory of the falling rate of profit centred on a variety of issues (Blaug, 1960; Hodgson, 1974; Mattick, 1969; Sweezy, 1970; Wright, 1979; Yaffe, 1973). In summary, labour-saving technical changes are necessary if long-term economic growth is to exceed the rate of growth of the labour supply. With no change in commodity values, the rate of profit tends to fall. However, the values of commodities are themselves altered by technical change, which may reduce the value composition of
capital and raise the rate of exploitation (at a constant real wage), thus preventing the rate of profit from falling. These conclusions are less than sharp. However, changes in input coefficients reflect the desire of capitalists to increase profits, thus restricting the forms that technical change might take.

The implications of this restriction were investigated by Okishio (1961), who asked about the types of technical changes that would be introduced by competitive firms. Okishio thus explicitly analysed the microeconomics of individual behaviour in order to understand the forms of technical change that actually appear. He considered a two-sector model of the economy: firms in sector 1 produce a capital good and firms in sector 2 produce a consumer good. Commodities are sold at prices of production (those prices at which firms in the two departments all earn the same rate of profit). Okishio assumed that supply and demand are in equilibrium and that the real wage is fixed. He argued that in a competitive market capitalists only adopt a technical change if it reduces costs at existing prices. In a competitive market (with equilibrium prices) any such technical change raises the immediate rate of profit of the innovator. The temporary inequality of rates of profit is then thought to induce a movement of capital that restores equilibrium and adjusts prices. Assuming constant real wages and market clearing, Okishio proved that cost-reducing technical changes must also increase the equilibrium rate of profit.

The publication of Okishio's work has reignited controversy over profit rates. The conclusions have been disputed in several ways. Laibman (1982), Rigby (1990), and Roemer (1978) all examined the consequences of relaxing Okishio's assumption of a constant real wage and showed that Okishio's conclusions are not robust. Alberro and Persky (1979), Nakatani (1980), Roemer (1979), Shaikh (1978), and Steedman (1980) have examined the implications of fixed capital for Okishio's conclusions; Reuten (1991) reviewed this debate, which is not resolved. Okishio's model can also be questioned on another ground, which forms the basis for this paper. Okishio employed the logically inconsistent assumptions of market clearing and constant wages. The issue is assumed away in Okishio (1961) and rarely since argued: the equilibrium assumptions are widely accepted. Yet these assumptions are critical in resolving the issue of the falling rate of profit and questions about them motivate the theoretical arguments in this paper.

3 Equilibrium and the rate of profit

How, then, are capital–output ratios, wage increases, the failure of demand, and productivity change related to the history of the rate of profit? This is a classic problem of macroeconomic dynamics. The technical apparatus of theory has not been able to characterise the problem well, for despite all the effort that has been put into the theory of the falling rate of profit, formal models simply have not specified how all these variables are related. So, for example, Okishio relied on the assumptions that prices are at equilibrium, that real wages are constant, that markets clear and that all capital is productively employed to prove that cost-reducing technical changes increase the equilibrium rate of profit. Roemer, Laibman, Rigby, and Salvadori (1981) have all adjusted Okishio's assumptions and question the generality of his conclusions. But there still does not exist a formal, dynamic, macroeconomic model in the Marxist tradition in which capital–output ratios, wage changes, demand, and technical change are all internally connected to each other and to the rate of accumulation.

Furthermore, existing theories rely overly on the notion of equilibrium. Even dynamics is commonly conceived as change from one equilibrium position to another. So prices of production are prices that support equal rates of profit. Indeed the entire idea of 'the price' reflects the central equilibrium concept that all instances of a commodity are offered for sale at the same price (Farjoun and Machover, 1983). In addition the
effects of technical change on profitability are usually calculated under the assumptions that demand and supply are equal, the wage rate is fixed exogenously, and all capital is gainfully employed in production. [See, for example, equation (2): demand is what is produced and capital is what is needed in production.]

Actually all economies are off equilibrium. Change is intrinsically nonequilibrium and is not generally well understood as a shift between a pair of equilibria. So instances of a commodity do not normally command the same price; the demand and supply of commodities differ geographically and vary historically; wages depend on the demand and supply of labour but also on historical and geographical conditioning; capital is undersupplied or oversupplied. Productivity change is an inherently probabilistic process in which marginal adjustments and learning reflect imperfect attempts to find better technical conditions rather than optimal states: firms innovate, learn, imitate, compete. And location is dominated by history and by local attempts to overcome history. The East Asian dragons and other newly industrialised economies (NIEs) have demonstrated just how powerful local struggle can be in escaping structural traps. So the essence of macro dynamics turns on the relations between the demand for labour, wages, the demand for commodities, and the supply and demand for capital—and the way these relations change over time. Yet many models of the rate of profit assume these problems away through their equilibrium assumptions: Okishio's theorem and Roemer's modifications reflect equilibria in which prices are prices of production, wages are fixed exogenously, demand can absorb all the commodities that are produced, and profits are calculated only on the capital employed in production.

The central relations that determine the history of profitability are these. Rapid rates of accumulation raise the demand for labour and therefore may tend to press wages upwards or induce firms to economise on labour. The demand and supply of commodities are linked through wages and investment policies. The aggregate profitability of capital depends not simply on the return on capital that is actually used in production but also on the amount of capital that can find productive use. That is: the history of profitability depends on the relations between accumulation and the rate of growth of the labour force; between wages and the demand for commodities; between investment policies and supply; and between capacity and demand. None of these conditions are found in conventional models of the falling rate of profit.

4 Accumulation without equilibrium
Models of this kind of system were also investigated by Nikaido (1977; 1978) and developed in Webber (1989). Unlike neoclassical (Burmeister, 1980; Debreu, 1959), von Neumann (1945), and Cambridge (Robinson, 1961; Sraffa, 1960) growth models, the argument does not presume that all industries make an equal rate of profit at equilibrium. The model presented here makes further progress towards realism because it is of a disequilibrium type, in which demand and supply are not necessarily equal and in which capital may be oversupplied. The model differs from the directions taken by recent growth theories: unlike the classical models of crossover dynamics (Dumenil and Levy, 1994; Flaschel and Semmler, 1987), the model eschews notions of equilibrium; unlike the new growth theory, the model is classical.

The argument is quite general: important definitions are offered and central relationships specified, either as equalities or as inequalities. However, we do not attempt to model the trajectories of variables or the particular functional forms of relationships, such as trade, productivity, and wages. So, for example, the trajectories of wages or of technologies are taken as given rather than being derived theoretically. It is only by passing over the functional relationships between the so-called 'independent parameters' that the model can derive necessary relations between them.
A one-sector system is analysed: a general multiregional model has not yet been constructed. The restriction to a single sector is limiting. In particular, it means that relative prices are ignored. It also implies that the model is unable to examine either interregional competition or the implications of the performance of different sectors for an aggregate economy. It is intended to generalise the model to several sectors and regions; indeed some theoretical work has already been published in this direction (Webber, 1996) and some empirical work has been completed (Webber, 1997). In any event, virtually all of the neoclassical and Marxist models with which this model may be compared are themselves either single-sector models or only trivially multisector.

Even if economies are not necessarily in equilibrium, they are subject to constraints. Three conditions constrain the behaviour of economic systems, which are listed below.

1. In aggregate, demand does not exceed supply:

\[ x^d \leq x^s. \]  

(In this formulation, demand includes exports and supply includes imports). After all, producers and consumers cannot consume what has not been produced. Demand may be growing faster than supply, but that is a different matter, at least in the short run.

2. Furthermore, supply cannot exceed the capacity of capital to finance production. Suppose that each unit of output requires on average \( a \) units of the commodity and \( l \) units of labour power for its production. The average unit of labour power consumes \( D \) units of the commodity per time period. So the total cost of production per unit of output is \( a + Dl \) (which will for brevity be denoted by \( T \)). It follows that the available capital \( K \) can only supply

\[ x^s \leq \frac{K}{a + Dl} \equiv \frac{K}{\tau}. \]  

Depending on the technology used in production and on the value of inputs, the available capital limits what can be supplied by firms. Again, the rate of growth of supply may exceed the rate of growth of capital, at least in the short run. [The formulation in inequality (4) is consistent with the existence of fixed capital; the coefficient \( a \) reflects not only inputs of circulating constant capital but also inputs of fixed capital used up.]

3. The demand for labour cannot exceed its supply. As labour is not produced within the capitalist production system, it is not entirely obvious what the supply of labour is. It is clear, though, that there is an upper bound on the availability of labour in a society; suppose that the bound is \( L \), the aggregate supply of labour. Then, remembering that the total supply is \( x^s \) and that the labour requirements per unit of output are \( l \), the constraint is

\[ lx^s \leq L. \]  

Within these limits lie actual levels of supply and demand. Existing models establish the levels of supply and demand by some equilibrating mechanism—and no such mechanism can be justified empirically. Levels of supply and demand have historically and contingently fixed levels within each region; their growth does, though, depend on economic conditions, subject to the constraints.

The rates of growth of supply and demand reflect production decisions, trade, and interregional competition.

1. The supply of labour is regarded as growing at a fixed, unchanging rate, \( g \). We follow the almost universal supposition that capitalists make production decisions on the basis of profitability. That is, profit rates act as a motive. (Of course the availability of funds also constrains decisions to produce.) This is, however, an hypothesis (for evidence
concerning it, see Webber, 1990). The hypothesis that capitalists make production decisions on the basis of profitability implies that the rate of increase in supply is

\[ \dot{x}^s = f(\pi), \quad f'(\pi) > 0, \]

the simplest form of which is

\[ \dot{x}^s = \beta \pi, \quad \beta > 0, \quad (6) \]

where \( \pi \) denotes the rate of profit and \( \beta \) the responsiveness of capitalists to profitability.

2. Within a single closed region the growth of demand depends on both the increase in the quantity supplied and the change in the inputs demanded per unit of supply: this is an accounting relationship. In a multiregion system, some of the increased demand within one region is supplied locally, so the effects of supply on local demand are mediated by the influence of imports, in particular by the ability of local firms to compete against importers for local demand.

Within a single closed region the rate of growth of demand depends on both the rate of increase in the quantity supplied and the inputs demanded per unit of supply. It is

\[ \dot{x}^{d,h} = \dot{x}^s + (a + Dl). \]

However, in an open region, some of that home market (designated by \( h \)) is supplied by foreigners and export markets are supplied by domestic producers. So the actual level of demand for local producers’ output is:

\[ x^d = \rho x^{d,h}, \quad \rho > 0. \quad (7) \]

In this equation, \( \rho \) denotes the ratio of total demand for domestic producers to domestic demand. In other words, \( \rho \) equals one plus the ratio of net exports to domestic demand; if \( \rho \) is increasing, so are net exports as a proportion of the domestic market. The parameter reflects the success of domestic producers in exporting or in import-substituting.

It is assumed that capital investment is made out of the surplus that arises during production. The aggregate rate of capital accumulation is

\[ \dot{K} = sn, \quad s > 0 \quad (8) \]

where \( s \) is the proportion of profits that is saved. Savings come from profits not wages.

The behaviour of capitalists is reflected in this model by the parameters \( \beta, s, \) and \( \rho \), which are taken as given. Of course, the decisions of producers reflect the success or failure of past decisions: firms modify their investment, output, and export decisions in the light of history. We seek in this paper, though, to understand the significance of those parameters for growth and to identify the relations that must hold between them if profitable accumulation is to continue. The assumptions embodied in equations (6), (7), and (8) achieve these aims.

Last, we must offer an appropriate definition of the rate of profit. The usual definition of the rate of profit must be notified in two respects. First, consider the calculation of the surplus. This equals the revenue obtained from sales less the direct costs of production (labour, raw materials, and other material inputs) and less depreciation on capital. Usually, in practice if not in principle, depreciation is calculated on the capital that is employed within production. Actually, however, all capital depreciates, whether or not it is productively engaged within production. Equally, even unsold goods are costly to produce. The real costs of production exceed the costs of supplying the actual level of demand, because there is unused capacity and some goods remain in stock. Models of economic growth do not commonly reflect this principle. Second, the rate of profit is calculated as the surplus divided by the amount of capital. It is usual in practice, if not in principle, to measure the amount of capital employed as that productively engaged
in production. In fact, though, the real measure against which the surplus needs to be assessed is the total amount of capital within the system, not only that capital which is used productively. An appropriate definition of the rate of profit must therefore incorporate both the disequilibrium assumptions of this theory: supply must at least equal demand and capital available exceed that actually employed productively.

These modifications are formally important. In the better discussions of economic development and the rate of profit (for example Harvey, 1982) it is clearly recognised that capital can be oversupplied; indeed, that one of the causes of economic crisis is the fact that there exists a fund of capital that cannot be employed productively. That clear recognition of the truth of the matter is, however, not commonly embodied within formal and mathematical models of economic dynamics, where the rate of profit is calculated on the basis of capital productively employed. Formal mathematical models have therefore so far been unable to examine the implications of overaccumulation. Here, that problem has been overcome.

The total demand for the commodities produced is \( x^d \). The total cost of production is \( (a + Dl)x^s \). Prices for inputs and for outputs are the same. Thus the aggregate rate of profit is:

\[
\pi = \frac{x^d - (a + Dl)x^s}{K} = \frac{x^d - \tau x^s}{K}. \tag{9}
\]

If there are no net exports, if demand equals supply, if the turnover period of capital equals one year, and if all capital is actually used productively, then definition (9) reduces to the usual definition:

\[
\pi = \frac{(1 - \tau)x}{\tau x} = \frac{S}{ax + Dlx} = \frac{S}{C + V}.
\]

Here, \( S \) denotes the surplus, \( C \) the constant capital, and \( V \) the variable capital; \( x \) is both demand and supply. But this usual definition rests on strict assumptions of equilibrium.

Our task is to understand the dynamics of this system. The system has three important characteristics. First it is a macro system: no attempt has been made to model the manner in which capitalists make decisions to invest in new technology nor to incorporate a theory about wage formation. Instead, the effects of different unit costs of production (\( \tau \)) on the rate of profit are examined. Second, the determinants of investment, of decisions to supply, and of demand are all different. Commonly, these are modelled interdependently; but then those models are incapable of examining the possibilities of oversupply and of overexpansion of capital. Third, the rate of profit is defined to reflect the facts that supply and demand may differ and that capital may be oversupplied.

Two important assumptions govern the analysis. First, it is supposed that \( \rho, \beta, s, \) and \( \tau \) are all independent of the rate of profit. That is, they are parameters, not functions. (In this sense, the model is rather distant from new growth models, in which the rate of accumulation of knowledge is determined endogenously: but this assumption is truly a matter of analytical simplicity rather than a necessary characteristic of the model.) Later, we examine some necessary relations between the parameters, relations that provide a basis for a theory of regulation. Second, it is supposed that \( \beta \) and \( s \) are constant (do not change over time), whereas the rates of change of \( \rho \) and \( \tau \) are constant (and equal to \( P \) and \( T \) respectively):

\[
P = \frac{d\rho}{\rho} = \text{constant}; \quad T = \frac{d\tau}{\tau} = \text{constant}.
\]

Again, some necessary changes in those parameters are deduced.
5 The dynamics

We begin by thinking about the evolution of profit rates when the constraints do not hold. Suppose, for example, that initially plenty of labour is available, demand is below output and the capacity utilisation rate is low. The system of equations implies a particular history of the rate of profit. In particular, the rate of profit changes in a manner that depends on the capacity utilisation rate and growth in effective demand \((P x^d/K)\), on the rate of change in the unit costs of production \((T)\), and on the difference between the rates of growth of output and of capital accumulation \((\beta - s)\), together with the existing rate of profit. Dependent on the magnitudes of those parameters, a great variety of trajectories of the rate of profit is possible.

This conclusion can be made more precise. If we take the total differential of equation (9) and substitute equations (6)-(8), we arrive at the differential equation that describes the history of profitability in this open region,

\[
\frac{d\pi}{dt} = P\frac{x^d}{K} + T\pi + (\beta - s)\pi^2,
\]

(10)

where \(P = d\rho/\rho\) is the rate of change in the ratio of total to domestic demand and \(T = d\tau/\tau\) is the rate of change in the unit costs of production \((a + Dl)\). Both \(P\) and \(T\) are assumed constant.

By differentiating equation (10) and substituting for \(P x^d/K\), we obtain the fundamental differential equation for the system,

\[
\frac{d^2\pi}{dt^2} = [P + 2T + 3(\beta - s)\pi]\frac{d\pi}{dt} - [P + T + (\beta - s)\pi][T + (\beta - s)\pi]\pi.
\]

(11)

This equation can be analysed numerically but is not the central equation used in the following qualitative analysis.

Our task is to understand the histories of profitability that are permitted by equations (10) and (11). We consider two separate cases. First, suppose that net exports comprise a fixed proportion of domestic demand \(P\); that is, \(P = 0\). This does not mean that exports equal imports, nor that exports and imports are growing at the same rate, it means that net exports form a constant proportion of domestic consumption. Second, we suppose that \(P \neq 0\); that is, net exports are growing or declining as a proportion of domestic demand.

5.1 \(P = 0\)

In this case, equation (10) simplifies to:

\[
\frac{d\pi}{dt} = T\pi + (\beta - s)\pi^2.
\]

(12)

This equation is simple to manipulate. The solution to equation (12) is:

\[
\pi_t = \frac{\pi_0}{1 - \pi_0 (\beta - s)t}, \quad \text{if } T = 0;
\]

(13)

\[
\pi_t = \frac{\pi_0 T \exp(Tr)}{\pi_0 (\beta - s)[1 - \exp(Tr)] + T}, \quad \text{if } T \neq 0.
\]

The implications of this result can be understood with the aid of some diagrams.

Suppose first that the unit costs of production are tending to rise. In figure 1 the possible relations between \(d\pi\) and \(\pi\) are plotted, when unit costs of production are tending to rise, that is, \(T > 0\). The graphs indicate that, no matter how fast output is growing and capital is accumulating, if the rate of profit ever falls to zero, it stays there. \(\pi = 0\) is an (unstable) equilibrium of this system. If the rate of profit ever falls below
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Figure 1. Graph of $d\pi$ as a function of $\pi$ for $T > 0$.

zero, it tends to fall further. If the rate of profit ever exceeds zero it tends to grow further. If output is growing at least as fast as capital is accumulating ($\beta - s \geq 0$) then the higher the rate of profit, the faster it grows (at least if the rate of profit is positive). However, in the case where output is growing more slowly than capital is accumulating, the rate of profit tends to grow up to the point at which $\pi = -T/(\beta - s)$; and if the rate of profit exceeds that value, it tends to fall back to it. These trajectories are illustrated in figure 2 (over). In general, if the rate of profit is positive, it grows, unless capital is accumulating faster than output is growing (when the rate of profit tends towards a fixed value). Thus, if costs of production are increasing, the rate of profit is growing without bound or tending to some fixed positive value. (Remember, the implications of the constraints have still to be analysed.)

Second, consider the case in which the unit costs of production remain constant; that is, $T = 0$ (figure 3). Now there are three possibilities: if output grows faster than capital accumulates, the rate of profit expands without limit (until the mathematics become indeterminate); if the two rates are the same, the rate of profit is constant, at whatever level it started; and if output is growing more slowly than capital is being accumulated, then the rate of profit falls (provided that the constraints never bind).

The third general case is characterised by falling unit costs of production ($T < 0$); see figure 4. Again there is an equilibrium when the rate of profit equals zero. In general, the graph shows that the rate of profit tends to decline, unless output is growing faster than capital is being accumulated. These relations are made explicit in figure 5. If output is growing no faster than capital is being accumulated, then the rate of profit tends to fall (if it is positive in the first place). If output grows faster than capital is accumulated, then the rate of profit falls (if it starts off at a low level) or rises explosively (if it starts high), at least in the absence of constraints.

These results can be summarised as follows. First, there is no general tendency for the rate of profit to rise or fall; history depends on the rate of change in unit costs of production, on the relative rates of capital accumulation and of growth of output and, in some cases at least, on the initial conditions of the system. Second, if output is growing faster than capital is being accumulated, then profitability rises (the case of $T < 0$ is more complex). Third, if capital is being accumulated more rapidly than output is growing, the rate of profit tends to fall, either to zero or to some positive limit (the case of $T > 0$ is more complex). The final case is one in which capital is accumulating at the
Figure 2. Graph of evolution of $\pi$ over time for $T > 0$.

Figure 3. Graph of evolution of $\pi$ over time for $T = 0$. 
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Figure 4. Graph of $d\pi$ as a function of $\pi$ for $T < 0$.

Figure 5. Graph of evolution of $\pi$ over time for $T < 0$. 
same rate as output is growing: this is really the circumstance that underlies many models that are used to examine the history of profitability. In this case, profitability either rises or falls, depending on whether the unit costs of production are rising or falling. The essential results of some earlier models are thus confirmed: the history of the rate of profit depends on the rate at which wages increase in relation to the rates of change of productivity. However, these conclusions are valid in the short term only: the constraints (3), (4), and (5) impose additional requirements on the history of the rate of profit. After all, in the long run, output cannot continue to expand faster than capital; nor demand faster than output; much less is the supply of labour indefinitely elastic.

The simplest constraint—and the one most commonly examined in debates about the rate of profit—is (5), that the labour force must exceed the demand for labour in the economy,

\[ \dot{x}^s \leqslant L. \quad (5) \]

If the labour force is growing at a constant rate, \( g \), it expands exponentially. The demand for labour falls if labour is being replaced in production (that is, if \( \dot{l} < 0 \), where \( \dot{\cdot} \) denotes rate of growth) but grows to the extent that supply is increasing; the net effect of these two forces determines the demand for labour. If the supply of labour poses no limitations on the growth of output, then constraint (5) does not affect the histories examined so far. If, however, rates of profit are relatively high—if, that is, profitability is growing—then output tends to increase faster than the labour force and that fact puts pressure on the supply of labour. If output does indeed press on the supply of labour then constraint (5) implies that the rate of growth of output is constrained,

\[ g = \dot{L} = \dot{l} + \beta \pi. \]

If labour becomes limiting, then, the maximum sustainable rate of profit is

\[ \pi = \frac{g - \dot{l}}{\beta}. \quad (14) \]

This is the established conclusion that the rate of growth of output \((\beta \pi)\) at equilibrium is limited by the rate of growth of the labour force net of labour-replacing technical changes.

Consider next the constraint that the demand for the output of domestic producers cannot exceed their supply. Define the ratio

\[ w = \frac{x^d}{x^s}. \]

It follows that

\[ \frac{dw}{w} = \dot{x}^d - \dot{x}^s = P + T. \quad (15) \]

As for the moment it is assumed that net exports are a constant proportion of domestic demand \((P = 0)\), it follows that the ratio of demand to supply is increasing exponentially if the unit costs of production \((\tau = a + Dl)\) are rising and is falling exponentially if the unit costs of production are falling. In other words, if unit costs of production are rising \((T > 0)\), the level of demand faced by domestic producers eventually exceeds their capacity to supply and that will force them to reduce unit costs. In effect, the system cannot sustain rising costs of production for ever; eventually the constraint binds and then \( T \leqslant 0 \). The system can sustain indefinitely the case in which unit costs of production are falling.
The constraint that output cannot exceed the capacity of capital to produce is more complex. Because the forms of the integrals are different, we need to consider the two cases, $T = 0$ and $T \neq 0$, separately. In both cases, we define a function

$$v = \frac{\tau x^s}{K},$$

or

$$\frac{dv}{v} = T + (\beta - s)\pi.$$  

If $T = 0$, then substitution of equation (13) yields the result that

$$v = \frac{v_0}{1 - \pi_0(\beta - s)t},$$

where $v_0$ denotes the initial value of $v$. Equation (17) implies the following.

1. If output is growing more slowly than capital is accumulating ($\beta - s < 0$), the rate of profit is falling and the ratio $\tau x^s/K$ is falling too. The constraint is never binding.

2. If output is growing at the same pace as capital is accumulating ($\beta - s = 0$), the rate of profit is constant and so is the ratio $\tau x^s/K$.

3. If output is growing more rapidly than capital is accumulating ($\beta - s > 0$), the rate of profit is rising and the ratio $\tau x^s/K$ is rising too. Indeed, as time passes, the ratio of output to capital becomes ever and ever greater; the constraint, that output cannot exceed the capacity of capital to produce, must eventually bind. Once that happens, the ratio $\tau x^s/K$ can no longer increase. Then $(dv/v) \leq 0$ so that $[T + (\beta - s)\pi] \leq 0$ or, as $T = 0$ and $\pi > 0$, $\beta - s < 0$. In other words, output cannot indefinitely grow faster than capital is accumulated; any prolonged period of such growth must give way to the case in which capital is accumulated at least as fast as output grows.

If $T \neq 0$, integration yields

$$v = \frac{v_0 T \exp(Tt)}{T + \pi_0(\beta - s)[1 - \exp(Tt)]}.$$  

To analyse the implications of equation (18) we shall suppose that $\pi_0 > 0$.

If $T > 0$, the following cases arise.

1. If $\beta - s = 0$ (output is growing at the same pace as capital is accumulating), both the rate of profit and the ratio $\tau x^s/K$ grow exponentially. Eventually, therefore, the constraint binds and

$$T + (\beta - s)\pi \leq 0.$$  

2. If $\beta - s > 0$ (output is growing more rapidly than capital is accumulating), both the rate of profit and the ratio $\tau x^s/K$ explode and again the constraint must eventually bind.

3. If $\beta - s < 0$ (output is growing more slowly than capital is accumulating), then either (a) $\pi_0 > -T/(\beta - s)$, in which case $v$ is falling, or (b) $\pi_0 < -T/(\beta - s)$ then $v$ rises to a limit, $v^*$ say. That limit may or may not exceed the constraint; its value depends not only on the parameters that describe the system but also on the starting values of the variables. If the value $v^* > 1$, the constraint becomes binding.

If $T < 0$, then the following occurs.

1. If $\beta - s = 0$, then $v$ falls exponentially to zero, as does the rate of profit. The constraint never binds.

2. If $\beta - s > 0$, the outcome again depends on the starting rate of profit.

(a) If $\pi_0 > -T/(\beta - s)$, then $v$ rises explosively over time and the constraint becomes binding.

(b) If $\pi_0 < -T/(\beta - s)$, $v$ falls over time, like the rate of profit. The constraint never binds.

3. $\beta - s < 0$, $v$ falls over time, as does the rate of profit.
This analysis is summarised in figure 6. Suppose that net exports as a proportion of domestic demand are constant. Then the following occurs.

1. The rate of profit may rise or fall, depending not only on the values of the parameters \( T \) (the rate at which unit costs are changing) and \( \beta - s \) (the difference between the rate of growth of output and the rate of capital accumulation), but also on the initial rate of profit.

2. However, the constraints—that demand (for output or for labour) not exceed supply and that output not exceed the capacity of the system to produce—limit the values of the parameters that are sustainable in the long run.

3. The constraint that demand not exceed supply implies that in the long run \( T \leq 0 \), for otherwise the constraint is violated. It is not possible in the long run for unit costs of production \( \tau = a + Dl \) to continue to increase. Therefore, trajectories of the rate of profit that assume \( T > 0 \) cannot be sustained. In the terms of figure 6, the first three cases are ruled out as sustainable long-run histories of the rate of profit.

4. If \( T = 0 \) and \( \beta - s > 0 \) (case 4) then, in the long run, output exceeds the system’s capacity to produce and the constraint implies that \( \beta - s \leq 0 \). In the long run, if unit costs of production are constant, output expands no faster than the rate at which capital is being accumulated. If it is socially possible to sustain the pair of conditions that \( T = \beta - s = 0 \) (case 5), the rate of profit can be sustained at a constant level. Otherwise the rate of profit falls to zero.

5. If \( T < 0 \) and \( \beta - s \leq 0 \) (cases 8 and 9), the rate of profit falls and neither constraint binds.

6. If \( T < 0 \) and \( \beta - s > 0 \) (case 7), history depends on the initial rate of profit. If the rate of profit is relatively low \( \left[ \pi_0 < -T/(\beta - s) \right] \), the rate of profit tends to fall. If the rate of profit is higher, the rate of profit grows and output eventually exceeds the capacity of the system to produce. The constraint then implies that \( T + (\beta - s)\pi \leq 0 \), which means that the rate of profit is relatively low \( \left[ \pi < -T/(\beta - s) \right] \) and so it falls.

7. Superimposed on all these conditions is the requirement that the supply of labour exceed the demand for labour. If that constraint ever binds, then it too imposes an upper bound to the rate of profit.

In other words, if net exports comprise a constant proportion of domestic demand, it is not possible to sustain a growth pattern in which the rate of profit increases indefinitely. Provided that the social apparatus (‘mode of regulation’) exists to ensure that the unit costs of production are constant and that capital is accumulated at the same rate as output grows (\( T = \beta - s = 0 \)), the rate of profit can be sustained at a positive level. If that condition cannot be sustained, the rate of profit falls. The second of these conditions is simple: output grows at the same rate that capital is accumulated. The first condition is more complex.

If \( T = 0 \), then

\[
T = \frac{d\tau}{\tau} = \frac{da + Ddl + lDdD}{a + Dl} = 0,
\]

whence

\[
\frac{dD}{D} = -\frac{da + Ddl}{Dl}.
\]  

Equation (20) is a rule governing the required pattern of wage increases in the system. Sustained profitability requires (at least) that the rate of increase in real wages shall match the rate at which labour inputs are decreased less the change in inputs of plant, equipment, and machinery per dollar of wages.
### Table

| $T$  | $w = xd/xs$ | $\beta - s$ | $\pi$ | $v = \tau x s / K$ | Implication |
|------|-------------|-------------|-------|--------------------|-------------|
| $> 0$ | ![Graph](image1) | $> 0$       | ![Graph](image2) | ![Graph](image3) | C1 $T + (\beta - s)\pi < 0$ |
|      | ![Graph](image4) | $= 0$       | ![Graph](image5) | ![Graph](image6) | C2 $T + (\beta - s)\pi < 0$ |
|      | ![Graph](image7) | $< 0$       | ![Graph](image8) | ![Graph](image9) | C3 Constraint may or may not bind |
| $= 0$ | ![Graph](image10) | $> 0$       | ![Graph](image11) | ![Graph](image12) | C4 $(\beta - s)\pi < 0$ |
|      | ![Graph](image13) | $= 0$       | ![Graph](image14) | ![Graph](image15) | C5 Constant rate of profit; No constraint |
|      | ![Graph](image16) | $< 0$       | ![Graph](image17) | ![Graph](image18) | C6 Falling rate of profit; No constraint |
| $< 0$ | ![Graph](image19) | $> 0$       | ![Graph](image20) | ![Graph](image21) | C7 $T + (\beta - s)\pi < 0$ |
|      | ![Graph](image22) | $= 0$       | ![Graph](image23) | ![Graph](image24) | C8 Falling rate of profit; No constraint |
|      | ![Graph](image25) | $< 0$       | ![Graph](image26) | ![Graph](image27) | C9 Falling rate of profit; No constraint |

### Figure 6
Possible trajectories of profitability, demand and supply, and capital: output ratio; accumulation, and regulation.
Aglietta (1979) and the regulationists who succeeded him did not quite find the conditions under which profits could be sustained. Aglietta claimed that the system had to be regulated in such a manner that the rate of increase of real wages matched the rate of increase in labour productivity \((dD/D = -dL/dL)\). In fact this is not quite the correct statement of the condition: equation (20) is more complete in this respect. In addition, the regulationists missed the second condition: \(\beta - s = 0\), output and capital must increase at the same rate. They also missed the third potential condition: that the demand for labour not exceed the supply.

Furthermore, these are conditions over social life in the long run. In the short term it is entirely possible for unit costs to rise and for output to rise faster than capital is accumulated (and then profitability would tend to increase). In fact, rising unit costs of production are entirely consistent with rising profitability, at least in the short run. That is to say, the following histories are consistent with the dynamics that have been presented.

1. The conditions \(T = \beta - s = 0\) hold exactly from one year to the next. Output grows at the same rate as capital is accumulated, and wage increases follow a particular rule. In that case, the rate of profit is constant.
2. The conditions \(T = \beta - s = 0\) hold on average over a period of years. In that case, the rate of profit is on average constant, but it fluctuates from year to year or from one period of years to another.
3. The conditions \(T = \beta - s = 0\) do not hold on average. In that case, the constraints ensure that in the long run \(T < 0\) and/or \(\beta - s < 0\) and the rate of profit falls.

Slightly differently expressed, if net exports form a constant proportion of domestic demand, then in the long run the rate of profit falls unless unit costs of production do not change and output is expanded at the same rate as capital is accumulated.

However, a more precise statement of the history of profitability requires that we take account of changing trade relations (another feature of regulationists' interpretations of postwar changes in profitability). It is to this issue that we now turn.

5.2 \(P \neq 0\)

We can understand some of the implications of this case from equation (10):

\[
\frac{d\pi}{dt} = P \frac{x^d}{K} + T\pi + (\beta - s)\pi^2.
\]  

Evidently, \(d\pi\) can be analysed into two components: the terms \(T\pi + (\beta - s)\pi^2\), the trajectories of which were investigated in section 5.1, and the term \(Px^d/K\), which forces an additional element on the history of profitability.

Some qualitative comments follow immediately.

1. If net exports comprise an increasing proportion of the domestic market \((P > 0)\), then for any given rate of profit, profitability rises faster than it would were \(P = 0\). That is to say an improvement in the balance of trade (import substitution or export success) raises the rate at which profits rise (or reduces the rate at which profits fall) for any given level of profits.
2. If net exports form a decreasing proportion of the domestic market \((P < 0)\), then for any given rate of profit, profitability is rising more slowly than if \(P = 0\). If the balance of trade is deteriorating, the rate at which profit rises is diminished (or the rate at which it falls is raised), for any given level of profits.
3. However, the difference between the actual change in profitability and the change which would have occurred were \(P = 0\) depends not only on the growth of net exports but also on the quantity \(x^d/K\) (the ratio of demand to the capital stock). In other words, whether the benefits of an improving balance of trade increase over time or
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The rate of profit diminishes depends on the relative rates at which capital is accumulated and the demand for local production rises.

An indication of the effects of changes in the balance of trade can be gleaned from the case in which costs of production are constant \((T = 0)\) and output grows at the same rate as capital is accumulated \((\beta - s = 0)\). As we deduced in section 5.1, this means that the rate of profit is constant if \(P = 0\). If \(P \neq 0\), the differential equation (11) can be simplified to

\[
\frac{d^2 \pi}{dt^2} = (P) \frac{d\pi}{dt},
\]

which can be readily integrated to yield

\[
\pi = \pi_0 + \frac{\pi_0}{P} [\exp(Pr) - 1].
\]

Here, \(\pi_0\) denotes the initial rate of profit and \(\pi_0\) the initial change in the rate of profit. In the case of import-substituting or export-led growth \((P > 0)\), the rate of profit grows exponentially. If the balance of trade is deteriorating and local producers are supplying smaller and smaller proportions of the domestic market, the rate of profit declines exponentially. Export-led or import-substituting growth works, but only for a time. The constraint that demand not exceed supply can be analysed by means of equation (15)

\[
\frac{dw}{w} = \dot{x}^d - \dot{x}^s = P + T,
\]

where \(w\) denotes the ratio of demand to supply. Evidently that ratio rises exponentially if \(P + T > 0\) and falls exponentially if \(P + T < 0\). That is to say: if unit costs of production are not falling sufficiently rapidly, export-led growth (with \(P > 0\)) will eventually run up against the constraint that demand cannot exceed supply. Formally, that constraint can only be avoided if unit costs of production \((\tau + Dl)\) are falling at least as fast as exports are growing (or imports are falling). If the constraint is imposed, then \(dw/w + T = 0\).

By an argument similar to that used earlier, it can be shown that either the rate of profit is falling or the rate of profit is rising but encounters the constraint that output not exceed the capacity to produce. That constraint is

\[
T + (\beta - s)\pi \leq 0.
\]

In other words, in the long run, either the rate of profit is falling or it is upper-bounded by the pair of constraints (15) and (19) (and, potentially by the supply of labour). But then,

\[
\frac{d\pi}{dt} = \frac{x^d}{K} P + T \pi + (\beta - s)\pi = -\frac{x^d}{K} T.
\]

If the two constraints are binding, then both

\[
\dot{x}^d = x^s, \quad \text{and} \quad \tau x^s = K,
\]

implying that the equation of constrained profitability becomes

\[
\frac{d\pi}{dt} = -\frac{1}{\tau} T,
\]

and the upper bound on the rate of profit is

\[
\pi \leq \frac{1 - \tau}{\tau}.
\]
Equations (22) and (23) make clear the difference that increasing net exports makes. If net exports are increasing as a proportion of the home market \((P > 0)\), technical change can continue to reduce unit costs of production \((-T > 0)\), and the rate of profit can continue to rise. If net exports are constant or falling \((P \leq 0)\), unit costs of production must rise \((T > 0)\), and the rate of profit must fall. The problem for national economies in the long run, of course, is that exports cannot continue to rise indefinitely as a proportion of home demand. In the short term, export-led growth raises profitability and therefore the rate of accumulation of capital. In the longer term, the rate of profit is constrained by capacity constraints and by the requirements that the demands for product and labour not exceed their supplies. In the even longer term, growth of net exports is constrained by the political and economic repercussions in export markets of this form of growth and then (with \(P = 0\)) rates of profit stabilise at best.

6 Conclusion: economic regulation and postwar economic history

The argument of this paper is predicated on the observations that demand, output, and investment decisions are made on different bases. Output decisions are not the same as investment decisions and, therefore, rates of capital accumulation and of output growth may differ. Although the growth of demand depends on the requirements of local production, it is also affected by export success. And underlying all of these is the rate at which unit costs of production are changed. However, the fact that decisions about demand, output, and investment are made on different bases does not mean that they are independent: capacity constraints and the requirements that demands not exceed supplies all impose limits on the possible rates at which those variables grow, at least in the long run. We are led, therefore, to analyse the possible histories of profitabilities over three different time horizons.

In the short run, the rate of change of unit costs, the rate of growth of net exports, and the relative rates of growth of output and capital can all take on unrelated values. In that short time frame, the constraints do not bind and the rate of profit can change in a great variety of ways. Roughly, the results of the paper imply that if demand is growing faster than output (because unit costs of production are rising or net exports are growing) and if output is growing faster than capital is being accumulated, the rate of profit is rising explosively. Equally, if demand is growing more slowly than output and output more slowly than capital is being accumulated, the rate of profit falls. (There are some intermediate and more complex cases.) These factors evidently make more complex than usual the calculation of the dynamics of rates of profit. Trade, the rates of growth of demand, supply, and capital stock, and the rates of technical and wage change all interact to produce an actual history of profitability.

In the longer run, if the rate of profit is rising, the constraints bind but exports as a proportion of domestic demand may grow or fall. If demand is growing more rapidly than output, the economy eventually runs up against the demand—supply constraint. This constraint yields the first regulatory condition: unit costs of production must decrease in the long run if net exports as a proportion of domestic demand are growing,

\[ P + T = 0 . \]

Also, the economy may run up against a second demand—supply constraint: that the demand for labour not exceed its supply. This constraint prompts the second (potential) regulatory condition: in the long run, the rate of growth of output is upper bounded by the relative rates of growth of the labour force and of the unit demand for labour,

\[ x^t = \beta \pi \leq (g - \bar{I}) . \]
And, third, economic growth is constrained by the limitation that output cannot exceed capacity to produce. But then rates of capital accumulation and of growth of output are constrained by the rate at which unit costs of production are changing: in the long run the rate of profit can grow only as permitted by the rate of reduction in unit costs of production,

\[
\frac{d\pi}{dt} = -\frac{T}{\tau}.
\]

These regulatory conditions in turn imply that particular patterns of wage bargaining and particular responses towards inducements to invest and to produce have been established within the social system. What this argument means is this: either the rates of investment, of growth of output, of change in net exports, and of change in unit costs of production cause the rate of profit to fall; or the rate of profit is rising and those changes drive the economy up against the constraints. In turn, those constraints mean that increases in the rate of profit depend on reducing unit costs of production or (equivalently) on increasing the level of net exports as a proportion of domestic demand.

But in the longest run, other nations do not permit an economy to continually increase its net exports: for one country's export success is another country's failure. In the extreme longest run, therefore, net exports are a constant proportion of domestic demand (either exactly or on average over a period of years). In that case, the three regulatory conditions are simplified: unit costs of production cannot continue to rise \((T < 0)\); the rate of profit is upper-bounded by the relative rates of growth of the labour force and of the unit demand for labour \([\pi < (g - \bar{I})/\beta]\); and the rate of profit is upper-bounded by the rate of change in unit costs of production and the difference between rates of capital accumulation and growth of output \([\pi < -T(\beta - \delta)]\). If the first and third of these constraints are met as equalities (either exactly or on average over a period of years), the rate of profit is constant (or fluctuates about a constant mean) and, owing to the second constraint, is limited by the rate of growth of the labour force. If the constraints are met as inequalities, the rate of profit falls.

Now there has been an observed fall in the rate of profit in the OECD (the data employed in this calculation are drawn from Webber (1997). This is true for the Japanese economy and for an aggregate region defined as the rest of the OECD. The observed fall can have two different explanations. Possibly rates of change in unit costs, rates of capital accumulation, rates of growth of output, and rates of growth of net exports as a proportion of the domestic market were such that the rate of profit was falling: the rate of profit in that case would have been following one of the trajectories described in figure 6. Alternatively, Japan and the rest of the OECD may have bumped up against one or more of the constraints (of either the long run or the longest run) and have been unable to maintain those constraints as equalities. The first of these explanations accepts that there is a long-run need to regulate national and international economies if the rate of profit is not to decline, but does not accept that such a failure of regulation was at the heart of the observed history of profitability since the second world war. The second explanation cites a failure of the regulatory apparatus to explain the history.

Within the terms of this model, the first explanation is correct. In Japan, the unit costs of production \(\tau = a + D1\) have been increasing slowly between 1960 and 1990; and in the rest of the OECD were increasing slowly until the 1980s. Second, rates of accumulation of capital have substantially exceeded rates of growth of output. And, third, the rate of increase of domestic demand has been lower than the rate of capital accumulation both in Japan and in the rest of the OECD; even though exports from
Japan have offset this effect, the quantities $P \frac{x^d}{K}$ have been falling or increasing only slowly. Thus, in equation (10)

$$\frac{d \pi}{dt} = P \frac{x^d}{K} + T \pi + (\beta - s) \pi^2,$$

the first term has been declining (or increasing only slowly), the second term was positive, and the third term has been negative. Therefore, the rates of profit both in Japan and in the rest of the OECD have been falling from an initial high towards a relatively low stationary point. This observed history has not been because of a failure of the model of regulation to match the constraints but owing essentially to a falling ratio of demand to capital, an overaccumulation of capital, and a failure of technical change to reduce unit costs of production in the face of wage increases. These causes were operating during the 1960s (and driving profit down then) as well as during the 1970s and (to a lesser extent) in the 1980s. According to this model and the data, the two economies have been following case 3 of figure 6.

References

Aglietta M, 1979 *A Theory of Capitalist Regulation* (New Left Books, London)

Alberro J, Persky J, 1979, “The simple analytics of falling profit rates, Okishio’s theorem and fixed capital” *Review of Radical Political Economics* 11 37 – 41

Barro R J, 1991, “Economic growth in a cross section of countries” *Quarterly Journal of Economics* 106 407 – 443

Blaug M, 1960, “Technical change and Marxist economics” *Kyklos* 13 495 – 509

Bluestone B, Harrison B, 1982 *The Deindustrialization of America* (Basic Books, New York)

Boddy R, Crotty J, 1975, “Class conflict and macro-policy: the political business cycle” *Review of Radical Political Economics* 7 1 – 19

Burmeister E, 1980 *Capital Theory and Dynamics* (Cambridge University Press, Cambridge)

BIE, 1992 *Recent Developments in the Theory of Economic Growth: Policy Implications* Bureau of Industry Economics (AGPS, Canberra, Australia)

Carney J, Hudson R, Lewis J (Eds), 1980 *Regions in Crisis: New Perspectives in European Regional Theory* (Croom Helm, London)

Debreu G, 1959 *Theory of Value* (Yale University Press, New Haven, CT)

Devine J N, 1988, “Falling profit rates and the causes of the 1929 – 33 collapse: towards a synthesis” *Review of Radical Political Economics* 20 87 – 93

Dumenil G, Levy D, 1994 *The Economics of the Profit Rate* (Edward Elgar, Aldershot, Hants)

Dunford M, Geddes M, Perrons D, 1981, “Regional policy and the crisis in the UK: a long-run perspective” *International Journal of Urban and Regional Research* 5 337 – 410

Englander A S, Mittelstadt A, 1988, “Total factor productivity: macroeconomic and structural aspects of the slowdown” *OECD Economic Studies* 10 7 – 56

Farjoun E, Machover M, 1983 *Laws of Chaos: A Probabilistic Account of Political Economy* (Verso, London)

Fischer S, 1988, “Symposium on the slowdown in productivity growth” *Journal of Economic Perspectives* 2(4) 3 – 7

Flaschel P, Semmler W, 1987, “Classical and neoclassical competitive adjustment processes” *Manchester School of Economic and Social Studies* 55 15 – 37

Gibson K D, Horvath R J, 1983, “Aspects of a theory of transition within the capitalist mode of production” *Environment and Planning D: Society and Space* 1 121 – 138

Glyn A, Sutcliffe B, 1972 *British Capitalism, Workers and the Profit Squeeze* (Penguin Books, Harmondsworth, Middlesex)

Goldstein J P, 1985, “The cyclical profit squeeze: a Marxian Microfoundation” *Review of Radical Political Economics* 17 103 – 128

Griliches Z, 1988, “Productivity puzzles and R&D: another nonexplanation” *Journal of Economic Perspectives* 2(4) 9 – 21

Grossman G M, Helpman E, 1991 *Innovation and Growth in the Global Economy* (MIT Press, Cambridge, MA)

Grossman G M, Helpman E, 1994, “Endogenous innovation in the theory of growth” *Journal of Economic Perspectives* 8 23 – 44
Accumulation and the rate of profit

Hahnel R, Sherman H, 1982, “Note: the rate of profit over the business cycle” Cambridge Journal of Economics 6 185 – 194

Harvey D, 1982 The Limits to Capital (Chicago University Press, Chicago, IL)

Henderson J, Castells M (Eds), 1987 Global Restructuring and Territorial Development (Sage, London)

Henley A, 1987, “Labour’s shares and profitability crisis in the United States” Cambridge Journal of Economics 315 – 330

Hodgson G, 1974, “The theory of the falling rate of profit” New Left Review 84 55 – 82

Holmes J, 1983, “Industrial reorganization, capital restructuring and locational change: an analysis of the Canadian automobile industry in the 1960s” Economic Geography 59 251 – 271

Laibman D, 1982, “Technical change, the real wage and the rate of exploitation: the falling rate of profit reconsidered” Review of Radical Political Economics 14 95 – 105

Levine R, Renelt D, 1992, “A sensitivity analysis of cross-country growth regressions” American Economic Review 82 942 – 963

Lipietz A, 1986, “Behind the crisis: the exhaustion of a regime of accumulation. A ‘regulation school’ perspective on some French empirical work” Review of Radical Political Economics 18 13 – 32

Lipietz A, 1987 Mirages and Miracles: The Crisis of Global Fordism (Verso, London)

Long J B de, Summers L H, 1991, “Equipment investment and economic growth” Quarterly Journal of Economics 106 445 – 502

Lucas R E, 1988, “On the mechanics of economic development” Journal of Monetary Economics 22 3 – 42

MacEwan A, Tabb W K (Eds), 1989 Instability and Change in the Global Economy (Monthly Review Press, New York)

Maddison A, 1987, “Growth and slowdown in advanced capitalist economies: techniques of quantitative assessment” Journal of Economic Literature 25 649 – 698

Mahon R, 1984 The Politics of Industrial Restructuring: Canadian Textiles (University of Toronto Press, Toronto)

Mandel E, 1978 Late Capitalism (Verso, London)

Mankiw N G, Romer D, Weil D N, 1992, “A contribution to the empirics of economic growth” Quarterly Journal of Economics 107 407 – 437

Marx K, 1967 Capital 3 Volumes (Penguin, London)

Massey D, 1981, “The U.K. electrical engineering and electronics industries: the implications of the crisis for the restructuring of capital and locational change”, in Urbanization and Urban Planning in Capitalist Society Eds M J Dear, A J Scott (Methuen, London) pp 199 – 230

Massey D, Meegan R, 1982 The Anatomy of Job Loss (Methuen, London)

Mattick P, 1969 Marx and Keynes: The Limits of the Mixed Economy (Peter Sargent, Boston, MA)

Moseley F, 1990, “The decline in the rate of profit in the postwar United States economy” Review of Radical Political Economics 22 17 – 37

Nakatani T, 1980, “The law of the falling rate of profit and the competitive battle: comment on Shaikh” Cambridge Journal of Economics 4 65 – 68

Neumann J von, 1945, “A model and general economic equilibrium” Review of Economic Studies 13 1 – 19

Nikaido H, 1977, “Refutation of the dynamic equalization of profit rates in Marx’s scheme of reproduction”, WP 7722, Modelling Research Group, Department of Economics, University of Southern California, Los Angeles, California

Nikaido H, 1978, “Do profit rates equalize by movement of money capital in Marx’s scheme of reproduction?”, WP 7812, Modelling Research Group, Department of Economics, University of Southern California, Los Angeles, California

Okishio N, 1961, “Technical changes and the rate of profit” Kobe University Economic Review 7 86 – 96

Pack H, 1994, “Endogenous growth theory: intellectual appeal and empirical shortcomings” Journal of Economic Perspectives 8 55 – 72

Parijs P van, 1980, “The falling rate of profit theory of crisis: a rational reconstruction by way of obituary” Review of Radical Political Economics 12 1 – 16

Peet R (Ed.), 1987 International Capitalism and Industrial Restructuring (Allen and Unwin, London)

Piore M J, Sabel C F, 1984 The Second Industrial Divide: Possibilities for Prosperity (Basic Books, New York)

Reuten G, 1991, “Accumulation of capital and the foundation of the tendency of the rate of profit to fall” Cambridge Journal of Economics 15 79 – 93

Rigby D L, 1990, “Technical change and the rate of profit: an obituary for Okishio’s theorem” Environment and Planning A 22 1039 – 1050
Robinson J, 1961, “Equilibrium growth models” *American Economic Review* 51, 360–369
Roemer J E, 1977, “Technical change and the ‘tendency of the rate of profit to fall’” *Journal of Economic Theory* 16, 403–425
Roemer J E, 1978, “The effect of technological change on the real wage and Marx’s falling rate of profit” *Australian Economic Papers* 17, 152–166
Roemer J E, 1979, “Continuing controversy on the falling rate of profit: fixed capital and other issues” *Cambridge Journal of Economics* 3, 379–398
Romer P M, 1986, “Increasing returns and long-run growth” *Journal of Political Economy* 94, 1002–1037
Romer P M, 1990, “Endogenous technical change” *Journal of Political Economy* 98, S71–S102
Romer P M, 1994, “The origins of endogenous growth” *Journal of Economic Perspectives* 8, 3–22
Salvadori N, 1981, “The falling rate of profit with a constant real wage. An example” *Cambridge Journal of Economics* 5, 59–66
Shaikh A, 1978, “Political economy and capitalism: notes on Dobb’s theory of crisis” *Cambridge Journal of Economics* 2, 92–99
Shaikh A, 1980, “Marxian competition versus perfect competition: further comments on the so-called choice of technique” *Cambridge Journal of Economics* 4, 75–83
Shaikh A, 1982, “Neo-Ricardian economics—a wealth of algebra, a poverty of theory” *Review of Radical Political Economics* 14, 67–83
Sheppard E, Barnes T, 1990 *The Capitalist Space-Economy* (Blackwell, Oxford)
Sherman H J, 1990, “Cyclical behavior of the labor share” *Review of Radical Political Economics* 22, 92–112
Solow R, 1957, “A contribution to the theory of economic growth” *Quarterly Journal of Economics* 70, 65–94
Sraffa P, 1960 *The Production of Commodities by Means of Commodities* (Cambridge University Press, Cambridge)
Steedman I, 1980, “A note on the ‘choice of technique’ under capitalism” *Cambridge Journal of Economics* 4, 61–64
Sweezy P M, 1970 *The Theory of Capitalist Development* (Modern Reader, New York)
Webber M J, 1986, “Regional production and the production of regions: the case of steeltown”, in *Production, Work, Territory: The Geographical Anatomy of Industrial Capitalism* Eds A J Scott, M Storper (Allen and Unwin, Boston, MA) pp 195–224
Webber M J, 1989, “Capital flows and rates of profit” *Review of Radical Political Economics* 21, 113–135
Webber M J, 1990, “Profitability and capital accumulation in Canadian manufacturing industries” *Environment and Planning A* 22, 1051–1071
Webber M J, 1996, “Profitability and growth in multi-region systems: theory and a model” *Economic Geography* 72, 335–352
Webber M J, 1997, “Profitability and growth in multiregion systems—prologue to a historical geography” *Economic Geography* 73, 405–426
Webber M J, Rigby D L, 1986, “The rate of profit in Canadian manufacturing, 1950–1981” *Review of Radical Political Economics* 18, 33–55
Webber M J, Rigby D L, 1996 *The Golden Age Illusion: Rethinking Postwar Capitalism* (Guilford Press, New York)
Weisskopf T E, 1979, “Marxian crisis theory and the rate of profit in the postwar US economy” *Cambridge Journal of Economics* 3, 341–378
Wolff E N, 1986, “The productivity slowdown and the fall in the US rate of profit 1947–1976” *Review of Radical Political Economics* 18, 87–110
Wright E O, 1979 *Class, Crisis and the State* (Verso, London)
Yaffe D, 1973, “The Marxian theory of crisis, capital and the state” *Economy and Society* 2, 186–232
Young A, 1991, “Learning by doing and the dynamic effects of international trade” *Quarterly Journal of Economics* 106, 369–405