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## Panel II New technologies, innovations and competitiveness



**Background Paper**

## Technological change and dual economies

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## INTRODUCTION<sup>1</sup>

### Technological Change and Dual Economies

by  
Charles Cooper<sup>1</sup>

The idea of dual economy is venerable. It was essential to a great deal of nineteenth century classical economics. It was revived as one of the main pillars of post-war development economics, by Arthur Lewis's influential reversion to Classicism in "Economic Development with Unlimited Supplies of Labour" (Lewis, 1954). This was a point of departure for a great deal of the economic debate on development after the 1950's. After Lewis the dual economy framework became inescapable, whether one agreed or disagreed with his particular formulation. Lewis's ideas could be attacked, (Frank, 1959), or supported and developed (Ranis and Fei, 1964), but they could not be ignored. The central economic characteristics of the dual economy concept were largely accepted as the basis for much of development economics. The assumption of an infinitely elastic supply of labour at a more or less fixed wage rate recurred, for example, in the economic models which were mobilised in the early Indian debates on economic planning (Mahalanobis, 1955, and Raj and Sen, 1961 are good examples). It also recurred in a vast literature on project evaluation in which the shadow price of labour is set at or near to zero. And in a world which is still importantly characterised by national economies with a large excess supply of labour and a dominant rural subsistence economy, the dual economy framework remains central. Its predominance in the development economics literature is maintained.

This paper has two purposes. First, in Part II it will explore the way technological change has been treated in the analysis of labour surplus dual economies. This is straightforwardly accomplished, since for interesting and important reasons, which mainly relate to the economic historic context in which the post war discussion of dual economy came into being, technological change was seldom treated as a central issue. Even so the way it was approached is illuminating, if only in contrast to the observable circumstances of the present day.

Second, in Part III it will explore how thinking about technological change in the context of dual economy might have to be adapted when these circumstances of the present day are taken into account. The immediately relevant circumstances are:

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liberalisation in the world economy, along with the emergence of patterns of generic<sup>2</sup> technological change. We will discuss how generic technological change requires changes in the mainly implicit assumptions about technology and technological change usually associated with dual economy models.

Beyond this there have been some important conceptual changes in the way innovation and technological change is approached, especially in what might be called the Schumpeterian tradition. This paper focusses on two of these changes. The first is the new importance attached to concepts of path-dependence in economic development - or at least in certain aspects of economic development<sup>3</sup>.

Put simply, path dependence in technological matters, implies that the choices and options that are open to us today in any particular economic context, depend importantly on past technological decisions and accomplishments. It is a very simple idea, a kind of belated discovery that 'history matters', but it has important practical implications, especially as far as the time needed to develop technological capabilities is concerned.

The second change in the approach to technological change is closely related to the idea of path dependence, and concerns the idea of endogenous technological change.

Some economic aspects of path dependence and endogeneity will be discussed in Part III of the paper, together with some considerations about learning in the various institutions which together form part of 'national innovation systems'.

Path dependence and the endogeneity of technological change have implications for technology policy during the labour surplus, dualistic phase of economic development, which arguably have been overlooked in the literature. In a final part of the paper we will draw some conclusions.

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<sup>2</sup> By generic technological change most writers refer to technologies which are applied across a number of sectors. The information technologies, which are applied in many control systems in many different industries are a good example of this phenomenon, but there are many others

<sup>3</sup> For a recent and exceptionally clear argument on this apparently simple idea, which explains why its simplicity hides some radical implications for economic thought, see Paul David (1988).

## II. Technological Change in Dual Economy Models of Development.

The literature on dual economy systems is very large and it is neither practicable nor necessary to attempt a review. This paper is concerned with a particular aspect only: namely the treatment of technology questions in the dual economy tradition. There are in essence two aspects to the discussion of technology questions. First there is a relatively limited concern with the question of technological change. Second, there is a much extensive concern with issues of optimal choice of technology - ie. with the 'choice of techniques'- much of which is characteristically concerned with the structural characteristics of the dual economy, notably with the implications of an excess supply of labour. It is legitimate, of course, to see this as a major contribution of dual economy theory to technology policy questions. This paper will however, be concerned primarily with the first less developed part of the discussion- that is to say with the treatment of issues of technological change. It will make only limited and passing reference to the debates on choice of techniques.

As far as technological change questions are concerned, it is probably sufficient to base discussion on Arthur Lewis's seminal paper, and to reflect on some of its implications (Lewis, 1954). That will be the starting point. Then, because Lewis's discussion is at least implicitly imbued with closed economy assumptions, the next step will be to examine an early and influential open economy formulation of the Lewis model, by Fei and Ranis (1974).

The outlines and basic assumptions of the Lewis model are extremely well known and do not need much discussion. The key points are as follows. The economy consists of a modern sector (industry in this discussion) and a subsistence sector. Institutional arrangements in the subsistence sector are not very clearly delineated and are certainly more appropriate to the times in which Lewis was writing to the rural circumstances in today's developing countries<sup>4</sup>. There is a labour surplus in the rural sector, in the sense that the migration of workers to the modern sector will not cause a fall in output (Lewis's assumptions on work-leisure preferences in the rural sector, which account for this, are not very clear). It is assumed that arrangements in the subsistence sector are such that all persons working there enjoy access to the average product of labour in the sector - and this average product of labour is what determines the minimum real wage in the modern industrial sector. This is one of the more debateable and debated assumptions of the model, but we will not enter into that here<sup>5</sup>. The level of output in industry is determined by the prevailing modern sector technology and this minimum real wage: production is expanded to the point where the marginal product of labour is equal to the real wage.

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<sup>4</sup> One obvious inappropriateness to today's conditions is that Lewis's rural sector is barely affected at all by capitalist forms of organisation or indeed by monetisation - though his recognition of the problems in the determination of the institutional real wage that arise from the existence of rent in the subsistence sector is a nod in the direction of monetisation.

<sup>5</sup> One problem is that, to be practical at all, Lewis's argument requires that the surplus of food produced in the rural sector after migration of workers to the modern sector, has to be transferred through some form of market. There is no discussion of this, nor of the implications which the incursion of intersectoral trade in food will have for the economic organisation of the rural sector - a matter which in the end, must influence the way the institutional real wage is actually formed.

At this point the surplus value-added in production above the wage bill accrues as profit to the owners of capital. It is this surplus, properly reinvested, which provides for reinvestment and expansion, and which therefore drives the economy. Reinvestment of surplus and the accumulation of capital stock will expand the modern sector so that eventually rural surplus labour will be fully absorbed. Given the assumptions of the system, the economy will then fit the requirements of the neoclassical growth model (Fei and Ranis, 1964).

This structure of assumptions has, as might be expected, been the subject of extensive debate and refinement, which need not be discussed here. The relevant question for present purposes is simply: what arguments are made about the effects of technological change. There are, in fact, two such arguments in Lewis's 'Unlimited Supplies' paper, both of which are rather strange in a present day perspective.

The first argument relates to Lewis's concern with conditions which might bring the accumulation process to a halt. It depends importantly on two points: on the mechanism which determine the real wage; and on the economic relation between the two sectors. Assume that the industrial real wage is determined as above, by the average product of labour in the subsistence sector, and that the supply of wage goods is set by marketed surpluses which it provides. In this situation Lewis points out that expansion of the modern sector can endanger the process of accumulation in two ways: by driving up the average product of labour in subsistence production as more and more people leave for the modern sector and thus increasing the minimum real wage; and by turning the terms of trade against the industrial sector as increasing demand for food meets an inelastic supply from the subsistence sector<sup>6</sup>. Hence, says Lewis, the need for agricultural revolution to accompany industrial accumulation.

However, agricultural revolution - in so far as it takes the form of increasing factor productivities in the subsistence sector may not do the trick. In a famous image, Lewis points out that technological change in the subsistence sector will escape the "Scylla" of adverse terms of trade as food prices fall relative to prices of industrial output. There is still however, the "Charybdis" of the real wage effect: the institutionally determined minimum real wage will rise as the average real product of labour in the subsistence sector rises. This leads to the conclusion that technological change in the subsistence sector can *slow down accumulation* in the modern sector unless the elasticity of demand for food is less than unity<sup>7</sup>. However, since Lewis agrees that this condition is likely to be met (low income demand for wage goods is in general price inelastic), it is a little puzzling that he should be so concerned about a deceleration of modern sector accumulation.

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<sup>6</sup> Lewis points out that if the two sectors do not trade, only the first of these mechanisms - ie the labour market mechanism which determines the real wage - will operate, but that this would by itself - and ceteris paribus - ensure that the money wage measured in terms of industrial output, would have to rise.

<sup>7</sup> This has the implication that in order to support accumulation, technological change in the subsistence sector must *reduce* the average *value* product of labour there, through the demand elasticity effect. This is a curious result which, of course, depends entirely on Lewis's assumptions about the formation of the real wage in the modern sector



What can one say about this part of Lewis's dual economy analysis in terms of the experience of technological change and development in the developing countries? Three points suggest themselves.

First and on the face of it, these are rather strange reflections on the likely outcome of technological change in the rural sector. In most historic situations in developing countries in the years since "Unlimited Supplies" was published, the inelasticity of supply of wage goods from the rural sector has been a problem, and in most cases it has been a problem for modern sector wage workers, rather than a threat to capitalist surpluses. In short the burden has been mainly borne by reductions in urban real wages as food prices rise, suggesting strongly that Lewis's wage formation assumptions are unrealistic at least in modern terms. Furthermore, the terms of trade effect of such price rises were offset historically, by increases in industrial tariffs under protectionist policies, which mainly preserved capitalists surpluses (whether or not they were used for accumulation).

Second, in justice to Lewis, it must be recalled that he was writing in a period prior to decolonisation in Africa and coincident with it in the West Indies. At the time, economic structures similar to that which he describes existed in many African economies. And it was (and is) argued that an important concomitant to colonial wage policy was precisely to avoid increases in factor productivities in the peasant sectors because it was presumed that these would have what we might call the 'Lewis effect' of driving up the minimum wage at which rural people would be willing to work in the modern sector<sup>8</sup>. That has all changed of course, in part because of massive population pressures in rural areas which drove down living standards. This has been the basis of some well-known pieces of economic analysis (Harris and Todaro, 1970). In this light it is not altogether clear that Lewis's real wage mechanism can be rejected without examination - at least for the case of Africa. It is plausible to argue that it has simply operated in a different direction from that which he anticipated because of the pressures of population growth<sup>9</sup>, which of course would tend to drive down the average product per person in the rural economy, or at least slow down its growth.

A third observation is that whatever conclusions one might reach regarding the plausibility of the wage determination system, or the outcomes of rural technological change for accumulation, or the broader merits or demerits of the analysis as a whole, there is an element in Lewis which we would do well to keep in mind. It is simply the Classical insight that the real wage is made up of goods, and that technological factors determine the real costs of making them.

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<sup>8</sup> To quote: "...capitalists (in colonial economy) have a direct interest in holding down the productivity of subsistence workers....". And later: "...owners of plantations have no interest in seeing knowledge of new techniques or new seeds conveyed to the peasants... and they will not be found using their influence to expand the facilities for agricultural extension....". Unfortunately these responses are not necessarily confined to a colonial capitalist class.

<sup>9</sup> In this regard it is an interesting reflection that the first part of 'Unlimited Supplies' takes a good deal of space to justify the possibility of their being surplus labour and especially in Africa argues that it is not present everywhere. Times - and populations - have changed.

Surplus generation, capital accumulation and the real wage itself are importantly influenced by the possibilities of improved efficiencies in the production of wage goods (just as in a parallel way, the capital intensity of production can be much reduced by reducing the costs of making machines, even without changing their designs). These are dimensions of technological change which are rather easily forgotten, and about which Classical thinking contains useful reminders. And as far as this goes, it is worth bearing in mind that not all wage goods are final outputs of the rural sector, many come from the industrial sector itself.

There is a second set of observations about technological change in 'Unlimited Supplies'. This is much briefer and treated in a perfunctory way by Lewis. This concerns the issue which is much more central to most present day discussions of technological change: namely technological advance in the industrial sector itself. How does Lewis treat this matter?

The answer must be very lightly. There is the following remark:

"...for the purposes of this analysis, it is unnecessary to distinguish between capital formation and the growth of knowledge within the capitalist sector. Growth of technical knowledge outside the capitalist sector would be fundamentally important, since it would raise the level of wages, and so reduce the capitalist surplus. But inside the capitalist sector knowledge and capital work in the same direction, to raise the surplus and to *increase* employment." (Lewis, 1954; my italics)

The emphasis on the 'problems' that flow from rural technological advance is there once again. More interesting are two other aspects. The first is the assertion that new technology - like accumulating capital stock - will help to increase employment. This sounds a bit odd to present day ears. The reasoning is, however, quite clear: technological advance will increase factor productivities at all levels of employment; therefore, for any given level of the real wage (and so of the wage measured in terms of industrial goods), the point of equality between the level of wages and the marginal product of labour which determines the optimal level of employment, will be reached at higher levels of employment than before. Nowadays we are more accustomed to thinking of the rise in factor productivity associated with technological change as threatening employment, rather than increasing it. Lewis's conclusion comes from a purely supply side argument and flows simply from the fact that there is no explicit 'demand side' in the model. If effective demand is given and markets cannot be much expanded, it is not at all clear that technological change will have the same effect in increasing employment as the quantitative accumulation of capital. In fact one of the major concerns of the present time, is precisely that it will not and that there are grave dangers of technological unemployment. Lewis has been criticised for this by many authors, though it is seldom recognised that there was probably a stronger rationale for abstracting from demand constraints than merely that it leads to a simpler kind of analysis. In 1954, early in the post-War Keynesian period, economists were quite generally 'bullish' about the prospects of expanding demand to meet technological unemployment.

A second point about the treatment of technological change is that Lewis does not discuss at all what policies might lead to its generation. Technological advance is

simply a nice addition enhancing the effects of capital accumulation in the process of labour absorption and the eventual emergence of full employment. It *need* not be sought. On the face of it this is curious. Elsewhere, especially in discussing the problems for accumulation in the modern sector which can arise from technological change outside of it, Lewis spends considerable time worrying about conditions which might undermine the capitalist's surplus. Technological advance, of course, would offset these conditions directly - and since there is no demand constraint to worry about, it would be an unambiguous gain to the society. Furthermore, although a section of the paper discusses the implications of open economy, in which one might have expected some reflections on the implications of international technological change<sup>10</sup> there are none, despite its potential importance in determining the implication of trade for domestic accumulation.

If therefore, Lewis had believed that technological change could be facilitated in various ways within the dual economy structure, one might have expected him to discuss them. That he does not do so, presumably reflects the dominant assumptions of the times: that technological advances are exogenous and more or less costlessly available over the whole world economy and so would be taken up pretty well automatically by enterprises everywhere. Furthermore, Lewis may also be influenced by the fact that at the time he wrote 'Unlimited supplies' most modern sector industries likely to be set up in developing countries were by and large technologically stagnant.

The Lewis model had, as has been observed, an extraordinary influence. There have been relatively few major changes to the form in which the model has been described here. Most of the developments took the form of modifications and developments of key assumptions - such as those concerning the mechanisms of wage determination and the formation of markets for wage goods. These, in general, rested importantly on empirical research. An important line of conceptual development came a decade after the original article, in the so-called Fei and Ranis model (1964). This was a largely successful effort to link the Lewis structure to the dominant neoclassical growth model. The focus was on the change from the labour surplus condition to a fully employed state in which the more conventional assumptions of neoclassicism could be expected to apply. From the point of view of this paper this first Fei-Ranis extension adds little to the conclusions already sketched out regarding the 'Unlimited Supplies' paper itself. The main additional 'technology' point is that at the point where a switch to full employment occurs, there will also occur a shift from an originally highly labour intensive form of technology in the modern sector, to increasing capital intensity.

A further important expansion of the dual economy framework also came from Fei and Ranis twenty years after the Lewis paper (Fei and Ranis, 1974). This was an extension of their earlier analysis to an open economy form and an descriptive empirical analysis of the process of accumulation in Korea and Taiwan, both economies in which export expansion had played a large part in the growth process.

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<sup>10</sup> With a given wage rate in terms of industrial outputs and a fixed technology, technological change in the international economy would also threaten the generation of surplus - unless one assumes that the internationally best practice technology would not only be immediately available to the dual economy, but would also be taken up immediately.

To conclude Part II it will be helpful to examine some of the implications of the Fei-Ranis effort to incorporate open economy assumptions into the model.

A central focus of the Fei-Ranis analysis is on 'turning points' through which the economy progresses on its way from the labour surplus dual economy structure to the fully employed situation - in which it is assumed that the neoclassical rules of the game will apply. Fei and Ranis discuss three main turning points. They are discussed below in a slightly different order to that followed in the Fei-Ranis paper.

First, there is the 'export substitution point'. This is described as the point at which a switch occurs from 'land-based' exports to the export of labour intensive manufactures. In Taiwan for example it is the point at which rice and sugar were 'substituted' as the main exports, by textiles. The substitution process is essentially seen as the culmination of a successful 'infant industry' period of traditional import substitution. Export substitution is regarded as especially important:

"...for a small labour surplus economy with a colonial heritage of primary product production, the emergence of the export substitution phase, replacing the import substitution phase is a highly significant phenomenon..." (Fei and Ranis, 1974).

It is significant precisely because it offers an effective escape from the demand limitations of the 'import substitution' phase which precedes it. It therefore holds out the prospect of a solution to the problem of unemployment, which was not attainable under import substitution. It resolves the issue of the putative conflict between 'growth and employment'. It is easy to agree to all this - the more especially in the light of two considerations: first, the subsequent history of Korea and Taiwan, in which vigorous export growth certainly accounted for the successful resolution of the employment problem; and, second, in view of the fact that the export promoting economies, are by and large the only ones which have resolved the dual economy structure (at least amongst the developing countries). What is not discussed, and not at all clear, is how Korea and Taiwan were so successful in emerging from the import substituting phase on these terms, when so many other import substituting economies failed so signally to do so.

Successful export substitution and rapid export growth leads to the second important turning point. This is the 'commercialisation point'. This is the crucial point at which surplus labour is finally 'mopped up' by increasing employment in the modern sector. Fei and Ranis characterise it as the point at which the *rural wage rate* starts to be equated to the marginal value product of labour in the rural sector<sup>11</sup>. The institutional real wage of the Classical dual economy phase no longer rules in the modern sector and the wage is expected to rise. This has obvious importance for the present discussion because the new economic context determined by this new wage formation process implies that there are new technological requirements in production.

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<sup>11</sup> In fact this implies a rather more profound structural change, rather than just a quantitative increase of modern sector employment. The more or less precapitalist subsistence sector of Arthur Lewis's analysis, must be transformed into a fully marketised economy with a rural working class working for wages.

This is especially important in connection with export development. It is discussed at various points in the rest of the paper<sup>12</sup>.

The third Fei and Ranis turning point is the 'reversal point' at which an absolute decline in rural population sets in. This is not of great importance to the discussion in this paper and, therefore, will not be explored further.

Fei and Ranis treat technological factors in much the same way as did Lewis before them. For example:

"..... The increase in real wages (after the commercialisation point) is expected to be accompanied by .... a shift towards more capital and skill intensive technology and output mix ... (and) an increased concern with the provision of an adequate supply of highly talented manpower...." (Fei and Ranis, *op. cit.*; our parentheses).

It is a matter of well attested history that such a shift took place in Korea, but there is no discussion in Fei and Ranis of how the structural changes which accompanied it are likely to come about. With the advantages of hind sight we know that an important factor was a shift of resources to less labour intensive industries which had grown up behind import substituting protective tariffs, and which, in due course, entered international markets. This shift followed along much the same lines as Fei and Ranis describe for the initial shift at the 'export substitution point'.

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It is reasonable to conclude this part of the paper with the observation that, despite the relative neglect of technological factors in the literature on the dual economy, technological change actually 'matters' quite considerably in the labour surplus phase of development. There are at least three reasons for this.

First, depending to some extent on the way the real wage is determined in practice - and there seem to be a number of possibilities - there is usually a 'real wage drift' (to borrow a term from Fei and Ranis) even under conditions of labour surplus, i.e. well before the Fei-Ranis 'commercialisation point'. Lewis was quick to see this possibility, which he ascribed to increases in the average product per person in the subsistence sector as migration to the modern sector gets under way. Both in Korea and in Taiwan, despite the absence of labour organisations and despite the undisputed fact of surplus labour during the period in question, real wages rose. In Taiwan by a factor of 1.7 (between 1952-54 and 1967-69); and in Korea by the same factor (between 1955-57 and 1968-70)<sup>13</sup>. In each case this was in fact a higher proportionate rate of growth of real wages than during the period after the putative 'commercialisation point' had been reached.

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<sup>12</sup> An interesting question is: when did Korea and Taiwan arrive at the 'commercialisation point'. This has been a fruitful field for disagreement. Fei and Ranis suggest that excess labour had been absorbed by the second half of the 60's. Some Korean economists on the other hand, argue that there was substantial labour surplus, unemployment and underemployment right through the 70's.

<sup>13</sup> These are ratios based on the data given by Fei and Ranis (1964).

It amounts to about 10 per cent per annum - a high rate by any measure and quite remarkable for conditions of labour surplus. By comparison the rate of growth of the real wage after the Fei-Ranis 'commercialisation point' was about 6-7 per cent per annum. In short, whatever the economic reason, the growth of the real wage during the labour surplus period in these economies was a major potential pressure on capitalist profits<sup>14</sup> and accumulation. Probably the only way this can be contained is by increasing factor productivities in the modern sector by way of technological advance.

Second, under conditions of liberalisation, foreign competition - on domestic markets just as much as in export markets - will also threaten modern sector accumulation, unless local firms can keep up technologically. In Korea, and to some extent in Taiwan too, during the early period of industrialisation, foreign competition on domestic markets was contained by protection, which many scholars have seen as being important in allowing learning processes<sup>15</sup>. However, in most of today's developing countries liberalisation has been comprehensive and immediate. The need for rapid technological change is therefore all the greater.

Third, successful export development, even in the labour intensive industries, and even in early stages, requires some important technological capabilities. Success in export markets depends importantly on the development of new products and the adaptation of old. In the labour surplus phase, during the period of 'export substitution' Korea was able greatly to expand the product base of its exports<sup>16</sup>. The rapid growth of labour intensive exports from Korea and Taiwan in the early phase was not just a matter of low wage cost advantages. It also depended on the development of a widening range of more sophisticated, if labour intensive, products. That was in some degree, a technological achievement.

Fourth, once the labour intensive phase is over - or conceivably even before - the focus of export activity shifts to more skill intensive lines of production. In both Korea and Taiwan, this shift was successfully accomplished - but it involved new sectors of production, which had been building up their technological capabilities in relatively protected domestic market during the labour surplus period. This pattern of development speaks of 'path dependence' - one of the questions to be taken up in Part III which follows.

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<sup>14</sup> Fei and Ranis are initially inclined to ascribe this real wage growth to an "...upward revision of the institutional real wage in agriculture as productivity change occurs..." - in other words, essentially to the Lewis model of real wage determination in the subsistence sector. However, they (Fei and Ranis) hedge their bets somewhat in a footnote (Fei and Ranis, 1974, fn 18) in which they say: "... and/or once the more realistic possibility of a wage gap (between agriculture and industrial workers) is admitted, due to a change in the size of that gap...". This, of course, evades the issue of what causes the rise in real wages during a period of labour surplus, since we have no accepted - or acceptable theory to explain the wage gap - though there is no doubt it exists.

<sup>15</sup> See for example Kim Linsu (1993), p. 362.

<sup>16</sup> Prof. Joungeil Lim of the Institute of Advanced Engineering, Seoul, in a recent seminar at UNU/INTECH showed the remarkable rate of new product development which accompanied the early export push.

### III. Some Technological Factors

Part II shows that the technological requirements of industrialisation, even during the early dual economy phase, are likely to be considerably more demanding than early (and later) writing on the labour surplus economy suggested - thought this was more a sin of omission than of commission. In Part III this theme is further pursued. It will deal with two extensions to the preceding arguments. First it will explore the implications of *generic* technological change for the early industrialisation; second it will consider the notion that there are path dependencies in technological development and discuss some of its implications. This second part of the discussion will be related to the idea of 'endogenous technological change'.

#### Generic Technologies

As a first step, it will be helpful to return briefly to some Schumpeterian ideas about interfirm competition.

In Schumpeterian competition, technological change in the form of new products and processes, is one of the main bases of the competitive struggle. This is in contrast to the text book picture of competition which has come down from Marshall and Jevons and which has played a central role in modern economic analysis. In the Marshall - Jevons world, competition is a process which results in minimisation of the costs of production at a *given* technology. New technologies essentially produce new equilibrium conditions, and competition will result in the establishment of the implied new equilibrium. The economy is portrayed as moving from one equilibrium condition to the next, each equilibrium being determined by a particular set of technological conditions. In the Schumpeterian world, technological competition happens more or less continually and the economy is characterised by a sequence of disequilibrium conditions. To put the matter in a somewhat extreme form: competition in the Schumpeter system generates disequilibrium.

Schumpeter himself recognised the importance of this contrast between competition as conventionally conceived and his own concept of 'entrepreneurial competition' whereby firms seek to steal a march on their competitors by establishing temporary preferential access to new technologies - and benefit from the rents which result<sup>17</sup>.

Associated with the idea of innovative competition, is the idea of the *innovative industry* as a particular form of economic organisation. Innovative industries are oligopolistic structures in which competition is importantly conducted by technological means - new products and process in particular. These industries are made of a small number of innovator firms and a much larger number of imitators - firms which use various strategies of imitation (which often include licensing of the innovative technology) in order to survive.

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<sup>17</sup> Schumpeter would not have accepted that preferential access to a technology generated rents. He saw the exceptional surplus from a technological monopoly, as 'entrepreneurial profit' - a return to what he regarded as true entrepreneurship (Schumpeter, 1939)

There are a variety of other strategies which firms may use to deal with the problems of innovation by the leading enterprises in the industry. For example, these might include cost cutting through exploitation of particular advantages - such as low real wages - which the follower firm might enjoy. (Freeman, 1982). Cost minimisation is, of course, an important competitive response in innovative industries as well as in competitive ones.

Not all industries are innovative in this sense. An important idea first put forward in connection with the role of technological factors in international trade, is that it is possible to think of industrial sectors as forming a spectrum. At one end are the highly innovative industries - such as the industry making personal computers for example - where innovative competition is dominant and survival depends on being able to emulate innovative products as they appear. At the other end, are industries - like garments production - in which conventional cost minimisation at more or less constant or slowly changing technologies is the dominant mode of competition. (Dosi, Pavitt, Soete, 1989). Other industries are in intermediate positions. Furthermore, the prevalence of innovative competition in any particular industry changes with time. These are useful ideas to keep in mind in discussing generic technological change.

It is a common assumption in the literature on the economics of innovation, that technological change has accelerated in the international economy, on the one hand - and that it has become much more multi-sectoral in its impacts. This multisectorality is what people have in mind when they talk of generic technological change. The idea is that certain key technologies - in the information field for example, or biotechnologies - find applications in a large number of sectors as well as in their sectors of origin.

The defining characteristic of generic technological changes is that they may find applications in many industrial sectors. For example, the computerised control systems for production processes are used across many sectors, some highly sophisticated technologically - like the manufacture of fine chemicals and pharmaceuticals - and some quite simple - like textile weaving. This means that certain important types of new technology have an influence on the nature of competition in sectors which up till quite recently were thought to have reached a type of stagnation as far as production technology is concerned. For example new methods of control along with new types of equipment have changed the technologies of textiles production.

This technological reinvigoration of sectors which were supposed to have become stagnant, is often important for developing countries, for many of these sectors have played an important part in the initial stages of industrialisation. Precisely because they were slow moving technologically, they were of special interest in countries which have a limited endowment of technological capabilities. These were amongst the sectors where cost minimisation remained the key element of competition and which therefore were especially favoured in countries with abundant labour and low real wage rates. They were the archetypal technologies in the early stages of the dual economy structure. The incursion of generic technologies tends to change the situation - sometimes quite sharply - with the result that the maintenance of these industries, especially under conditions of market liberalisation, requires more considerable technological capabilities than before.



Generic technological change implies that the innovative competition has become more important in a wider range of industries. And liberalisation has meant that industrialisation has come to require entry into internationally oligopolistic industries in which such forms of competition prevail - or at least are more prevalent than they used to be.

The process of generic technological change should not be exaggerated. It underlies a movement away from the traditional cost minimising/constant technology sort of competition in labour intensive sectors which has been important in the dual economy phase. It does not however, mean that these traditional patterns of competition have disappeared. On the one hand there are sectors in which technologies are relatively stagnant, or where the new technologies do not have such an advantage that they supplant low wage, labour intensive production. On the other, even in sectors where there is growing innovative competition (in some branches of textiles for example) there often remain possibilities of competitive survival by reducing the costs of production for older products or on older processes. So the conventional sources of comparative advantage remain important. The main conclusion to be drawn is that they are less adequate to survival in an open world economy undergoing generic technological change than they were in earlier years.

### **Path Dependence and Endogenous Technological Change**

The basic idea that there are path dependencies in the accumulation of technological capabilities within firms is well established and need not be discussed in detail here<sup>18</sup>. Paul David (1974) made one of the earlier approaches to the idea. In a discussion of the determinants of actual technological choices made by manufacturing firms, David argued that the range of technical options over which a firm will be able to exercise a choice at any point in the future, will be importantly influenced - and conceivably constrained - by the technical choices it makes today. Today's choices will determine what the firm learns in the immediate future - both about production activities and about the technology itself, and the knowledge it accumulates will determine the choices open to it, the next time it faces a technological decision.

This approach, along with some contemporaneous but independent writing and case material on technological learning processes in Latin American firms by Jorge Katz and his colleagues (Katz, 1974) were early recognitions of the significance of the accumulation of technological capabilities in determining both production performance and technological choices open to firms. Katz and his associates, in particular underlined the costly nature of learning processes (Katz, *op. cit.*) and so placed it amongst the key investment activities of the firm.

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<sup>18</sup> There is a detailed discussion of the main ideas in Cooper (1994)

The path dependent nature of the process of accumulation of technological capabilities leads naturally to the idea that firms within an industry will be differentiated from one another by the level and types of technological capability - and that this will influence their performance in production as well as their competitive strategies in face of innovative competition. It follows that different firms will meet future competitive technological challenges with varying degrees of success. A firm's history matters<sup>19</sup>. Furthermore, it requires time for a firm to build up the capabilities needed to cope with competition based on technological change and to make efficient use of technologies in production; it also requires investment.

These ideas, together with a much older set of ideas on the imperfect excludability of knowledge, including particularly technological knowledge, and the associated notion that there are important externalities associated with the generation of technological knowledge, are incorporated in the recent literature on growth models incorporating endogenous technological change. This literature, which had its origins in the Romer's work on endogenous technological change (inter alia, Romer 1986, 1990), has recently been succinctly and lucidly explored from the standpoint of its relevance for developing countries (Barros, 1994), so it can be dealt with in a summary way.

In their simplest form growth models with endogenous technological change appeal to a straightforward idea: firms invest in the development of technology (by building up human capital), as well as making use of the more conventional factors of production, capital and undifferentiated labour. These technological investments generate technological knowledge which is partly internalised by the firm and has the effect of increasing its efficiency. Human capital has the properties of a factor of production and can be included within a conventional constant returns production function. However, the technological knowledge created by the firm cannot be perfectly excluded. In parts it spills over and becomes available to other firms as an externality. This is presumed to increase total factor productivity in the aggregate production function. The individual firms can be assumed to face a constant returns production function, but in the economy as a whole, technological externalities generated by the spill-over of knowledge from the human capital investments of each individual firm create increasing returns to scale. More sophisticated formulations of the concept deal with investments in R and D and different different patterns of innovation. These will not be dealt with here.

The endogenous growth concept helps to formalise a number of ideas regarding technology policy in developing countries, some of which - like the case for state intervention to deal with the sub-optimality associated with externalities - have been around for a long time.

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<sup>19</sup> A rather obvious point perhaps, and very clear to all who are concerned with industrial organisation questions or behavioural approaches to the firm, but not really a part of formal microeconomic theory for all that.

Others however are rather newer and raise some interesting possibilities, especially regarding comparative advantage and competitiveness. Barros (op.cit.) suggests:

".....if the competition from abroad is too large for a country with limited innovation capacity, the adverse effect on domestically generated innovations may be significant...In this case the country tends to concentrate its resources on the production of simpler products which demand less technological capability.....this specialisation will have a negative effect on its productivity increase....." (Barros, op. cit. pp.545)

This is a strong argument about path dependence. It 'fits' intuitively with a number of casual observations:

- When technologically more sophisticated producers enter traditional labour intensive industries, the old products are to some extent substituted and at the same time the original less technologically advanced firms get confined to a narrower lower value added and more traditional part of the market. Something of this kind happens in garments and textiles industries, where high value added firms following marketing and information techniques of the Benetton kind, confine older competitors to lower income segments of the market
- At a more aggregative level, the dismantling of protection in the Latin American economies has resulted in a marked reversal of industrial structure - with a strong reliance on natural resource based industries where skill requirements are less exacting than they were in the heavily protected industries of the past, and where value-added per worker and the real wage are lower and grow more slowly<sup>20</sup>.
- And at a still more aggregative level, it seems possible to divide export promoting developing countries into distinct categories - some achieve a high growth exports and also of real wages, by virtue of high value-added growth rates. Korea, Taiwan, and the 'first tier NIC's' fit this description. Others maintain export growth by holding wages down and have a much more modest productivity performance. Cases in point are Chile and Sri Lanka. The cases where growth of value added per worker has been especially high - like Korea and Taiwan - have also achieved major structural shifts in the export pattern, towards more sophisticated products, whereas the low growth category show little change in the pattern of exports.

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When the influence of generic patterns of technological change are brought into the picture the arguments of Part II about the technological requirements during the labour surplus phase of dual economy development are considerably strengthened. If generic technologies penetrate the older once technologically stagnant sectors which were the implicit basis for 'modern sector' accumulation in the Lewis and Fei-Ranis worlds, the need for building technological capabilities becomes pressing - even in early stages of

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<sup>20</sup> This pattern and the problems of escaping from it are the subject of policy research at the UN Economic Commission for Latin America under Prof. Jorge Katz, to whom I am indebted for this observation.

industrialisation. This is especially the case in liberalised economies where survival on domestic markets in the face of import competition, as well as success in export markets, require increasing technological sophistication. Reverting to the Fei-Ranis framework, it seems that the attainment of the export-substitution turning point, which in their view is a signally important step on the road towards the absorption of surplus labour, is more difficult in a liberalised world economy in which generic technological change is at work in a widening range of industrial sectors.

Path dependency and endogeneity of technological change raise some further problems. They bring in a crucial time dimension. The process of developing industrial export capability needs time, especially in order for local firms to build up their technological capabilities in production of more sophisticated products.

#### IV. Concluding Notes

The notion that technological considerations are important during the dual economy part of economic development, is not particularly surprising new or revolutionary. In countries like India and China, governments have long since acted on the need for forms of social organisation to deal with it - though the degree of success with which their efforts have been met is open to debate. It is nevertheless worth exploring the technology question against the background of dual economy thinking - especially in relation to open economy forms of industrial development. Arguably it helps to organise thought on the matter. And it is worth doing for another reason too. This is that in a number of smaller economies - especially in Africa and Latin America - the old notion that there in the labour surplus phase, there is little need for concern about technology matters beyond ensuring a proper choice of labour intensive techniques, is more or less taken for granted. Thinking in and about this group of countries echoes the early Fei-Ranis type of assumption.

The points raised in this paper are intended to put in question the adequacy of these early arguments and to suggest how they need to be modified. The main conclusions can be summarised as follows.

First, in the open world economy, the exigencies of generic technological change mean that technological dynamism is essential to industrialisation even in the earliest stages of industrialisation and even in the labour intensive lines of production which will and should predominate. Industrialisation increasingly involves the capacity for successful entry into innovative oligopolies at world level.

Second, as an extension of the argument in the paper, this emphasis on the technological change as a sine qua non of industrialisation is likely to lead to a slowing down in the rate at which surplus labour is absorbed in the modern sector. The Fei-Ranis 'solution' to the growth versus employment trade off depended on countries crossing the 'export substitution' turning point and then experiencing very rapid export growth. As far as the unemployment problem is concerned, the acceleration of technological change in traditional industries means that we need fast export growth a fortiori. The high export demand route - as followed by Taiwan and Korea - is still an important option for many countries, but it is not clear that it can work for the large economies like India and China.

Third, the requirements in terms of technological capabilities, of the export substitution turning point in the Fei-Ranis model are more exacting than is made to appear. As technological sophistication in the production of even labour intensive goods increases, so does the need for an accumulation of technological capabilities at the level of the firm. And the lessons of path dependence teach us that this is a process which takes time and probably has to be started early in the process of industrialisation.

Fourth, as well as the export substitution point of Fei and Ranis - at which labour intensive manufactured exports displace primary exports - there is a further turning point, when a process of upgrading exports to higher value added goods begins. In the

Fei-Ranis schedule this is supposed to happen after the full absorption of surplus labour when real wages begin to rise steeply. In practice, in the successful cases of export-led growth, upgrading appears to start in advance of this. This is partly because real wages may start rising quite rapidly well before the full absorption of surplus labour and partly because the need for product changes in demanding export markets may demand a shift to more sophisticated technologies regardless of the condition in labour markets. In Korea as we have seen, the real wage rose fast even during the labour surplus phase, and value-added per worker rose too at about the same rate<sup>21</sup>. The extraordinary rate of export growth was at least in part due to the structural change in the export pattern towards higher value added goods in demand in developed country markets. This is a quite significant departure from the expectations we normally associate with the dual economy system. This of course means that the argument of point (3) above applies *a fortiori*.

Fifth, the idea of endogenous growth and the concept of path dependence suggest that export led economies may get established on higher or lower income growth paths depending on their technological capabilities in the initial condition. Korea, it is argued, was able to maintain competitiveness in relatively high productivity industries and so - by upgrading the structure of its manufactured exports, has kept on a path of high income growth. Other countries, like Sri Lanka, with very labour intensive exports may get caught on a path of low productivity and real wage growth and find it very difficult to make a switch to competitiveness in the higher wage production. Barros (1993) argues that the switch in Korea was facilitated by the prior accumulation of technological capability in protected high value added industries, which subsequently were able to face international competition successfully. Kim (1993) would agree with this diagnosis. Many others would disagree, and it is at least clear that in other economies the protectionist phase though protracted, did not produce the same kind of learning process as seems to have happened in Korea. Probably there is more agreement that Korean policies of 'selective intervention' by the state were important in supporting subsequent export development. This is an question of very considerable importance in economies emerging from the labour surplus phase (or, if point (4) is accepted, even in those which are still stuck with surplus labour).

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<sup>21</sup> Over the 1970's during which many economists would argue there was still a labour surplus in the Korean economy, value added per worker grew at a substantial 7 per cent per annum and so did the real wage. Profits share in value added was maintained constant during this period. It did not increase in the way predicted by most dual economy models.

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