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The Lewis Model of Economic Development

Ian St John

Economics Department

istjohn@habselstree.org.uk

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Abstract

Arthur Lewis's dualistic model of economic development is among the most influential models in development economics. Appearing in 1954, at the beginning of a surge in the study of economic development, the model outlines a growth process in which a large subsistence sector of the economy, characterised by an over-supply of labour and zero marginal productivity of labour, releases labour to a growing capitalist sector with positive labour productivity. The subsistence sector has unproductive workers at the margin and a low 'subsistence' wage. By offering a wage above the subsistence wage, the capitalist sector can draw upon an unlimited supply of labour, facing a perfectly elastic supply curve of labour. Since wages to the capitalist sector are low and constant, profits in the growing capitalist sector are high and these profits provide the funds for capital investment, which further raises the productivity of labour in the capitalist sector, encouraging firms to expand further, generating more profit and more investment. As a result, growth proceeds rapidly, with workers leaving the subsistence sector and entering the modern economy. This growth-mechanism only slows when surplus labour in the subsistence sector is exhausted. From this point, the capitalist sector must pay higher wages to induce people to move from the subsistence to the capitalist sectors. Wages in both rise and the growth in profits slows. The phase of development with unlimited supplies of labour comes to an end – but by this point the economy will be significantly more capitalistic. In developing this model, Lewis drew upon British experience during the Industrial Revolution and his knowledge of economic conditions in the West Indies. In the process he turned for inspiration to the analyses of growth in the works of the classical economists, notably Malthus, Ricardo, and Marx. This paper sets out the analytical relationships at the heart of Lewis's model, which we interpret in terms of an economy characterised by a subsistence rural sector and a capitalistic industrial sector.

Arthur Lewis and Development Economics

Development Economics emerged in the 1950s, and, according to Kirkpatrick and Barrientos, W.A. Lewis's 1954 'Economic Development with Unlimited Supplies of Labour' is 'the single most influential contribution to the establishment of development economics as a discipline.'[1] In constructing his model, while a Professor at the University of Manchester, Lewis drew upon his reading in the history of the British Industrial Revolution. In works such as the Hammonds *The Village Labourer* (1913) and studies by G.D.H. Cole and T.S. Ashton, he encountered the importance, for Britain's early industrialisation, of a large surplus of cheap labour in the countryside, stimulated by the enclosure movement, which meant accelerated economic growth could coincide with low wages, ensuring high profit margins and funds for capital investment. He drew, also, upon his experience of growing up on the island of St Lucia in the West Indies in the 1920s and his subsequent research on development problems in the Caribbean. In 1961, for example, Lewis reflected upon the slow rate of economic growth per head in Jamaica since the nineteenth century. He pointed to the steady rate of population growth (1.2 per cent per annum) which, in conjunction with the limited supply of land and the shift of farming from sugar to less-labour-intensive banana cultivation, led to low productivity and a drift of labour from agriculture into domestic service (which absorbed 18 per cent of the population) and small trading. As a result, he estimated that by 1930 about 13 per cent of Jamaica's population consisted of 'disguised unemployment' – which was exactly the kind of reserve of cheap labour which Britain and European economies had had in the eighteenth and early nineteenth centuries and which underlay his growth model.[2]

Lewis's Model: the Theoretical Context

Lewis begins his article with the sentence: 'This essay is written in the classical tradition, making the classical assumption, and asking the classical question.'[3] He meant by this that his framework of analysis was within the tradition of economics which began with Adam Smith in the 1770s, was developed by Thomas Malthus and David Ricardo in the early nineteenth century, and ended with Karl Marx in the 1860s. These economists focused on the growth of an economy and its relationship to the division of income, and saw growth as driven primarily by the accumulation of capital. This classical model was dislodged from the centre of economic thinking in the 1870s by the neo-classical 'marginalist' revolution and its emphasis on relative prices, and

[1] Quoted in D. Ghosh, 'The Metamorphosis of Lewis's dual economy model', *Journal of Economic Methodology*, Vol. 14, No. 1 (March 2007), p. 5.
[2] W.A. Lewis, 'Jamaica, 1830-1930. Comments on a Study in Economic Growth' in M. Faulkus (ed.), *Readings in the History of Economic Growth* (Oxford University Press, London, 1968), pp. 261-267.
[3] W.A. Lewis, 'Economic Development with Unlimited Supplies of Labour', reprinted in A. Agarwala and S. Singh, *The Economics of Underdevelopment* (Oxford University Press, Bombay, 1958), p. 400.

later by the Keynesian revolution of the 1930s, which concentrated on short-run movements in output and aggregate demand. Lewis, then, in his 1954 article was making a bold attempt to re-assert the relevance of classical economic thinking for the modern problems of economic growth.

Lewis notes that classical models of economic growth – certainly those of Ricardo, Malthus, and Marx – all assumed that the long-run wages of workers were fixed at a subsistence wage. For Ricardo and Malthus this subsistence wage was a product of demographics: if real wages rose, then workers would have more surviving children, and this would increase the supply of labour, which in turn would exert downward pressure on wages back to subsistence level. Marx rejected this explanation. Instead, he argued that rising real wages would cause employers to substitute machine for workers, increasing unemployment and pushing wages back down to subsistence levels. While the mechanisms differed, the central contention remained: in the long run, wages would remain close to subsistence level. It followed that the long-run supply of labour was perfectly elastic. Firms could recruit as many workers as they wanted in the long run at the subsistence wage. During the twentieth century, Lewis acknowledged, this assumption was abandoned. Real wages manifestly rose above subsistence levels and the long run labour supply curve was assumed to be upward sloping: as employment and the economy grew, real wages tended to rise. But this was true only of the *developed* world. In the developing world supplies of labour were *not* limited and a model assuming long-run subsistence wages remained relevant. In the greater part of Asia, for example, 'labour is still unlimited in supply' and 'it is obviously the relevant assumption for the economies of Egypt, of India, or of Jamaica'.[1] In such cases the labour-supply curve was still perfectly elastic at the subsistence wage. In effect, while the classical model no longer applied to the developed world, it *continued to apply* to the developing world, where economic conditions still approximated to those within which Malthus and Ricardo were writing. Hence it was that Lewis in 1954 felt able to approach problems of development in poorer countries through the lens of the classical tradition – and this is what his article does.

The Sources of Unlimited Supplies of Labour

Lewis writes that:

> An unlimited supply of labour may be said to exist in those countries where population is so large relatively to capital and natural resources, that there are large sectors of the

[1] *Ibid.,* pp. 400-401.

> economy where the marginal productivity of labour is negligible, zero, or even negative.[1]

What are those sectors where many workers contribute virtually nothing to output? The paradigm case is workers in agriculture, and this is the one we will focus on. But for Lewis it includes far more than agricultural labour: it applies to petty retailing where traders crowd around innumerable market stalls and 'if the number of stalls were greatly reduced the consumers would be no whit worse off.' It applies to domestic service, where rich people maintain large retinues of underemployed servants. It applies to the docks, where workers wait often in vain for jobs. It applies railway stations where 'young men rush forward to carry your bag'. It applies to women, many of whom are absorbed into the domestic economy and don't supply wage labour at all. In the modern world, Lewis would no doubt point to the ranks of young men outside fast-food shops on bicycles and mopeds waiting for a delivery. What all these cases mean is that, at the going (subsistence) wage the supply of labour exceeds the demand for it and many people are either unemployed or underemployed and contribute very little to the output of the economy. What also unites these cases is that the labour is unskilled: supplies of skilled labour are always less than perfectly elastic and can represent a bottleneck in the development process. Lewis sums up as follows:

> When we take account of all the sources we have now listed – the farmers, the casuals, the petty-traders, the retainers (domestic and commercial), women in the household, and population growth – it is clear that there can be in an over-populated economy an enormous expansion of new industries or new employment opportunities without any shortage of unskilled labour becoming available in the labour market. From the point of view of the effect of economic development on wages, the supply of labour is practically unlimited.[2]

Implicit within Lewis's analysis is the idea of an economy with two sectors: a sector in which there is surplus (zero productivity) labour, and a sector that can draw upon this labour to expand. This is why Lewis's model is said to be a 'dualistic' growth model, with development emerging out of the interaction of two sectors. What are these two sectors? Lewis chiefly speaks of a 'subsistence' sector and a 'capitalist' sector. By the latter, he means two things: first, that is uses fixed capital supplied by capitalists; and second, that these capitalists are profit-maximising and employ labour only so long as it is profitable to do so. There is no 'surplus' or under-employed labour in the capitalist sector. The capitalist sector could be constituted by any type of production that involves fixed capital and a profit-maximising use of resources: not just manufacturing industry, but capital-intensive modern farming, department store retailing, a railway transit system, etc. By the 'subsistence' sector Lewis means that

[1] *Ibid*., p. 402.
[2] *Ibid*., pp. 405-06.

part of the economy not using fixed capital – capital being more in the nature of what the classical economists called the 'wage fund', i.e. circulating capital advanced to pay wages. This sector is *not* profit-maximising and absorbs whatever is the labour supply to it. It is this sector that is characterised by 'surplus' or underemployed labour.

The non-fixed capital/fixed capital distinction is a strong one and not realistic. In reality, there is no obvious reason why capitalists wouldn't invest some of their capital in the subsistence sector since, with so much labour available, the marginal product of such capital would probably be high and, of course, any subsistence worker will in practice use some fixed capital. Subsequent commentators on Lewis's work have tended to talk of 'traditional' and 'modern' sectors, the modern being profit-maximising, the traditional being governed by custom and family ties. In this paper we shall designate the two sectors as 'agricultural' and 'industrial'. This makes the model easier to picture, and the concept of endemic surplus labour makes most sense when applied to peasant family-farms.

Lewis's Model of the Economy[1]

Lewis assumes that the total labour force in the economy (L_t) at time t is fixed and exogenously determined. This labour force is distributed between two sectors: an agricultural (farm) sector and an industrial sector. Thus:

L_{FT} = Farm sector labour force at time t.

L_{Mt} = Industry sector labour force at time t.

According to Lewis, the farm sector is a residual employer of labour; i.e. agriculture absorbs whatever labour is not employed in the industrial sector. In other words:

$$L_{FT} = L_t - L_{Mt} \qquad (1)$$

At the commencement of Lewis's analysis we imagine an economy where employment in the industry sector is low, with most workers engaged in agriculture. We may think of an agricultural sector made up of small family farms. In effect, any member of the family who has *not* left the family farm and migrated to the city to work in industry will simply be absorbed onto the family farm.

The Agricultural (Subsistence) Sector

[1] In setting out the mathematical relationships of the model I have drawn upon DIY Macroeconomic Model Simulation - 16 A Lewis Model of Economic Development. These authors base their model on the exposition of Lewis's work in M. Todaro and S. Smith, *Economic Development* (Pearson, Harlow, Twelfth Edition, 2015), pp. 124-129.

Agricultural output results from the inputs of two factors, labour and land. There is no capital employed in the rural sector. Land is fixed in supply. Given this, farm output at time t, Y_{FT}, is a function of labour inputs only; that is:

$$Y_{FT} = f(L_{FT}) \qquad (2)$$

Farm output is a positive function of labour inputs but, with the fixed factor of land, labour is subject to diminishing marginal returns; i.e.

$$\frac{\partial Y_{Ft}}{\partial L_{FT}} > 0 \qquad (3)$$

$$\frac{\partial^2 Y_{FT}}{\partial L_{FT}^{\ 2}} < 0 \qquad (4)$$

Where (3) is the marginal product of farm labour (MPL_{Ft}) and (4) is the change in the marginal product of farm labour as employment increases – being negative, due to diminishing marginal returns.

The large supply of labour to the rural sector, combined with a fixed amount of land and diminishing returns, means that the marginal product of labour in the agricultural sector is zero:

$$\frac{\partial Y_{Ft}}{\partial L_{FT}} = 0 \qquad (5)$$

As noted, the rural sector acts as a reservoir of labour. Everyone not working in industry is absorbed into the family farms even if they add nothing to output. Each family feeds its members by dividing the total output of the farm among the number of people on the farm. Remuneration is thus based on custom and kinship rather than maximising economic behaviour. This average wage per worker when the marginal product of labour is zero is designated by Lewis the Subsistence Wage (W_S). Following the classical tradition, Lewis considers the subsistence wage as exogenously given and constant. For the classical economists the subsistence wage *was* a subsistence wage to which the remuneration of labour tended due to Malthusian population growth. Lewis doesn't state that this is the case: he fluctuates between regarding it as 'what is required for subsistence consumption' and considering it as determined by a 'conventional standard of living.' It is best regarded as equal to the average product of labour in the rural sector with no particular connotation of 'subsistence'. For a given population and a given amount of land, it can be taken as fixed. This is the important point.[1]

[1] Gollin argues that the idea of a total farm output divided among the family members is a 'romanticized' vision of the rural or traditional sector. Data suggests that there is significant variation of incomes *within* traditional rural communities (Gollin, 'The Lewis Model: A 60-Year Retrospective', p. 78.)

Figure 1 represents the rural labour market.

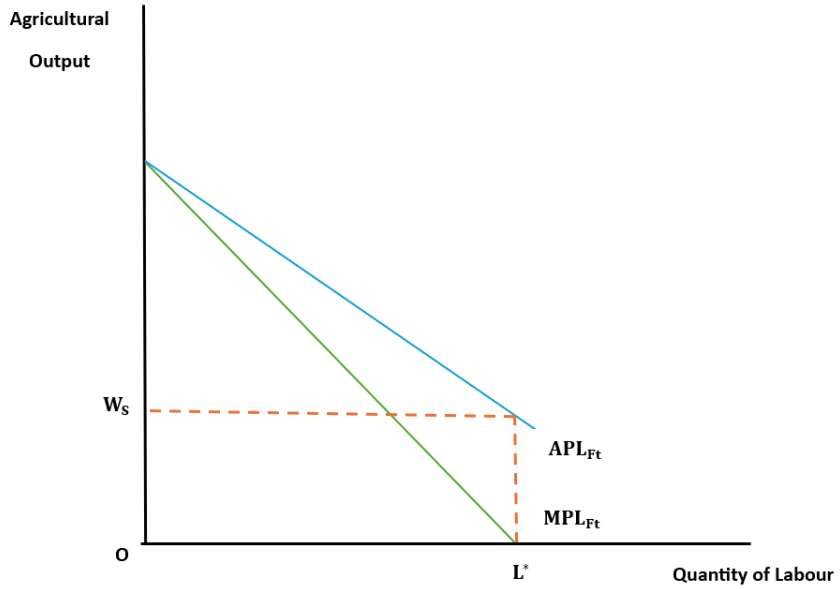

Figure 1. Determination of Subsistence Wage in the Rural Sector

As the employment of labour in agriculture increases the marginal product of labour declines until, once it reaches L^*, the marginal product of each additional worker in the rural sector is zero. At L^* the total output of the farm is the average product of labour multiplied by the quantity of labour inputs, i.e. L^*W_S. All output is paid out to the workers on the farm. The average product of labour is the amount of output received by each family member and this is the subsistence wage W_S.

The Total product function for the rural sector is depicted in **Figure 2**.

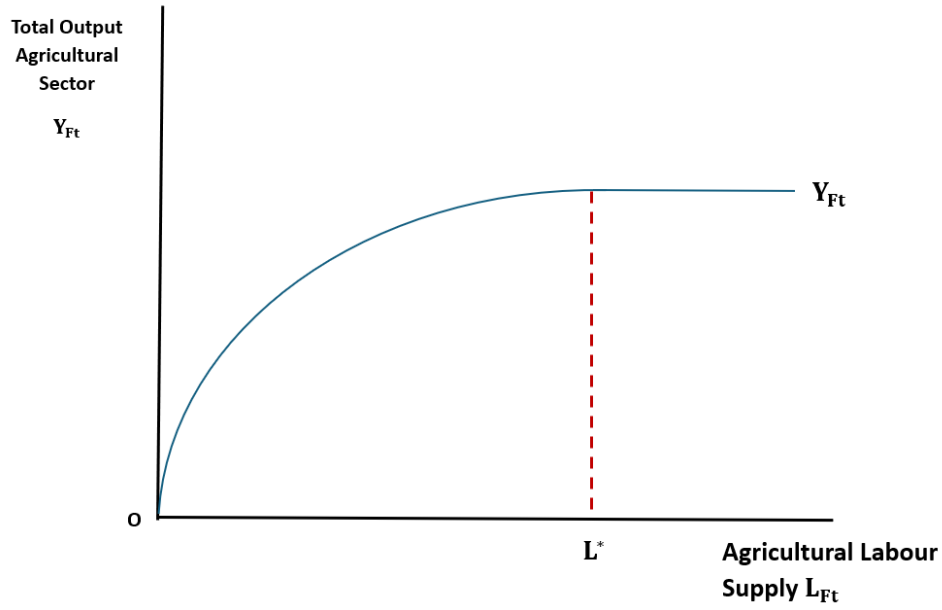

Figure 2. Total Output in the Industrial Sector

As labour inputs increase from zero, total agricultural product increases but at a decreasing rate due to the law of diminishing marginal returns. Once employment level L^* is reached total output ceases to increase as labour inputs increase since the marginal product of labour is zero.

Hence, there are two production functions in the rural sector according to whether labour inputs are below or above the employment level L^*.

(i) When $L_{Ft} < L^*$ then $Y_{Ft} = L_{Ft}^{\alpha}$ where o < α < 1
This means that farm output is a function of labour inputs (L_{Ft}) when employment is *less than* L^*. The marginal product of labour is positive:
$\frac{\partial Y_{Ft}}{\partial L_{Ft}} = \alpha L_{Ft}^{\alpha-1}$
while there is diminishing marginal returns since the second derivative of output by labour is negative:
$\frac{\partial^2 Y_{FT}}{\partial {L_{FT}}^2} = (\alpha - 1)\alpha L_{Ft}^{\alpha-2}$
which is negative since (α – 1) < 0.

(ii) When $L_{Ft} > L^*$ then $Y_{Ft} = (L^*)^{\alpha}$
Since L^* corresponds to the employment level where the marginal product of labour is zero, then beyond L^* each additional worker adds nothing to output and output is fixed at the level corresponding to L^*. There is no marginal product of labour since output is fixed. In so far as the *actual* labour force in the rural sector (L_{Ft}) exceeds L^* then there is surplus (unproductive) labour in the rural sector.

The Industrial Sector

In the industrial sector:

$Y_{Mt} = f(L_{Mt}, K_{Mt})$

Output in the industrial sector (Y_{Mt}) at time t is a function of the inputs of labour and capital at time t. We assume a Cobb-Douglas production function with no technical progress:

$$Y_{Mt} = L_{Mt}^{\alpha} K_{Mt}^{\beta} \qquad (6)$$

Since $\alpha + \beta = 1$, there is constant returns to scale.

This sector is subject to diminishing marginal returns in the short run, with labour the variable factor and capital the fixed. The marginal product of labour is:

$$MPL = \alpha L_{Mt}^{\alpha-1} K_{Mt}^{\beta} \qquad (7)$$

which is positive since o < $\alpha < 1$. Diminishing marginal returns are shown by the fact that the second derivative of output with respect to labour is negative:

$$\frac{\partial MPL}{\partial L} = (\alpha - 1)\alpha L_{Mt}^{\alpha-2} K_{Mt}^{\beta} \qquad (8)$$

This is negative since $(\alpha - 1)\alpha < 0$.

The short-run total and marginal product functions with respect to labour (for a given amount of capital) in the industrial sector are shown below.

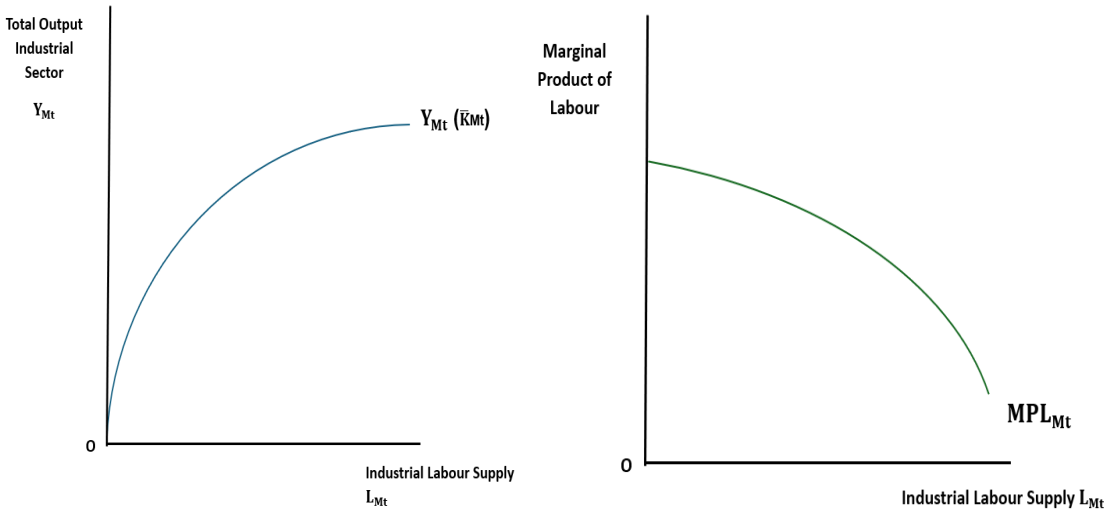

Figure 3. The Total and Marginal Product of Labour in Industry

Wage rates in the industrial sector are, at first, fixed and determined by the subsistence wage in agriculture. Lewis assumed that firms in the industrial sector can attract unlimited supplies of labour from the rural sector provided they offer a wage *above* the agricultural subsistence wage of W_S. Specifically, he argued that firms in the industrial sector would need to offer a wage-premium to underemployed rural workers to induce them to leave their family farms and undertake the cost and stress of a move to the city. This wage-premium he estimated to be about 30 per cent. Thus, the wage in the industrial sector is determined by the subsistence wage in agriculture *plus* a fixed premium-wage mark-up. Hence, the industrial wage is:

$$W_{Mt} = W_S(1 + p) \qquad (9)$$

where W_{Mt} is the industrial wage and p is the industrial wage premium (p > 0).

So long as underemployed surplus labour in agriculture persists, i.e. so long as $L_{Ft} > L^*$, then labour in the rural sector can be attracted in unlimited quantities to the industrial sector at a wage of $W_S(1 + p)$. Since the marginal product of such labour in farming is zero, agricultural output is not affected by this loss of labour. Thus, industrial

firms face a perfectly elastic supply curve of labour as long as $L_{Ft} > L^*$. This supply of labour curve to the industrial sector is illustrated below.

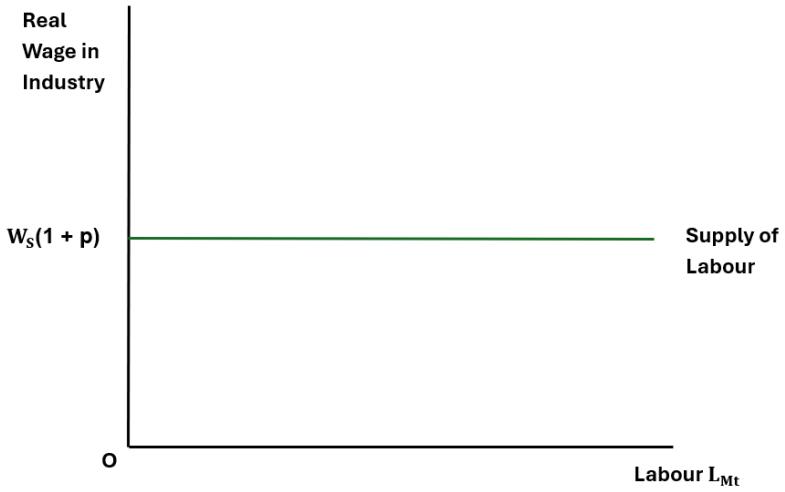

Figure 4. Labour Supply curve to Industry with Unlimited Supplies of Labour

Figure 4 shows that firms can hire any amount of labour that they wish at the wage $W_S(1 + p)$. The industrial sector is a *price-taker* in the labour market in the early stages of development.[1] This is the 'unlimited supplies of labour' in the title of Lewis's article.[2]

There is, however, a sharp discontinuity in the labour supply curve to the industrial sector once it has absorbed all the surplus (zero marginal product) labour in the rural sector. Beyond this point, as labour is drawn from the rural sector, the marginal product of agricultural labour becomes *positive* and starts to rise. The average product of the rural workforce also rises and increases above W_S. In **Figure 1**, this is represented by a movement in labour supply to the left of L^*. Henceforward, if the industrial sector is to attract more labour from the countryside it must offer an ever-increasing wage. As Lewis notes, 'When the labour surplus disappears our model of the closed economy no longer holds. Wages are no longer tied to a subsistence level.'[3] The industrial wage is no longer fixed at $W_S(1 + p)$; instead, it rises with employment. Thus:

$W_{Mt} = aL_{Mt}$ when $L_{Ft} < L^*$ (10)

[1] D. Gollin, 'The Lewis Model: A 60-Year Retrospective', *Journal of Economic Perspectives*, Vol. 28, No. 3 (Summer 2014), p. 72.
[2] There is an inconsistency in the model at this point. While it may be the case that that a worker leaving the subsistence sector has a zero marginal product, their removal from the farm will raise the average amount of product (income) received by those who remain and this ought to *raise* the subsistence wage from the beginning. To this objection, Lewis replied that ongoing population growth would offset this effect in rural areas, keeping average incomes relatively constant, and that even if rural average incomes started to rise this wouldn't immediately impact on the industrial wage – perhaps the wage premium for industrial labour might fall.
[3] *Ibid*, p. 435.

The industrial sector now faces an upward-sloping labour supply curve. In our model, we assume this is a simple linear curve with a gradient of **a**.

Combining these two scenarios, with at first surplus labour in the rural sector when $L_{Ft} > L^*$ and the industrial wage is $W_S(1 + p)$, followed by a situation when the surplus labour is exhausted ($L_{Ft} < L^*$) and the industrial wage is $W_{Mt} = W_S(1 + p) + aL_{Mt}$, we arrive at the following supply curve of labour to industry.

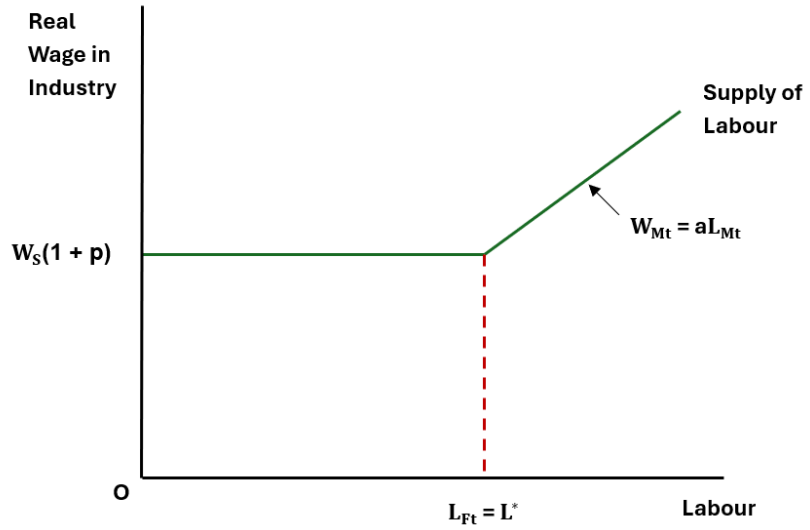

Figure 5. The Labour Supply Curve to Industry with Unlimited and Limited Supplies of Labour

The discontinuity in the labour supply curve to industry, corresponding to the point where all surplus labour has been released by the agricultural sector, is called the 'Lewis turning point'.

The Industrial Sector's Demand for Labour

Firms in the industrial sector are (unlike the rural sector) profit maximising, and will increase their employment of labour so long as the marginal product of labour exceeds its wage. In other words, they will employ labour until:

MPL = Wage

Lewis assumes that the movement of the industrial sector to this point does not occur instantaneously but follows a gradual path, as workers from the rural sector move from the countryside and take up industrial jobs in the city. Hence, the demand for labour at time t equals the employment of labour at t-1 plus an increase in employment so far as the marginal product of labour at time t-1 exceeds the wage at t-1. Formally:

$$L_{Mt} = L_{Mt-1} + \delta(MPL_{Mt-1} - W_{Mt-1}) \qquad (11)$$

This tells us that the employment of labour in industry at time t is equal to employment at time t-1 plus an increase in employment proportional to the difference between the marginal product of labour at time t-1 and the wage of labour at t-1. So long as the marginal product of labour exceeds the wage, then employment will increase at some rate δ. This captures how Lewis assumes that firms move *towards* the MPL = W condition at a gradual rate. Hence, we can regard the value of δ as being some positive number less than one; 0 < δ < 1. If MPL < W then employment would contract at the same rate.

So long as the marginal product of labour exceeds the market wage firms will recruit more labour from the rural sector. In terms of the initial phase of our model, when the wage necessary to attract labour from the rural sector is $W_S(1 + p)$, then if $MPL_{Mt} > W_S(1 + p)$ firms will employ more rural labour in their industries. As employment in industry increases so, due to diminishing returns, will the marginal product of labour decline, until $MPL_{Mt} = W_S(1 + p)$, at which point firms will stop recruiting more rural labour.

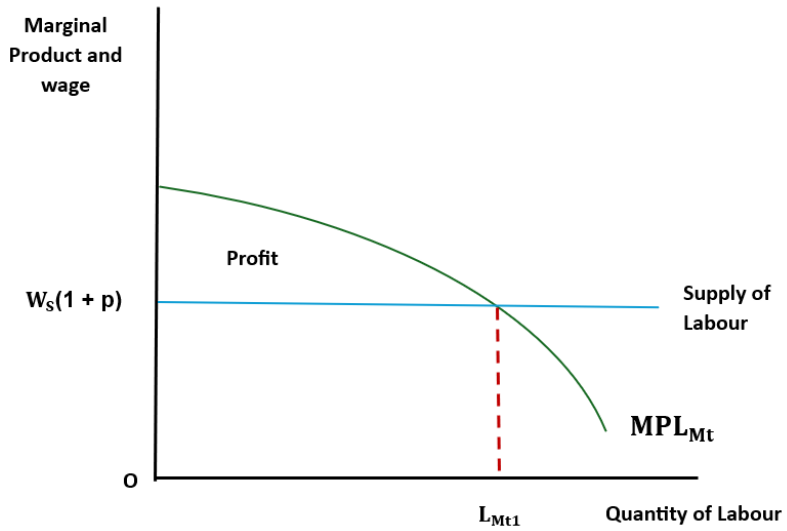

Figure 6. Employment Determination in Industry with Unlimited Supplies of Labour

In **Figure 6** we see that, when the wage is $W_S(1 + p)$, at which the industrial sector has access to a perfectly elastic supply of labour, industrial employment will be OL_{Mt1}, where the marginal product of labour is equal to the wage.

This is a conventional comparative-static result and doesn't yield long run economic development. To convert the Lewis model from a static to a dynamic one, two further assumptions are required.

Lewis's Development Process

First, Lewis's profit equation for the industrial sector is as follows:

$$\pi_{Mt} = Y_{Mt} - W_{Mt}L_{Mt} \qquad (12)$$

Here:

π_{Mt} = Total profit in the industrial sector

Y_{Mt} = Output of the industrial sector

W_{Mt} = The wage rate for industrial labour

L_{Mt} = Employment in the industrial sector

Thus, profit is the difference between total real output in the industrial sector and the total wage paid to the industrial labour force. The average profit per worker is:

$$\frac{\pi_{Mt}}{L_{Mt}} = \frac{Y_{Mt}}{L_{Mt}} - W_{Mt} \qquad (13)$$

In other words, so long as the average product of labour exceeds the wage, there will be positive profits in the industrial sector. The area 'Profit' indicated in **Figure 6** indicates the profit of industrial firms when the wage is $W_S(1 + p)$ and employment is L_{Mt}.

Second, Lewis assumes that 'some' of this surplus is re-invested by firms as fixed capital. He doesn't, however, say how large 'some' is. To simplify, we assume that *all* the surplus is re-invested by firms. Hence, the capital stock in the industrial sector at time t is:

$$K_{Mt} = K_{Mt-1} + \pi_{Mt-1} \qquad (14)$$

The capital stock at time t is equal to the capital stock at time t-1 plus the addition to capital arising from re-invested profit. There is no depreciation.

This investment function is crucial since it is what makes the model *dynamic*. To quote Lewis:

> The key to the [growth] process is the use which is made of the capitalist surplus. In so far as this is reinvested in creating new capital, the capitalist sector expands, taking more people into capitalist employment out of the subsistence sector. The surplus is then larger still, capital formation is still greater, and so the process continues until the labour surplus disappears.[1]

[1] *Ibid*., p. 412.

The reason a growth process is initiated is that, as capital accumulates, the capital/labour ratio rises and the increase in capital per worker *raises* the marginal product of labour. That is:

$\frac{\partial}{\partial \mathrm{K}}$ (MPL) > 0

where:

$$\frac{\partial}{\partial \mathrm{K}}(\alpha \mathrm{L}_{\mathrm{Mt}}^{\alpha-1} \mathrm{K}_{\mathrm{Mt}}^{\beta}) = \alpha\beta \mathrm{L}_{\mathrm{Mt}}^{\alpha-1} \mathrm{K}_{\mathrm{Mt}}^{\beta-1} \qquad (15)$$

Since α and β are both positive, the partial derivative of the marginal product of labour with respect to capital is positive. Hence, rising accumulation of capital *increases* the marginal product of labour relative to the industrial wage $\mathrm{W_M}$ and this causes the demand for labour in the industrial sector increases since, as we have seen:

$$\mathrm{L_{Mt}} = \mathrm{L_{Mt-1}} + \delta(\mathrm{MPL_{Mt-1}} - \mathrm{W_{Mt-1}}) \qquad (11)$$

Hence, we get the following growth process: firms in the industrial sector employ more labour when the marginal product of labour exceeds the wage; as employment increases the marginal product of labour falls towards $\mathrm{W_M}$ until, when MPL = $\mathrm{W_M}$, employment expansion ceases; but the effect of increased capital investment is to raise the marginal product of labour so restoring the positive difference between the MPL and the wage causing firms to increase employment again, until MPL = $\mathrm{W_M}$, at which point further increases in the marginal product of labour cause MPL > $\mathrm{W_M}$, permitting employment to increase again, and so on. *It is capital accumulation out of re-invested profit which ensures that the growth process is self-sustaining.*

Development Before and After the Lewis Turning-Point

Development in the Lewis model occurs in two distinct phases.

1. *Economic Growth with Unlimited Supplies of Labour*

At first, the industrial sector can absorb any amount of labour as it wants from the rural sector at the fixed wage of $\mathrm{W_S}$(1 + p). Economic development thus proceeds with a perfectly elastic supply curve of labour.

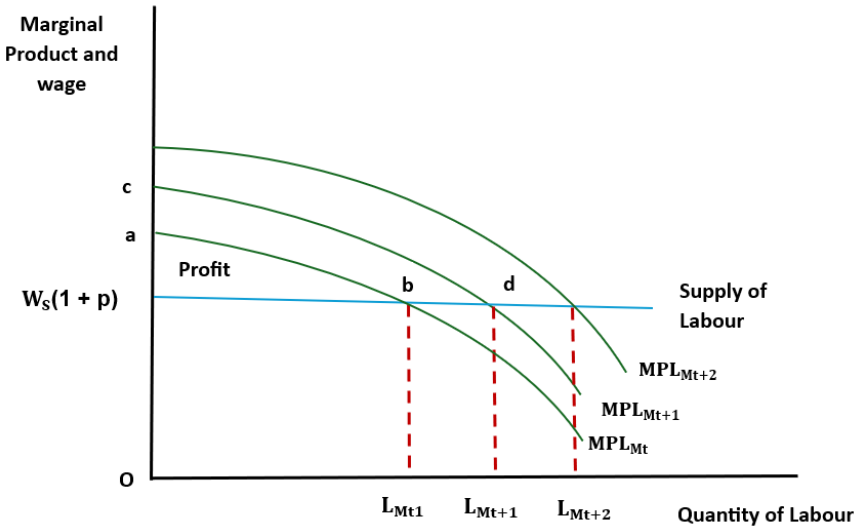

Figure 7. Expansion of the Industrial Sector due to Capital Accumulation

In **Figure 7**, the industrial sector initially has a marginal product of labour line $\mathrm{MPL_{Mt}}$ and, with a given wage of $\mathrm{W_S}(1 + \mathrm{p})$, employs labour from the rural sector until $\mathrm{MPL_{Mt}}$ = $\mathrm{W_S}(1 + \mathrm{p})$ at employment level $\mathrm{L_{Mt1}}$. At this level of employment, the sector's profit is the area abW$_\mathrm{S}(1 + \mathrm{p})$. These profits are invested to increase the capital stock. As a result, each worker has more capital than before and this raises labour productivity, with the result that the marginal product curve shifts out to $\mathrm{MPL_{Mt+1}}$. At employment level $\mathrm{L_{Mt1}}$ the marginal product of labour exceeds the wage, and so firms expand employment to $\mathrm{MPL_{Mt+1}}$. Profits are now equal to the area cdW$_\mathrm{S}(1 + \mathrm{p})$. Again, this profit is invested, raising the capital/labour ratio and increasing the marginal product of labour to $\mathrm{MPL_{Mt+2}}$. Firms increase employment to $\mathrm{L_{Mt2}}$, and profits increase still further, leading to more investment and additional increases in the marginal productivity of labour, and so on as the industrial sector grows in employment along the perfectly elastic wage line. During this growth process labour shifts from the rural to the industrial sector. GDP rises since workers are moving from zero to positive productivity occupations. Because the total income of labour in the rural sector remains fixed (because the labour being removed has zero marginal product) then agriculture's share of national income falls while the industrial sector's rises. And within the industrial sector, the rising productivity of labour means that the average product of labour rises relative to the fixed wage, with the result that the share of profits in national income is rising – and so, therefore, is capital investment as a share of GDP. This is the phase of rapid economic development in the Lewis model.[1]

[1] Because real wages in agriculture and industry remain constant, and the share of labour in total output is falling, then Lewis's model assumes that firms export their growing output – especially since capitalists spend their rising incomes on capital goods, not consumption goods.

2. *Economic Growth with Limited Supplies of Labour*

The phase of rapid growth based on the movement of underemployed rural labour to the industrial sector ends once the reservoir of surplus zero-productivity labour in agriculture is exhausted. When this point is reached, the labour-supply curve ceases to be perfectly elastic at the wage $W_S(1 + p)$. This is because, henceforward, as labour is drawn from the rural to industrial sectors the workers involved have a *positive* marginal product – they contribute tangibly to the output of the family farm. Indeed, as the rural sector moves *up* its downward sloping marginal product of labour line it experiences *increasing* marginal returns. Thus, as workers leave the rural sector the average product of labour rises and so the rural wage *rises*. This means that if the industrial sector is to recruit more labour it must pay a higher wage W_2, where $W_2 > W_S(1 + p)$. Moreover, this wage W_2 rises continuously as labour is drawn from the farming sector. The supply curve of labour to the industrial sector is no longer horizontal – it is upward sloping like any conventional labour supply line. In other words, assuming a linear relation between the industrial wage and the quantity of labour employed, we can express the wage function as:

$$W_2 = W_S(1 + p) + bL_{Mt} \qquad (16)$$

once $L_{Ft} < L^*$.

The effect of this is to markedly slow the growth process as initially envisaged by Lewis. There are two reasons for this.

First, we saw before that the demand for labour in the industrial sector is:

$$L_{Mt} = L_{Mt-1} + \delta(MPL_{Mt-1} - W_{Mt-1}) \qquad (11)$$

Previously, the demand for labour was checked in the short-run only by the fall in the marginal product of labour due to diminishing returns. But now, in addition, the demand for labour is also checked by the rising wage W_{Mt-1}. Hence the expansion of employment and thus output in the industrial sector will be reduced and the rate of structural change of the labour force from agriculture to industry will slow.

Second, the profit-fuelled dynamism of the industrial sector will diminish. Growth in the industrial sector happens because firms re-invest profits as capital, raising the marginal product of labour. Profits in the industrial sector equal:

$$\pi_{Mt} = Y_{Mt} - W_{Mt}L_{Mt} \qquad (12)$$

with average profit per worker equal to:

$$\frac{\pi_{Mt}}{L_{Mt}} = \frac{Y_{Mt}}{L_{Mt}} - W_{Mt} \qquad (13)$$

Previously profit per worker fell only with the falling average product per worker due to diminishing returns in the industrial sector. Now, however, profit per worker also falls because the wage of industrial workers (W_{Mt}) is rising as the surplus of labour in the rural sector is exhausted. In particular, once $L_{Ft} < L^*$ the industrial wage rises at the rate:

$$W_{Mt} = bL_{Mt} \qquad (17)$$

Hence, once surplus labour is exhausted, the profit function becomes:

$$\pi_{Mt} = Y_{Mt} - (bL_{Mt})\, L_{Mt}$$

$$\pi_{Mt} = Y_{Mt} - bL_{Mt}^{2} \qquad (18)$$

In which case, the rate of change of profit with respect to an increase in labour is:

$$\frac{\partial \pi_{Mt}}{\partial L_{Mt}} = \frac{\partial Y_{Mt}}{\partial L_{Mt}} - 2bL_{Mt} = \frac{\partial Y_{Mt}}{\partial L_{Mt}} - 2W_{Mt} \qquad (19)$$

This shows that the change in profit due to a change in labour is equal to the real marginal product of labour minus the marginal cost of employing that labour. The marginal cost of employing labour rises as a rate double the wage or average cost. A profit maximising firm in the industrial sector will employ labour until the marginal cost of employing that labour is equal to its marginal product. During the phase of unlimited supplies of labour this meant:

$$\frac{\partial Y_{Mt}}{\partial L_{Mt}} = W_{Mt}$$

Whereas, once labour supply becomes less than perfectly elastic, this becomes:

$$\frac{\partial Y_{Mt}}{\partial L_{Mt}} = 2bL_{Mt} \qquad (20)$$

Profit now declines more rapidly since, not only does the marginal product of labour decline as employment increases, but the wage of labour rises and the marginal cost of labour rises at a rate double the rise in wages (on the assumption of linear supply lines for labour). All this means that the employment and growth effect of a given increase in the marginal product of labour will be much less *once the Lewis model reaches limited supplies of labour.* Diagrammatically we have the following:

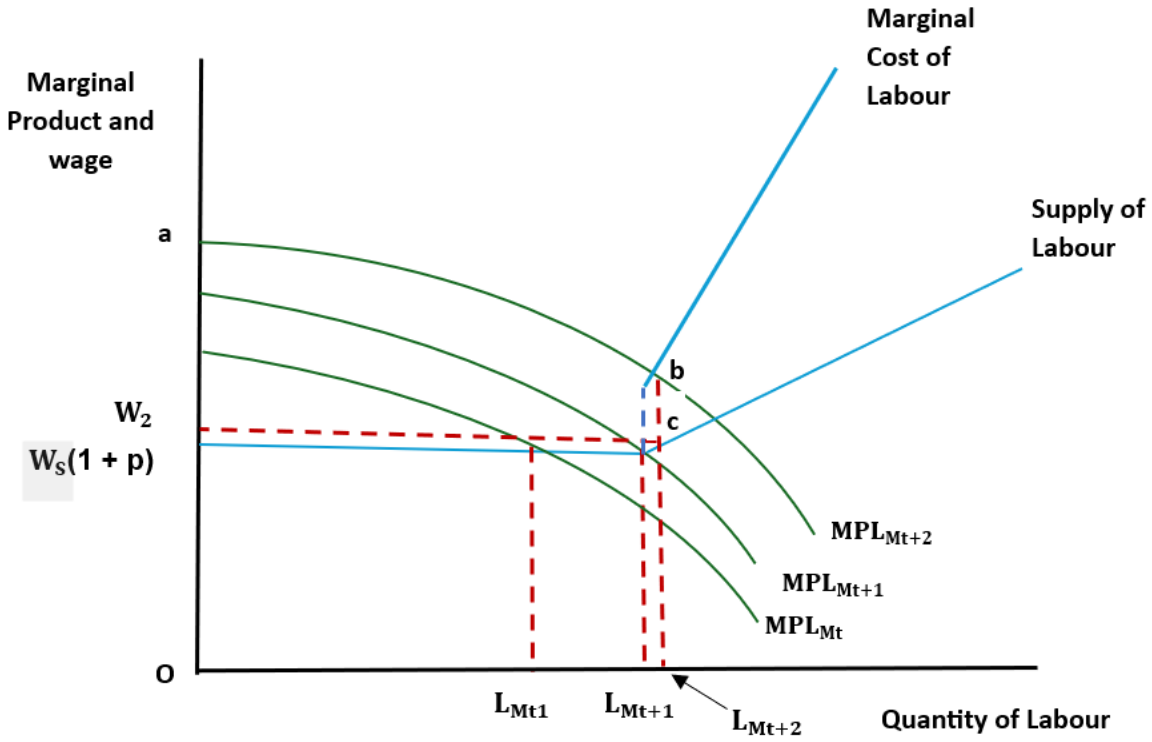

Figure 8. Growth in the Industrial Sector once Labour Supply becomes Limited

In this diagram, economic growth proceeds initially with unlimited supplies of labour at wage $W_S(1 + p)$. When the marginal product of labour shifts from MPL_{Mt} to MPL_{Mt+1} due to capital accumulation then employment rises from L_{Mt1} to L_{Mt+1}. However, at employment level L_{Mt+1}, rural supplies of zero marginal product labour end. From this point the industrial sector must pay a rising wage to attract more labour along the upward labour supply line. Since, by employing more labour, the industrial sector raises the wage it must pay *all* labour, the marginal cost of an extra worker is that workers wage *plus* the increased wage now paid to all workers already employed (this is the condition known as monopsony in labour markets). For this reason the marginal cost of labour line shifts upwards at the discontinuity point, thereafter rising at a gradient double that of the labour supply line. Hence, when the marginal product of labour line shifts to MPL_{Mt+2}, employment only increases to L_{Mt+2}, since at this point the marginal product of labour equals the marginal cost of labour. The wage paid by the industrial sector rises to W_2, and industrial profits are squeezed to abcW_2 – less than they would have been if the wage had remained at $W_S(1 + p)$. The diminution of profit reduces the funds available for re-investment so, going forward, the size of the shifts in the marginal product curves of labour will diminish and wages will continuously rise, steadily reducing the surplus of output over the wage bill available for investment.

Growth and development continues, but at a slower rate than under the previous regime of unlimited supplies of labour.

This slowing of the rate of structural transformation from rural to industrial labour is a necessary corollary of the Lewis growth process. But, by the time it begins, the economy will have already entered upon a modern growth path. Incomes per head will have risen, increasing demand for the products of industry and services. Cities have grown relative to the countryside. With the rural surplus labour cleared, wages in agriculture rise also. Industry will now have the funds to invest in improved technology and, with rising real wages, there will be an incentive to substitute machinery for labour. The economy is on its way to modernisation and the supplies of surplus rural labour will have done their work.