MIGRATION AND THE WAGES DIFFERENTIAL *

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1. Introduction

In this paper we do not try to develop a complete theory of labour migration from the agricultural to the non-agricultural sector of an economy; rather, we try to express some ideas and to investigate some ad hoc hypotheses which have been taken by some theorists.

Therefore, in the first two sections of this paper we summarize, in some way, the existing theoretical and empirical work in this area of research, and in the following five sections, we try to extend it by investigating in a more analytical way the determinants and the mechanics of labour migration between the two sectors of an economy, i.e. the agricultural and nonagricultural.

2. Determinants of Migration

Economic history is replete with evidence of persistent sectoral differentials in labour incomes (or wages), for example in the studies of Borts-Stein (1964), Watanabe (1965), Williamson (1965), Reynolds (1965), Taira (1966), and Ohkowa-Rovosky (1972).

The question which the economist usually faces is why the earnings of the workers in the various sectors of the economy (i.e. agricultural and nonagricultural for our case) are not equal, in spite of the mass of labour migration between the two sectors.

In trying to find a plausible answer to this question, the economists who deal with migration research work along two lines. The first line, which has received more attention, concerns the direction and magnitude of the response of migrants to labour earnings differentials over space. The second line pertains to the connection

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between migration and those earnings, that is, the effectiveness of migration in equalizing inter-regional earnings of comparable labour.

For these lines of work, research has been focussed to two different approaches. The first approach takes into account expected earnings, introducing an urban unemployment variable. The theoretical works of Todaro (1968, 1969, 1970) and Zarembka (1970) fall into this category. The second approach uses the hypothesis that current wage differentials cause labour transfer between sectors. The theoretical works of Lewis (1954, 1958), Fei-Ranis (1961, 1964) and Jorgenson (1961, 1967) fall into this category.

Most studies concerned with the first line of research, ie. the direction and magnitude of the response of migrants to labour earnings differentials over space, have found a relationship between income and migration, and usually in the expected direction, that is, high earnings are associated with in-migration and low earnings with out-migration. Of course, the significance of wage differentials (current or expected) is not the only determinant of migration, and not all determinants are necessarily economic.

We will mention here some empirical works concerning the significance of the various determinants of migration, Zarembka (1972). Beals, Levy and Moses (1967) studied internal migration in Ghana, and concluded that migration is responsive to income differentials and that geographic distance-as a surrogate for differences in culture, social organization and language as well as for transport cost-is a strong deterrent to migration. Also, regions of large population are attractive to migrants, but the educational level does not seem to directly affect migration.

The major findings of Sahota (1968) in a study of Brazil were again that internal migration is highly responsive to earning differentials and that distance is a strong deterrent to migration. However, he found that pecuniary costs of moving are more important than cultural and social differences. Further, Sahota found evidence that education is important to migration, even abstracting from its influence on other variables, and that urbanization and industrialization, as well as population density turn out to be related to migration. In sum, he asserts that "economic costs and returns appear, on the whole, to dominate the behaviour of migrants, though some evidence of the non-economic 'push' and 'pull' factors is not denied".

Greenwood (1963) analyzed migration in Egypt and similarly concluded that "distance acts as an important impediment to migration" and that "migration is away from low-wage and toward high-wage regions. His conclusions concerning urbanization, population density, and education were much the same as those of Sahota.

In studying Colombia, Schultz (1971), also found that migration responds to the market forces of wage differentials and employment opportunities and that distance to the city and schooling influence migration in the expected direction.

He found, additionally, that migration in Colombia is increased with the frequency of rural violence.

Sjaastad (1961), in his study of interstage migration, shows that the observed relationship between net migration and wages differential is quite small and weak. He shows that over the decade 1940-1950, an increase in per capita labour earnings of $1000 (1947-49 dollars) induced net in-migration or retarded net out-migration by only 4 or, at most, 5 per cent of the population aged between fifteen and twenty-four years at the end of the decade. The percentage was lower for other ages and hence lower for the total population.

Hanna (1959) concludes that the low income states are dominated by occupations with relatively low earnings at the national level, and the earnings within particular occupations in low-income states tend to be lower than the national average. Opposite relationships characterize the high-income states. Hanna's study, together with the observed relation between income and net migration, supports the hypothesis that migration does constitute a response to spatial earnings differentials; moreover, this evidence is consistent with the hypothesis that migration is a search for opportunities in higherpaying occupations, Sjaastad (1962).

Are these wages differentials real or not? There has been considerable debate in the literature about the question above. Recent studies confirm the hypothesis of real income differentials, Reynolds (1965), Johnston-Nielsen (1966), Hellemer (1968), Warren (1966).

The second line of research, ie. how effective is migration in equalizing interregional earnings of comparable labour, has received much less attention than the first line. The models of dual development of Fei-Ranis (1964) and Jorgenson (1961) assume that the migrant's response to an emerging wage gap is sufficiently rapid, compared to the forces causing the divergence in wages, to permit a convergence to short-run equilibrium in every period. Furthermore, Jorgenson argues that the differential which is necessary to cause a movement of the agricultural labour force into the non-agricultural sector is roughly proportional to the industrial wage, and he assumes that :

$$\frac{w_1(t)}{w_2(t)} = \mu \quad \text{where } 0 < \mu < 1 \qquad w_1(t) = \text{agricultural wage}$$

$$w_2(t) = \text{industrial wage}$$

or

$$w_2(t) - w_1(t) = (1 + \mu)\, w_2(t) \qquad (2.1)$$

According to Todaro (1969), in his low-income economy, or Harris and Todaro (1970) in their two -sector model, migration follows a two-stage process. In the first stage the unskilled rural worker migrating to an urban area initially spends a period of time in the "urban traditional" sector (or stays unemployed). In the second stage, he obtains a more permanent job in the modern sector. The above authors assume that the decision to migrate from rural to urban areas is a function of the real wage differential and the probability of obtaining a job in the urban sector; thus the determinants of migration are expected earnings differentials rather than real current earnings differentials. These authors argue that the real wage in the urban sector is constrained to be greater than or equal to a politically fixed minimum wage, which is higher than the earnings in the agricultural sector, and that migration is still to be viewed as an equilibrium process, since labour migration continues in each period until the expected income differential is zero.

Sjaastad (1962) and DeVoretz (1969) utilize a capital-theoretic framework which explicitly introduces calculations of present values and migration costs. According to Sjaastad migration is treated as an investment increasing the productivity of human resources, an investment which has costs and which also renders returns. Treating migration as an investment, there exists a ready-made criterion to test the effectiveness of migration in reducing earnings differentials over space. That criterion is, of course, the rate of return on resources allocated to migration.

Wellisz (1974), follows Kenen (1963) and Hagen (1958) by using their short-run migration function which is :

$$M(t) = f(w_2(t)/w_1(t)) \text{ with } f(1) = 0 \text{ and } dM/d\left(\frac{w_2}{w_1}\right) > 0 \qquad (2.2)$$

Presented in diagrammatic terms the argument is that if the growth in demand for urban labour relative to the net increase in the number of urban-born workers is faster than the growth in demand for rural labour relative to the net increase in the number of ruralborn workers, an equilibriating migration stream is generated.

Suppose, in Fig. 1, that the initial agricultural wage $O_1 w_1^0$ equals the initial urban wage $O_2 w_2^0$ if full equilibrium is assumed. Two events now take place :

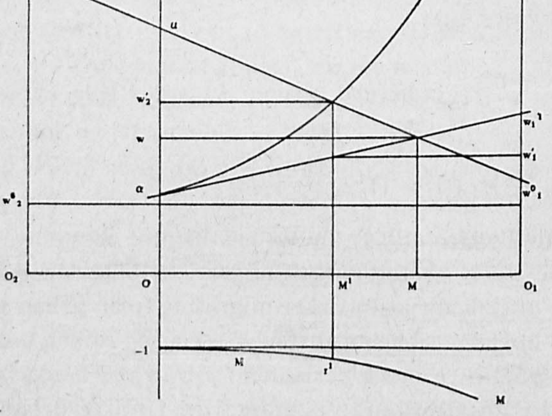

Figure 1

(1) capital accumulation (or technological change) drives up the marginal products of the initial stocks of labour $O_2 w_2^1$ and $O_1 w^1_1$ respectively, and (2), the stocks of the two kinds of labour increase from natural causes by O_2 O and O_1 O respectively. No workers are hired during this period.

During the subsequent period workers are being hired, but there is no capital accumulation and no natural growth of labour. For the time being, it will be assumed that the labour markets are competitive and that the wages announced at the beginning of the period clear the markets by the end of the period.

If migration from rural to urban areas was not permitted, or if it were prohibitively expensive, the urban wage would settle at Ou and the rural wage at Oa. If migration was economically and physically costless, a migration flow $O\hat{M}$ would restore the static equilibrium and establish a new common wage $O\hat{w}$. With positive but finite migration costs, an intermediate situation will be reached within a finite and arbitrarily short time span: the migration volume will be less than $O\hat{M}$, the urban wage higher than $O\hat{w}$ but lower than Ou, and the agricultural wage lower than $O\hat{w}$ but higher than Oa.

Let MM relate the migration volume to the wage differential w_2/w_1 indicated on the negative y axis. If $w_1/w_2 = 1$ (shown by $y = -1$), then $M = 0$; if w_2/w_1 equals, say M^1r^1 then OM^1 workers will migrate. If such a volume of out-migration from agriculture occurs, the marginal product of the remaining stock of agricultural workers will be $O_1 w'_1$. The urban wage required to effect the transfer of OM^1 workers is equal to $O_1w'_1$ multiplied by the differential M^1r^1, ie. it is equal to Ow'_2. It follows that wages $O_1 w'_1$ and Ow'_2 satisfy the short-term equilibrium conditions for the two markets. If the urban wage were set at a higher level, the migration volume would be higher, and there would be urban unemployment at the end of the period; if it were set at a lower level, the migration volume would be lower and there would be unfilled vacancies.

The "supply of in-migrants curve", αS_a, is obtained by relating successive values of w_2, and by obtaining the corresponding volumes of M, given the migration function, the initial stock of rural labour and the demand for agricultural labour. The shape of the supply of in-migrants curve thus depends crucially on the shape of the function relating the volume of migration to the wage differential.

3. The Costs of Migration

According to Sjaastad (1962) the costs of the people who migrate can be broken down into money and non-money costs. The former include the out-of-pocket expenses of movement, while the latter include foregone earnings and the "psychic" costs of changing one's environment.

Increased expenditures for food, lodging, transportation etc. constitute the money costs. There is no doubt that there is no data on these expenses incurred by migrants in the course of moving. Of course, an estimate can be found by questionning the migrants themselves or by taking into account specific distances. Maddox (1960), for example, estimates that many farm people can travel as far as five hundred miles from their home, take ten days to find non-farm jobs, and wait a week for their first pay-cheque after they start work, with a nest egg of no more than $100 per person. Nevertheless, the order of magnitude of the money cost is sufficiently small so that it cannot account for the large earnings differentials observed between the agricultural and non-agricultural sectors.

In his study of internal migration in the United States in 1949-50, Sjaastad (1961, 1962) suggests that the marginal costs associated with additional distance are considerably higher than could be attributed to the costs considered in Maddox' estimate. The migration variable was defined as the number of (net) migrants going from state i to state j as a function of all (net) migrants from state i. Regression coefficients obtained indicate that the attractiveness of a given destination was unaffected by a 10 per cent gain in annual per capita labour earnings and a simultaneous 16 per cent increase in distance. At the mean of the income and distance variables these percentages imply that the typical migrant would be indifferent between two destinations, one of which was 146 miles more distant than the other, if the average annual labour earnings were $106 (1947-49 dollars) higher in the more distant one. Nelson (1957) and others, tried to appeal to market imperfections such as lack of information to explain the apparently high distance cost of migration, but it seems that there is no simple way of testing such hypothesis.

The non-money costs may be divided into the opportunity costs and "psychic" costs. The opportunity costs consist from the loss of income during the migration process itself, searching for, and learning a new job. This size of the foregone earnings can be estimated if we take into account the time taken to move from the rural to the urban area and to search for or learn a new job. Of course, the time spent in the migration process itself is a function of the distance and the time spent in searching for an urban job is function of the level of urban unemployment.

The "psychic" costs, are those costs which are relevant with the psychic world of the migrant, ie. the psychological pressure on the migrant when he leaves his family, friends, familiar surroundings etc. These costs are difficult to quantify. Psychic costs together with money costs and opportunity costs, could explain the existence of earnings differentials.

Given the earnings levels at all other places, there is some minimum earning level at the place under consideration which will cause a given individual to be indifferent between migrating and remaining at home. In other words, the wages differential reflects the belief that farm workers require some premium over their agricultural wage to induce them to incur the costs of moving to a perhaps less well-known and more risky urban area, Zarembka (1970a). The difference in lifestyle between the city and the remote hinterland is much greater than that between the city and the surrounding area, and the costs and time of travel preclude frequent visits of the out-migrant back to his distant native home. For an inhabitant of a remote region, migration means a sharper and more permanent break than that for a migrant from a suburban area. Therefore, psychic costs apparently increase very sharply with distance, Schwartz (1973), Wellisz (1974).

Since direct migration costs are relatively small in many developing regions, the major determinant of costs is the loss of income during the migration process itself. This suggests that c(t), the current cost of migration, might be a function of the income in the sector from which the migrant departed. In fact, we shall assume that the cost of migrating from rural to urban areas is a linear function of income per labourer in agriculture, but that there is no cost associated with movement in the opposite direction, Kelley-Williamson-Cheetham (1972). Thus we have :

$$c(t) = \beta(t) \cdot w_1(t) - \Theta \qquad (3.1)$$

where $\beta(t) \geqslant 0$ is a decreasing function of time showing that as the economy becomes more developed, the migration process becomes quicker, and $\Theta \geqslant 0$ is a fixed parameter over time. When $\Theta = 0$, the costs of migration are proportional to the rural wage; when $\beta(t) = 0$, the migration costs are constant over time.

4. The Migration Decision

We could say that this section is a continuation of section 2 because it also deals with determinants of migration. But we prefer to separate it from section 2 because we would like to present here some new points on the decision to migrate and the wage differentials.

Suppose, for the moment, that there exists a wage differential between the agricultural and the non-agricultural sector, the two wages being $w_1(t)$ and $w_2(t)$ respectively. Suppose also that each individual's utility function is given by :

$$u(x) = \frac{1}{1-v} x^{1-v}, \quad 0 \leqslant v < 1 \qquad (4.1)$$

We assume that the direct cost of moving between the two sectors is very small, so that it may be omitted from the cost function (3.1). Therefore, (3.1) becomes (for $\Theta = 0$)

$$c(t) = \beta(t) \cdot w_1(t) \qquad (4.2)$$

or in utility terms

$$u(c(t)) = \frac{1}{1-v} (\beta(t)\, w_1(t))^{1-v} = \frac{1}{1-v} \beta(t)^{1-v}\, w_1(t)^{1-v} \qquad (4.3)$$

(4.3) shows the utility lost by the individual who migrates.

We define P(t) as the probability of an individual finding a job in the non-agricultural sector. If we assume that employment and unemployment in the non-agricultural sector are two mutually exclusive events, then the individual who migrates to the urban area has a probability of 1-P(t) of not finding a job or, equivalently, of not earning any wage.

Therefore, the individual in agriculture migrates to the non-agricultural sector if and only if he assumes that he will gain greater utility than by staying in the agricultural sector. Hence, the decision to migrate is given by the expression :

$$(1-P(t))\; u(0) + P(t) \cdot u(w_2(t)) - u(c(t)) > u(w_1(t)) \qquad (4.4)$$

From (4.1) and (4.3) it is known that

$$u(0) = 0$$

$$u(w_i(t)) = \frac{1}{1-v} w_i(t)^{1-v} \quad i = 1,2$$

and

$$u(c(t)) = \frac{1}{1-v} \beta(t)^{1-v} w_1(t)^{1-v} \qquad (4.5)$$

We substitute (4.5) into (4.4) and obtain :

$$P(t) \frac{1}{1-v} w_2(t)^{1-v} - \frac{1}{1-v} \beta(t)^{1-v} w_1(t)^{1-v} > \frac{1}{1-v} w_1(t)^{1-v}$$

or

$$P(t)\, w_2(t)^{1-v} > (1 + \beta(t)^{1-v})\, w_1(t)^{1-v}$$

or

$$\frac{w_1(t)}{w_2(t)} < \left(\frac{P(t)}{1+\beta(t)^{1-v}}\right)^{\frac{1}{1-v}} \qquad (4.6)$$

From (4.6) we see that, at time t, given the probability of somebody finding a job in the non-agricultural sector and the costs of migration, an individual in the agricultural sector migrates to the non-agricultural sector if and only if :

$$\frac{w_1(t)}{w_2(t)} < \mu(t) \qquad (4.7)$$

where

$$\mu(t) = \left(\frac{P(t)}{1+\beta(t)^{1-v}}\right)^{\frac{1}{1-v}} \qquad (4.8)$$

In the case where $w_1(t)/w_2(t) \geqslant \mu(t)$, nobody is willing to migrate. We call this case the "relative equilibrium". Thus, the lowest wages ratio for the relative equilibrium is:

$$\frac{w_1(t)}{w_2(t)} = \left(\frac{P(t)}{1+\beta(t)^{1-v}}\right)^{\frac{1}{1-v}} = \mu(t) \qquad (4.9)$$

Let's see now some properties of (4.9) or (4.8). $\mu(t)$ always lie between zero and one. We obtain this by giving to P(t) and $\beta(t)$ extreme values. Thus, for $P(t) = 0$ and $0 \leqslant \beta(t) \leqslant \infty$ we have that $\mu(t) = 0$; for $P(t) = 1$ and $\beta(t) = 0$ we have that $\mu(t) = 1$; for $P(t) > 0$ and $\beta(t) > 0$ it is $0 < \mu(t) < 1$.

We further assume that as the economy becomes more developed, P(t) tends to one, which means that, as time passes, it becomes easier for the individual of the agricultural sector to find a job in the non-agricultural sector. At the same time, $\beta(t)$ tends to zero, that is, the costs of migration are a decreasing function of time. Therefore, as $t \rightarrow \infty$, $P(t) \rightarrow 1$ and $\beta(t) \rightarrow 0$, or in other words, $\mu(t) \rightarrow 1$.

In the Harris-Todaro (1970) model and in Harberger (1971), P(t) is given by the ratio of the employed to the total urban labour force. A more plausible determinant of the chances of a single migrant is given by the number of vacancies, V(t), occurring per period t divided by the number of candidates for these vacancies, that is the urban unemployed, U(t), Todaro (1969), Lal (1973). However, for either formulation of P(t), its equilibrium value $P_e(t)$ will be determined by the equilibrium migration condition, which the above authors found to be :

$$P_e(t) = \frac{w_1(t)}{w_2(t)} \qquad (4.10)$$

Of course, the probability P(t) is a theoretical concept, and differs from that which the prospective rural migrants into urban areas take into account. Speare (1971), in a questionnaire survey which he conducted among the immigrants into the city of Taichung in Taiwan, reports that the immigrants from rural areas had only very hazy notions about urban jobs. Also, Speare (1971) and Wilkinson (1970) point out that an *a priori* probability presumably reflects the actual experience of earlier migrants.

Comparing (4.10) with (4.9) or with the equivalent :

$$P_e(t) = (1+\beta(t)^{1-v})\left(\frac{w_1(t)}{w_2(t)}\right)^{1-v} \qquad (4.11)$$

we see that our expression for the equilibrium probability is more general than (4.10) because it does not depend solely on the rural-urban wage differential, as does the expression (4.10), but also on the costs of migration $\beta(t)$ and the utility parameter v, which we could say reflects the tastes of the individuals.

In the case where we have full employment, which means that the vacancies at time t are always equal to the amount of unemployment, and hence $P(t) = 1$, and where $v = 0$ then :

$$\mu(t) = \frac{w_1(t)}{w_2(t)} = \frac{1}{1+\beta(t)} \tag{4.12}$$

From (4.12) we see that, even in this simple special case of full employment, the wages in the two sectors cannot be the same if there exists a positive cost of migration, which can be expressed by $\beta(t) > 0$. This result has also been obtained by Wellisz (1974), as we have already seen in section 2 with the help of figure 1.

5. The labour-allocation curve

For any period of time t we define

$L_i(t)$ is the stock of labour in the ith sector, $(i = 1,2)$

$L(t)$ is the total stock of labour in the economy

$L_{ii}(t)$ is the natural increase of labour in the ith sector, $(i = 1,2)$

$M_i(t)$ is the number of labourers who migrate from the ith sector, $(i = 1,2)$

The truth of the following expressions is obvious

$$L(t) = L_1(t) + L_2(t) \tag{5.1}$$

$$L_1(t) = L_1(t-1) + L_{11}(t) - M_1(t) + M_2(t) \tag{5.2}$$

$$L_2(t) = L_2(t-1) + L_{22}(t) + M_1(t) - M_2(t) \tag{5.3}$$

We now define

$l_i(t) = \frac{L_i(t)}{L(t)}$ the proportion of labour engaged in the ith sector, $(i = 1,2)$

$\eta_i(t) = \frac{L_{ii}(t)}{L_i(t)}$ the natural or physiological rate of increase of labour in the ith sector, $(i = 1,2)$

$m_i(t) = \frac{M_i(t)}{L_i(t)}$ the rate of migration from the ith sector $(i = 1,2)$.

Under the above notation, the expressions (5.1), (5.2) and (5.3) are written :

$$\frac{\dot{L}(t)}{L(t)} = \eta_1(t)\, l_1(t) + \eta_2(t)\, l_2(t) \tag{5.4}$$

$$\frac{\dot{L}_1(t)}{L_1(t)} = \eta_1(t) + \frac{1}{l_1(t)}\,[\, m_2(t)\, l_2(t) - m_1(t)\, l_1(t)\,] \tag{5.6}$$

$$\frac{\dot{L}_2(t)}{L_2(t)} = \eta_2(t) + \frac{1}{l_2(t)}\left[m_1(t)\, l_1(t) - m_2(t)\, l_2(t) \right] \tag{5.7}$$

where of course

$$l_1(t) + l_2(t) = 1 \tag{5.8}$$

In our case, where we assume that migration takes place from the argicultural o the non-agricultural sector only, $M_2(t) = 0$.Therefore (5.6) and (5.7) may be simplified as the following :

$$\frac{\dot{L}_1(t)}{L_1(t)} = \eta_1(t) - m_1(t) \tag{5.9}$$

$$\frac{\dot{L}_2(t)}{L_2(t)} = \eta_2(t) + m_{12}(t) \tag{5.10}$$

where $$m_{12}(t) = m_1(t)\, \frac{l_1(t)}{l_2(t)} = \frac{M_1(t)}{L_2(t)} \tag{5.11}$$

Suppose now that labour force grows at a constant (or variable) rate η, ie.

$$\dot{L}(t) / L(t) = \eta \tag{5.12}$$

determined by :

$$\eta_1(t)\, l_1(t) + \eta_2(t)\, l_2(t) = \eta \tag{5.13}$$

Solving the system (5.8) and (5.13) for $l_1(t)$ and $l_2(t)$, we find:

$$l_1(t) = \frac{\eta - \eta_2(t)}{\eta_1(t) - \eta_2(t)} \tag{5.14}$$

and

$$l_2(t) = \frac{\eta_1(t) - \eta(t)}{\eta_1(t) - \eta_2(t)} \tag{5.15}$$

(5.14) and (5.15) have meaning only for the case where $\eta_1(t) \neq \eta_2(t)$. Of course, this is a mathematical restriction necessary for the existence of the solution of the system above, but it can be justified in practice by the higher fertility of the people in the agricultural sector, that is :

$$\eta_1(t) > \eta > \eta_2(t) \tag{5.16}$$

We assume that the rates of natural change of the labour in the two sectors, $\eta_i(t)$, $(i = 1,2)$, are variable, and $\eta_1(t)$ is decreasing whilst $\eta_2(t)$ is increasing over time. We have to introduce two types of exogenous rates of fertility:

Type I :

$$\eta_1(t) = (\eta + \Theta_1) + \eta_1(0)\, e^{-\eta_1 t} \tag{5.17}$$

$$\eta_2(t) = (\eta - \Theta_2) - \eta_2(0)\, e^{-\eta_2 t} \tag{5.18}$$

and Type II :

$$\eta_1(t) = \eta + \eta_1(0)\, e^{-\eta_1 t} \tag{5.19}$$

$$\eta_2(t) = \eta - \eta_2(0)\, e^{-\eta_2 t} \tag{5.20}$$

where η_i and Θ_i for $i = 1,2$ are parameters that are constant over time. It can be seen that Type II is a special case of Type I where $\Theta_1 = \Theta_2 = 0$.

In type one the fertility of people in the argicultural sector is decreasing over time, but it never reaches the average fertility rate of the whole economy, η. In the non-agricultural sector the fertility of people is increasing over time, but it never reaches the common rate η. Therefore, for type one :

$$\lim_{t \to \infty} \eta_1(t) = \eta + \Theta_1 \quad \text{and} \quad \lim_{t \to \infty} \eta_2(t) = \eta - \Theta_1 \tag{5.21}$$

It is obvious that, for type two where $\Theta_1 = \Theta_2 = 0$, we have :

$$\lim_{t \to \infty} \eta_1(t) = \eta \ \text{decreasingly}$$

$$\tag{5.22}$$

$$\lim_{t \to \infty} \eta_2(t) = \eta \ \text{increasingly}$$

Let us now see how (5.14) and (5.15) behave as $t \to \infty$. Thus, using (5.21) we obtain :

$$\lim_{t\to\infty} l_1(t) = \lim_{t\to\infty} \frac{\Theta_2 + \eta_2(0)\, e^{-\eta_2 t}}{(\Theta_1 + \Theta_2) + \eta_1(0)\, e^{-\eta_1 t} + \eta_2(0)\, e^{-\eta_2 t}}$$

$$= \frac{\Theta_2}{\Theta_1 + \Theta_2} = p_1 \tag{5.23}$$

and

$$\lim_{t\to\infty} l_2(t) = \lim_{t\to\infty} \frac{\Theta_1 + \eta_1(0)\, e^{-\eta_1 t}}{(\Theta_1 + \Theta_2) + \eta_1(0)\, e^{-\eta_1 t} + \eta_2(0)\, e^{-\eta_2 t}}$$

$$= \frac{\Theta_1}{\Theta_1 + \Theta_2} = p_2 \tag{5.24}$$

From (5.23) and (5.24) we see that, as time passes, or, as the economy becomes more developed, for the first type of exogenous change in fertility of people in the two sectors, the proportions of labour engaged in the agricultural and the non-agricultural sectors, tend to the constants $0 < p_1 < 1$ and $0 < p_2 < 1$ respectively, where $p_1 + p_2 = 1$. From (5.23) and (5.24) one may derive :

$$\lim_{t\to\infty} \frac{l_1(t)}{l_2(t)} = \lim_{t\to\infty} \frac{L_1(t)}{L_2(t)} = \frac{\Theta_2}{\Theta_1} = \frac{p_1}{p_2} = p \gtreqless 1 \tag{5.25}$$

Using (5.22) we obtain :

$$\lim_{t\to\infty} l_1(t) = \lim_{t\to\infty} \frac{\eta_2(0)\, e^{-\eta_2 t}}{\eta_1(0)\, e^{-\eta_1 t} + \eta_2(0)\, e^{-\eta_2 t}} = \lim_{t\to\infty} \frac{1}{1 + \dfrac{\eta_1(0)}{\eta_2(0)}\, e^{(\eta_2 - \eta_1)t}} \tag{5.26}$$

and

$$\lim_{t\to\infty} l_2(t) = \lim_{t\to\infty} \frac{\eta_1(0)\, e^{-\eta_1 t}}{\eta_1(0)\, e^{-\eta_1 t} + \eta_2(0)\, e^{-\eta_2 t}} = \lim_{t\to\infty} \frac{1}{1 + \dfrac{\eta_2(0)}{\eta_1(0)}\, e^{(\eta_1 - \eta_2)t}} \tag{5.27}$$

In (5.26) and (5.27), it is more reasonable to assume that $\eta_2 > \eta_1$, which means that the decrease in the rate of fertility of the people in the agricultural sector is less than the increase of the same rate in the non-agricultural sector. Therefore, for $\eta_2 - \eta_1 > 0$ the above limits are equal to :

$$\lim_{t \to \infty} l_1(t) = 0 \quad , \quad \lim_{t \to \infty} l_2(t) = 1 \tag{5.28}$$

and so :

$$\lim \frac{l_1(t)}{l_2(t)} = 0 \tag{5.29}$$

$$t \to \infty \tag{5.29}$$

From (5.28), we see that as time passes, the agricultural sector decreases in size relative to the non-agricultural sector. At $t = \infty$, the agricultural sector has disappeared, or preferably, we could say that it has become fully developed, and so it has been absorbed in the non-agricultural sector, so that the economy has only one sector.

In the case where $\eta_1 = \eta_2$, it is always true that

$$l_1(t) = \frac{\eta_2(0)}{\eta_1(0) + \eta_2(0)}, \; l_2(t) = \frac{\eta_1(0)}{\eta_1(0) + \eta_2(0)} \tag{5.30}$$

and

$$\frac{l_1(t)}{l_2(t)} = \frac{\eta_2(0)}{\eta_1(0)} \tag{5.31}$$

which means that, in this case where the changes in the rates of fertility in the two sectors are equal, the proportions of the labour force engaged in the two sectors remain constant over time.

From the above discussion we can derive geometrically the labour allocation curves between the two sectors as in figure 2, for the two types of fertility rates. In figure 2 the exogenous increase in labour force L(t) is depicted by the 45° lines.

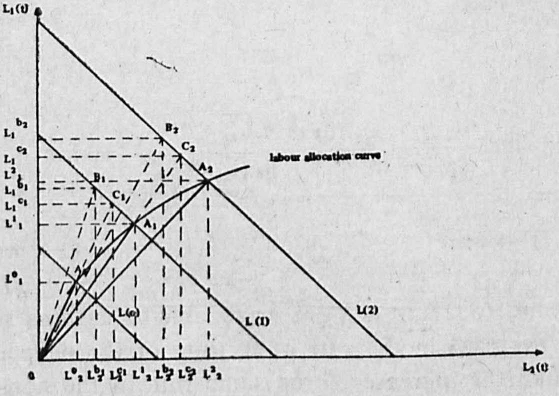

Figure 2

The lines show the allocations of labour between the two sectors possible at a particular time. For example, the point A_0 on the line L(0) shows that the labour allocation of the L(0) workers, is $L_1(0)$ in the agricultural sector (on vertical axis) and $L_2(0)$ in the non-agricultural sector (on horizontal axis). The ratio $L_1(0)/L_2(0)$ or $l_1(0)/l_2(0)$ is shown by the slope of the straight line from the origin to point A_0.

Suppose now that, at time t = 0, the actual labour force engaged in the two sectors is L_1^0 and L_2^0 for the agricultural and non-agricultural sectors respectively. If we suppose now that the natural rate of increase of labour in the two sectors was the same, then at time t = 1, where the total labour force in the economy is L(1), the point which shows the natural labour allocation between the two sectors is C_1, on the L(1) line, with $L_1{}^{c}{}_1$ and $L_2{}^{c}{}_1$ the corresponding levels of labour force for the two sectors. In this case it is :

$$\frac{L_1^0}{L_2^0} = \frac{L_1{}^{c}{}_1}{L_2{}^{c}{}_1}$$

Of course, this is not the case in reality, where the natural rate of increase of labour in the agricultural sector is greater than that in the non-agricultural sector, and so (5.16) applies. This means that the point, in figure 2, which shows the natural labour allocation between the two sectors at time t = 1, is not the point C_1 but another, say B_1, which lies on the left of point C_1 and on the line L(1), and which gives $L_1{}^{b}{}_1$ and $L_2{}^{b}{}_1$ workers for the agricultural and non-agricultural sectors respectively. It is obvious that :

$$\frac{L_1{}^{b}{}_1}{L_2{}^{b}{}_1} > \frac{L_1{}^{c}{}_1}{L_2{}^{c}{}_1}$$

Until now, the discussion has been based on natural rates of change of labour force, and not on actual changes. By the word 'actual' we mean that the change in the labour force in the two sectors is the combined result of the natural (exogenous) change of labour plus the (endogenous) net migration between the two sectors. Therefore, suppose that $L_1{}^{b}{}_1 L_1^1$ ($= L_2{}^{b}{}_1 L_2^1$) workers migrated in time t = 1, from the agricultural to the nonagricultural sector. This change in the volume of the labour force in the two sectors passes point B_1 down and to the right along the line L(1), say to point A_1. Thus, point A_1 shows the actual allocation of labour force between the two sectors, with L_1^1 and L_2^1 workers for the agricultural and non-agricultural sectors respectively for the time period t = 1. It is clear that :

$$\frac{L_1{}^{b}{}_1}{L_2{}^{b}{}_1} > \frac{L_1^1}{L_2^1}$$

In figure 2 point A_1 lies on the right of point C_1. Of course it is possible for point A_1 to lie on the left of point C_1 or to coincide with it. The position of A_1 depends on the volume of migration. The greater is the migration, the further is point A_1 down from point B_1, along the line L(1).

The same analysis applies to the points A_2, A_3, etc. in figure 2. The only point that we must note here is that the angles $C_1\hat{O}B_1$, $C_2\hat{O}B_2$, etc. are decreasing towards zero or almost zero according to the adopted type of natural rate of fertility in the two sectors.

In figure 3 is shown the complete labour-allocation curve as $t \to \infty$ for the two types. If we assume that, at time $t = 0$, all the labour force was engaged in the agricultural sector ($L_1(0) = L(0)$, $L_2(0) = 0$), then for $t = 0$ the labour allocation ratio is given by :

$$\frac{L_1(0)}{L_2(0)} = \tan (L_2\hat{O}L_1) = \tan 90^0 = \infty$$

If we now assume that at time $t = 0$, there were some people working in the non-agricultural sector, then the labour allocation ratio, for $t = 0$, is given by :

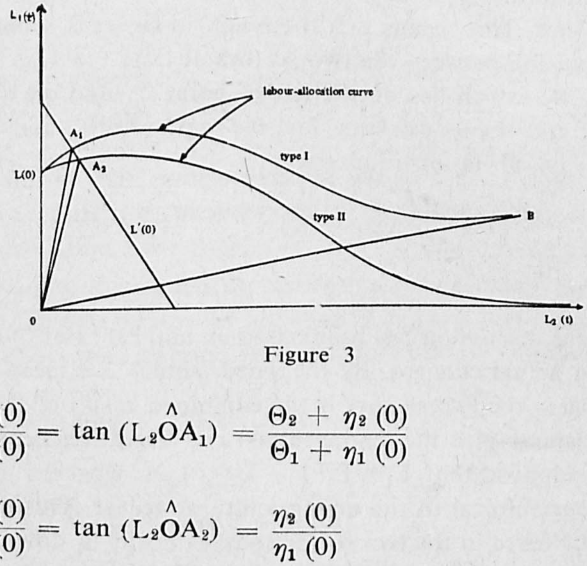

Figure 3

type I : $$\frac{L_1(0)}{L_2(0)} = \tan (L_2\hat{O}A_1) = \frac{\Theta_2 + \eta_2(0)}{\Theta_1 + \eta_1(0)}$$

type II : $$\frac{L_1(0)}{L_2(0)} = \tan (L_2\hat{O}A_2) = \frac{\eta_2(0)}{\eta_1(0)}$$

As $t \to \infty$ the labour-allocation ratio tends to :

type I : $$\frac{L_1(\infty)}{L_2(\infty)} = \tan (L_2\hat{O}B) = \frac{\Theta_2}{\Theta_1} = p$$

type II : $$\frac{L_1(\infty)}{L_2(\infty)} = \tan 0^0 = 0$$

In figure 3, the relative positions of the two labour-allocation curves and of the points A_1 and A_2 depend, of course, on the values of the Θ's and the η's.

6. The Supply of Labour

In section 5 we analyzed the labour-allocation curve. In this section we are going a step further by trying to find the supply of labour functions for each of the two sectors.

Form (5.10) and (5.12) we obtain :

$$\frac{\dot{l}_2(t)}{l_2(t)} = \frac{\dot{L}_2(t)}{L_2(t)} - \frac{\dot{L}(t)}{L(t)} = \eta_2(t) + m_{12}(t) - \eta \qquad (6.1)$$

Substituting $\eta_2(t)$ into (6.1), using the expressions (5.18) and (5.20) for types I and II respectively we obtain :

$$\text{type I:} \quad \frac{\dot{l}_2(t)}{l_2(t)} = m_{12}(t) - \Theta_2 - \eta_2(0)\, e^{-\eta_2 t} \qquad (6.2)$$

and

$$\text{type II:} \quad \frac{\dot{l}_2(t)}{l_2(t)} = m_{12}(t) - \eta_2(0)\, e^{-\eta_2 t} \qquad (6.3)$$

The limiting values which (6.2) takes are :

$$\left.\frac{\dot{l}_2(t)}{l_2(t)}\right|_{t=0} = m_{12}(0) - \Theta_2 - \eta_2(0), \quad \left.\frac{\dot{l}_2(t)}{l_2(t)}\right|_{t=\infty} = m_{12}(\infty) - \Theta_2 \qquad (6.4)$$

and the limiting values of (6.3) are :

$$\left.\frac{\dot{l}_2(t)}{l_2(t)}\right|_{t=0} = m_{12}(0) - \eta_2(0), \quad \left.\frac{\dot{l}_2(t)}{l_2(t)}\right|_{t=\infty} = m_{12}(\infty) \qquad (6.5)$$

In both case I and case II we have, from (5.25) and (5.29) respectively, that as $t \rightarrow \infty$, $l_1(t) / l_2(t)$ tends to a constant, p and 0 respectively. This means that in both (6.4) and (6.5) :

$$\left.\frac{\dot{l}_2(t)}{l_2(t)}\right|_{t=\infty} = 0 \qquad (6.6)$$

or for type I : $m_{12}(\infty) = \Theta_2$ (6.7)

and for type II : $m_{12}(\infty) = 0$ (6.8)

From (6.7) we see that for the first type of assumption about the natural fertility of the people, at time $t = \infty$, there still exists a constant rate of migration of workers from the agricultural to the non-agricultural sector, equal to the gap between the natural rates of increase of population in the total economy and that in the non-agricultural sector. So, there is migration to fill this gap.

For the second type, where at $t = \infty$ there is no such gap, we see from (6.8) that migration at time $t = \infty$ is equal to zero.

We will try now to introduce wages differentials into our formulation, using a similar urbanization function as those of Todaro (1969) and Zarembka (1970). The urbanisation function is of the general form :

$$\frac{\dot{l}_2(t)}{l_2(t)} = F\left(\frac{w_2(t)}{w_1(t)}\right) \qquad (6.9)$$

which must obey the restriction

$$\frac{\dot{l}_2(t)}{l_2(t)} \to \infty \text{ as } \frac{w_2(t)}{w_1(t)} \to \infty \qquad (6.10)$$

One possible such function is that used by Mass-Colell and Razin (1974). It is of the simple form :

$$\frac{\dot{l}_2(t)}{l_2(t)} = \delta\left[\frac{w_2(t) - w_1(t)}{w_1(t)}\right] \qquad (6.11)$$

where δ is a positive constant.

(6.11) can be written as

$$\frac{\dot{l}_2(t)}{l_2(t)} = \delta\left(\frac{w_2(t)}{w_1(t)} - 1\right) = \delta\left(\frac{1}{\mu(t)} - 1\right) \qquad (6.12)$$

or using, (4.12), which is the case for full employment and $v = 0$, we obtain :

$$\frac{\dot{l}_2(t)}{l_2(t)} = \delta\,\beta(t) = \delta\,\beta(0)\,e^{-\beta t} \qquad (6.13)$$

where $\beta(t) = \beta(o)\,e^{-\beta t}$, $\beta(0), \beta \geqslant 0$.

Comparing (6.13) with (6.1) we derive a function for the rate of migration, ie. :

$$m_{12}(t) = \eta - \eta_2(t) + \delta\,\beta(0)\,e^{-\beta t} \qquad (6.14)$$

From (6.14) we obtain for the two types of $\eta_2(t)$ the results that :

type I : $$m_{12}(t) = \Theta_2 + \eta_2(0)\,e^{-\eta_2 t} + \delta\,\beta(0)\,e^{-\beta t} \qquad (6.15)$$

$$m_{12}(0) = \Theta_2 + \eta_2(0) + \delta\,\beta(0) \qquad (6.16)$$

$$m_{12}(\infty) = \Theta_2 \qquad (6.17)$$

and type II : $$m_{12}(t) = \eta_2(0)\,e^{-\eta_2 t} + \delta\,\beta(0)\,e^{-\beta t} \qquad (6.18)$$

$$m_{12}(0) = \eta_2(0) + \delta\,\beta(0) \qquad (6.19)$$

$$m_{12}(\infty) = 0 \qquad (6.20)$$

From the above we see that (6.17) does not contradict (6.7) and (6.20) does not contradict (6.8). Also from (6.16) and (6.19), after substitution into (6.4) and (6.5) respectively, we obtain that at time $t = 0$, for both types of $\eta_2(t)$:

$$\left.\frac{\dot{l}_2(t)}{l_2(t)}\right|_{t=0} = \delta\,\beta(0) \qquad (6.21)$$

Before we try to find the supply function of labour in the two sectors, we must note some points which can be derived from the discussion above. From section 4 we know that as $t \to \infty$, then $\beta(t) \to 0$ or $w_1(t)/w_2(t) \to 1$. But from (6.11) or (6.13), we also know that as $t \to \infty$, or $w_1(t)/w_2(t) \to 1$, $\dot{l}_2(t)/l_2(t) \to 0$. Therefore, we conclude from (6.17) and (6.20) that for type I of $\eta_2(t)$, there still exists migration of workers between the two sectors, even for the case where the two wages become equal when $t \to \infty$. This illustrates the case, observed in reality, that in some countries where there is no wage gap between the two sectors, there is still migration. Of course, for the type II of $n_2(t)$, we do not have migration when $w_1(t) = w_2(t)$.

We are now able to derive the supply functions of labour for the two sectors. It is known from (5.10) that :

$$\frac{\dot{L}_2(t)}{L_2(t)} = \eta_2(t) + m_{12}(t) \tag{6.22}$$

We substitute $m_{12}(t)$ from (6.14) into (6.22) and obtain :

$$\frac{\dot{L}_2(t)}{L_2(t)} = \eta + \delta\,\beta(0)\,e^{-\beta t} \tag{6.23}$$

Taking the integrals of both sides of (6.23) from $t_1 = 0$ to $t_1 = t$, we have :

$$\int_0^t \frac{dL_2(t_1)}{L_2(t)} = \int_0^t (\eta + \delta\,\beta(0)\,e^{-\beta t_1})\,dt_1$$

or

$$\ln L_2(t_1)\Big|_0^t = \eta t_1 - \frac{\delta\,\beta(0)}{\beta}\,e^{-\beta t_1}\Big|_0^t$$

or

$$\ln L_2(t) - \ln L_2(0) = \eta t - \frac{\delta\,\beta(0)}{\beta}(e^{-\beta t} - 1)$$

or

$$L_2(t) = \exp[\ln L_2(0) + \eta t - \frac{\delta\,\beta(0)}{\beta}(e^{-\beta t} - 1)]$$

or

$$L_2(t) = L_2(0)\,e^{\eta t - \frac{\delta\,\beta(0)}{\beta}(e^{-\beta t} - 1)} \tag{6.24}$$

which is the supply function of labour in the non-agricultural sector over time. The supply function of labour for the agricultural sector can be found from :

$$L_1(t) = L(t) - L_2(t)$$

substituting $L(t)$ and $L_2(t)$ from (5.12) and (6.24) respectively, ie. it is :

$$L_1(t) = [\,L(0) - L_2(0)\cdot e^{-\frac{\delta\,\beta(0)}{\beta}(e^{-\beta t} - 1)}\,]\,e^{\eta t} \tag{6.25}$$

We can see the mechanics of labour migration and supply curves of labour with the help of figure 4.

In the case of full employment ($P(t) = 1$) and $v = 0$, the expression (4.4), which shows the condition under which workers migrate from the agricultural to the nonagricultural sector, can be written in the simple form :

$$w_2(t) - w_1(t) > c(t) \tag{6.26}$$

(6.26) means that if the gap between the current wages in the two sectors is less or equal to the current cost of migration, then nobody is willing to migrate.

Suppose now that a time $t = t_1$ the marginal productivity of labour curves for the two sectors are given, in figure 4, by the curves $MPL_1(t_1)$ and $MPL_2(t_1)$.

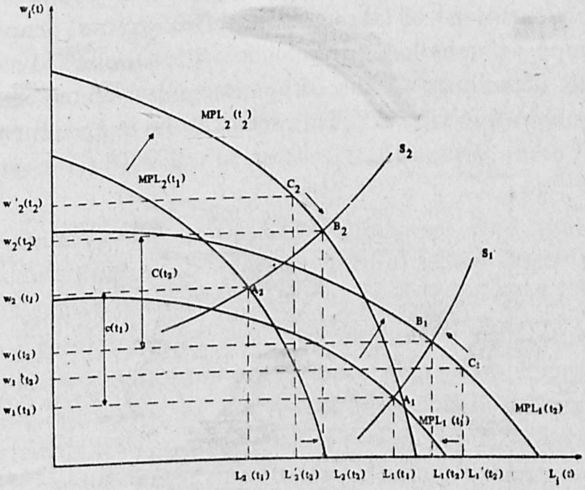

Figure 4

The workers engaged in the two sectors are $L_1(t_1)$ and $L_2(t_2)$, with corresponding wages $w_1(t_1)$ and $w_2(t_1)$. We say that the system is in "relative equilibrium,, if the gap in the wages is less than or equal to c(t), (ie. $w_2(t) - w_1(t) \leqslant c(t)$) at which level nobody is willing to migrate from the agricultural to the non-agricultural sector; it is in "relative disequilibrium" if the gap in the two wages is greater than c(t), ie. if migration is taking place.

Suppose now that at time $t = t_1$ $\Delta w(t_1) \leqslant e(t_1)$, which means that, at time t_1, the system is in relative equilibrium. Due to capital accumulation and technological change in both sectors, suppose that at time $t = t_2$ the marginal productivity curves of labour shift to $MPL_1(t_2)$ and $MPL_2(t_2)$. In the same period the labour force in the two sectors has increased by the amounts $L_1(t_1)$ $L'_1(t_2)$ and $L_2(t_1))$ $L'_2(t_2)$, which means that the wages of the two sectors are now $w'_1(t_2)$ and $w'_2(t_2)$. If the difference between the new wages is greater than $c(t_2)$, the critical value, then the system is in relative disequilibrium. Migration starts from sector one to sector two This means that as workers leave sector one, the wage rate in that sector increases and that in sector two decreases. Therefore, in relative disequilibrium situations, we see that the wages move in opposite directions and, after some time, the difference between them reaches the critical value c(t), at which migration stops and the system is again in relative equilibrium.

In figure 4, the points A_1 $(L_1(t_1), w_1(t_1))$ and A_2 $(L_2(t_1), w_2(t_2))$ show the relative equilibrium position of the system at time $t = t_1$. At time $t = t_2$ the points B_1 $(L_1(t_2), w_2(t_1))$ and B_2 $(L_2(t_2), w_2(t_2))$ similarly show the relative equilibrium position of the system. Points between (C_1, B_1) and (C_2, B_2) show the relative disequilibrium positions of the system during time period t_2, in which the number of workers that migrate from the first to the second sector is equal to $L'_1(t_2)$ $L_1(t_2) = L_2(t_2)$ $L'_2(t_2)$. If we now join the relative equilibrium points of each sector we derive the supply functions of labour for the two sectors, denoted by S_1 and S_2. Each of these supply curves looks like a conventional upward-sloping labour-supply curve, but is actually the locus of demand-supply intersections at successive time periods, as shown in figure 5. This seems to be in agreement with Mazumbar

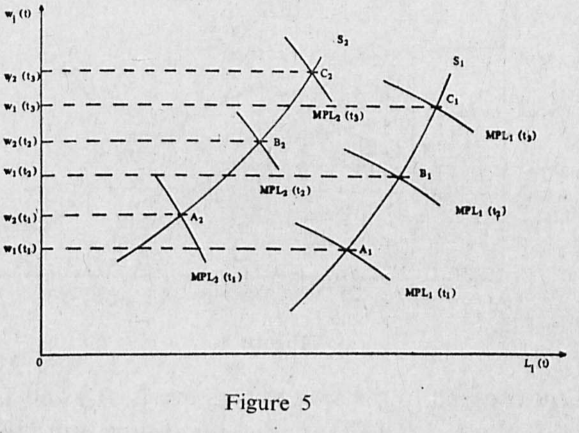

Figure 5

(1959), who writes that the wage-rate cannot be determined simply by the intersection of supply and demand curves for labour, because the supply curve itself varies with the wage level.

In the above exposition, it must be noted that the shape and the position of the marginal productivity of labour curves depend upon the level of capital accumulation and on the kind of technological progress. Also, the wage rate depends upon the rate of increase in labour force. If, for example, in period $t = t_2$ the wages differential was less than the critical value $c(t_2)$, then no migration occurs from one sector to the other. Another extreme case is that in which in period $t = t_2$ the wages differential is negative, which means that there is migration of workers, but from the second sector to the first. This seems to be quite unrealistic for a developing economy and contradicts (4.8).

2.7 Conclusions

In this paper we have tried to classify migration research according to the adopted methods and instruments. The following chart shows this classification:

$$\text{Migration}\left\{\begin{array}{l}\text{Direction and Magnitude in response}\\ \\ \text{Equilibrium process, with respect}\end{array}\right\}\text{to}\left\{\begin{array}{c}\text{current}\\ \\ \text{expected}\end{array}\right\}\text{wage differentials}$$

The main conclusion of this paper is that there always exists a wage gap between the agricultural and non-agricultural sectors in the cases where there exist costs of migration whether monetary or psychic or both.

We generalized Todaro's equilibrium value of probability of finding a job into the non-agricultural sector, (4.10), including not only the wages of the two sectors, but also the costs of migration and a utility parameter of the individuals as in (4.11). From there, we see that even in the case of full employment there still exists a wage differential between the sectors, if, of course, there is a positive cost of migration.

In our formulation of wages differentials we find that as $t \rightarrow \infty$, the probability of finding a job in the non-agricultural sector tends to one and the costs of migration tend to zero, so the wages tend to be equal.

Investigating the mechanics of labour migration between the two sectors, we conclude that the assumptions about the natural or physiological rates of change of the labour force in the two sectors play a basic role in determining the results obtained. In particular, if we assume that as $t \rightarrow \infty$ the natural rates of change of the labour forces in the two sectors tend to two destinct values around the average rate of change of the labour force in the total economy, then the ratio (of allocation) of the labour force engaged in the agricultural sector by that engaged in the non-agricultural sector tends to a positive value. If we assume that the two natural rates of change of labour tend to become equal as $t \rightarrow \infty$, then we conclude that as $t \rightarrow \infty$, the agricultural sector disappears, which means that it has been fully developed and so the economy behaves like a one-sector economy or, if we still want to take two sectors into account, the economy must be divided into the consumption goods sector and into the capital goods sector, as has been done by Uza wa (1961, 1963) and others.

Finally, from our migration function, we conclude that migration from the agricultural to the non-agricultural sector stops when the two wage rates are equal and the two natural rates of increase of labour are equal. In the other case, of different natural rates of increase of labour, we find that, even with equal wage rates in the two sectors, migration is still positive and its constant rate is equal to the constant deviation of the natural rate of change of the labour force in the non-agricultural sector from that of the labour force as a whole.

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