3.2 Economic Theories of Population Growth

In this section the demographic transition process observed in the previous section will be examined in terms of economic theories.

3.2.1 The Malthus model

Thomas Robert Malthus (1766–1834) is known as a pioneer in the economic theory of population. His *Principle of Population* ([1798] 1926) was a reflection of England's premiere entrance into the process of modern demographic transition.

His population theory may be summarized as follows: as with other animals, human beings have a natural instinct to bear children to a physical maximum; under this 'fixity of passion' people tend to multiply in an exponential rate; where the production of food is constrained by the fixed endowment of natural resources, especially land, and can increase only arithmetically, whatever slack of food supply per capita beyond a subsistence level may exist will eventually be used up by increased population; further increases in population are bound to be checked by famines, pests, and wars of desperate competition for limited food supply; thus, it is not possible that the levels of living and income per capita for the majority of people can remain beyond a subsistence minimum in the long run.

This theory may be expressed by line GG in Figure 3.3, which represents a relationship between the wage rate (W) or an average income per labourer and the growth rate of population ($\dot{N}/N$) where N and $\dot{N}$ denote respectively, population and its absolute increase. Line GG cuts through the horizontal axis at $\bar{W}$. The wage rate measured by the distance between O and $\bar{W}$ is defined as the subsistence wage rate that is barely sufficient for a labourer and his family to subsist, and, hence, keeps average family size and total population constant.

Line GG is upward-sloping to indicate a relationship by which any increase in the wage rate beyond $\bar{W}$ (due to an increase in labour demand or a decrease in labour supply) results in a positive rate of population growth. The exponential growth in the labour force that is implied from the positive population growth rate will eventually close any excess labour demand and thereby drive the wage rate back to $\bar{W}$.

On the other hand, as continued growth in population and the labour force creates excess labour supply, the wage rate is pushed down below the subsistence level so that the population would decrease via the Malthusian check to recover the labour demand–supply equilibrium at the subsistence wage

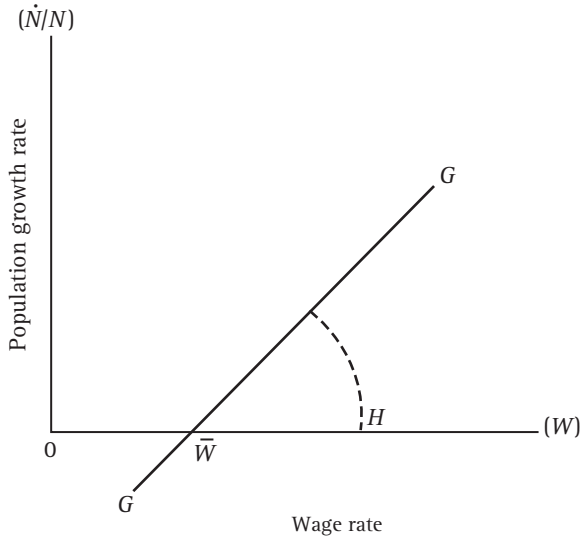

FIG. 3.3 *The Malthusian population theory and its revision*

rate. Thus, in the Malthus model the sustained divergence of the wage rate from $\bar{W}$ never occurs.

While Malthus is known as a heretic in the English Classical School, his population model has been accepted, widely, even by opponents such as David Ricardo. However, Malthus's prediction has not stood the test of subsequent history. Indeed, according to the commonly observed pattern of demographic transition, both the birth-rate and the natural rate of population growth decrease in Phase 3, which corresponds to the period characterized by sustained increase in the real wage rate. This association of population growth deceleration with sustained increases in the wage rate indicates that the relationship between $\dot{N}/N$ and W is not linearly rising as represented by line GG, but turns to be downward-sloping towards H after a certain threshold is reached, as indicated by the dotted line in Figure 3.3.

*3.2.2 The household utility maximization model**

Even though the Malthus model did not stand the empirical test for the later stage of development, it was relevant to English economy in the 1770s and 1780s when the theory was developed. During this period employment opportunities expanded with the beginning of the Industrial Revolution

* Readers not interested in the technical analysis of economics may skip this section.

following the Agricultural Revolution. Even if the wage rate per hour may not have increased very significantly, the household income level increased from increased working hours and employment of females and children. Such a condition induced people in the labour class to marry earlier and produce more children. When this tendency coincided with decreases in the death-rate (owing to improved living conditions) the first population explosion in the epoch of modern economic growth took place in England. Indeed, the way that the birth-rate responded positively to increased income per capita was consistent with Malthus's theory. Such a positive response through adjustments in the marriage age and rate can be universally observed in premodern societies, e.g. Wrigley and Schofield (1981) for England, and A. Hayami (1992) for Japan. The rising trend of the birth-rate for Phase 1 in England seems to reflect the premodern response to the early phase of industrialization.

To predict the future course of demographic changes in developing economies, a more general model should be envisaged that is able to explain both the empirical relevance of the Malthus theory for the early phase and its divergence from reality in the later phase of development. Attempts to build such a model have used an approach of maximizing the utility function common to household members (Leibenstein, 1957; Easterlin, 1975; Becker, 1976). Figure 3.4 presents a model that follows the Liebenstein approach, in

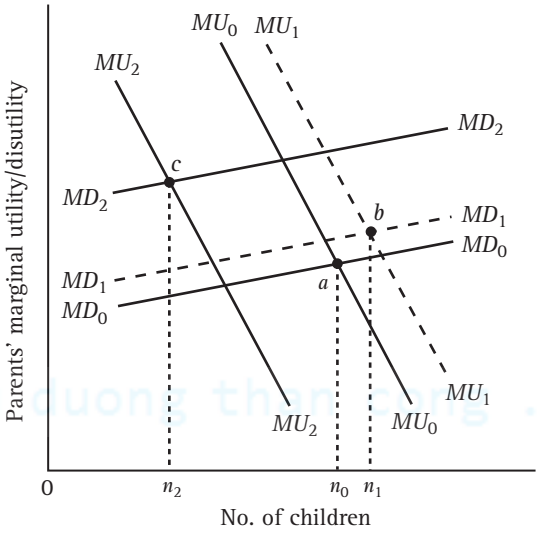

FIG. 3.4 *A household utility maximization model on the determination of the number of children*

consideration of its relative ease in understanding, even though the Becker model is a little more general in incorporating an explicit choice among consumption goods, and the number and quality of children in parents' utility function.

The model in Figure 3.4 assumes that parents have sole decision-making power within a household and that a husband and wife have the same utility function. Their marginal utilities and marginal disutilities from having an additional child are represented by lines *MU* and *MD* respectively. The vertical difference between *MU* and *MD* measures net marginal utility of parents.

Parents' utility for having children may be derived from (a) instinctive pleasure, such as love of children and satisfaction of having heirs; (b) expected income from children for the household; and (c) security for parents during old age. It is reasonable to assume that utilities from these sources increase at decreasing rates, corresponding to increases in the number of children.

On the other hand, the disutility of having children may be generated from (a) physical and psychological hardships in bearing and rearing children; (b) costs paid for child-bearing and rearing; and (c) opportunity costs of parents' labour used for child-bearing and rearing. While the marginal disutility from the first element is likely to increase in response to an increased number of children, both increasing and decreasing effects are conceivable from the second and third elements. In Figure 3.4, *MD*s are drawn in moderately upward-sloping forms, but the theoretical conclusion would be unchanged with the assumption of horizontal or moderately downward-sloping forms.

Assuming that in the initial period the marginal utility and disutility had been located at MU_0 and MD_0 respectively, parents' net utility would have been maximized by the number of children measured by $\underline{On}_0$. In the beginning of industrialization, employment and income-earning opportunities may have increased without accompanying significant developments in financial and insurance markets and social security systems for the majority of households. In such an institutional environment, any marginal increase in household income would result in an expansion in the demand for children as represented by a shift from MU_0 to MU_1. This shift might not be so small since an increased number of children would enhance old-age security that is considered to be a superior good for which demand tends to increase faster than income.

On the other hand, in the early stage of industrialization, when labour laws and primary school systems had not been established, expected earnings from children would have increased from increased employment and income-earning opportunities. This effect could have largely compensated for the

increased opportunity of mothers' labour corresponding to their increased market opportunities. In sum, the upward shift in the marginal disutility curve would have been minor, as represented by a shift from MD_0 to MD_1. It is even possible that *MD* shifted downwards.

Anyway, it is reasonable to expect that the upward shift in *MU* exceeded the shift in *MD* to result in an increase in the optimum number of children in the early stage of industrialization (Phase 1). This is considered the same response to increased income opportunities for labour due to reductions in labour supply caused by major calamities such as famines, pests, and wars in the premodern era as Malthus contemplated.

However, as modern economic growth continued, major changes in social and economic systems emerged. As mentioned earlier, with the introduction of school systems, the cost of children increased. This paralleled the increased opportunity cost of mothers' labour under expanded labour markets. Progress in birth control technology decreased the marginal cost of reducing the number of children, which implied an increased marginal cost of increasing their number. All these factors combined, the marginal disutility of increasing the number of children should have experienced a major upward shift, as represented by MD_1 to MD_2, in the late stage of industrialization (Phase 3).

More importantly, the marginal utility curve that had shifted upwards in the early stage began to shift downwards in the late stage. The utility of having children for old-age security decreased with development of social security systems and private insurance markets. With increased social mobility, the probability of children staying with and taking care of parents decreased. Most decisively, the reduced death-rate reduced the utility of having many children for parents in terms of both instinctive pleasure and future security. Thus, when modern economic growth reached a stage at which social and economic systems were completely modernized, further increases in the wage rate and per capita income would have had the effect of shifting parents' utility curve downwards from MU_1 to MU_2 with the result of reducing the number of children from $\underline{On}_1$ to $\underline{On}_2$.

In this way, the premodern response of demography to economic growth, as theorized by Malthus, and the contrary response in advanced modern society can be understood within one theoretical framework. The difficulty in developing countries today is that, through a sharp decline in the death-rate from exogenous causes the response of the birth-rate to economic growth has not yet transformed into the modern pattern because of an adjustment lag in social institutions and value systems. A major question is how soon institutions and value systems will be adjusted and how effectively such programmes as education for women and extension of family planning will be

able to promote the adjustments in low-income economies in the short to medium run.

3.3 Theories of Resource Constraint on Economic Growth

Although the speed of population growth in developing economies has been decelerating since the 1970s, it will continue to be 'explosive' in low-income economies, at least for a couple of decades. Is it possible that the low-income economies (characterized by high dependency on natural resources) will be set on the track to sustained growth in per capita income with decreasing availability of natural resources per capita? A clue to answering this question may be found in the theories that have analysed how fixed endowments of natural resources may constrain economic development under growing population.

3.3.1 From Malthus to the Club of Rome

As explained previously, it was Malthus who first pointed out the possibility of the growing relative scarcity of natural resources as a binding constraint on economic growth. The Malthus theory based on the fixity of both human passion and natural resources has had great influence on public opinion because of its simplicity and intuitive appeal.

Although the famine that Malthus predicted as an inevitable consequence of population growth was largely eradicated from industrialized economies during the nineteenth century, fear of the Malthusian crisis has never been erased. Indeed, the Malthus prediction has been publicized repeatedly on the occasions of food supply shortages and price increases in the world market due to crop shortfalls, wars, and other reasons. For example, towards the end of the nineteenth century India (previously an exporter of wheat) turned into an importer of wheat, and crop failure in the USA caused international wheat prices to rise. At that time Sir William Crookes (a leading scientist in England, known for his discovery of the element thallium) preached on the danger of a Malthusian food crisis (Crookes, 1899).

A dramatic reappearance of the Malthus theory in a somewhat different form was presented in a report to the Club of Rome by Meadows *et al.* (1972), titled *The Limits to Growth*. This report was not only concerned with the population-food crisis, but also with the crisis of natural resource exhaustion

and environmental degradation due to overexploitation and waste of resources resulting from the exponential growth in economic activities. It predicted that, if this exponential growth was not curbed, industrialization would stop and economic activities would begin to shrink by the first two decades of the twenty-first century due to resource exhaustion. Then, world population would be curtailed because of an increase in the death-rate due to food shortage and environmental pollution.

This report had exceptionally strong public appeal, because in 1973, a year after its publication, a so-called 'World Food Crisis' due to world-scale crop failure and the first oil crisis triggered by the OPEC embargo in response to the fourth Middle East War did occur. A several-fold increase in food and energy prices resulted. However, as the crisis passed and commodity prices declined, the effect of this report on the public diminished and its theoretical and statistical basis became subject to criticism.[2]

A major limitation of the simulation analysis is the assumption that exponential increases in population, industrial production, and other economic activities at the average rates in the past (1900–70) will remain unchanged in the future with proportional increases in food and raw material consumption. The analysis does not consider the rational response of economic agents to save the increasingly scarce resources. Mechanical extensions of past trends, with no consideration of possible changes in production coefficients, are bound to lead economic growth into collision with the fixed endowment of natural resources. In this regard, the 'systems dynamics' analysis based on a large equation system is essentially the same approach as Malthus's exponential extrapolation of population under the 'fixity of passion' that eventually collides with the fixed endowment of land resources.

This type of mechanistic approach has merit in showing a magnified picture of a potential danger implied in present trends, and, thereby, spurs the public to take action to prevent the danger from materializing. For example, Crookes (1899)—who pointed out the danger of the approaching Malthusian food crisis—proposed the concept of a new technology to extract ammonium from air, then considered a dream. However, his dream came true with the development of an aerial ammonium-fixation method developed by Haber and Bosch during World War I, which later proved to be a key invention for avoiding the materialization of the Malthusian crisis.

Irrespective of its scientific credibility and predictive power, the contribution of the Club of Rome report in drawing public awareness to the need for saving and conserving the environment and natural resources must be duly recognized. However, it is inevitable that simple extrapolations of past

trends will produce future predictions that will widely diverge from actual outcomes.[3]

*3.3.2 The Ricardo model**

As explained in Chapter 1, the development of human society has been realized through developments in technology and institutions that facilitated substitution of man-made capital for natural resources. The Malthus theory that focused on the side of human behaviour driven by animal instincts without due regard for capital formation activities could be a theory of population, but could hardly be called a theory of economic development.

It was David Ricardo (1772–1823) who clarified the mechanism on how economic growth is constrained by natural resource endowments, by building the genuine theory of economic development. His *Principles of Political Economy and Taxation* was published in 1817, towards the completion of the Industrial Revolution in England. This was the period when population growth reached its peak (see Figure 3.1).

Ricardo's development theory identified capital accumulation in modern industries, which emerged from the Industrial Revolution, as the driving force of economic growth. 'Capital' in his view was the 'wage fund', defined as the sum of payments to labour in advance of sale of commodities produced by the labour applied, as well as payments for the purchase of tools and structures complementary to the use of labour. Therefore, the demand for labour increases proportionally with the increase in the wage fund. On the other hand, the supply of labour is determined by the number of labourers existing who are willing to work full time regardless of the wage rate. This implies that labour supply is constant in the 'short run' (defined as the period within which population is constant). Therefore, as new investment is added to the wage fund, labour demand increases by raising the wage rate along the inelastic supply in the short run. If the wage rate is raised above the subsistence wage rate in the Malthusian sense ($\bar{W}$ in Figure 3.3), however, population begins to increase with subsequent increases in the labour force. Therefore, the supply of labour is considered infinitely elastic in the long run (defined as the sufficiently long period in which population and labour force are allowed to change), under which the wage rate always tends to be pushed back to the subsistence level. Thus, in the long run the wage cost to industry does not rise, and profit increases proportionally with the increase in capital. Since the rate

* Readers not interested in the technical analysis of economics may skip explanations with the use of Figure 3.5 in this section.

of profit does not decline, incentive is maintained to reinvest profits so that production and employment continue to increase in the modern industrial sector.

However, the subsistence wage for industrial workers depends on food prices. Unlike industrial production, agriculture cannot escape from decreasing returns in production since it is constrained by the endowments of the land. To the extent that food demand is met by production using the most fertile 'superior' land, its marginal cost remains constant. However, if increased food demand (corresponding to population growth) exceeds the output produced on the most superior land, the next superior land must be brought into cultivation, resulting in an increased marginal cost, since more labour and capital must be applied to produce the same amount of food per unit of inferior land. Thus, as more inferior lands are opened for food production, the marginal cost will increase progressively. In this process demands for superior lands increase since it is more profitable to cultivate superior lands. Consequently, higher rents must be paid to the landlords for using superior lands up to the difference between production costs on superior lands and those of the 'marginal land' (the most inferior land being used in production).

As food prices rise corresponding to the cost hikes, nominal monetary wages paid to industrial workers need to be raised to maintain their subsistence living. As the wage cost rises, profit does not continue to increase proportionally with the increase in capital. Thus, as food demand continues to increase corresponding to capital accumulation and employment growth, food prices will eventually be raised to a level at which the rate of profit will become so low as to provide no incentive for further investment. Economic growth will stop at this point.

The Ricardo theory, summarized above, is reconstructed as a model in modern economics in Figure 3.5. The left-hand diagram represents a labour market for the modern industrial sector, in terms of the Marshallian partial equilibrium model. Line *DD* represents a labour demand curve, which is assumed to correspond to a schedule of the marginal value product of labour for a given stock of capital in use.[4]

While the diagram is structured in a neoclassical fashion, the classical characteristic of the Ricardo theory is represented by the shape of labour supply. Adopting the Malthusian law (line *GG* in Figure 3.3), Ricardo assumed a horizontal supply of labour at the subsistence wage rate ($\underline{O\bar{W}}$) in the long run, as represented by line *LS*. However, because labour force remains constant in the short run and, because the marginal disutility of labour relative to the marginal utility of income is considered negligibly small

for workers living at a near-subsistence level, the short-run supply of labour can be assumed to be inelastic to the wage rate, as represented by the vertical line *SS*.

Assume that at the beginning of industrialization the labour demand schedule is given as DD_0 corresponding to the stock of capital K_0 owned by industrial capitalist-entrepreneurs, and that the long-run equilibrium in the initial period is established at point A with labour employed by $\underline{OL}_0$ at the subsistence wage rate. Then, total value product in the industrial sector is represented by area $\underline{ADOL}_0$ of which area $\underline{A\bar{W}OL}_0$ is paid to workers and the remaining area $\underline{AD\bar{W}}$ becomes profit or return to capital.

As a common assumption of both Classical and Marxian economics, labourers who are at the subsistence level consume their entire wage incomes, and wealthy capitalists (always seeking increased profits) reinvest nearly all the profits they receive, so that capital stock increases from K_0 to $K_1(K_0 + \text{area } \underline{AD\bar{W}})$. Correspondingly, labour's marginal products shift upwards, resulting in a shift to the right of the labour demand curve from DD_0 to DD_1, and the wage rate increases beyond $\underline{O\bar{W}}$ to $\underline{OW}_S$.[5] However, as the wage rate rises above the real wage rate, Malthus's law will begin to operate (with increases in population and labour force). Therefore, with a lapse of time, the short-run labour supply curve *SS* will shift rightwards to pull down the wage rate along the labour demand curve DD_1 to point *B*, at which the new long-run equilibrium level of employment $\underline{OL}_1$ is determined.

If scale neutrality of production and Say's law of production to create demand are assumed according to the theory of Ricardo, product, capital stock, and labour employment will increase at the same rate in the long run under the constant subsistence wage rate as measured by product unit.[6] Then, total wage payment (wL) and total profit $(Y - wL)$ increase at the same rate as total output (Y) and capital (K), so that the rate of profit or return to capital $[(Y - wL)/K]$ remains constant. Thus, the horizontal supply of labour (supported by the Malthus law of population) prevents the profit incentive of capitalist-entrepreneurs for investment from decreasing and, thereby, guarantees continuation in capital accumulation and output growth in the modern industrial sector.

The constraint to such growth of the modern sector is decreasing returns in food production that operate in the agricultural sector. The right-hand diagram of Figure 3.5 presents a market for food represented by 'corn' (grain), where the horizontal axis measures corn output/consumption and the vertical axis measures its price. Line *HS* represents the supply schedule of corn determined by its marginal costs. According to Ricardo, this schedule rises stepwise, because land is distributed from the most superior to the most

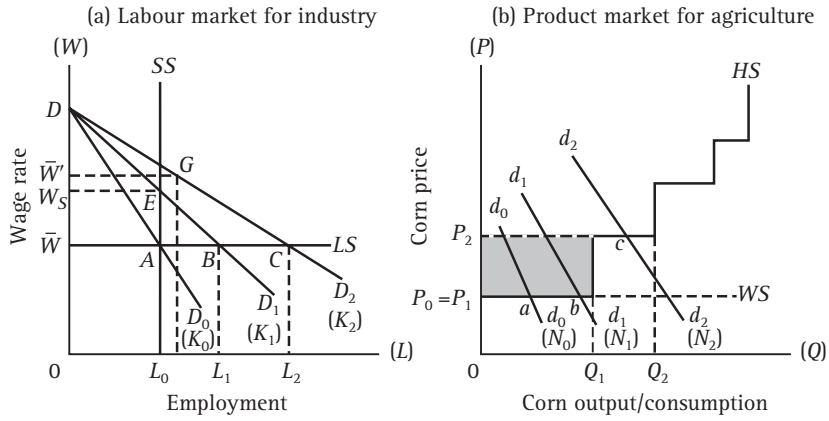

FIG. 3.5 *The Ricardo model of economic development*

inferior category and the area belonging to each category is fixed. The marginal cost of corn production remains constant at $\underline{OP}_0 (= \underline{OP}_1)$ up to the maximum output that can be produced by the best land category ($\underline{OQ}_1$), but jumps up to $\underline{OP}_2$ as output exceeds this limit and the second-class land is brought into cultivation. The stepwise increases continue as the land of more inferior qualities is brought into production.

Because corn is consumed mostly by labourers and because their per capita income is constant in the long run at the subsistence wage rate, a shift in its demand curve *dd* occurs in response to population growth alone. Assume that d_0d_0 in the right-hand diagram represents a corn demand curve corresponding to employment in the industrial sector represented by $\underline{OL}_0$. As this employment increases to $\underline{OL}_1$, and then to $\underline{OL}_2$, population growth proportional to the growth in employment shifts the corn demand to d_1d_1, and then to d_2d_2 respectively. To the extent that corn demand is met by production using only the best land category, as in the case of d_1d_1, the price of corn stays at $\underline{OP}_0 (= \underline{OP}_1)$. As the corn demand is expanded to d_2d_2, however, the corn price rises to $\underline{OP}_2$; corresponding to the margin cost of production using the second grade of land. Here it is assumed that the increase in the marginal cost of increasing corn output by means of bringing the second-grade land into cultivation is the same as applying more capital and labour to production in the first-grade land.

As the corn price rises from $\underline{OP}_0$ to $\underline{OP}_2$, the subsistence wage rate of $\underline{O\bar{W}}_0$ which used to be sufficient for labourers to purchase corn in a sufficient quantity for their subsistence at $\underline{OP}_0$, becomes less sufficient. Therefore, the wage rate in the industrial sector will have to be raised in the long run to $\underline{O\bar{W}}'$,

which enables labourers to purchase sufficient corn for their survival. Then, the profit in the industrial sector, with the application of capital by K_2, decreases from area $\underline{CD\bar{W}}$ to $\underline{GD\bar{W}'}$. Therefore, the rate of profit to capital in the industrial sector will decline progressively as lower-grade lands are opened for cultivation. This will have the effect of depressing the income of capitalist-entrepreneurs and their investment incentives.

On the other hand, as the corn price rises from $\underline{OP}_1$ to $\underline{OP}_2$, corn producers using the first-grade lands can capture excess profit by $\underline{P}_1\underline{P}_2$ per unit of output. Since excess profit is obtainable by using the first-grade instead of the second-grade land, competition among producers to use the first-grade land will raise its rent to $\underline{P}_1\underline{P}_2$, with the landlords' revenue amounting to the shadowed area. Thus, landlords capture windfall gains from capital accumulation in the industrial sector through expansions in population and food demand.

The Ricardo theory predicts that, under given natural resource endowments in terms of fixed land areas by grade, food-price increases resulting from population growth will drive the economy into a 'stationary state' where the rate of profit is so low that it provides no incentive for additional investment and labourers' real wage rates do not diverge from a subsistence minimum, while landlords alone receive enlarged rent revenue which is largely wasted on conspicuous consumption. This mechanism of fixed land resource endowments that constrain economic growth in the early stage of industrialization is commonly called the 'Ricardian trap', or alternatively called the 'food problem' by T. W. Schultz (1953).

The policy that Ricardo proposed for unbinding the British economy from the trap of land resource constraint was liberalization of grain imports, or more specifically, repeal of the Corn Laws that had imposed a tariff barrier on the import of cheap grain from abroad as part of the mercantile system. Ricardo argued that superior lands should be available in infinite amounts not within Britain, but in the world including new continents. Therefore, if trade was liberalized, total corn supply from both domestic and external sources would become horizontal at a low price ($\underline{OP}_0$), as represented by line *WS*. Then, labour supply in the modern industrial sector could continue to be horizontal at the wage rate $\underline{O\bar{W}}$ on which capital accumulation and economic growth in the modern sector could be sustained. The repeal of the Corn Laws was a necessary condition to sustain modern economic growth that began with the Industrial Revolution. As such, Ricardo provided to the emerging bourgeois class a theoretical edge to fight the vested interests of landed aristocracy and gentry.

The Ricardo model sets out clearly the problem of natural resource constraints that low-income economies will have to face when they undertake

industrial development when agriculture is stagnant. If rapid population growth in the early industrialization stage is not paralleled with increases in food supply, food prices will rise sharply to pull up the cost of living to low-income people characterized by the high Engel coefficients. This would produce strong pressure for wage hikes through organized bargains as well as food riots. Resultant wage increases would imply a serious blow to industries in the early stage, which are dependent on labour-intensive technologies.

This Ricardian trap faced by low-income developing economies today cannot be solved by liberalization of food imports alone. Ricardo's advocacy for free trade was relevant to England in the early nineteenth century, when its population was only a small fraction of world population and its supremacy in industrial productivity made it easy to earn sufficient foreign exchange for food imports. It is not easy for developing economies today to earn sufficient foreign exchange from the export of industrial products during the early stage of industrialization. Also, if many populous developing economies compete for food imports, the international price would rise so much that the domestic price could hardly remain stable.

For them, there appears to be no other way to escape the Ricardian trap but to advance agricultural technology concurrently with industrialization. Ricardo did not deny the possibility of improving agricultural technology, but considered that it was too limited to overcome decreasing returns in agricultural production in the long run. This idea was created when technological advances in agriculture were mainly based on the experiences and trials of farmers. History has proved that, with the organized application of science to the problem of agricultural production (which began in late nineteenth century), food production in advanced economies has increased faster than population. It is obvious that the escape from the Ricardian trap for developing economies is to follow the experience of agricultural productivity growth of advanced industrial economies in the past.

*3.3.3 The dual economy model**

It was W. Arthur Lewis (1954) who built upon the thrust of the Ricardo model a new two-sector model as a theory of economic development in developing economies today. His model analyses the process of development through interactions between the traditional sector (represented by

* Readers not interested in the technical analysis of economics may skip explanations with the use of Figure 3.6 in this section.

agriculture) and the modern sector (represented by industry), which have different behavioural principles. In the modern industrial sector the wage rate is supposed to be established at the equation with marginal productivity of labour, as dictated in neoclassical economics, whereas that of the traditional agricultural sector is considered to be institutionally determined at a subsistence level along the tradition of classical economics, including Ricardo's theory.

Lewis's model is the same as Ricardo's at the point that labour supply to the industrial sector is characterized by infinite elasticity, which ensures parallel increases in capital accumulation and profit. The two models differ on the mechanism of producing the horizontal labour supply schedule. While Ricardo based this mechanism on the Malthusian population law, Lewis based it on surplus labour existing in the traditional sector.

According to Lewis, excess labour is employed in rural communities in developing economies because of their customs of mutual help and income-sharing within family, tribe, and/or village, so that labour's marginal product is much lower than the institutional wage rate, if not zero. Labourers, whose marginal contributions to agricultural output are below the institutional wage rate, should be willing to migrate to the industrial sector if employment there is offered at the fixed institutional rate. Accordingly, labour supply to the industrial sector would remain horizontal up to the point when all the surplus labour finishes migrating from the agricultural sector. Until then, the Ricardian process of parallel increases in capital and profit will continue.

Once all the surplus labour in agriculture is absorbed into industry, the wage rate in the agricultural sector will rise along its marginal product curve, corresponding to further absorption of labour by industry. As this point marks the transition from the traditional economy (subject to the classical principle) to the modern one (subject to the neoclassical principle), it is called the 'turning-point'. After the turning-point is reached, the dual nature of the economy is lost, and agriculture becomes a part of the modern economy in which the wage rate and per capita income continue to rise along the upward-sloping labour supply curve. In this way, Lewis pointed out that the mechanism to achieve economic modernization is latent in the traditional economic system characterized by poverty and surplus labour.

Lewis himself did not recognize the danger that the dual economic growth process could be stopped by the Ricardo–Schultz food problem before reaching the turning-point. This possibility is clearly indicated in the Ranis–Fei model that extended and formalized the Lewis theory (Ranis and Fei, 1961; Fei and Ranis, 1964).

Figure 3.6 is a simplified representation of the Ranis–Fei model. Horizontal axis O_1O_2 represents the total labour force, with the industrial labour force measured from O_1 to the right and the agricultural labour force measured from O_2 to the left. For example, point S implies the distribution of labour force between $\underline{O_1S}$ to industry and $\underline{O_2S}$ to agriculture. The upper portion of the diagram represents the market demand and supply relationships for industrial labour that are essentially the same as in the left-hand diagram in Figure 3.5. The lower portion represents a production response to labour input (production function), in the agriculture sector in an inverted shape. Concave curve $\underline{O_2R}$ represents the relationship where agricultural output increases at a decreasing rate corresponding to increases in labour input from origin (O_2) until point S, beyond which labour's marginal product becomes zero.

A purely traditional economy before industrialization is represented by point O_1 at which all labourers are engaged in agricultural production. It is assumed at this point that labour's marginal productivity in agriculture is zero, but output is shared equally among labourers according to the principle of mutual help and income-sharing in rural communities. Income per worker is, therefore, represented by the tangency of a straight line connecting O_2 and R. This average productivity ($\bar{W}$) is considered the determinant of the cost of living, hence the institutionally determined subsistence wage rate.

Starting from point O_1 the agricultural labour force migrates to the industrial sector as the demand curve for industrial labour shifts to the right in

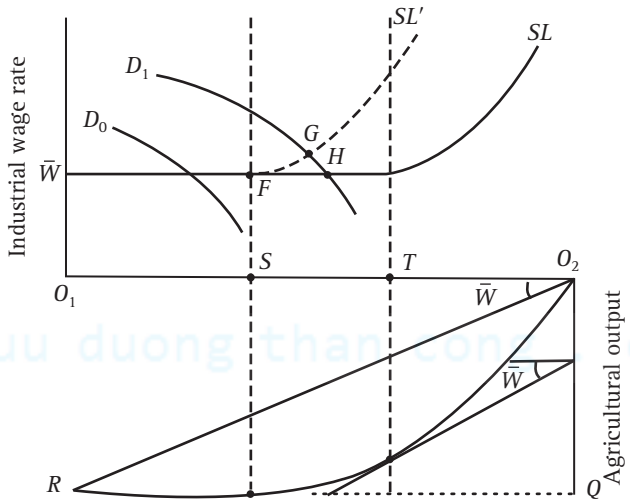

FIG. 3.6 *The dual economy model of the Lewis–Ranis–Fei type*

response to capital accumulation in the industrial sector. It may appear that the supply price of labour to industry remains constant until industrial labour employment reaches point *T* (the Lewis turning-point) because agricultural labour's marginal product continues to be lower than the institutional wage rate offered by industry. If so, the turning-point will be reached through parallel increases in capital stock and profit supported by the infinitely elastic labour supply.

However, once industrial employment exceeds point *S*, agricultural labour's marginal product becomes positive. Further labour migration to industry results in an absolute decline in total (and per capita) food output, so that food prices rise relative to industrial product prices. Point *S* is called the 'shortage point' as it marks the beginning of a food supply decrease.

Beyond this shortage point, the wage rate (measured in industrial product units) needs to be increased so that industrial labourers can purchase the same food basket for their subsistence. Correspondingly, the labour supply curve to industry becomes upward-sloping from point *S*. This curve's slope could well be sharp, because rises in food prices and cost of living for labourers are likely to be sharp in response to reduction in the production of foodstuffs characterized by low demand elasticities. If so, the rate of profit in the industrial sector may decline sharply from point *S*, so that capital accumulation stops before reaching point *T*.

The shortage point in the Ranis–Fei model represents another formulation of the Ricardian trap in which developing economies may be caught when they try to achieve economic modernization by forcing resource reallocation from agriculture to industry, while neglecting the efforts to increase agricultural productivity. This danger is more strongly advocated by Dale W. Jorgenson (1961) in his two-sector model which is similar to the Ranis–Fei model except that no surplus labour is assumed to exist in agriculture and the wage determination in the agricultural sector is based on the neoclassical marginal principle. In the absence of surplus labour in agriculture, industrialization must be supported from its very beginning by technological progress in agriculture to prevent food prices and the cost of living from rising sharply.[7]

It has been the subject of major academic debate whether surplus labour exists in the rural sector of developing economies and whether its wage determination is based on the classical or the neoclassical principle (Hayami and Ruttan, 1985: ch. 2). Irrespective of which theory is adopted, the same conclusion pertains—that successful industrialization cannot be expected without the parallel effort of increasing food production to avoid the danger of being caught in the Ricardian trap.

It must also be pointed out that the contribution of agriculture to industrialization is not only in the supply of food and labour but in many other areas, such as provision of domestic markets for industrial commodities, earning of foreign exchange through exports of agricultural products, and transfer of savings through taxation and financial markets. Industrialization and modern economic growth can hardly be successful without healthy developments in the agricultural sector, which is so dominant in the early stage of development (Mellor, 1966; Johnston and Kilby, 1975; Hayami and Ruttan, 1985).

NOTES

1. Further back to about the beginning of the first millennium, world population is guestimated within a wide range from 150 to 300 million, considering the estimates of 210 to 250 million by Woytinsky and Woytinsky (1953), about 250 million by Berelson (1974), 170 million by McEvedy and Jones (1978), and about 300 million by the World Bank in its *World Development Report 1984*.
2. For a major study in support of the advocacy of the Club of Rome, see the joint report to President Carter by the Council on Environmental Quality and the US Dept. of State (1980). For a criticism, see Simon and Kahn (1984).
3. The same comment may be applied to a recent prediction by Brown and Kane (1994) on the arrival of the Malthusian food crisis within a couple of decades, advocating strengthening of population control. However, the possibility cannot be denied that a major surge in world food prices may occur in the relatively near future. The reason is not so much continued population growth as deceleration in the productivity of major food staples, such as rice and wheat, since the mid-1980s, due to a decline in public investment in agricultural research and irrigation systems since the late 1970s. This applies not only to food but to energy as well. Considering the fact that high investments induced by high food and energy prices during the 1970s resulted in oversupply and low prices in the 1980s, high prices may well emerge for a decade to come. It must be recognized that both governments and international agencies tend to overly respond to short-run price fluctuations by neglecting long-run investment in research and development geared to increasing food production as well as saving energy. Unless such myopic behaviour of public agencies is corrected, recurrent food and energy crises will continue to be repeated. For empirical evidence, see section 4.3.2.
4. Unlike the neoclassical (Marshallian) presentation of the labour market in Figure 3.5, labour demand in the theory of Ricardo and the English Classical School in general is determined by the wage fund e.g. long-run employment is determined by dividing the wage fund by the subsistence wage rate, and short-run employment

is equal to existing the labour force, while the long-run wage rate is equal to the subsistence wage rate and the short-run wage rate is given by dividing the wage fund by the existing labour force. While the same conclusion can be derived from the wage fund theory, it is more precise and easier for readers trained in neoclassical economics to understand the nature and significance of the Ricardian model in terms of neoclassical representation as in Figure 3.5. To further understand Ricardo's original theory as well as Marx's theory (discussed in the next chapter), see Negishi (1989).

5. The shift in the labour supply curve from DD_0 to DD_1 in a rotational manner with point D being fixed is a very special case. The reason this special shift is assumed is because it is the only way to present the Ricardian case of constant factor shares by using linear demand curves. A more general case can be drawn with the use of nonlinear curves including both increasing and decreasing returns to labour. However, this cannot be done without complicating the diagrammatic presentation.
6. Say's law precludes the possibility of any product price declining in the long run. Under the assumption of constant returns to scale, the production function of relating output (Y) to labour (L) and capital (K) inputs,

$$Y = F(L, K)$$

is linear homogeneous and, hence, labour productivity $(y = Y/L)$ can be expressed as the function of the capital–labour ratio $(k = K/L)$ alone as

$$y = f(k).$$

At the profit-maximizing equilibrium the profit rate (r) and the wage rate (w) can be expressed, respectively, as

$$r = f'(k) \quad \text{and} \quad w = f(k) - kf'(k).$$

Therefore, for given $\bar{w}$, $\bar{k}$ and $\bar{r}$ are constant, implying that K and L change proportionally with the rate of profit to remain constant. The assumption of constant returns in industrial production could well be a fairly close approximation of technology in the days of early industrialization. Imagine a case in which a workshop employing ten weaving workers with ten looms invests in the purchase of two additional looms and an increase in the wage fund equivalent to two additional weavers' advance payments, with no possible increase in average output per worker and per loom.
7. Jorgenson's neoclassical model assumed a Malthusian mechanism in which population grows as per capita food availability exceeds a minimum subsistence level resulting from agricultural productivity increases. As Birdsall (1988) points out, the neoclassical one-sector growth model of the Solow–Swan variety (Solow, 1956; Swan, 1956) is also Malthusian because it predicts that capital and consumption per capita will decrease with higher rates of population growth, even

though this model has little relevance to the development of developing economies. In contrast, the endogenous growth model of the Romer–Lucas variety (Romer, 1986; Lucas, 1988) is anti-Malthusian as it assumes the role of population growth to enhance scale economies and thereby to promote capital accumulation. For these two theories, see Sections 5.3 and 6.3.