VI. MAKING EMPLOYMENT PROJECTIONS BY ASSUMING A CONSTANT RATE OF CHANGE IN LABOUR PRODUCTIVITY

A. Introduction

Employment projections are an indispensable input to those comprehensive planning exercises that are designed to accommodate future growth in the working-age population and the labour force. Employment projections can be compared to labour force projections in order assess future surpluses or shortages in the labour market. The comparison should indicate whether projections of factors influencing the supply of labour, such as population, and projections of factors influencing the demand for labour, such as value added, are realistic. Such comparisons should also indicate whether the policies underlying those projections are conducive to balancing the supply and demand sides of the labour market.1/.

A variety of methods can be used to project total employment as well as employment for the various industries comprising a nation's economy. The methods, which vary in complexity, have different data requirements and use different assumptions. One of the simplest techniques derives employment projections for each industry by multiplying projected levels of value added by constant average employment-value added ratios (box 12).2/ That method is easy to apply because it requires very little information and assumes a fixed relationship between employment and value added over time.3/ However, the projections that the employment-value added ratio method yields may not be valid, since it recognizes neither the possibility of factor substitution (e.g. capital for labour) nor the possibility of technical progress.

This method is a special case of the labour productivity method described in this chapter. In particular, if it is assumed that the rates of change of labour productivity by industry equal zero, the labour productivity method would be mathematically equivalent to the constant employment-value added ratio method. The employment-value added ratio method is not described in this volume owing to its limited value in medium-term planning and especially in long-term planning.

To ensure that development plans are based on realistic projections of future trends, many planners prefer to use methods of employment projections that implicitly or explicitly allow for factor substitution or technical change. The simplest among these methods projects employment for each industry by dividing projected levels of value added by the projected levels of average labour productivity, which are assumed to grow at constant rates. The assumptions concerning the rates of change in labour productivity used with this method, which is capable of making national or urban-rural projections, can be based on historical experience or on expected labour productivity trends.

Box 12

Glossary

Average employment-value added ratio
For a given time period, the quantity of labour employed, divided by the valued added produced.

Average labour productivity
The level of output per unit of labour input, usually measured as value added per man-hour or man-year.

Elasticity of employment with respect to value added
For a given time period, the proportionate change in the quantity of labour employed, divided by the proportionate change in the value added.

Factor substitution
The process by which one factor of production (e.g. labour) is replaced in production by some other factor of production (e.g. capital).

Marginal-employment-value added ratio
For a given time period, the change in the quantity of labour employed, divided by the change in the value added.

Technical progress
The application of new scientific knowledge in the form of inventions and innovations to capital, both physical and human, usually leading to lower costs or increased output.

The labour productivity method is less rigid in its basic assumptions than the employment-value added ratio method because it allows, albeit implicitly, for capital-labour substitution and technical change. However, it is more restrictive in its assumptions than the more complex methods for making employment projections which will be described in chapters VII and VIII. Thus, it makes the implicit assumption that the elasticity of employment with respect to value added is equal to one.

Furthermore, the labour productivity method makes it possible to utilize actual historical experience as a basis for preparing projections, since it utilizes time series data on employment and value added. In addition, since it may require a relatively limited amount of data (time series containing

observations for as few as two points in time) the labour productivity method can be more readily applied at the urban-rural level than the more complex methods.

However, the fact that the labour productivity method utilizes time series data, calls for caution. First, labour productivity for any given year is very sensitive to fluctuations in economic activity and shifts in government policy. Consequently, estimates of past trends in labour productivity can be heavily influenced by past developments or policies which may not continue in the future. Such estimates may be, therefore, inappropriate for preparing future projections of employment.

Secondly, in developing countries, value added and employment data may often have different coverage. Thus, time series data on employment may be limited to modern establishments in various industries, while the data on value added, obtained from the national accounts, may refer (at least in principle) to entire industries. Since historical periods often involve significant increases in the shares of modern at the expense of traditional establishments in different industries and since the two types of establishments have very different levels of labour productivity, the resulting time series data may be inappropriate as the basis for applying the labour productivity method.

B. The technique

1. Overview

This overview lists the inputs required, indicates the type of results that can be generated and outlines the computational steps involved in making employment projections with this method.

(a) Inputs

To project employment at the national level, the following inputs are required:

(i) Projected levels of value added, by industry;
(ii) Assumed levels of labour productivity, by industry, for the initial year of the projection;
(iii) Assumed constant percentage rates of change of labour productivity, by industry.

If, in addition to employment, shortages and/or surpluses in the labour market are to be projected, the inputs should also include:

(iv) Projected total labour force; and
(v) Projected non-civilian employment.

For a national projection, the inputs should refer to the entire country. For an urban-rural projection, they should refer to urban and rural areas. The inputs are listed in box 13.

Box 13

Inputs for making employment projections assuming a constant rate of change in labour productivity

1. Value added, by industry (national or urban and rural)

2. Assumptions on initial-year levels of labour productivity, by industry (national or urban and rural)

3. Assumptions on constant rates of change in labour productivity, by industry (national or urban and rural)

4. Total labour force (national or urban and rural; if projection of labour market balances is desired)

5. Non-civilian employment (national or urban and rural; if projection of labour market balances is desired)

Since the labour productivity method will be described in the context of making quinquennial projections, the projected levels of value added would be for dates five years apart, starting with the initial year of the projection. Projected total labour force and projected non-civilian employment would be for the same dates. Given the appropriate annual inputs, however, the method could be used for making annual projections.

(b) Outputs

In the case of a national projection, the method could be used to generate the following outputs:

(i) Levels of employment by industry;
(ii) Various employment aggregates, such as total employment and the growth in total employment;
(iii) Indicators of the structure of employment, such as the proportions of total employment accounted for by major sectors (e.g. primary, secondary and tertiary), defined in (box 14);
(iv) Rates of change in employment, including that of total employment or employment by major sector.

If the inputs include projected total labour force and projected non-civilian employment, the outputs could also include:

(v) Absolute and relative levels of excess supply of labour and/or excess demand for labour.

Box 14

Glossary

Excess demand for labour
The amount by which the quantity of labour demanded exceeds the quantity of labour available at the prevailing level of wages and salaries.

Excess supply of labour
The amount by which the quantity of labour available exceeds the quantity of labour demanded at the prevailing level of wages and salaries.

Primary sector
The part of the economy that specializes in the production of agricultural products and the extraction of raw materials. Major industries in the sector generally include: agriculture, forestry, fishing and mining.

Secondary sector
The part of the economy that uses raw materials and intermediate products to produce final goods and other intermediate products. Major industries comprising the sector generally include: manufacturing, construction and utilities.

Tertiary sector
The part of the economy that provides various services to businesses and households. Major industries of the sector generally include: banking and insurance, public administration, health and education.

If the method is used to prepare an urban-rural projection, the results would include all those listed under (i) through (v), which would be for urban and rural areas as well as for the entire country. In addition, they would include indicators of the urban-rural distribution of employment. The outputs that the technique can generate are shown in box 15.

(c) Computational steps

The first step in projecting employment with this method is to project the levels of labour productivity, by industry, for a given projection date.

Box 15

Types of outputs that can be derived from employment projections made by assuming a constant rate of change in labour productivity

1. Employment by industry (national or urban, rural and national)

2. Employment aggregates (national or urban, rural and national)

   Total employment and employment by sector (e.g. primary, secondary and tertiary)

   Growth in total employment and employment by sector

3. Indicators of the structure of employment (national or urban, rural and national)

   Proportions of total employment found in different sectors

4. Indicators of the urban-rural distribution of employment (national only; if urban and rural employment is being projected)

   Proportions of total employment and of employment by sector in different locations

5. Rates of growth of employment (national or urban, rural and national)

   The rates of growth in total employment and employment by sector

6. Labour market balances (national or urban, rural and national)

   Absolute and relative levels of excess supply of and/or excess demand for labour

After this is done, the projected levels of employment by industry are obtained by dividing the projected levels of value added, by industry, for the date by the projected levels of labour productivity. The method can also be used to derive levels of total employment and employment in major sectors, such as primary, secondary and tertiary, along with other date-specific indicators. If the employment projection is accompanied by a labour force projection, the projected total employment along with the projected total labour force and non-civilian employment can be used to calculate the surplus or shortage of labour.

2. National level

This section will introduce the steps needed to compute the levels of employment by industry and to compute other results for a given projection date or interval at the national level. A summary of those steps is presented in box 16, while a subset of the steps needed to project levels of employment by industry is depicted in the form of a flow diagram (figure XV).

(a) Labour productivity, by industry

In order to implicitly allow for the effect of factor substitution or technical change, the levels of labour productivity, by industry, for any future year will be normally computed using assumptions on positive rates of change of labour productivity. This method requires that constant rates of change in labour productivity by industry be used along with the levels of labour productivity for the initial year of the projection.

(i) Discrete growth

If it is assumed that labour productivity grows in discrete intervals, the levels of labour productivity at the end of the projection interval (t to t+5) can be calculated as follows:

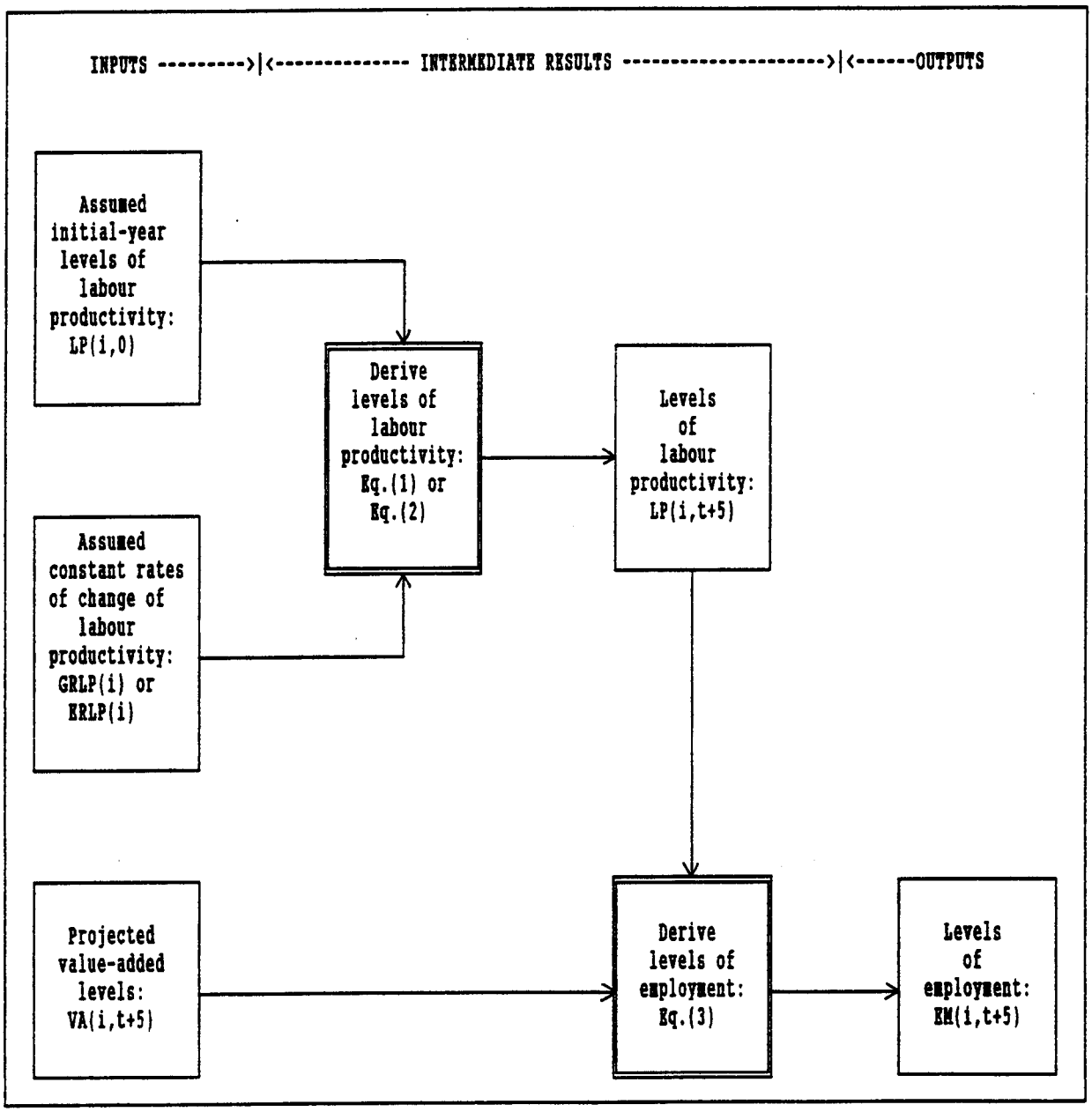
$$LP(i,t+5) = LP(i,0) \cdot (1 + GRLP(i)/100)^{t+5}; \qquad (1)$$

$$i = 1,\ldots,I,$$

where:

$i = 1,\ldots,I$	are industries of the nation's economy,
I	is the number of industries,
t	is the year of the projection period,4/

Figure XV. Steps to derive the levels of employment, by industry



LP(i,t+5) is the labour productivity in industry i at the end of the interval,

LP(i,0) is the labour productivity of industry i in the initial year of the projection period, and

Box 16

Computational steps to project employment at the national level, assuming a constant rate of change in labour productivity

The steps used to project employment at the national level over a five-year projection interval are:

(1) By means of suitable formulae, derive levels of labour productivity, by industry, for the end of the interval using the assumed initial-year levels of labour productivity and the assumed constant rates of change of labour productivity by industry.

(2) For each industry, divide the assumed levels of value added for the end of the interval by the levels of labour productivity by industry for the same date to obtain projected levels of employment.

(3) Calculate various aggregates, such as total employment and the increase in total employment.

(4) Derive indicators of the structure of employment, such as the proportions of total employment accounted for by each sector.

(5) Obtain rates of growth of employment, such as the rate of growth of total employment.

(6) If the labour force projection is available, calculate the absolute and percentage levels of excess supply of or excess demand for labour.

GRLP(i) is the annual geometric rate of change of labour productivity in industry i expressed in percentage.

(ii) Continuous growth

If one assumes that labour productivity grows continuously, then the levels of labour productivity at the end of the projection interval (t to t+5) are obtained as follows:

$$LP(i,t+5) = LP(i,0) \cdot e^{[(ERLP(i)/100) \cdot (t+5)]}; \quad (2)$$

$$i = 1,\ldots,I,$$

where:

ERLP(i)	is the annual exponential rate of change of labour productivity in industry i expressed in percentage, and
e	is the base of the natural logarithm.5/

(b) Employment by industry

Having calculated the levels of labour productivity by industry, the levels of employment for each industry can be obtained by dividing the projected levels of value added by the levels of labour productivity:

$$EM(i,t+5) = VA(i,t+5)/LP(i,t+5); \quad (3)$$

$$i = 1,\ldots,I,$$

where:

EM(i,t+5)	is employment in industry i at the end of the interval, and
VA(i,t+5)	is the value added in industry i at the end of the interval.

(c) Other results

Once the levels of employment by industry are derived for the end of a given projection interval, several derivative indicators can be calculated, which would be useful in planning. These indicators include aggregates, indicators of the structure and rates of change of employment.

(i) Employment aggregates

A key aggregate that can be calculated from the projected levels of employment by industry is the level of total employment. Also, using the industry level results, it is possible to obtain the levels of employment in major sectors, such as the primary, secondary and tertiary sectors. Once total and sectoral levels are obtained for different dates five years apart, increases in total and sectoral employment over the intervening projection interval can be calculated.

a. Total employment

Total employment can be obtained by aggregating the levels of employment across industries. For the end of a projection interval (t to t+5) this number could be calculated as:

$$EM(t+5) = \sum_{i=1}^{I} EM(i,t+5), \qquad (4)$$

where:

EM(t+5) is the total employment at the end of the interval.

b. Employment by sector

A variety of criteria can be used to aggregate industries into sectors. Thus, one could aggregate industries into primary, secondary and tertiary sectors or into agricultural, industrial and service sectors. For illustrative purposes, the primary-secondary-tertiary-sector mode of aggregation will be used. In addition, it will be assumed that the numbering of industries for which the levels of employment are being projected lists industries of the primary, secondary and tertiary sectors one after another.

i. Employment in the primary sector

Using these aggregation and classification rules, employment in the primary sector for the end of the projection interval (t to t+5) can be obtained as:

$$EMP(t+5) = \sum_{i=1}^{Ip} EM(i,t+5), \qquad (5)$$

where:

Ip	is the number of industries in the primary sector, and
EMP(t+5)	is the employment in the primary sector at the end of the interval.

ii. Employment in the secondary sector

Employment in the secondary sector can be obtained as:

$$EMS(t+5) = \sum_{i=Ip+1}^{Ip+Is} EM(i,t+5), \qquad (6)$$

where:

Is	is the number of industries in the secondary sector, and
EMS(t+5)	is the employment in the secondary sector at the end of the interval.

iii. Employment in the tertiary sector

Employment in the tertiary sector can be calculated as follows:

$$EMT(t+5) = \sum_{i=Ip+Is+1}^{I} EM(i,t+5), \qquad (7)$$

where:

EMT(t+5)	is the employment in the tertiary sector at the end of the interval.

c. Growth in total employment

The growth in total employment over the projection interval (t to t+5) equals the difference between total employment at the end and total employment at the beginning of the interval:

$$EMGR = EM(t+5) - EM(t), \qquad (8)$$

where:

EMGR	is the growth of total employment during the interval.

d. Growth in employment by sector

The increase of employment over the projection interval in the primary, secondary and tertiary sectors, respectively, is obtained as follows:

Growth of employment in the primary sector is calculated as:

$$EMPGR = EMP(t+5) - EMP(t), \quad (9)$$

Growth of employment in the secondary sector is calculated as:

$$EMSGR = EMS(t+5) - EMS(t), \quad (10)$$

Growth of employment in the tertiary sector is calculated as:

$$EMTGR = EMT(t+5) - EMT(t), \quad (11)$$

where:

EMPGR	is the growth of employment in the primary sector during the interval,
EMSGR	is the growth of employment in the secondary sector during the interval, and
EMTGR	is the growth of employment in the tertiary sector during the interval.

(ii) Indicators of the structure of employment

Once the various employment aggregates are obtained, it is possible to derive the proportions of total employment accounted for by each sector.

a. Proportions by sector

The proportions of total employment accounted for by each sector (e.g., primary, secondary and tertiary) can be obtained as follows:

The proportion of employment in the primary sector is calculated as:

$$PEMP(t+5) = EMP(t+5) / EM(t+5), \quad (12)$$

The proportion of employment in the secondary sector is calculated as:

$$PEMS(t+5) = EMS(t+5) / EM(t+5), \quad (13)$$

The proportion of employment in the tertiary sector is calculated as:

$$PEMT(t+5) = EMT(t+5) / EM(t+5), \quad (14)$$

where:

PEMP(t+5)	is the proportion of total employment accounted for by the primary sector at the end of the interval,
PEMS(t+5)	is the proportion of total employment accounted for by the secondary sector at the end of the interval, and
PEMT(t+5)	is the proportion of total employment accounted for by the tertiary sector at the end of the interval.

(iii) Rates of growth of employment

As part of an employment projection, it is also possible to compute average annual rates of growth in employment, for the total employment and for employment by sectors.

a. Rate of growth of total employment

The average annual rate of growth of total employment for a given projection interval can be computed from the total employment at the beginning and the end of the interval. If, as part of the projection process, it is assumed that growth occurs over discrete intervals, then the percentage rate of growth can be obtained using the formula for calculating a geometric growth rate:

$$GGREM = [(EM(t+5) / EM(t))^{1/5} - 1] \cdot 100, \quad (15)$$

where:

GGREM	is the average annual geometric growth rate of total employment for the interval.

Alternatively, if it is assumed that growth is continuous, then the growth rate of total employment can be calculated using the formula for calculating an exponential growth rate:

$$EGREM = [(\ln (EM(t+5) / EM(t))) / 5] \cdot 100, \quad (16)$$

where:

ln	is the natural logarithm, and
EGREM	is the average annual exponential growth rate of total employment for the interval.

b. Rates of growth of employment by sector

Assuming discrete growth, the percentage rates of growth of employment for sectors can be obtained as follows:

The geometric growth rate for the primary sector is calculated as:

$$GGREMP = [(EMP(t+5) / EMP(t))^{1/5} - 1] \cdot 100, \quad (17)$$

The geometric growth rate for the secondary sector is calculated as:

$$GGREMS = [(EMS(t+5) / EMS(t))^{1/5} - 1] \cdot 100, \quad (18)$$

The geometric growth rate for the tertiary sector is calculated as:

$$GGREMT = [(EMT(t+5) / EMT(t))^{1/5} - 1] \cdot 100, \quad (19)$$

where:

GGREMP	is the average annual geometric growth rate of employment in the primary sector for the interval,
GGREMS	is the average annual geometric growth rate of employment in the secondary sector for the interval, and
GGREMT	is the average annual geometric growth rate of employment in the tertiary sector for the interval.

If the projections were based on the assumption of continuous growth, then the rates of growth of employment by major sector would be calculated

using the formula for obtaining the exponential growth rate. The calculations would be as follows:

The exponential growth rate for the primary sector is calculated as:

$$EGREMP = [(\ln (EMP(t+5) / EMP(t))) / 5] \cdot 100, \quad (20)$$

The exponential growth rate for the secondary sector is calculated as:

$$EGREMS = [(\ln (EMS(t+5) / EMS(t))) / 5] \cdot 100, \quad (21)$$

The exponential growth rate for the tertiary sector is calculated as:

$$EGREMT = [(\ln (EMT(t+5) / EMT(t))) / 5] \cdot 100, \quad (22)$$

where:

EGREMP	is the average annual exponential growth rate of employment in the primary sector for the interval,
EGREMS	is the average annual exponential growth rate of employment in the secondary sector for the interval, and
EGREMT	is the average annual exponential growth rate of employment in the tertiary sector for the intervals.

(iv) Labour market balances

Once various projection results are obtained, it is possible to calculate the excess demand for labour or excess supply of labour using projections of labour force and employment as indicators of the future supply of and demand for labour, respectively. Also, it is possible to calculate the excess demand or excess supply as a percentage of the total labour force.

In countries where there is a sizeable non-civilian employment which may include military or internal security personnel, the projected labour force to be used in these calculations should not be the projected total labour force, which can be obtained as described in chapter V. The projected labour force to be used is the projected civilian labour force, which can be calculated as the difference between the projected total labour force and projected non-civilian employment, where the latter projection is an additional input.

The reason for this is related to the fact that in projections regarding the labour market, the projections of demand for labour (or employment) will normally apply to the civilian segment of the labour market. Therefore, projections of the supply of labour (or labour force) used to compute excess supply or demand, must also be those for the civilian segment of the market.

To calculate excess supply or excess demand, therefore, the civilian labour force may first have to be calculated; for the end of the time interval (t to t+5), this can be obtained as:

$$CLF(t+5) = LF(t+5) - NEM(t+5), \tag{23}$$

where:

CLF(t+5)	is the civilian labour force at the end of the interval,
LF(t+5)	is the total labour force at the end of the interval, and
NEM(t+5)	is the non-civilian employment at the end of the interval.

The excess supply of (or demand for) labour for the end of the interval can be obtained as the difference between the projected civilian labour force and the projected employment for that date:

$$EXL(t+5) = CLF(t+5) - EM(t+5), \tag{24}$$

where:

EXL(t+5)	is the excess supply of labour (if positive) or excess demand for labour (if negative) for the end of the interval.

The excess demand or excess supply as a percentage of the civilian labour supply (civilian labour force) can be calculated as:

$$PEXL(t+5) = [\ EXL(t+5)\ /\ CLF(t+5)\ ] \cdot 100, \tag{25}$$

where:

PEXL(t+5)	is the excess supply of labour or excess demand for labour as a percentage of the civilian labour force at the end of the interval.

3. Urban-rural level

This section will describe a procedure to calculate an urban-rural projection of employment. The procedure, which is similar to that used in the national projection, projects the levels of labour productivity and employment by industry and derives a variety of other results.

(a) Labour productivity by industry

Labour productivity in urban and rural areas can be calculated by industry for a given projection date using an urban-rural equivalent of the step shown by equation (1) or equation (2).

(i) Discrete growth

If it is assumed that the growth in labour productivity over time occurs in discrete intervals, the levels of labour productivity at the end of the projection interval (t to t+5) would be calculated as:

$$LP(i,k,t+5) = LP(i,k,0) \cdot (1 + GRLP(i,k)/100)^{t+5}; \qquad (26)$$

$$i = 1,\ldots,I;$$

$$k = 1,2,$$

where:

$k = 1,2$	are urban and rural locations,
$LP(i,k,t+5)$	is the labour productivity in industry i in location k at the end of the interval,
$LP(i,k,0)$	is the labour productivity of industry i in location k in the initial year of the projection period, and
$GRLP(i,k)$	is the annual geometric rate of change of labour productivity in industry i in location k expressed in percentage.

(ii) Continuous growth

If it is assumed that the growth in labour productivity is continuous, the levels of labour productivity at the end of any projection interval would be obtained by means of an urban-rural equivalent of the step indicated by equation (2).

(b) Employment by industry

Given the levels of labour productivity by industry in each area, the levels of employment by sector can be obtained using an urban-rural equivalent of equation (3):

$$EM(i,k,t+5) = VA(i,k,t+5)/LP(i,k,t+5); \quad (27)$$

$$i = 1,\ldots,I;$$

$$k = 1,2,$$

where:

EM(i,k,t+5) is the employment in industry i in location k at the end of the interval, and

VA(i,k,t+5) is the value added in industry i in location k at the end of the interval.

(c) Other results

The indicators described in relation to the national projection can also be computed as part of an urban-rural projection. Those indicators are, however, calculated for urban and rural areas and for the entire country, using steps analogous to those indicated by equations (4) through (22). The projection would also permit the calculation of the excess supply of (or excess demand for) labour using calculations analogous to those described by equations (23) through (25). These calculations would refer to the urban and rural areas as well as the entire country. In addition, indicators of the distribution of employment by location--proportions urban and rural--can be calculated.

(i) Proportions of employment that are urban and rural

The proportions of employment occurring in urban and rural areas, respectively, can be derived both for total employment and employment by sector.

a. Proportions of total employment

The proportion of total employment that is urban (k=1) is obtained as a ratio of total employment in urban areas to total employment in the entire country:

$$PEMURB(t+5) = EM(1,t+5)/EM(t+5), \quad (28)$$

where:

PEMURB(t+5) is the proportion of total employment that is urban at the end of the interval, and

EM(k,t+5) is total employment in location k at the end of the interval.

The proportion of total employment that is rural (k=2) can be obtained as the complement of the proportion urban:

$$PEMRUR(t+5) = 1 - PEMURB(t+5), \quad (29)$$

where:

PEMRUR(t+5) is the proportion of total employment that is rural at the end of the interval.

b. Proportions of employment by sector

Proportions of employment in the primary, secondary and tertiary sectors that are urban (k=1) can be calculated as ratios of urban employment in those sectors to national employment in those sectors. In particular, the proportions can be calculated as follows:

The proportion of employment in the primary sector that is urban is:

$$PEMPURB(t+5) = EMP(1,t+5)/EMP(t+5), \quad (30)$$

The proportion of employment in the secondary sector that is urban is:

$$PEMSURB(t+5) = EMS(1,t+5)/EMS(t+5), \quad (31)$$

The proportion of employment in the tertiary sector that is urban is:

$$PEMTURB(t+5) = EMT(1,t+5)/EMT(t+5), \quad (32)$$

where:

PEMPURB(t+5) is the proportion of employment in the primary sector that is urban at the end of the interval,

PEMSURB(t+5) is the proportion of employment in the secondary sector that is urban at the end of the interval,

PEMTURB(t+5) is the proportion of employment in the tertiary sector that is urban at the end of the interval,

EMP(k,t+5) is the employment in the primary sector in location k at the end of the interval,

EMS(k,t+5) is the employment in the secondary sector in location k at the end of the interval, and

EMT(k,t+5) is the employment in the tertiary sector in location k at the end of the interval.

For each sector, the proportions of employment that are rural (k=2) can be obtained as complements of proportions urban:

The proportion of employment in the primary sector that is rural is:

$$PEMPRUR(t+5) = 1 - PEMPURB(t+5), \tag{33}$$

The proportion of employment in the secondary sector that is rural is:

$$PEMSRUR(t+5) = 1 - PEMSURB(t+5), \tag{34}$$

The proportion of employment in the tertiary sector that is rural is:

$$PEMTRUR(t+5) = 1 - PEMTURB(t+5), \tag{35}$$

where:

PEMPRUR(t+5) is the proportion of employment in the primary sector that is rural at the end of the interval,

PEMSRUR(t+5) is the proportion of employment in the secondary sector that is rural at the end of the interval, and

PEMTRUR(t+5) is the proportion of employment in the tertiary sector that is rural at the end of the interval.

This completes the discussion of the technique for making employment projections. The following section will discuss the preparation of the inputs needed for making the projection.

C. The inputs

This section will first list the inputs used by the labour productivity method of employment projection and then describe how they can be prepared.

1. Types of inputs required

The following types of inputs are required in order to apply the labour productivity method:

(i) Projected levels of value added, by industry;
(ii) Assumptions on initial-year levels of labour productivity, by industry;
(iii) Assumptions on constant rates of change of labour productivity, by industry.

If projections of labour surpluses and/or shortages are also to be prepared, the inputs should include:

(iv) Projected total labour force;
(v) Projected non-civilian employment.

Depending on whether one wishes to make a national projection or a projection for urban and rural areas, those inputs will refer to the entire country or to urban and rural areas.

2. Preparation of the inputs

The projected levels of value added, by industry, can be obtained directly from value added projections, which are part of a typical development planning exercise. Procedures for making such projections are not discussed in this module or elsewhere in this volume, but a brief description of the procedure that has been often used by planners to project value added by industry is given in box 17. Projections of the total labour force can be prepared as described in chapter V, while those of non-civilian employment can be obtained by considering likely future developments in the non-civilian sector of the economy. Assumptions on the initial-year levels of labour productivity and on constant rates of change of labour productivity would need to be prepared by the user of the method. Typically, one would first prepare assumptions on the rates of change of labour productivity.

(a) Assumptions on rates of change of labour productivity

Assumptions on rates of change of labour productivity can be derived from time series data on value added and employment, by industry, for a recent time period. These rates of change can be obtained from such time series, which can be fairly long (referring to 15 or more years) or very short (referring to

as few as two years). Alternatively, assumptions on the rates of change of labour productivity can be selected on the basis of anticipated trends in factors influencing labour productivity, including government policies. Of course, assumptions that are not based on empirical data are very likely to be less reliable, since there is always the danger of using hoped-for trends in place of plausibly anticipated trends.

Wherever possible, 10 or more observations on labour productivity, covering a period of 10 years or longer should be used if the assumptions on rates of change of labour productivity are derived from historical data. The reason is that labour productivity tends to be quite sensitive to the business cycle, declining during periods of economic down-turn and increasing during periods of economic expansion. In addition, historical data on labour productivity may reflect specific government policies (e.g., a wage freeze, pressure to expand employment, land reform), which may not apply over long time periods. As a result, unless a longer time series is used, estimated rates of change of labour productivity may reflect conditions prevailing over short, a typical periods and may not be suitable for medium-range and especially long-term projections.

Before describing and illustrating how rates of change of labour productivity can be estimated from both longer time series as well as very short time series, we shall briefly discuss this type of information and sources from which they are typically obtained. Some problems typical to this kind of data will also be briefly described.

(i) Time series data

Time series data on employment, by industry, at the national or urban-rural level generally can be obtained from annual surveys of establishments or from periodic labour force surveys of households. Unfortunately, in many countries those data may refer only to the "modern" establishment in various industries. However, where data on "traditional" establishments are available only for a few years, they may be used as a basis for inflating the employment in modern establishments in order to estimate total employment levels, by industry, over time.

Time series on value added, by industry, would normally be obtained from the national accounts, and they would refer (at least in principle) to entire industries. Unfortunately, national accounts (or other relevant data sources) will rarely include value added information for industries broken down by urban-rural location. Therefore, the use of the method with rates of change in labour productivity derived from relatively long time series would be normally possible only at the national level. Where one wishes to make projections of employment by location using rates of productivity change grounded in historical data, it would be often necessary to find estimates of those rates using relatively short time series.

Box 17

A procedure to project value added

A common procedure to project value added by industry makes use of an input-output model along with projected levels of final demand, by industry, for selected future dates.

The input-output model, which is normally constructed around a fixed input-output matrix can show the implications of a specific change in one part of the economy for the rest of the economy. Each row of the input-output matrix indicates the way in which the output of the industry corresponding to that row is used to satisfy final demand or as inputs to other industries. Each column of the matrix shows the origins of the inputs used by the given industry, including those of factors of production (e.g. labour). The projected final demand indicates projected levels of final use of goods and services produced in various industries at various future dates. Examples of final use are household consumption and government consumption.

Once the planner has projected levels of final demand for each industry, projected levels of value added by industry can be calculated by substituting the projected levels of final demand, by industry, into the input-output model. In particular, the projected level of value added for any given industry can be obtained as the difference between the derived value of total production for the industry, and the derived value of intermediate inputs purchased from other industries.

Examples of longer time series data on employment and value added by industry at the national level are shown in tables 49 and 50, respectively. Such time series would be required to derive time series of labour productivity by industry, such as those presented in table 51, which were obtained by dividing the time series of value added in table 50 by those of employment in table 49. Such time series of labour productivity would be used to estimate constant rates of change of labour productivity using OLS or some similar regression analysis technique.

Tables 52 and 53 provide examples of very short time series, which include observations on employment and value added for urban and rural areas, by industry, for just two years. Such data would be required to derive observations of labour productivity by location and industry, such as those shown in table 54. These observations were derived by dividing for each industry the value added (table 53) by the employment (table 52). Information on labour productivity such as that presented in table 54 would make it possible to estimate constant rates of change of labour productivity by industry and location for the time period between the dates to which the data refer.

Table 49. Employment for the entire country, by industry: 1968-1978

(Thousands of employed persons)

Year	Agri-culture	Mining	Manufac-turing	Utilities	Cons-truction	Trade	Transport	Ser-vices
1968	1656.5	5.0	124.5	9.6	57.6	79.3	68.5	312.8
1969	1688.5	5.4	127.7	9.2	53.8	79.7	73.9	330.1
1970	1739.8	6.3	137.8	8.9	55.8	77.4	84.4	336.8
1971	1766.1	7.2	155.4	9.0	59.8	85.4	82.1	365.9
1972	1764.8	7.1	145.5	11.3	64.3	83.9	86.2	375.7
1973	1843.5	7.4	159.8	9.6	69.4	81.1	82.5	391.4
1974	1846.3	9.4	171.8	10.0	76.0	100.5	89.2	442.1
1975	1887.0	8.3	170.3	13.7	71.0	94.1	83.7	468.5
1976	1917.8	10.3	184.0	14.4	81.8	104.9	88.4	483.3
1977	1955.6	9.5	198.2	15.6	85.4	108.5	89.5	503.3
1978	1994.0	6.7	217.3	15.3	93.8	109.4	95.1	516.2

Table 50. Value added for the entire country, by industry: 1968-1978

(Millions of local currency units; constant 1968 prices)

Year	Agri-culture	Mining	Manufac-turing	Utilities	Cons-truction	Trade	Transport	Ser-vices
1968	155.2	2.2	44.6	8.2	18.4	41.2	38.1	119.2
1969	165.4	2.0	48.6	9.1	18.6	44.0	38.6	128.1
1970	172.4	2.6	52.5	9.8	19.0	44.6	41.2	139.0
1971	175.9	2.7	59.3	10.6	20.2	47.1	43.1	152.9
1972	189.3	2.5	63.6	11.6	23.1	42.6	42.4	172.2
1973	199.4	3.6	70.8	11.9	23.8	45.5	45.2	185.7
1974	202.6	3.9	74.9	12.7	22.2	46.4	44.7	207.1
1975	237.1	3.5	75.5	13.7	21.2	49.5	42.0	223.0
1976	235.2	3.8	89.6	15.4	20.7	51.8	46.4	237.5
1977	256.5	4.0	103.9	16.5	22.3	50.5	47.7	252.6
1978	260.3	2.6	118.9	18.0	23.5	50.9	50.3	266.9

Table 51. Average labour productivity for the entire country, by industry, 1968-1978

(Local currency units per person-years of employment)

Year	Agri-culture	Mining	Manufac-turing	Utilities	Cons-truction	Trade	Transport	Ser-vices
1968	0.093	0.440	0.358	0.854	0.319	0.519	0.556	0.381
1969	0.097	0.370	0.380	0.989	0.345	0.552	0.522	0.388
1970	0.099	0.412	0.380	1.101	0.340	0.576	0.488	0.413
1971	0.099	0.375	0.381	1.177	0.337	0.551	0.524	0.418
1972	0.107	0.352	0.437	1.026	0.359	0.507	0.491	0.458
1973	0.108	0.486	0.443	1.239	0.342	0.561	0.547	0.474
1974	0.109	0.414	0.435	1.270	0.292	0.461	0.501	0.468
1975	0.125	0.421	0.443	1.000	0.298	0.526	0.501	0.476
1976	0.122	0.368	0.486	1.069	0.253	0.493	0.524	0.491
1977	0.131	0.421	0.524	1.057	0.261	0.465	0.532	0.502
1978	0.130	0.388	0.547	1.176	0.250	0.465	0.528	0.517

Table 52. Employment for urban and rural areas, by industry: 1973 and 1978

(Thousands of employed persons)

Year	Agri-culture	Mining	Manufac-turing	Utilities	Cons-truction	Trade	Transport	Ser-vices
				Urban				
1973	16.8	5.9	137.9	8.9	59.4	72.9	81.2	274.9
1978	22.2	5.9	184.2	12.7	81.4	98.8	92.2	334.3
				Rural				
1973	1826.7	1.5	21.9	0.7	10.0	8.2	1.4	116.5
1978	1971.8	0.8	33.1	2.6	12.4	10.6	2.9	181.9

Table 53. Value added for urban and rural areas, by industry: 1973 and 1978

(Millions of local currency units; constant 1968 prices)

Year	Agri-culture	Mining	Manufac-turing	Utilities	Cons-truction	Trade	Transport	Ser-vices
				Urban				
1973	6.9	3.1	66.9	10.3	21.2	43.6	44.8	146.8
1978	12.9	2.4	111.8	15.7	21.2	48.9	49.3	200.2
				Rural				
1973	192.5	0.5	3.9	1.6	2.6	1.9	0.4	38.9
1978	247.3	0.2	7.1	2.3	2.3	2.0	1.0	66.7

Table 54. Average labour productivity for urban and rural areas, by industry: 1973 and 1978

(Local currency units per person-years of employment)

Year	Agri-culture	Mining	Manufac-turing	Utilities	Cons-truction	Trade	Transport	Ser-vices
				Urban				
1973	0.412	0.524	0.485	1.159	0.357	0.597	0.552	0.534
1978	0.581	0.406	0.606	1.236	0.260	0.494	0.534	0.599
				Rural				
1973	0.105	0.336	0.177	2.260	0.258	0.237	0.257	0.334
1978	0.125	0.250	0.214	0.884	0.185	0.188	0.344	0.367

(ii) Rates of change based on time series consisting of several observations

Estimating constant rates of change will differ depending on the number of observations in the time series being utilised. It will be shown initially how to obtain estimates of these rates from relatively long time series.

a. Estimation procedures

The procedure used to estimate constant rates of change in labour productivity will differ depending on whether the assumption of discrete growth or the assumption of continuous growth is used.

i. Discrete growth

If it is assumed that labour productivity grows in discrete intervals, estimates of constant rates of change in labour productivity, by industry, at the national level can be obtained from time series data on labour productivity by estimating the coefficients of a set of functions that can be derived from the following functions:

$$LP(i,t') = LP(i,0) \cdot (1 + GRLP(i)/100)^{t'}; \qquad (36)$$

$$i = 1,\ldots,I,$$

where:

t'	is the calendar year,
$LP(i,t')$	is the labour productivity in industry i in year t',
$LP(i,0)$	is the labour productivity of industry i in the initial year of the time series.

In order to arrive at the functions to be estimated, it would be necessary to take natural logarithms of the functions by industry shown in equation (36) and to add a random disturbance term (box 18) to each:

$$\ln LP(i,t') = a(i) + b(i) \cdot t' + u(i,t'); \qquad (37)$$

$$i = 1,\ldots,I$$

where:

$a(i) = \ln LP(i,0)$,

$b(i) = \ln[\ 1 + GRLP(i)/100\ ]$,

Box 18

Glossary

Asymptotically unbiased

An estimator, such as the coefficient in a regression equation, is said to be asymptotically unbiased if the probability that the estimator is different from the true value of the parameter it purports to assess approaches zero as the size of the sample approaches infinity.

Coefficient of determination, R^2

The measure of the goodness of fit of a regression equation, which denotes the proportion of the variance in the dependent variable associated with independent variable(s) included in the regression. The coefficient may lie between 0 and 1: when it is close to 0, it suggests a weak relationship; when it is close to 1, a strong one.

Random disturbance term

The term added to a regression equation as an average relationship between dependent and independent variables, which ensures equality between the left and the right hand side of the equation for each observation. The disturbance or error term may represent random disturbances in an observation or it may reflect errors of measurement.

Statistically significant

An estimate of a particular statistic, such as a partial regression coefficient, is said to be statistically significant if the probability that it could have occurred by chance is less than, say, 5 per cent.

t-statistic

In regression analysis, a statistic calculated for each partial coefficient which makes it possible for the analyst to determine whether or not the coefficient is statistically significant.

and where:

a(i)	is the intercept coefficient of the function for industry i,
b(i)	is the partial coefficient of the function for industry i, and

u(i,t') is the random disturbance term in the function for industry i in year t'.

The functions indicated in equation (37) can be estimated from time series data on labour productivity by industry using such standard methods of regression analysis as OLS.

Once the coefficients of the functions shown in equation (37) are estimated, the estimates of constant geometric rates of change of labour productivity, GRLP(i)'s, can be obtained as follows:

$$GRLP(i) = [\text{antiln } b^*(i) - 1] \cdot 100; \qquad (38)$$

$$i = 1,\ldots,I,$$

where:

b*(i) is the estimate of the partial coefficient of the function for industry i, and

antiln is the antilogarithm of the natural logarithm.

This estimate of GRLP(i) is <u>asymptotically unbiased</u> and has other desirable properties.

Estimates of labour productivity for urban and rural areas can also be obtained using longer time series of labour productivity, given the assumption of discrete growth in labour productivity. Initially, one would transform urban-rural equivalents of the functions shown in equation (36) and add a random disturbance term to each. The result would be urban-rural counterparts of functions indicated in equation (37), which, when estimated, would provide the basis for deriving the estimates of the rates of change of labour productivity for the two areas. In particular, those estimates would be derived from the estimates of the partial coefficients using the urban-rural equivalent of the step described by equation (38).

ii. <u>Continuous growth</u>

If it is assumed that labour productivity grows continuously over time, estimates of constant rates of change of labour productivity, by industry, for the entire country can be obtained from time series data on labour productivity by estimating parameters of the functions that can be derived from the following set of functions:

$$LP(i,t') = LP(i,0) \cdot e^{[(ERLP(i)/100) \cdot t']}; \qquad (39)$$

$$i = 1,\ldots,I.$$

In order to derive the functions to be estimated, it is necessary to take natural logarithms of the functions indicated in equation (39) and add a random disturbance term to each:

$$\ln LP(i,t') = a(i) + b(i) \cdot t' + u(i,t'); \qquad (40)$$

$$i = 1,\ldots,I,$$

where:

$a(i) = \ln LP(i,0)$,

$b(i) = ERLP(i)/100$.

These functions can be estimated for each industry from time series data on labour productivity using OLS regression technique. The functions shown in equation (40) are identical to those indicated by equation (37), except for the interpretation of their partial coefficients, b(i)'s, in terms of constant rates of change of labour productivity.

Once the estimates of the coefficients are obtained, the ERLP(i)'s can be estimated by multiplying the corresponding estimates of partial coefficients, b*(i)'s, by 100:

$$ERLP(i) = b^*(i) \cdot 100; \qquad (41)$$

$$i = 1,\ldots,I.$$

An analogous procedure could be used to obtain estimates of rates of change of labour productivity from longer urban and rural time series of labour productivity. First, one would transform urban-rural equivalents of the functions shown in equation (39) and add random disturbance terms to each. This would yield urban-rural counterparts of functions shown in equation (40), which, when estimated, would provide the basis for deriving estimates of rates of change in labour productivity in urban and rural areas. Those rates would be derived from the estimates of the partial coefficients by means of the urban-rural equivalent of the step indicated in equation (41).

b. Illustrative estimations

This section will illustrate the estimation of constant rates of change of labour productivity for the entire country using the time series on labour productivity, by industry, shown in table 51.

i. Discrete growth

If discrete growth in labour productivity is assumed, it will first be necessary to estimate the coefficients of the functions shown in equation (37). Estimates of those functions, obtained from the time series data of table 51, using OLS, are shown in table 55.

Those results are fairly typical of those that could be obtained from time series data in a developing country. Coefficients of determination, R^2's (column 4), for agriculture, manufacturing, construction, trade and services range between 0.502 (trade) to 0.945 (agriculture), and according to t-statistics (shown in parenthesis in column 3), the estimates of coefficients of the time variable are all statistically significant.6/ On the other hand, for mining, utilities and transport, the R^2's are very low and the coefficients of the time variable are not statistically significant.

The estimates of the functions need further to be used to derive the estimates of the rates of change of labour productivity as illustrated in table 56. In particular, the estimate of the rate of change for each industry (column 3) is obtained by taking the antilogarithm of the estimate of the partial coefficient for the industry (column 2), subtracting 1 from the result and multiplying by 100. For example, the estimate of the annual percentage rate of change in labour productivity in agriculture, 3.66, is obtained as:

$$3.66 = [\text{antiln}\ (0.0359) - 1] \cdot 100, \qquad (38)$$

where 0.0359 is the estimate of the partial coefficient for agriculture.

ii. Continuous growth

If the growth in labour productivity is assumed to be continuous, then the coefficients of the functions indicated in equation (40) would need to be estimated. Estimates of those functions, based on the data shown in table 51, are identical to the estimates of the functions indicated by equation (37) and presented in table 55. The use of those estimates to derive estimates of the constant rates of change in labour productivity is different from that based on the assumption of discrete growth in labour productivity.

The derivation of the estimates of rates of change of labour productivity is illustrated in table 57, where the estimate of the rate of change for any industry (column 3) is obtained by multiplying the estimate of the partial coefficients for the industry (column 2) by 100. For example, the estimate of the annual percentage rate of change in labour productivity in agriculture, 3.59, is obtained as:

$$3.59 = 0.0359 \cdot 100, \qquad (41)$$

Table 55. Estimates of the coefficients of functions relating the logarithm of average labour productivity to time, by industry, for the entire country: $\ln LP(i,t') = a(i) + b(i)*t' + u(i,t')$ a/

Industry	Coefficients: Intercept	Coefficients: Time variable b/	R-square
(1)	(2)	(3)	(4)
Agriculture	-73.106	0.036 (12.448)	0.945
Mining	0.035	-0.000 (-0.051)	0.000
Manufacturing	-80.332	0.040 (11.310)	0.934
Utilities	-29.818	0.015 (1.458)	0.190
Construction	64.852	-0.033 (-4.396)	0.682
Trade	33.188	-0.017 (-3.014)	0.502
Transport	-0.207	-0.000 (-0.053)	0.000
Services	-61.068	0.031 (11.780)	0.939

a/ Estimated by ordinary least squares (OLS).
b/ t values are shown in parentheses.

Table 56. Computing estimates of constant rates of change in average labour productivity, by industry, assuming discrete growth in labour productivity: entire country

Industry	Coefficient of time variable a/	Rate of change of labour productivity b/
(1)	(2)	(3)
Agriculture	0.036	3.66
Mining	-0.000	-0.05
Manufacturing	0.040	4.11
Utilities	0.015	1.53
Construction	-0.033	-3.29
Trade	-0.017	-1.70
Transport	-0.000	-0.02
Services	0.031	3.10

a/ From table 55, col. 3.
b/ [Antiln(Col.2) - 1] . (100).

Table 57. Computing estimates of constant rates of change in average labour productivity, by industry, assuming continuous growth in labour productivity: entire country

Industry	Coefficient of time variable a/	Rate of change of labour productivity b/
(1)	(2)	(3)
Agriculture	0.036	3.59
Mining	-0.000	-0.05
Manufacturing	0.040	4.03
Utilities	0.015	1.52
Construction	-0.033	-3.35
Trade	-0.017	-1.72
Transport	-0.000	-0.02
Services	0.031	3.05

a/ From table 55, col. 3.
b/ (Col.2) . (100).

where 0.0359 is the estimate of the partial coefficient for agriculture.

(iii) Rates of change based on time series consisting of two observations

Rates of change of labour productivity (both discrete and continuous) can be estimated from time series including as few as two observations on labour productivity, such as those shown in table 54. Since such estimates may be more sensitive to swings in business activity or government policy than those obtained from time series data consisting of several observations, they should be used with considerably more caution for making medium-term and especially long-run employment projections.

a. Estimation procedures

The procedure used to estimate constant rates of change in labour productivity, using observations referring to two dates, will vary depending on the type of assumption on the labour productivity growth used.

i. Discrete growth

If it is assumed that the labour productivity grows in discrete intervals, estimates of the rates of change of labour productivity, by industry, for the entire country based on observations for two points in time can be obtained by using the following formulae, obtained by solving equation (36) for the growth rate in labour productivity:

$$GRLP(i) = [(LP(i,t')/LP(i,0))^{1/t'} - 1] \cdot 100; \qquad (42)$$

$$i = 1,\ldots,I,$$

where:

LP(i,0)	is the labour productivity of industry i in year 0, and
LP(i,t')	is the labour productivity in industry i in year t'.

Where labour productivity data are available for urban and rural areas for two points in time, estimates of rates of change of labour productivity by industry for the two areas can be obtained using urban-rural equivalents of the formulae shown in equation (42).

ii. Continuous growth

If labour productivity growth is assumed to be continuous, estimates of the rates of change of labour productivity by industry at the national level can be obtained by using the following formulae, derived from equation (39):

$$ERLP(i) = [(\ln (LP(i,t')/LP(i,0))) / t'] \cdot 100; \quad (43)$$

$$i = 1,\ldots,I.$$

The urban-rural counterparts of the formulae shown in equation (43) can be used to estimate rates of change of labour productivity for the two locations, by industry, assuming continuous growth.

b. Illustrative estimations

This section will illustrate the procedures used to estimate constant rates of change of labour productivity by location and industry, using the observations of labour productivity shown in table 54.

i. Discrete growth

Table 58 illustrates the estimation of annual rates of change of labour productivity, by industry, for urban and rural areas using data such as those shown in table 57, assuming discrete growth. For each industry, the level of labour productivity corresponding to the later year (column 3) would be divided by the level of labour productivity referring to the earlier year (column 2). The ratio of the two levels (column 4) would then be raised to the power that equals 1 over the number of years between the two years. The estimate of the rate of change for the industry (column 5) would be obtained by subtracting 1 from this result and multiplying by 100.

For example, the annual percentage rate of growth of labour productivity for rural agriculture, 3.55, is obtained as follows:

$$3.55 = [(0.125/0.105)^{1/5} - 1] \cdot 100, \quad (42)$$

where 0.105 and 0.125 are the levels of labour productivity in rural agriculture in 1973 and 1978 and 5 is the number of years in the 1973-1978 time period.

ii. Continuous growth

Table 59 illustrates how the rates of change of labour productivity for urban and rural areas can be estimated, assuming continuous growth and using the productivity levels shown in table 54. For any given industry, the level

Table 58. Computing estimates of constant rates of change in labour productivity during 1973-1978, by industry, assuming discrete growth in labour productivity: urban and rural areas

Industry	Levels of labour productivity in 1973 a/	Levels of labour productivity in 1978 b/	Ratio of labour productivity, 1973 to 1978 c/	Estimate of rate of change in labour productivity, 1973 to 1978 d/
(1)	(2)	(3)	(4)	(5)
		Urban		
Agriculture	0.412	0.581	1.41	7.12
Mining	0.524	0.406	0.78	-4.96
Manufacturing	0.485	0.606	1.25	4.58
Utilities	1.159	1.236	1.07	1.29
Construction	0.357	0.260	0.73	-6.12
Trade	0.597	0.494	0.83	-3.69
Transport	0.552	0.534	0.97	-0.64
Services	0.533	0.598	1.12	2.32
		Rural		
Agriculture	0.105	0.125	1.19	3.55
Mining	0.336	0.250	0.74	-5.75
Manufacturing	0.177	0.214	1.21	3.83
Utilities	2.260	0.884	0.39	-17.11
Construction	0.258	0.185	0.72	-6.44
Trade	0.237	0.188	0.79	-4.50
Transport	0.257	0.344	1.34	5.98
Services	0.334	0.366	1.10	1.88

a/ From table 54, year 1973.
b/ From table 54, year 1978.
c/ (Col. 3)/(Col. 2).
d/ $[(\text{Col. } 4)^{1/5} - 1] \cdot (100)$.

Table 59. Computing estimates of constant rates of change in labour productivity during 1973-1978, by industry, assuming continuous growth in labour productivity: urban and rural areas

Industry	Levels of labour productivity in 1973 a/	1978 b/	Ratio of labour productivity, 1973 to 1978 c/	Estimate of rate of change in labour productivity, 1973 to 1978 d/
(1)	(2)	(3)	(4)	(5)
		Urban		
Agriculture	0.412	0.581	1.41	6.88
Mining	0.524	0.406	0.78	-5.09
Manufacturing	0.485	0.606	1.25	4.48
Utilities	1.159	1.236	1.07	1.28
Construction	0.357	0.260	0.73	-6.31
Trade	0.597	0.494	0.83	-3.76
Transport	0.552	0.534	0.97	-0.64
Services	0.533	0.598	1.12	2.29
		Rural		
Agriculture	0.105	0.125	1.19	3.48
Mining	0.336	0.250	0.74	-5.92
Manufacturing	0.177	0.214	1.21	3.76
Utilities	2.260	0.884	0.39	-18.76
Construction	0.258	0.185	0.72	-6.65
Trade	0.237	0.188	0.79	-4.61
Transport	0.257	0.344	1.34	5.81
Services	0.334	0.366	1.10	1.87

a/ From table 54, year 1973.
b/ From table 54, year 1978.
c/ (Col. 3)/(Col. 2).
d/ [ln(Col. 4)/5] . (100).

of labour productivity referring to the later year (column 3) is divided by the level of labour productivity corresponding to the earlier year (column 2). The result is the ratio of the two productivity levels (column 4). Then, the logarithm of this ratio is taken and the result is divided by the number of years between those two years. The estimate of the rate of change of labour productivity (column 5) is obtained by multiplying this result by 100.

For example, the rate of change for rural agriculture, 3.48, is derived as follows:

$$3.48 = [\ (\ln (0.125/0.105)\ )\ /\ 5\ ]\ \cdot\ 100; \qquad (43)$$

where 0.105 and 0.125 are the levels of labour productivity in rural agriculture in 1973 and 1978, while 5 is the number of years in the 1973-1978 interval.

(iv) Rates of change based on the assessment of factors influencing labour productivity trends

Another approach to determining rates of change of labour productivity calls for selecting these rates on the basis of the likely future trends in government policies and other relevant factors influencing productivity trends. Owing to its *ad hoc* nature, this approach should be used with caution. In many situations, however, it may prove necessary to combine this approach with the empirical estimation, so that the rates of labour productivity change used in the projection reflect both historical trends in labour productivity and the planner's judgements regarding the likely impact of possible future policies or other factors.

(b) Assumptions on initial-year levels of labour productivity

In most countries, the levels of labour productivity for the initial year would be obtained through some kind of forward extrapolation from the productivity levels for recent year(s). Recent productivity levels can be combined with estimates of the rates of change of labour productivity to obtain the levels of labour productivity for the initial year by using suitable procedures to project labour productivity.

Described below are procedures for deriving levels of labour productivity, classified by industry, using alternative assumptions on the growth of labour productivity. Use of the procedures will be illustrated in a later section.

(i) Procedures to derive initial-year levels of labour productivity

The procedures used for deriving the initial-year levels of labour productivity vary depending on whether that labour productivity is assumed to grow discretely or continuously.

a. Discrete growth

Where discrete growth in labour productivity is assumed, the initial-year levels of labour productivity for the entire country can be obtained using the following version of the functions indicated by equation (1):

$$LP(i,0) = LP(i,-t^*) \cdot (1 + GRLP(i)/100)^{t^*}; \qquad (44)$$

$$i = 1,\ldots,I,$$

where:

t^*	is the number of years between the year to which the observed levels of labour productivity used refer and the initial year of the projection period (t=0),
$-t^*$	is the year preceding the initial year of projection (t=0) in which the levels of labour productivity were observed,
LP(i,0)	is the level of labour productivity of industry i in the initial year of the projection period, and
$LP(i,-t^*)$	is the level of labour productivity of industry i observed in year $-t^*$.

To derive initial-year levels of labour productivity, it would be necessary to use observations on the levels of labour productivity for a recent year ($-t^*$ in equation (44)) and estimates of the rates of change in labour productivity that assume discrete growth in labour productivity.

Where labour productivity has fluctuated widely during the period to which the data refer, it would be preferable to use the mean levels of labour productivity, by industry, for several years rather than the levels pertaining to any single year. This would reduce the likelihood that conditions peculiar to any particular year would unduly influence the initial-year levels of labour productivity. In such a case, $-t^*$ will refer to the central point of the time period to which the mean levels of labour productivity refer.

Initial-year productivity levels for urban and rural areas, can be obtained by a procedure analogous to that applying to the national level (equation (44)). In this case, it would be necessary to use the levels of productivity for urban and rural areas for a recent year or mean levels for

several such years along with the rates of change of labour productivity for the two areas.

(b) Continuous growth

If it is assumed that the labour productivity growth is continuous, the initial-year levels of labour productivity can be obtained using the following versions of the functions indicated by equation (2):

$$LP(i,0) = LP(i,-t^*) \cdot e^{[(ERLP(i)/100) \cdot t^*]}; \qquad (45)$$

$$i = 1,\ldots,I.$$

To compute initial-year levels of labour productivity, it would be necessary to use levels of labour productivity for a recent year or mean levels of productivity for several such years along with estimates of the rates of change of labour productivity assuming continuous growth in labour productivity.

To derive initial-year levels of labour productivity for urban and rural areas, it would be necessary to use the urban-rural equivalents of the formulae shown in equation (45). This would require data on recent levels of labour productivity for urban and rural areas along with the estimates of rates of change in labour productivity for those areas.

(ii) Illustrative derivations of initial-year levels of labour productivity

This section will illustrate the derivation of the levels of labour productivity for the initial year of the projection period assuming discrete growth of labour productivity. The illustrations, which will be for the entire country and for urban and rural areas separately, will take 1980 as the initial year of the projection period and 1978 as the year to which the recent levels of labour productivity refer. Hence, $-t^*$ will equal -2 and t^* will equal 2.

The illustrative examples will use the data and estimates presented earlier in illustrating the procedures for estimating constant rates of change of labour productivity. In particular, the example for the entire country will be based on the levels of labour productivity for 1978, shown in table 51, and the estimates of the rates of change in labour productivity indicated in table 56 (column 3). The example for urban and rural areas will use levels of labour productivity for 1978 displayed in table 54, along with the estimates of rates of change in labour productivity shown in table 58. The national and urban-rural estimates of the rates of change of labour productivity will be used on the assumption that the estimated rates of change would prevail between 1978 and 1980.

Table 60 shows how initial-year levels of labour productivity are derived for the entire country. For each industry, the level of labour productivity in the initial year (column 5) is obtained by multiplying the observed level of labour productivity for the industry in a chosen year (column 2), which is year 1978, by a factor (column 4) indicating the growth in labour productivity for the industry until the initial year, which is year 1980. This factor is calculated using the rate of change of labour productivity previously estimated for that industry (column 3).

For example, the initial-year level of labour productivity in agriculture, 0.140, is obtained as follows:

$$0.140 = 0.131 \cdot (1 + 3.66/100)^2, \qquad (44)$$

where 0.131 is the level of labour productivity in agriculture in 1978; 3.66 is the estimate of the historical annual percentage rate of change of labour productivity in agriculture; while 2 is the number of years between 1978 and 1980.

Tables 61 and 62 illustrate the derivation of the initial-year levels of labour productivity for urban and rural areas by industry. As shown in either table, the level of labour productivity for any given industry (column 5) is found as the product of the level of labour productivity in a chosen year (column 2) and the factor (column 4) indicating the growth in labour productivity between the selected year and the initial year of the projection. This factor is obtained from the rate of change of labour productivity used for the industry (column 3).

Thus, the level of labour productivity in rural agriculture for the initial year, 0.134, is calculated as follows:

$$0.134 = 0.125 \cdot (1 + 3.55/100)^2, \qquad (45)$$

where 0.125 is the labour productivity in rural agriculture in 1978 and 3.55 is the estimate of the rate of change in labour productivity in rural agriculture.

D. Illustrative examples of projections

The examples presented below will illustrate the use of the labour productivity method to prepare a national projection and an urban-rural projection, respectively. These examples will indicate how the relevant calculations are made for the projection interval 0-5. In addition, they will provide complete projection results for the 20-year period. The examples will be based on the assumption that the growth in labour productivity occurs over discrete intervals. However, they will also illustrate steps to be used when continuous growth of labour productivity is assumed.

Table 60. Calculating initial-year levels of labour productivity, by industry, assuming discrete growth in labour productivity: entire country

Industry	Levels of labour productivity in year -2 a/	Constant rate of change of labour productivity b/	Factor indicating increase in labour productivity between year -2 and year 0 c/	Level of labour productivity in year 0 d/
(1)	(2)	(3)	(4)	(5)
Agriculture	0.130	3.66	1.074	0.140
Mining	0.388	-0.05	0.999	0.388
Manufacturing	0.547	4.11	1.083	0.593
Utilities	1.176	1.53	1.030	1.213
Construction	0.250	-3.29	0.935	0.234
Trade	0.465	-1.70	0.966	0.450
Transport	0.528	-0.02	0.999	0.529
Services	0.517	3.10	1.063	0.550

a/ From table 51, year 1978.
b/ From table 56, col. 3.
c/ $[1 + ((\text{Col. } 3)/100)]^2$.
d/ (Col. 2) . (Col. 4).

Table 61. Calculating initial-year levels of labour productivity, by industry, assuming discrete growth in labour productivity: urban areas

Industry	Levels of labour productivity in year -2 a/	Constant rate of change of labour productivity b/	Factor indicating increase in labour productivity between year -2 and year 0 c/	Level of labour productivity in year 0 d/
(1)	(2)	(3)	(4)	(5)
Agriculture	0.581	7.12	1.147	0.667
Mining	0.406	-4.96	0.903	0.367
Manufacturing	0.606	4.58	1.093	0.664
Utilities	1.236	1.29	1.026	1.268
Construction	0.260	-6.12	0.881	0.230
Trade	0.494	-3.69	0.927	0.459
Transport	0.534	-0.64	0.987	0.528
Services	0.598	2.32	1.046	0.627

a/ From table 54, year 1978, urban.
b/ From table 58, col. 5, urban.
c/ $[1 + ((\text{Col. } 3)/100)]^2$.
d/ (Col. 2) . (Col. 4).

Table 62. Calculating initial-year levels of labour productivity, by industry, assuming discrete growth in labour productivity: rural areas

Industry	Levels of labour productivity in year -2 a/	Constant rate of change of labour productivity b/	Factor indicating increase in labour productivity between year -2 and year 0 c/	Level of labour productivity in year 0 d/
(1)	(2)	(3)	(4)	(5)
Agriculture	0.125	3.55	1.072	0.134
Mining	0.250	-5.75	0.888	0.222
Manufacturing	0.214	3.83	1.078	0.231
Utilities	0.884	-17.11	0.687	0.608
Construction	0.185	-6.44	0.875	0.162
Trade	0.188	-4.50	0.911	0.172
Transport	0.344	5.98	1.123	0.387
Services	0.366	1.88	1.038	0.381

a/ From table 54, year 1978, rural.
b/ From table 58, col. 5, rural.
c/ $[1 + ((\text{Col. } 3)/100)]^2$.
d/ (Col. 2) . (Col. 4).

1. National level

The calculations involved in projecting employment presented in this example will be based on the inputs contained in table 63. These include projected levels of value added, by industry, along with the assumed levels of labour productivity for the initial-year and the assumed rates of change in labour productivity, by industry. The value added levels are given for dates five years apart, starting with the initial year of the plan, which is denoted as year 0. The assumed initial-year levels of labour productivity are those which were derived as part of the example shown in the section on inputs (table 60). The assumed rates of change of labour productivity are the rates derived by the illustrative estimation of such rates from time series data based on discrete growth assumption (table 56).

(a) Labour productivity by industry

For any given year during the projection period, the levels of labour productivity can be calculated for each industry from the initial-year levels and the assumed constant rates of change of labour productivity by industry. The calculations for the end of the projection interval 0-5 (year 5), assuming discrete growth in labour productivity over time are illustrated in table 64. The level of productivity in year 5 for each industry (column 4) is obtained by substituting values into equation (1). Thus, labour productivity is the product of the initial-year level of labour productivity (column 2) and the factor indicating the increase in labour productivity between the initial year and year 5. This factor is obtained using the assumed rate of change of labour productivity for the industry (column 3).

(i) Discrete growth

For example, the level of labour productivity in agriculture at the end of the interval 0-5, 0.168, is obtained as:

$$0.168 = (0.140)\ (\ 1 + 3.66/100\ )^5, \qquad (1)$$

where 0.140 is the initial-year level of labour productivity in agriculture (column 2); 3.66 is the annual geometric growth rate of labour productivity in this industry (column 3); and 5 is the number of years between the initial year (year 0) and year 5.

(ii) Continuous growth

If the growth of labour productivity is assumed to be continuous, then the same inputs as above would produce the same result for labour productivity in agriculture in year 5, 0.168:

Table 63. Inputs for projecting employment, by industry: entire country

Industry	Value added in year (millions of LCUs a/)					Initial-year labour productivity (thousands of LCUs a/ per person)	Rate of change of labour productivity (percentage)
	0	5	10	15	20		
Agriculture	273.1	308.2	347.8	392.5	443.1	0.140	3.66
Mining	2.9	4.0	5.5	7.6	10.4	0.387	-0.05
Manufacturing	140.4	212.7	322.5	489.3	742.7	0.593	4.11
Utilities	21.2	31.9	48.0	72.5	109.4	1.212	1.53
Construction	25.6	31.5	38.9	48.0	59.3	0.234	-3.29
Trade	59.0	85.1	122.9	177.6	256.7	0.449	-1.70
Transport	56.0	73.0	95.3	124.4	162.5	0.528	-0.02
Services	312.5	464.3	691.2	1031.2	1541.4	0.549	3.10

a/ Local currency units.

Table 64. Calculating labour productivity, by industry: entire country, year 5

Industry	Initial-year labour productivity a/ (thousands of LCUs d/ per person)	Rate of change of labour productivity b/ (percentage)	Labour productivity c/ (thousands of LCUs d/ per person)
(1)	(2)	(3)	(4)
Agriculture	0.140	3.66	0.167
Mining	0.387	-0.05	0.386
Manufacturing	0.593	4.11	0.725
Utilities	1.212	1.53	1.308
Construction	0.234	-3.29	0.198
Trade	0.449	-1.70	0.412
Transport	0.528	-0.02	0.528
Services	0.549	3.10	0.640

a/ From table 63.
b/ From table 63.
c/ (Col. 2) . $(1 + (\text{Col. } 3)/100)^5$.
d/ Local currency units.

$$0.168 = (0.140) \cdot e^{[(3.66/100) \cdot 5]}. \quad (2)$$

For relatively low annual rates of change in labour productivity, such as 3.66 per cent, the results obtained with different assumptions on the type of growth of labour productivity (discrete or continuous) would be very similar.

(b) Employment by industry

Once the levels of labour productivity by industry are computed for a given date, the levels of employment for that date can be obtained from the assumed levels of value added and the projected productivity levels, as illustrated in table 65. The employment level for each industry (column 4) is obtained by dividing the value added for the industry (column 2) by the level of labour productivity for the industry (column 3).7/

Thus, the level of employment in agriculture in year 5, 1,835.5, is obtained as:

$$1{,}835.5 = 308.2/0.168, \quad (3)$$

where 308.2 is the projected value added in agriculture and 0.168 is the projected level of labour productivity in agriculture in year 5.

Performing the calculations illustrated above for each five-year interval of the entire projection period produces the projected levels of employment by industry for the entire period. The projected levels for the 20-year projection interval are shown in table 66.

(c) Other results

Other results that are useful in planning can be obtained as part of a projection at the national level. These include various employment aggregates, indicators of the structure of employment and the rates of growth of employment.

(i) Employment aggregates

The employment aggregates that can be derived from the projections by industry include total employment and employment in various sectors at dates five years apart. They also include increases in total employment and employment by sector over the intervening projection intervals.

a. Total employment

Total employment at the end of a given projection interval is obtained by aggregating the projected levels of employment by industry. Total employment

Table 65. Deriving employment, by industry: entire country, year 5

Industry	Value added a/ (LCUs d/)	Labour productivity b/ (thousands of LCUs d/ per person)	Projected employment c/ (thousands of persons)
(1)	(2)	(3)	(4)
Agriculture	308.2	0.167	1835.5
Mining	4.0	0.386	10.4
Manufacturing	212.7	0.725	293.2
Utilities	31.9	1.308	24.4
Construction	31.5	0.198	159.1
Trade	85.1	0.412	206.3
Transport	73.0	0.528	138.3
Services	464.3	0.640	725.1

a/ From table 63.
b/ From table 64, col. 4.
c/ (Col. 2)/(Col. 3).
d/ Local currency units.

Table 66. Projected employment, by industry: entire country

(Thousands of persons)

Industry	Year				
	0	5	10	15	20
Agriculture	1946.8	1835.5	1730.8	1632.2	1539.4
Mining	7.6	10.4	14.3	19.6	27.0
Manufacturing	236.7	293.2	363.5	450.8	559.4
Utilities	17.5	24.4	34.0	47.6	66.6
Construction	109.1	159.1	232.0	338.5	494.0
Trade	131.1	206.3	324.7	511.1	804.7
Transport	105.8	138.3	180.7	236.2	308.7
Services	568.6	725.1	926.6	1186.6	1522.3

in year 5, 3,392.3, is computed by adding the projected levels of employment by industry. Total employment is shown in table 67 for the entire 20-year projection period. The increase in total employment over this period is indicated in figure XVI.

b. Employment by sector

Employment in the primary, secondary and the tertiary sector can be obtained by aggregating employment projected for various industries, using appropriate aggregation rules. For illustrative purposes, we shall assume that the primary sector consists of agriculture and mining, the secondary sector of manufacturing, utilities and construction and the tertiary sector of trade, transport and services.

i. Employment in the primary sector

Employment in the primary sector in year 5, 1,846.0, is obtained as:

$$1{,}846.0 = 1{,}835.5 + 10.4, \tag{5}$$

where 1,835.5 and 10.4 are, respectively, projected levels of employment in agriculture and mining.

ii. Employment in the secondary sector

Employment in the secondary sector in year 5, 476.7, is obtained as:

$$476.7 = 293.2 + 24.4 + 159.1, \tag{6}$$

where 293.2, 24.4 and 159.1 are, respectively, projected levels of employment in manufacturing, utilities and construction.

iii. Employment in the tertiary sector

Employment in the tertiary sector in year 5, 1,069.6, is obtained as:

$$1{,}069.6 = 206.3 + 138.3 + 725.1, \tag{7}$$

where 206.3, 138.3 and 725.1 are, respectively, projected levels of employment in trade, transportation and services.

Employment by sector obtained for different dates over the projection period is presented in figure XVII.

Table 67. Employment aggregates, structure and rates of growth: entire country

Indicators	Year 0	5	10	15	20
Employment aggregates (thousands of persons)					
Levels of employment					
Total	3123.2	3392.3	3806.6	4422.6	5322.1
Primary	1954.4	1846.0	1745.1	1651.8	1566.3
Secondary	363.2	476.7	629.5	836.9	1120.1
Tertiary	805.5	1069.6	1432.0	1933.8	2635.8
Growth in employment					
Total	269.1	414.3	616.0	899.6	
Primary	-108.4	-100.9	-93.3	-85.5	
Secondary	113.4	152.9	207.4	283.1	
Tertiary	264.1	362.3	501.8	701.9	
Indicators of employment structure					
Proportions of total employment by sector					
Primary	0.63	0.54	0.46	0.37	0.29
Secondary	0.12	0.14	0.17	0.19	0.21
Tertiary	0.26	0.32	0.38	0.44	0.50
Rates of growth of employment (percentage)					
Total	1.67	2.33	3.05	3.77	
Primary	-1.14	-1.12	-1.09	-1.06	
Secondary	5.59	5.72	5.86	6.00	
Tertiary	5.84	6.01	6.19	6.39	

Figure XVI. Total employment

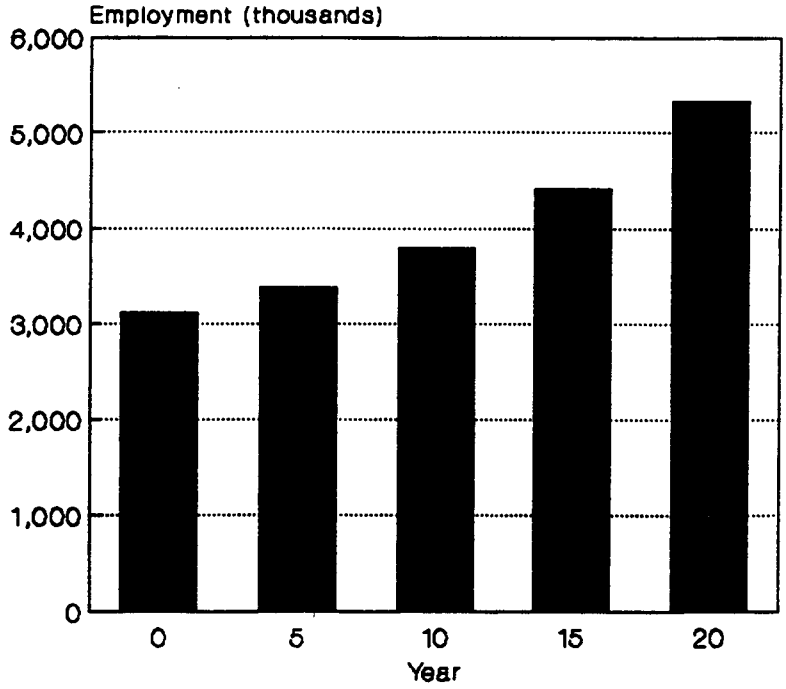
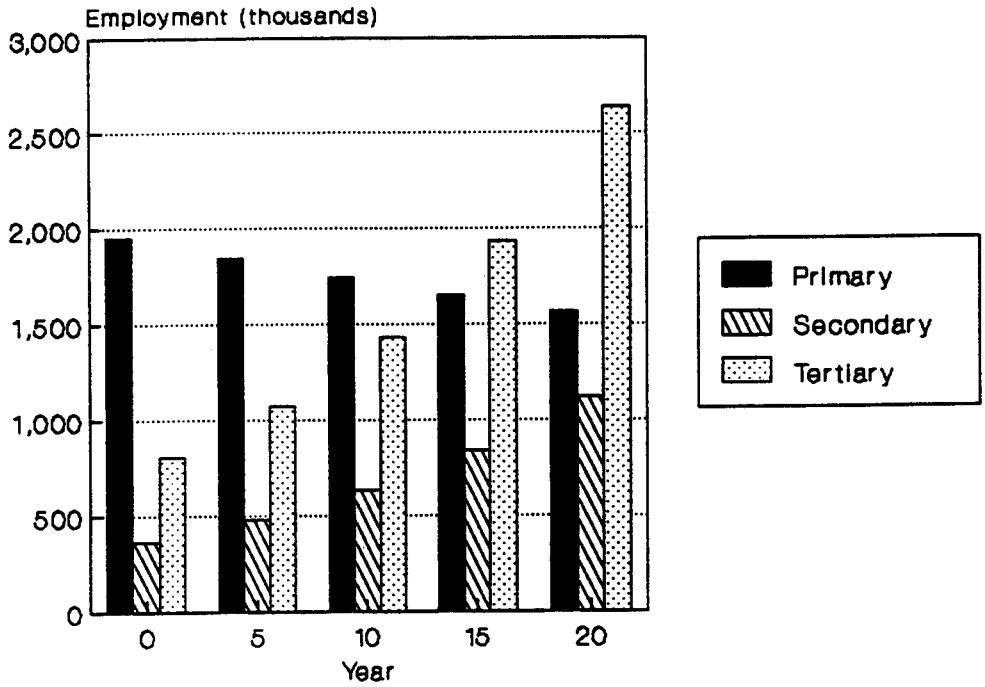


Figure XVII. Employment: primary, secondary and tertiary sectors



c. Growth in total employment

The growth in total employment over a given projection interval equals the difference between total employment at the end of the interval and total employment at its beginning. For the interval 0-5, the growth in total employment 269.1, is obtained as:

$$269.1 = 3{,}392.3 - 3{,}123.2, \tag{8}$$

where 3,123.2 and 3,392.3 are, respectively, total employment at the beginning and the end of the interval (shown in columns corresponding to years 0 and 5) .

d. Growth in employment by sector

The change in employment over the interval 0-5 in various sectors is obtained as follows:

Decline of employment in the primary sector, -108.4, is:

$$-108.4 = 1{,}846.0 - 1{,}954.4, \tag{9}$$

where 1,954.4 and 1,846.0 are, respectively, the levels of employment in the primary sector in years 0 and 5;

Growth of employment in the secondary sector, 113.4, is:

$$113.4 = 476.7 - 363.2, \tag{10}$$

where 363.2 and 476.7 are the levels of employment in the secondary sector in years 0 and 5;

Growth of employment in the tertiary sector, 264.1, is:

$$264.1 = 1{,}069.6 - 805.5, \tag{11}$$

where 805.5 and 1,069.6 are the levels of employment in the tertiary sector in years 0 and 5.

(ii) Indicators of the structure of employment

Indicators of the structure of employment that can be calculated as part of an employment projection include proportions of total employment found in each sector.

a. Proportions by sector

For the end of the interval 0-5, these proportions are obtained as follows:

The proportion of total employment found in the primary sector, 0.54, is:

$$0.54 = 1{,}846.0 / 3{,}392.3, \tag{12}$$

where 1,846.0 and 3,392.3 are, respectively, employment in the primary sector and the total employment;

The proportion of total employment found in the secondary sector, 0.14, is:

$$0.14 = 476.7 / 3{,}392.3, \tag{13}$$

where 476.7 is employment in the secondary sector;

The proportion of total employment found in the tertiary sector is 0.32:

$$0.32 = 1{,}069.6 / 3{,}392.3, \tag{14}$$

where 1,069.6 is employment in the tertiary sector.

(iii) Rates of growth of employment

The rates of growth of employment can be calculated for total employment and for employment in each sector.

a. Rate of growth of total employment

If growth in employment is assumed to occur over discrete intervals, the average annual growth rate of total employment for a given interval is obtained using the geometric growth rate formula. For the projection interval 0-5, this annual growth rate, 1.67 per cent (table 67), is obtained as follows:

$$1.67 = [\ (3{,}392.3 / 3{,}123.2)^{1/5} - 1\ ] \cdot 100, \tag{15}$$

where 3,123.2 and 3,392.3 are the levels of total employment in years 0 and 5, respectively, and 5 is the length of the interval.

Rates of growth of total employment over the 20-year projection period, which were computed using the geometric growth rate formula, are shown in figure XVIII.

If it is assumed that growth in employment is continuous, the average annual growth rate of total employment for a given interval is obtained by substituting the same data as above in the exponential growth rate formula. For the projection interval 0-5, this annual growth rate, 1.65 per cent, is obtained as follows:

$$1.65 = [(\ln (3{,}392.5 / 3{,}123.2)) / 5] \cdot 100. \qquad (16)$$

b. Rates of growth of employment by sector

Assuming discrete growth, the rates of increase in employment by sector for the interval 0-5 are calculated as follows:

The annual rate of growth of employment in the primary sector which is negative, -1.4 per cent, is obtained as follows:

$$-1.14 = [(1{,}846.0 / 1{,}954.4)^{1/5} - 1] \cdot 100, \qquad (17)$$

where 1,954.4 and 1,846.0 are the levels of employment in the primary sector in years 0 and 5, respectively;

The annual rate of growth of employment in the secondary sector, 5.59 per cent, is obtained as follows:

$$5.59 = [(476.7 / 363.2)^{1/5} - 1] \cdot 100, \qquad (18)$$

where 363.2 and 476.7 are the levels of employment in the secondary sector in years 0 and 5, respectively;

The annual rate of growth of employment in the tertiary sector, 5.84 per cent, is obtained as:

$$5.84 = [(1{,}069.6 / 805.5)^{1/5} - 1] \cdot 100, \qquad (19)$$

where 805.5 and 1,069.6 are the levels of employment in the tertiary sector in years 0 and 5.

The rates of growth of employment in primary, secondary and tertiary sectors over the 20-year projection interval are shown in figure XIX.

Figure XVIII. Rate of growth in total employment

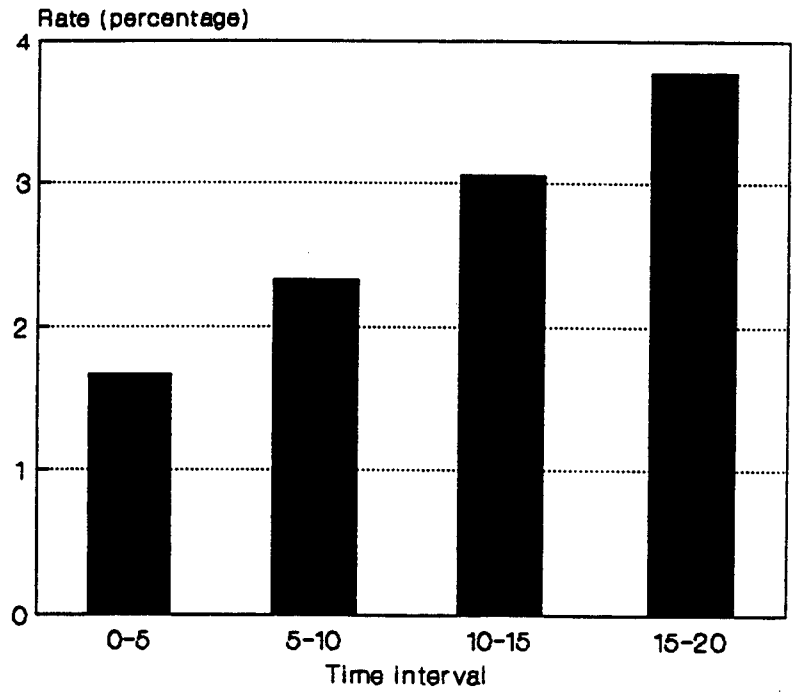
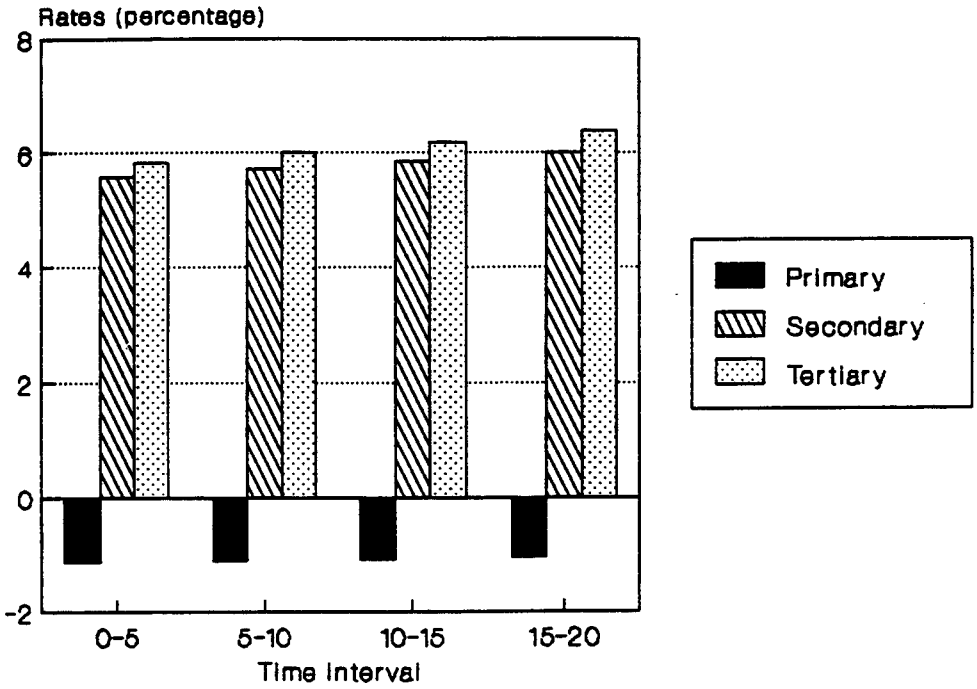


Figure XIX. Rates of growth of employment: primary, secondary and tertiary sectors



If continuous growth is assumed, rates of employment by sector would be calculated using the exponential growth rate formula. The calculations would be analogous to that indicated by equation (16) for total employment.

(iv) Labour market balances

If labour force projections are available for the same years as the employment projection, it is possible to calculate the levels of excess demand for or excess supply of labour. Also, it is possible to calculate the excess demand for or excess supply of labour as a percentage of the level of labour supply.

The calculations can be based on the projected total labour force, diminished where necessary by the size of non-civilian employment, and the projected total employment as indicators of the labour supply and the labour demand.

In order to illustrate these calculations, we shall use projections of the total labour force and the total employment (shown, respectively, in tables 37 and 67) along with the illustrative projections of non-civilian employment, which are shown in table 68. These calculations are illustrated in table 69.

For example, the civilian labour force in year 5 interval, 3,615.4, can be calculated as follows:

$$3{,}615.4 = 3{,}651.9 - 36.5, \tag{23}$$

where 3,651.9 and 36.5 are the projected total labour force and the projected non-civilian employment for year 5, shown in columns 2 and 3. The calculated level of civilian labour force for year 5 is shown in column 4.

The excess supply of labour for the same date, 223.1, is calculated as follows:

$$223.1 = 3{,}615.4 - 3{,}392.3, \tag{24}$$

where 3,615.4 is the civilian labour force and 3,392.3 is the total employment, shown in columns 4 and 5, respectively.

The excess supply expressed as a percentage of the civilian labour force in year 5, 6.17 per cent, is calculated as follows:

$$6.17 = (223.1 / 3{,}615.4) \cdot 100. \tag{25}$$

This percentage is shown in column 7.

Table 68. Projected non-civilian employment: entire country

(Thousands of persons)

Year	Non-civilian employment
(1)	(2)
0	32.5
5	36.5
10	41.5
15	47.4
20	53.8

Table 69. Labour market balances: entire country

Year	Total labour force a/	Non-civilian employment b/	Civilian labour force c/	Total employment d/	Excess supply/ demand e/	Excess supply/ demand f/
	(thousands of persons)					(percentage of civilian labour force)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	3251.5	32.5	3219.0	3123.2	95.8	2.98
5	3651.9	36.5	3615.4	3392.3	223.1	6.17
10	4147.8	41.5	4106.3	3806.6	299.7	7.30
15	4735.4	47.4	4688.0	4422.6	265.4	5.66
20	5377.4	53.8	5323.6	5322.1	1.5	0.03

a/ From table 37, "Labour force (Total)".
b/ From table 68.
c/ (Col. 2) - (Col. 3).
d/ From table 67, "Levels of employment (Total)".
e/ (Col. 4) - (Col. 5).
f/ ((Col. 6)/(Col. 4)) . (100).

2. Urban-rural level

This example will illustrate the use of the labour productivity method to project employment for urban and rural areas, which will be similar to the example for the country as a whole. The inputs for urban and rural areas are shown in tables 70 and 71, respectively. Among the inputs are projected levels of value added along with the assumed initial-year levels of labour productivity and the assumed constant rates of change of labour productivity. The assumed initial-year levels of labour productivity are those shown in tables 61 and 62. The assumed rates of change of labour productivity are similar to those shown in table 58. The differences could be interpreted as modifications based on judgements as to how policies over the projection period may influence the growth of labour productivity.

The example will focus on those calculations which are unique to an urban-rural projection of employment. Like the previous example, it will be based on the assumption that growth in labour productivity and employment occurs over discrete time intervals.

(a) Labour productivity

For any given date, such as year 5, levels of labour productivity and levels of employment, by industry, are obtained by means of calculations that are identical to those used to make the national projection. In the urban-rural projection, however, these calculations are performed for either area. The calculations of the levels of labour productivity and employment for year 5 for the urban areas are illustrated in tables 72 and 73, respectively.

In table 72, the levels of labour productivity, by industry, for the urban areas in year 5 (column 4) are derived from the initial-year levels of labour productivity (column 2) and the constant rates of change of labour productivity (column 3). In table 73, the projected levels of employment, by industry, for the urban areas in year 5 (column 4) are obtained using the projected levels of value added (column 2) and the projected levels of labour productivity (column 3) for the date.

Projected levels of employment, by industry, for urban and rural areas at dates five years apart can be found by performing these calculations for the relevant dates over the projection period, starting with the initial year of the projection. Those levels can be aggregated across the two locations to obtain the levels of employment by sector for the entire country. Tables 74 through 76 display urban, rural and national projected levels of employment, by industry, respectively.

Table 70. Inputs for projecting employment, by industry: urban areas

	Value added in year					Initial-year labour productivity	Rate of change of labour productivity
	0	5	10	15	20	(thousands of LCUs a/ per person)	(percentage)
	(millions of LCUs a/)						
Agriculture	13.8	16.2	19.0	22.4	26.4	0.667	5.000
Mining	2.7	3.8	5.2	7.1	9.8	0.367	0.500
Manufacturing	132.3	201.8	307.6	469.0	715.0	0.664	5.000
Utilities	18.6	28.3	43.2	65.9	100.4	1.268	1.500
Construction	23.1	28.7	35.5	44.1	54.7	0.230	-1.000
Trade	56.7	82.2	119.1	172.6	250.1	0.459	0.500
Transport	54.9	71.7	93.7	122.5	160.1	0.528	1.000
Services	237.0	361.3	550.8	839.8	1280.3	0.627	2.000

a/ Local currency units.

Table 71. Inputs for projecting employment, by industry: rural areas

	Value added in year					Initial-year labour productivity	Rate of change of labour productivity
	0	5	10	15	20	(thousands of LCUs a/ per person)	(percentage)
	(millions of LCUs a/)						
Agriculture	259.3	292.0	328.7	370.1	416.7	0.134	3.500
Mining	0.2	0.3	0.4	0.4	0.6	0.222	0.000
Manufacturing	8.0	11.0	14.9	20.4	27.8	0.231	4.000
Utilities	2.6	3.6	4.8	6.6	9.0	0.607	0.000
Construction	2.4	2.9	3.4	3.9	4.6	0.162	-1.000
Trade	2.2	2.9	3.8	5.1	6.6	0.172	0.000
Transport	1.1	1.3	1.6	1.9	2.4	0.387	2.000
Services	75.5	103.0	140.4	191.5	261.1	0.380	1.500

a/ Local currency units.

Table 72. Calculating labour productivity, by industry: urban areas, year 5

Industry	Initial-year labour productivity a/ (thousands of LCUs d/ per person)	Rate of change of labour productivity b/ (percentage)	Labour productivity c/ (thousands of LCUs d/ per person)
(1)	(2)	(3)	(4)
Agriculture	0.666	5.0	0.850
Mining	0.367	0.5	0.376
Manufacturing	0.663	5.0	0.847
Utilities	1.268	1.5	1.366
Construction	0.229	-1.0	0.218
Trade	0.459	0.5	0.470
Transport	0.527	1.0	0.554
Services	0.626	2.0	0.692

a/ From table 70.
b/ From table 70.
c/ (Col. 2) . $(1+(\text{Col. } 3)/100)^5$.
d/ Local currency units.

Table 73. Deriving employment, by industry; urban areas, year 5

Industry	Value added a/ (LCUs d/)	Labour productivity b/ (thousands of LCUs d/ per person)	Projected employment c/ (thousands of persons)
(1)	(2)	(3)	(4)
Agriculture	16.2	0.850	19.0
Mining	3.8	0.376	10.0
Manufacturing	201.8	0.847	238.1
Utilities	28.3	1.366	20.7
Construction	28.7	0.218	131.3
Trade	82.2	0.470	174.6
Transport	71.7	0.554	129.3
Services	361.3	0.692	521.9

a/ From table 70.
b/ From table 72, col. 4.
c/ (Col. 2)/(Col. 3).
d/ Local currency units.

Table 74. Projected employment, by industry: urban areas

(Thousands of persons)

Industry	Year				
	0	5	10	15	20
Agriculture	20.6	19.0	17.5	16.2	14.9
Mining	7.4	10.0	13.4	18.0	24.1
Manufacturing	199.4	238.1	284.5	339.8	405.9
Utilities	14.7	20.7	29.3	41.5	58.8
Construction	100.7	131.3	171.2	223.3	291.2
Trade	123.6	174.6	246.8	348.8	493.0
Transport	104.0	129.3	160.7	199.9	248.6
Services	378.0	521.9	720.7	995.2	1374.2

Table 75. Projected employment, by industry: rural areas

(Thousands of persons)

Industry	Year				
	0	5	10	15	20
Agriculture	1928.4	1828.1	1733.0	1642.9	1557.4
Mining	1.0	1.3	1.6	2.0	2.5
Manufacturing	34.8	39.0	43.7	48.9	54.9
Utilities	4.3	5.8	8.0	10.9	14.8
Construction	15.1	18.6	22.9	28.1	34.6
Trade	13.0	17.0	22.4	29.3	38.5
Transport	2.8	3.1	3.4	3.7	4.1
Services	198.4	251.1	317.9	402.4	509.3

Table 76. Projected employment, by industry: entire country

(Thousands of persons)

Industry	Year				
	0	5	10	15	20
Agriculture	1949.1	1847.1	1750.5	1659.0	1572.3
Mining	8.4	11.2	15.0	20.0	26.6
Manufacturing	234.1	277.1	328.1	388.8	460.8
Utilities	18.9	26.6	37.3	52.4	73.6
Construction	115.7	149.8	194.1	251.4	325.8
Trade	136.5	191.7	269.2	378.2	531.6
Transport	106.7	132.3	164.1	203.6	252.7
Services	576.4	773.1	1038.6	1397.6	1883.5

(b) Other results

An urban-rural projection of employment permits the calculation of all those additional results that can be obtained as part of the national projections. Those results, which refer to urban and rural areas and to the entire country include various aggregates, indicators of structure and rates of growth of employment, as well as labour market balances. They can be calculated by means of the steps illustrated in connection with the national projection. The results also include proportions of employment which are urban and rural.

Figure XX indicates projected levels of total employment for urban and rural areas and for the entire country, which were obtained in this illustrative projection.

(i) Proportions of employment that are urban and rural

The proportions of employment found in urban and rural areas, respectively, can be obtained for total employment and for employment by sector.

a. Proportions of total employment

The proportion of total employment that is urban at the end of the projection interval is calculated as a ratio of total employment in the urban areas to the total employment in the country as a whole for that date. At the end of the interval 0-5, the proportion of total employment that is urban, 0.37, is obtained as:

$$0.37 = 1{,}245.0 \ / \ 3{,}408.9, \tag{28}$$

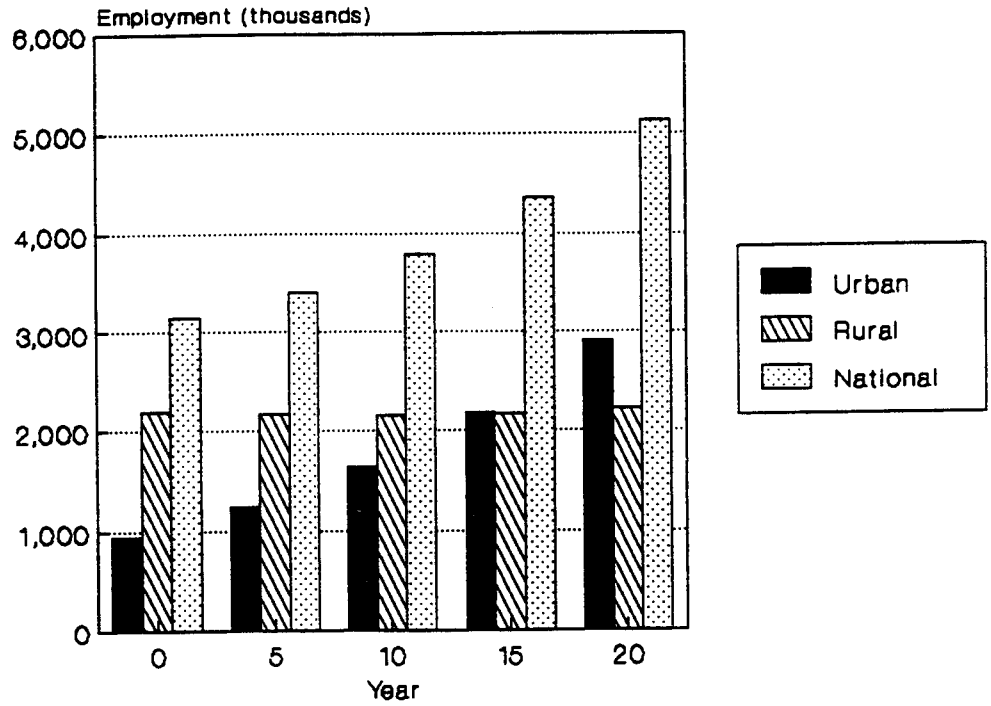
where 1,245.0 is total employment in the urban areas and 3,408.9 is total employment for the entire country.

The proportion of total employment that is rural, 0.63, is calculated as a complement of the proportion urban:

$$0.63 = 1 - 0.37, \tag{29}$$

where 0.37 is the proportion urban.

Figure XX. Total employment: urban, rural and national



These proportions along with all other results for the entire country, excepting the labour market balances, are shown in table 79; similar results for urban and rural areas are shown in tables 77 and 78. Labour market balances for urban and rural areas and the entire country were calculated using, among other things, illustrative projected levels of non-civilian employment, which are shown in tables 80 through 82. The results relating to the labour market balances are shown in tables 83 through 85.

Proportions of total employment over the 20-year period which are urban and rural are shown in figure XXI.

b. Proportions of employment by sector

For each sector, the proportions of employment in year 5 that are urban can be calculated as follows:

The proportion of employment in the primary sector that is urban, 0.02, is:

$$0.02 = 29.0 / 1{,}858.4, \tag{30}$$

where 29.0 is employment in the primary sector in the urban areas and 1,858.4 is employment in the primary sector in the entire country;

The proportion of employment in the secondary sector that is urban, 0.86, is:

$$0.86 = 390.2 / 453.5, \tag{31}$$

where 390.2 is employment in the secondary sector in the urban areas and 453.5 is employment in the secondary sector in the entire country;

The proportion of employment in the tertiary sector that is urban, 0.75, is:

$$0.75 = 825.8 / 1{,}097.0, \tag{32}$$

where 825.8 is employment in the tertiary sector in the urban areas and 1,097.0 is employment in the tertiary sector in the entire country;

The proportions of employment, by sector, that are rural can be obtained as complements of proportions of employment by sector which are urban:

The proportion of employment in the primary sector that is rural, 0.98, is:

$$0.98 = 1 - 0.02, \tag{33}$$

Table 77. Employment aggregates, structure and rates of growth: urban areas

Indicators	Year 0	5	10	15	20
Employment aggregates (thousands of persons)					
Levels of employment					
Total	948.2	1245.0	1644.2	2182.7	2910.7
Primary	28.1	29.0	30.9	34.1	39.0
Secondary	314.7	390.2	485.0	604.6	755.9
Tertiary	605.5	825.8	1128.3	1543.9	2115.8
Growth in employment					
Total	296.7	399.2	538.4	728.0	
Primary	0.9	1.9	3.2	4.9	
Secondary	75.5	94.9	119.6	151.3	
Tertiary	220.3	302.4	415.6	571.9	
Indicators of employment structure					
Proportions of total employment by sector					
Primary	0.03	0.02	0.02	0.02	0.01
Secondary	0.33	0.31	0.29	0.28	0.26
Tertiary	0.64	0.66	0.69	0.71	0.73
Rates of growth of employment (percentage)					
Total	5.60	5.72	5.83	5.93	
Primary	0.65	1.29	2.00	2.71	
Secondary	4.39	4.45	4.51	4.57	
Tertiary	6.40	6.44	6.47	6.50	

Table 78. Employment aggregates, structure and rates of growth: rural areas

Indicators	Year 0	5	10	15	20
Employment aggregates (thousands of persons)					
Levels of employment					
Total	2197.7	2163.9	2152.7	2168.3	2216.2
Primary	1929.4	1829.4	1734.6	1644.8	1559.9
Secondary	54.1	63.4	74.5	87.9	104.3
Tertiary	214.1	271.2	343.6	435.5	552.0
Growth in employment					
Total		-33.7	-11.3	15.6	48.0
Primary		-100.1	-94.8	-89.7	-84.9
Secondary		9.2	11.1	13.5	16.4
Tertiary		57.1	72.4	91.8	116.5
Indicators of employment structure					
Proportions of total employment by sector					
Primary	0.88	0.85	0.81	0.76	0.70
Secondary	0.02	0.03	0.03	0.04	0.05
Tertiary	0.10	0.13	0.16	0.20	0.25
Rates of growth of employment (percentage)					
Total		-0.31	-0.10	0.14	0.44
Primary		-1.06	-1.06	-1.06	-1.05
Secondary		3.20	3.29	3.38	3.47
Tertiary		4.84	4.85	4.85	4.86

Table 79. Employment aggregates, structure and rates of growth: entire country

Indicators	Year 0	5	10	15	20
Employment aggregates (thousands of persons)					
Levels of employment					
Total	3145.9	3408.9	3796.9	4350.9	5126.9
Primary	1957.5	1858.4	1765.5	1679.0	1598.9
Secondary	368.8	453.5	559.5	692.6	860.2
Tertiary	819.6	1097.0	1471.9	1979.4	2667.8
Growth in employment					
Total	263.0	388.0	554.0	776.0	
Primary	-99.1	-92.8	-86.5	-80.0	
Secondary	84.7	106.0	133.0	167.6	
Tertiary	277.4	374.8	507.5	688.4	
Indicators of employment structure					
Proportions of total employment by sector					
Primary	0.62	0.55	0.46	0.39	0.31
Secondary	0.12	0.13	0.15	0.16	0.17
Tertiary	0.26	0.32	0.39	0.45	0.52
Indicators of employment distribution					
Proportions urban					
Total	0.30	0.37	0.43	0.50	0.57
Primary	0.01	0.02	0.02	0.02	0.02
Secondary	0.85	0.86	0.87	0.87	0.88
Tertiary	0.74	0.75	0.77	0.78	0.79
Proportions rural					
Total	0.70	0.63	0.57	0.50	0.43
Primary	0.99	0.98	0.98	0.98	0.98
Secondary	0.15	0.14	0.13	0.13	0.12
Tertiary	0.26	0.25	0.23	0.22	0.21
Rates of growth of employment (percentage)					
Total	1.62	2.18	2.76	3.34	
Primary	-1.03	-1.02	-1.00	-0.97	
Secondary	4.22	4.29	4.36	4.43	
Tertiary	6.00	6.05	6.10	6.15	

Table 80. Projected non-civilian employment: urban areas

(Thousands of persons)

Year	Non-civilian employment
(1)	(2)
0	29.3
5	32.9
10	37.4
15	42.6
20	48.4

Table 81. Projected non-civilian employment: rural areas

(Thousands of persons)

Year	Non-civilian employment
(1)	(2)
0	3.3
5	3.7
10	4.2
15	4.7
20	5.4

Table 82. Projected non-civilian employment: entire country

(Thousands of persons)

Year	Non-civilian employment
(1)	(2)
0	32.5
5	36.5
10	41.5
15	47.4
20	53.8

Table 83. Labour market balances: urban areas

Year	Total labour force a/	Non-civilian employment b/	Civilian labour force c/	Total employment d/	Excess supply/ demand e/	Excess supply/ demand f/
	(thousands of persons)					(percentage of civilian labour force)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	968.3	29.3	939.0	948.2	-9.2	-0.98
5	1383.8	32.9	1350.9	1245.0	105.9	7.84
10	1881.1	37.4	1843.7	1644.2	199.5	10.82
15	2438.7	42.6	2396.1	2182.7	213.4	8.91
20	3032.4	48.4	2984.0	2910.7	73.3	2.46

a/ From table 46, "Labour force (Total)".
b/ From table 80.
c/ (Col. 2) - (Col. 3).
d/ From table 77, "Levels of employment (Total)".
e/ (Col. 4) - (Col. 5).
f/ ((Col. 6)/(Col. 4)) . (100).

Table 84. Labour market balances: rural areas

Year	Total labour force a/	Non-civilian employment b/	Civilian labour force c/	Total employment d/	Excess supply/ demand e/	Excess supply/ demand f/
	(thousands of persons)					(percentage of civilian labour force)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	2282.6	3.3	2279.3	2197.7	81.6	3.58
5	2269.1	3.7	2265.4	2163.9	101.5	4.48
10	2268.5	4.2	2264.3	2152.7	111.6	4.93
15	2298.6	4.7	2293.9	2168.3	125.6	5.48
20	2344.1	5.4	2338.7	2216.2	122.5	5.24

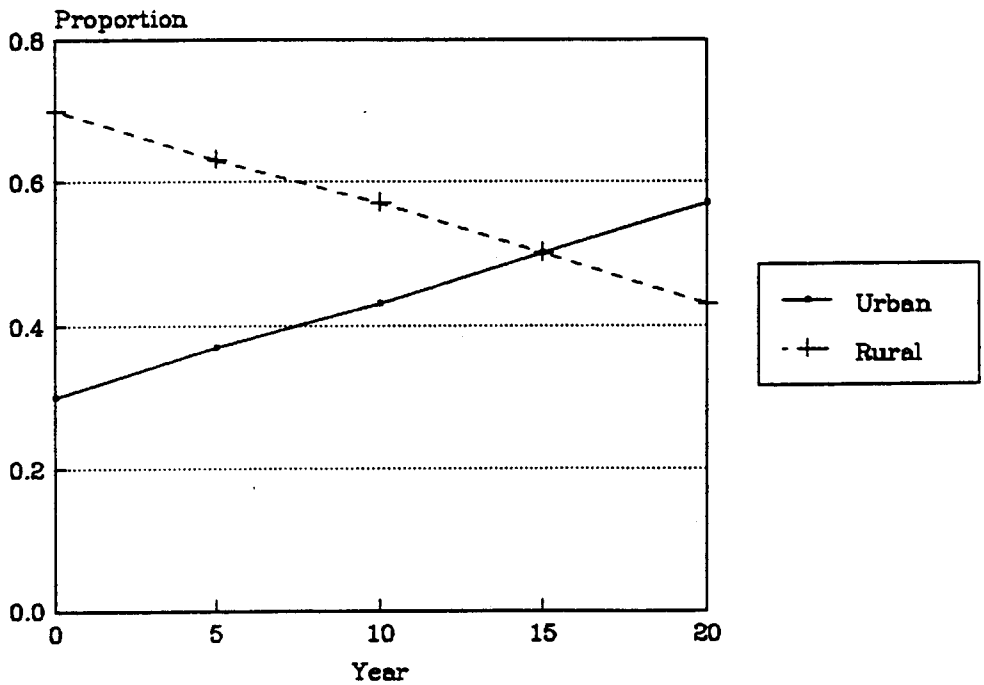
a/ From table 47, "Labour force (Total)".
b/ From table 81.
c/ (Col. 2) - (Col. 3).
d/ From table 78, "Levels of employment (Total)".
e/ (Col. 4) - (Col. 5).
f/ ((Col. 6)/(Col. 4)) . (100).

Table 85. Labour market balances: entire country

Year	Total labour force a/	Non-civilian employment b/	Civilian labour force c/	Total employment d/	Excess supply/ demand e/	Excess supply/ demand f/
	(thousands of persons)					(percentage of civilian labour force)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	3250.9	32.5	3218.4	3145.9	72.5	2.25
5	3652.9	36.5	3616.4	3408.9	207.5	5.74
10	4150.2	41.5	4108.7	3796.9	311.8	7.59
15	4737.3	47.4	4689.9	4350.9	339.0	7.23
20	5376.5	53.8	5322.7	5126.9	195.8	3.68

a/ From table 48, "Labour force (Total)".
b/ From table 82.
c/ (Col. 2) - (Col. 3).
d/ From table 79, "Levels of employment (Total)".
e/ (Col. 4) - (Col. 5).
f/ ((Col. 6)/(Col. 4)) . (100).

Figure XXI. Proportions of total employment: urban and rural



where 0.02 is the proportion of employment in the primary sector that is urban;

The proportion of employment in the secondary sector that is rural, 0.14, is:

$$0.14 = 1 - 0.86, \tag{34}$$

where 0.86 is the proportion of employment in the secondary sector that is urban;

The proportion of employment in the tertiary sector that is rural, 0.25, is:

$$0.25 = 1 - 0.75, \tag{35}$$

where 0.75 is the proportion of employment in the tertiary sector that is urban.

The proportions of employment, by sector, that are urban and rural for the entire projection interval are shown in table 79.

E. Summary

This chapter has described the method for preparing employment projections, by industry, using constant rates of change of labour productivity, which may be discrete or continuous. As part of the description of the method, procedures that can be used in making both national and urban-rural projections were presented. In addition, types of inputs required by the method were described, and the preparation of the inputs discussed. Lastly, two examples of projections--national and urban-rural-- were described. A complete listing of the outputs that can be generated by the method is shown in box 19.

Box 19

Outputs of the method for making employment projections assuming a constant rate of change in labour productivity

1. Employment by industry (national or urban, rural and national)

2. Employment aggregates (national or urban, rural and national)

Levels of employment:

Total

Primary sector
Secondary sector
Tertiary sector

Growth in employment:

Total

Primary sector
Secondary sector
Tertiary sector

3. Indicators of the structure of employment (national or urban, rural and national)

Proportions of employment by sector:

Primary sector
Secondary sector
Tertiary sector

4. Indicators of the urban-rural distribution of employment (national only; if urban and rural employment is being projected)

Proportions of employment urban:

Total

Primary sector
Secondary sector
Tertiary sector

(continued)

Box 19 (continued)

Proportions of employment rural:

Total

Primary sector
Secondary sector
Tertiary sector

5. Rates of growth of employment (national or urban, rural and national)

Total

Primary sector
Secondary sector
Tertiary sector

6. Labour market balances (national or urban, rural and national)

Excess supply of or excess demand for labour

Percentage excess supply of or excess demand for labour

F. Notation and equations

1. Indices, variables and special symbols

(a) List of indices

i = 1,...,I	are industries of the nation's economy
k = 1,2	are urban and rural locations
t	is the year of the projection period
t'	is the calendar year
t*	is the number of years between the year to which the observed levels of labour productivity used refer and the initial year of the projection period (t=0)
-t*	is the year preceding the initial year of projection (t=0) in which the levels of labour productivity were observed.

(b) List of variables

CLF(t+5)	is the civilian labour force at the end of the interval
EGREM	is the average annual exponential growth rate of total employment for the interval
EGREMP	is the average annual exponential growth rate of employment in the primary sector for the interval
EGREMS	is the average annual exponential growth rate of employment in the secondary sector for the interval
EGREMT	is the average annual exponential growth rate of employment in the tertiary sector for the interval
EM(i,k,t+5)	is the employment in industry i in location k at the end of the interval
EM(i,t+5)	is the employment in industry i at the end of the interval

EM(k,t+5)	is the total employment in location k at the end of the interval
EM(t+5)	is the total employment at the end of the interval
EMGR	is the growth of total employment during the interval
EMP(k,t+5)	is the employment in the primary sector in location k at the end of the interval
EMP(t+5)	is the employment in the primary sector at the end of the interval
EMPGR	is the growth of employment in the primary sector during the interval
EMS(k,t+5)	is the employment in the secondary sector in location k at the end of the interval
EMS(t+5)	is the employment in the secondary sector at the end of the interval
EMSGR	is the growth of employment in the secondary sector during the interval
EMT(k,t+5)	is the employment in the tertiary sector in location k at the end of the interval
EMT(t+5)	is the employment in the tertiary sector at the end of the interval
EMTGR	is the growth of employment in the tertiary sector during the interval
ERLP(i)	is the annual exponential rate of change of labour productivity in industry i expressed as percentage
EXL(t+5)	is the excess supply of labour (if positive) or excess demand for labour (if negative) for the end of the interval
GGREM	is the average annual geometric growth rate of total employment for the interval
GGREMP	is the average annual geometric growth rate of employment in the primary sector for the interval
GGREMS	is the average annual geometric growth rate of employment in the secondary sector for the interval

GGREMT	is the average annual geometric growth rate of employment in the tertiary sector for the interval
GRLP(i)	is the annual geometric rate of change of labour productivity in industry i expressed as percentage
GRLP(i,k)	is the annual geometric rate of change of labour productivity in industry i in location k expressed as percentage
LF(t+5)	is the total labour force at the end of the interval
LP(i,-t*)	is the observed level of labour productivity of industry i in year -t*
LP(i,0)	is the labour productivity of industry i in the initial year of projection period or in the initial year of the time series
LP(i,k,0)	is the labour productivity of industry i in location k in the initial year of the projection period
LP(i,k,t+5)	is the labour productivity in industry i in location k at the end of the interval
LP(i,t')	is the labour productivity in industry i in year t'
LP(i,t+5)	is the labour productivity in industry i at the end of the interval
NEM(t+5)	is the non-civilian employment at the end of the interval
PEMP(t+5)	is the proportion of total employment accounted for by the primary sector at the end of the interval
PEMPRUR(t+5)	is the proportion of employment in the primary sector which is rural at the end of the interval
PEMPURB(t+5)	is the proportion of employment in the primary sector which is urban at the end of the interval
PEMRUR(t+5)	is the proportion of total employment which is rural at the end of the interval
PEMS(t+5)	is the proportion of total employment accounted for by the secondary sector at the end of the interval
PEMSRUR(t+5)	is the proportion of employment in the secondary sector which is rural at the end of the interval

PEMSURB(t+5)	is the proportion of employment in the secondary sector which is urban at the end of the interval
PEMT(t+5)	is the proportion of total employment accounted for by the tertiary sector at the end of the interval
PEMTRUR(t+5)	is the proportion of employment in the tertiary sector which is rural at the end of the interval
PEMTURB(t+5)	is the proportion of employment in the tertiary sector which is urban at the end of the interval
PEMURB(t+5)	is the proportion of total employment which is urban at the end of the interval
PEXL(t+5)	is the excess supply of labour or excess demand for labour as a percentage of the civilian labour force at the end of the interval
VA(i,k,t+5)	is the value added in industry i in location k at the end of the interval
VA(i,t+5)	is the value added in industry i at the end of the interval

(c) <u>List of special symbols</u>

a(i)	is the intercept coefficient of the function for industry i
antiln	is the antilogarithm of the natural logarithm
b(i)	is the partial coefficient of the function for industry i
b*(i)	is the estimate of the partial coefficient of the function for industry i
e	is the base of the natural logarithm
I	is the number of industries
Ip	is the number of industries in the primary sector
Is	is the number of industries in the secondary sector
ln	is the natural logarithm

u(i,t') is the random disturbance term in the function for industry i in year t'

2. Equations

A. The technique

1. National level

(a) Labour productivity by industry

(i) Discrete growth

$$LP(i,t+5) = LP(i,0) \cdot (1 + GRLP(i)/100)^{t+5}; \quad i = 1,\ldots,I \tag{1}$$

(ii) Continuous growth

$$LP(i,t+5) = LP(i,0) \cdot e^{[(ERLP(i)/100) \cdot (t+5)]}; \quad i = 1,\ldots,I \tag{2}$$

(b) Employment by industry

$$EM(i,t+5) = VA(i,t+5)/LP(i,t+5); \quad i = 1,\ldots,I \tag{3}$$

(c) Other results

(i) Employment aggregates

a. Total employment

$$EM(t+5) = \sum_{i=1}^{I} EM(i,t+5) \tag{4}$$

b. Employment by sector

i. Employment in the primary sector

$$EMP(t+5) = \sum_{i=1}^{Ip} EM(i,t+5) \tag{5}$$

ii. Employment in the secondary sector

$$EMS(t+5) = \sum_{i=Ip+1}^{Ip+Is} EM(i,t+5) \tag{6}$$

iii. Employment in the tertiary sector

$$EMT(t+5) = \sum_{i=Ip+Is+1}^{I} EM(i,t+5) \tag{7}$$

c. Growth in total employment

$$EMGR = EM(t+5) - EM(t) \tag{8}$$

d. Growth in employment by sector

$$EMPGR = EMP(t+5) - EMP(t) \tag{9}$$

$$EMSGR = EMS(t+5) - EMS(t) \tag{10}$$

$$EMTGR = EMT(t+5) - EMT(t) \tag{11}$$

(ii) Indicators of the structure of employment

a. Proportions by sector

$$PEMP(t+5) = EMP(t+5) \ / \ EM(t+5) \tag{12}$$

$$PEMS(t+5) = EMS(t+5) / EM(t+5) \quad (13)$$

$$PEMT(t+5) = EMT(t+5) / EM(t+5) \quad (14)$$

(iii) Rates of growth of employment

a. Rate of growth of total employment

$$GGREM = [(EM(t+5) / EM(t))^{1/5} - 1] \cdot 100 \quad (15)$$

$$EGREM = [(\ln (EM(t+5) / EM(t))) / 5] \cdot 100 \quad (16)$$

b. Rates of growth of employment by sector

$$GGREMP = [(EMP(t+5) / EMP(t))^{1/5} - 1] \cdot 100 \quad (17)$$

$$GGREMS = [(EMS(t+5) / EMS(t))^{1/5} - 1] \cdot 100 \quad (18)$$

$$GGREMT = [(EMT(t+5) / EMT(t))^{1/5} - 1] \cdot 100 \quad (19)$$

$$EGREMP = [(\ln (EMP(t+5) / EMP(t))) / 5] \cdot 100 \quad (20)$$

$$EGREMS = [(\ln (EMS(t+5) / EMS(t))) / 5] \cdot 100 \quad (21)$$

$$EGREMT = [(\ln (EMT(t+5) / EMT(t))) / 5] \cdot 100 \quad (22)$$

(iv) Labour market balances

$$CLF(t+5) = LF(t+5) - NEM(t+5) \quad (23)$$

$$EXL(t+5) = CLF(t+5) - EM(t+5) \quad (24)$$

$$PEXL(t+5) = [EXL(t+5) / CLF(t+5)] \cdot 100 \quad (25)$$

3. Urban-rural level

(a) Labour productivity

(i) Discrete growth

$$LP(i,k,t+5) = LP(i,k,0) \cdot (1 + GRLP(i,k)/100)^{t+5}; \quad (26)$$

$$i = 1,\ldots,I;$$

$$k = 1,2$$

(ii) Continuous growth

(b) Employment by industry

$$EM(i,k,t+5) = VA(i,k,t+5)/LP(i,k,t+5); \quad (27)$$

$$i = 1,\ldots,I;$$

$$k = 1,2$$

(c) Other results

(i) Proportions of employment that are urban and rural

a. Proportions of total employment

$$PEMURB(t+5) = EM(1,t+5)/EM(t+5) \quad (28)$$

$$PEMRUR(t+5) = 1 - PEMURB(t+5) \quad (29)$$

b. Proportions of employment by sector

$$PEMPURB(t+5) = EMP(1,t+5)/EMP(t+5) \quad (30)$$

$$PEMSURB(t+5) = EMS(1,t+5)/EMS(t+5) \quad (31)$$

$$PEMTURB(t+5) = EMT(1,t+5)/EMT(t+5) \quad (32)$$

$$PEMPRUR(t+5) = 1 - PEMPURB(t+5) \quad (33)$$

$$PEMSRUR(t+5) = 1 - PEMSURB(t+5) \quad (34)$$

$$PEMTRUR(t+5) = 1 - PEMTURB(t+5) \quad (35)$$

B. The inputs

1. Types of inputs required

2. Preparation of the inputs

(a) Assumptions on rates of change of labour productivity

(i) Time series data

(ii) Rates of change based on time series consisting of several observations

a. Estimation procedures

i. Discrete growth

$$LP(i,t') = LP(i,0) \cdot (1 + GRLP(i)/100)^{t'}; \quad (36)$$

$$i = 1,\ldots,I$$

$$\ln LP(i,t') = a(i) + b(i) \cdot t' + u(i,t'); \quad (37)$$

$$i = 1,\ldots,I,$$

where:

$$a(i) = \ln LP(i,0)$$

$$b(i) = \ln[\ 1 + GRLP(i)/100\ ]$$

$$GRLP(i) = [\text{antiln } b^*(i) - 1] \cdot 100; \quad i = 1,\ldots,I, \tag{38}$$

ii. Continuous growth

$$LP(i,t') = LP(i,0) \cdot e^{[(ERLP(i)/100) \cdot t']}; \quad i = 1,\ldots,I, \tag{39}$$

$$\ln LP(i,t') = a(i) + b(i) \cdot t' + u(i,t'); \quad i = 1,\ldots,I, \tag{40}$$

where:

$a(i) = \ln LP(i,0)$

$b(i) = ERLP(i) \cdot 100$

$$ERLP(i) = b^*(i) \cdot 100; \quad i = 1,\ldots,I, \tag{41}$$

b. Illustrative estimations

i. Discrete growth

ii. Continuous growth

(iii) Rates of change based on time series consisting of two observations

a. Estimation procedures

i. Discrete growth

$$GRLP(i) = [\ (\ LP(i,t')/LP(i,0)\ )^{1/t'} - 1\ ] \cdot 100; \quad i = 1,\ldots,I, \tag{42}$$

ii. Continuous growth

$$ERLP(i) = [(\ln (LP(i,t')/LP(i,0))) / t'] \cdot 100; \quad (43)$$

$$i = 1,\ldots,I$$

b. Illustrative estimations

i. Discrete growth

$$3.55 = [(0.125/0.105)^{1/5} - 1] \cdot 100. \quad (42)$$

ii. Continuous growth

$$3.48 = [(\ln (0.125/0.105)] \cdot 100. \quad (43)$$

(iv) Rates of change based on the assessment of factors influencing labour productivity trends

(b) Assumptions on initial-year levels of labour productivity

(i) Procedures to derive initial-year levels of labour productivity

a. Discrete growth

$$LP(i,0) = LP(i,-t^*) \cdot (1 + GRLP(i)/100)^{t^*}; \quad (44)$$

$$i = 1,\ldots,I$$

b. Continuous growth

$$LP(i,0) = LP(i,-t^*) \cdot e^{[(ERLP(i)/100) \cdot t^*]}; \quad (45)$$

$$i = 1,\ldots,I$$

(ii) Illustrative derivations of initial-year levels of labour productivity

$$0.140 = 0.131 \cdot (1 + 3.66/100)^2, \tag{44}$$

$$0.134 = 0.125 \cdot (1 + 3.55/100)^2, \tag{45}$$

Notes

1/ Policies that can be considered in this context are those relating to investment allocation among sectors, modern sector wages (especially if those wages are set by the Government) and population variables.

2/ Throughout this chapter, "value added" will refer to value added measured in constant prices.

3/ This amounts to assuming equality between the marginal employment-value added ratio and the average employment-value added ratio.

4/ The initial year of the projection period is denoted by 0.

5/ Through much of this chapter, discussion of the labour productivity method is based on the alternative assumptions about growth of labour productivity--discrete and continuous. This should enable the user to make employment projections using either assumption. Making projections with both types of assumptions would, most of the time, result in very similar results.

6/ For a discussion on the use of t-statistics to assess statistical significance of regression coefficients, see Kmenta (1971).

7/ The time series data on employment which were used to obtain levels of labour productivity expressed employment in units of 1,000 employed persons. Therefore, the levels of employment in these illustrative examples will be given in thousands of employed persons.

Reference

Kmenta, Jan (1971), Elements of Econometrics. New York: Macmillan.