Tiainen, Pekka (2007), Population, growth accounting and long term labour projections. **Finnish approach application. Will be published.**

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Population, growth accounting and long term labour projections.
Finnish approach application

I Introduction

Population forecasts are a central tool for estimating long-term economic development. Population forecasts based on various basic assumptions can be calculated with great accuracy, and by varying the figures for the birth rate, death rate and migration flows, alternative population forecasts can be prepared. By including the labour force participation rate and productivity estimates, population growth can be linked to potential economic growth and, taking demand in consideration, to actual economic growth. This yields an opportunity of examining the factors of economic growth and sustainable growth and also linking these issues to environmental themes. This is the starting point for the long-term analysis of growth and employment applied in Finland.

In the report Finnish Labour Force 2025 (Suomen Työvoima 2025) that came out in early 2007, the analysis of the operational environment includes the global economy and integration. This article examines the question if the framework based on growth accounting, overall productivity and par-

tial productivity figures applied in Finland at the levels of national and regional economy and the Long-Term Labour Force Model could have a wider application. In this case, the purpose of this application would be utilising good practices in the analysis of the global economy, the situation of various countries and areas and, in the perspective of an individual country such as Finland, the development of the operational environment analysis.

The framework based on growth accounting is founded on an analysis developed for the sources of growth, at the background of which are the works by Solow, Denison and Jorgenson as well as the doctoral thesis of Tiainen and later applications based on it.

The quantitative application of the Labour Force 2025 analysis is built on the Long-term Labour Force Model developed in connection with the Labour Force 2000 report, and in that on a breakdown and interaction of the labour demand and supply that allow for an imbalance. The demand is based on a breakdown of individual sectors and a consequent aggregation, while the supply is based on demographic development and labour force participation rate, taking working time into account. Based on sectoral demand, the demand by profession can be derived, and based on demand and attrition from working life, job openings and educational needs can be derived.

This is the fifth time the Long-Term Labour Force Model was applied in the Labour Force Reports that are published every four years. Additional elements and a growth accounting frame of reference have been gradually introduced. The determination and anticipation of labour demand and supply goes back much further. Occupational structure and educational needs are derived as an interactive calculation by method called labour force requirement method.

As part of this work, analyses of European integration and the international economy as well as demographic, labour force and employment rate development estimates were included in the descriptions of the operational environment. At the same time, calculations were put forward concerning the kinds of bottlenecks that are about to arise. As a conclusion of these analyses, a growth strategy that highlights skills, quality and overall productivity while emphasising the saving of natural resources on the scale of Finland, Europe and the globe was outlined. At the same time, the question arises if the Finnish approach could have a larger scope of application in various countries, and in a wider sense at the global level.

The link to demographic development is essential, as demographic growth and change in the population structure as well as mobility have numerous connections to labour force development and growth as well as environmental issues. This is why it is necessary to take into account demographic development and, on the other hand, the link of population development with other financial and social development is an important dimension in demographics.

While the Finnish application contains important innovations, it also makes use of experiences derived from elsewhere, and development similar to the Finnish approach can partially be seen in international connections. This puts the development efforts in a clear perspective. The need for this analysis and the global strategy based on it is obvious in order to resolve imbalances, social and environmental problems and various conflicts.

In the 1990's, European-level labour force projections based on population and labour force shares were produced in transnational co-operation for the European Economic Area. In the beginning of the 2000's, overall productivity calculations started being produced for the EU member states. Since 2003, on the other hand, the Skillnet network has started developing calculations concerning future vocational development based on the demand for labour force similarly to the Finnish Long-Term

Labour Force Model and the associated professional structure analysis in co-operation with the Finnish Educational Administration.

Below, we will start by describing growth and demographic development on the global scale to motivate the need for analysis. The essential contents of growth accounting in the perspective of this analysis are presented next. This is followed by a description of the Long-Term Labour Force Model. Next the article goes on to describe basic results of the application relevant to Finland and the starting points for applying the analysis at the global level, proceeding in a similar fashion in case of various countries and larger entities. Finally, conclusions are put forward.

II Growth, population and employment developments at world level

The world population is growing rapidly. Whereas the global population totalled approximately 4.l billion people in 1975, this number had grown to more than 6,5 billion in 2006. Even though the growth of population has become slower, the population of the world will increase by aboat 1,5 billion to 8 billion in the year of 2030 again by 1-1,5 million in next 25 years before stabilizing.

At the same time there are big structural imbalances. The share of global production is high in traditional industrial countries but share of population small in relation to population share and population is ageing. Also most of population growth is in the developing and less developed countries or countries where per capita production is low. The growth of population will take place almost entirely in Asia, Africa and Latin America. Europe's role in world population growth is limited.

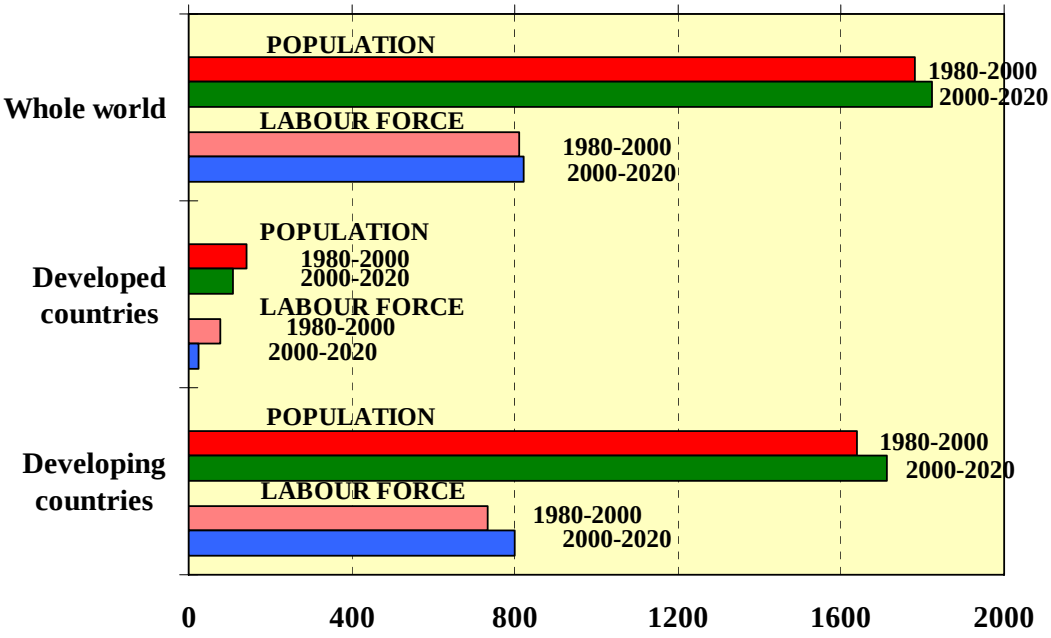
There is big oversupply of labour in developing world and still much unemployment also in more developed world.

Growth of production is much higher in developing world than in more developed world. So global convergence tendency is an important development however so that smaller regions can be loosers. Also number of old people is also increasing in developing world.

Basic problem is that it does take decenniums before per capita production differences become small because gaps are so great. Catching up living standard gaps, population growth, need to get down unemployment and rise living standard also in more developed world and need to cover productivity growth by production growth so that demand of labour is not decreasing achieves that global production is growing and it’s need for increase.

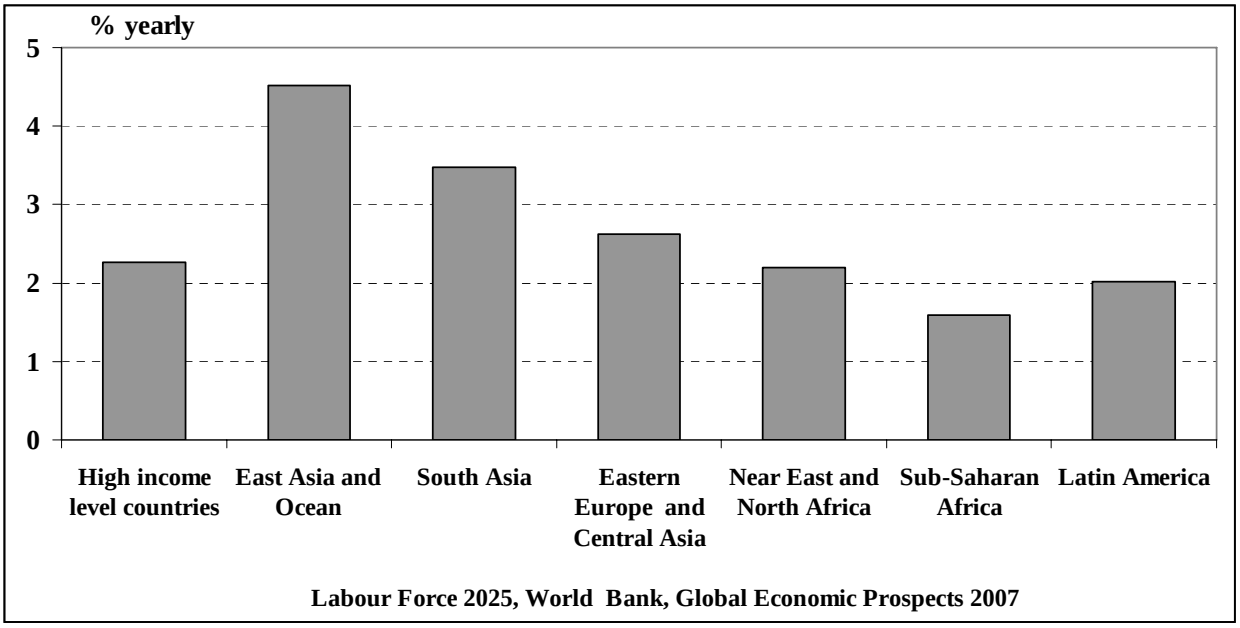
A potential growth of 3-4% in the GNP would mean that the global production is doubled every 18-23 years and, at a growth rate of 3.5%, every 20 years. This begs the question of what kind of production structure and resources the growth should be based on to avoid transgressing the limits set by the environment and space or to avoid growth that is associated with an inevitable process of destruction affecting the nature and the environment, which simultaneously would rob the foundation from development needed to resolve issues arising from population growth. The central question revolves around the role technological development will play in this.

CHART 1. CHANGES IN POPULATION AND LABOUR FORCES IN COUNTRY GROUPS, MILLION PEOPLE



Labour Force 2025, United Nations, ILO

Chart 2. Growth in income level per capia 2010-2030



Next growth accounting approach is presented and after that in Finland applicated long term labour force model.

III Growth accounting, total factor productivity - concept and measurement

The starting point in growth accounting is the decomposition of growth, measured in terms of net domestic product in basic values, into the contributions of the quantities of three production factors, input-related qualitative factors and total factor productivity, consisting of the measured components of the combined productivity of the production factors including a separated residual incl. the scale effect and non-measurable factors, such as technical progress, forming the final residual. Three components are further divided into subcomponents. Indices are constructed for all these components, by applying growth accounting. The shares in production of the production factors are used as weights for the production factor indices. The growth accounting is originally basing on method, which is developed by R.M. Solow, E.F. Denison (named father of growth accounting) and D.W. Jorgenson etc. (see Tiainen, 1994, 1999).

Concept and measurement of productivity

Productivity is treated in literature still in several different ways without the concept of productivity being throughly excellent. Very useful productivity measurement methods are resting on indices. By applying results of descriptive index theory we can examine whether the productivity measures used have foundations in index theory.

The productivity concept is rational to examine firstly in the case of one commodity, one input and one in a single point of time. The output will tell us what amount of the commodity will be produced. With the help of the ratio of change it will be possible to compare two or more different

points of time. The index number formula is needed to aggregate change relationships to commodity group level. The choice of index number formula and the choice of the various methods of calculating them will become necessary when there are more than one commodities or inputs or both, and two points of time. Total and partial productivity concepts are needed use in the case of one commodity, more than one inputs and one point of time. In the comparison of several points of time one shall in addition select a suitable construction strategy for index series. From the above it will be noted that the productivity coefficients require several different choices which, moreover, need to be compatible.

Productivity concept

Productivity means production per unit of input. Productivity concept is used because the growth of production is not explained solely by the amount of production inputs. The definition is valid whether there are one or more commodities or inputs. When one in the case of one input aggregates the inputs to a total input, which is used to devide production, we have total or overall productivity. If output is devided by one input, we obtain partial productivity connected with the input in question. Partial productivity and productivity in the case of one commodity and one input are special cases of total productivity.

Basic idea of productivity is simple despite the junge of concept and ways of measurement. Even in the simplest case of one homogenous product and input, the productivity examination show the key issues. In this case it is possible to obtain, from the measures of ratio of change of productivity. The following measures of productivity are yielding the same result T2-T6:

- The production volume to the volume of input (T1) so that change ratio is change ratio in production devided by change ratio in input.
- Technical coefficient z/x is the ratio of output total input (T2) so that change ratio is change ratio in technical coefficient.
- The direct volume relationship is also obtained by deflating value of output and by deflating costs (T3).
- The volume of production devided by deflated costs (T4) is the Caves-Christensen measure for the direct volume ratio. The next measure is obtained by deviding the deflated output by the input (T5).
- When the value of output consists of compensation for inputs, the value of production is production cost. Value of production is product of its price and quantity and the production cost is product of price and quantity of input. In this case, the ratio of production volume to the volume of input is the reverse figure of the ratio of production price to the input price T6). The measure is Jorgenson-Griliches price measure or dual case of measures basing on output and input qunatities.

Although the different ways of calculation on productivity lead to the same result, we are not dealing with unnecessary distinctions. First of all, productivity can be measured with various different ways, based on different data. Depending on existent statistics, one way of calculation on productivity is easy and the other more difficult to apply.

Productivity is an absolute parameter depending on the units of production and input. The total productivity ist not possible directly to calculate if there are several inputs or outputs. As in index theory, one must do away with commodity units before commodities can be compare and aggregate. The calculation of the change ratio is a way to eliminate the measurement units here as in general in index calculations.

New alternatives for measurement the in productivity appear when we compare two different points of time (Tiainen, 1999). The ratios can be calculated in several different ways by using various index formulas and their calculation methods. The change ratios obtained by this way differ somewhat in a way that has been studied in index theory. When there are several outputs and inputs and several points of time instead of just two, one has to choose a strategy for the construction of output and input indices. One must choose periods of comparison and to solve how comparison is carried out. This is independent of the choice of the index formula.

In descriptive index number theory, choices between different indexes can be made basing on axiomatic or a priori properties. In growth accounting theory, it is usual to derive macroeconomic measures from assumptions concerning on behaviour of the economic agents of the economy.

Total productivity of Solow

Solow (1957) starts from the general production function, in which the form of this production function is not fixed and the coefficient factor measures the shift of the production function and thus technical change. The basic eqution of total factor productivity calculations can be presented in the form

$$\frac{\dot{Q}}{Q} = \frac{\dot{T}}{T} + \frac{rK}{Q}\frac{\dot{K}}{K} + \frac{wH}{Q}\frac{\dot{H}}{H} = \frac{\dot{T}}{T} + v_K\frac{\dot{K}}{K} + v_L\frac{\dot{H}}{H}$$

Here Q ins production, K is capital and H is labour measured as working hours. Point above variables means small change (continuous time) so that we get relative changes of these variales. r is return on capital, w is wage and v_K and v_L are shares of labour and capital in such way that they will sum up to one in the basic case. The growth of production per working hours is

$$\frac{\dot{Q}}{Q} - \frac{\dot{H}}{H} = \frac{\dot{T}}{T} + v_K\left[\frac{\dot{K}}{K} - \frac{\dot{H}}{H}\right]$$

and

$$\frac{\dot{q}}{q} = \frac{\dot{T}}{T} + v_K\frac{\dot{k}}{k}$$

where we write q=Q/H (labour productivity) and k=K/H (capital intensity). This is the basic equation for Solow's residual examination (1957) and, along with the equation before it, a starting point for other residual studies.

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T/T and its counter part for the discrete time is called the Solow residual. If we increase land R to the equation, we sum land per working hours to the last eqution so that v_R is share of land and is used as the weigth. Sum of weights is here still one. Land reflects use natural resources.

Denison's growth accounting: an interpretation

The aim of Denison's approach is, like Solow's (1957), to distribute the growth rate of the output among the factors which generated the growth. The determiners are divided, according to Solow's example, into two large categories: the total factor of production input and output per input unit. This method of division has been established more generally, too, albeit the concepts that have been used vary. There is, however, no generally approved method to divide the determiners into each category. Denison restricts his classification to the above large categories, but places the main emphasis on the study of individual sources of growth, the number of which is large in his approach. One of them is the quality of labour input. One part of the factors goes beyond the limits of the neoclassical frame of reference. One of the essential features of his method is also the analysis of the average annual growth rate between two points of time while individual years only effect the result so that national income weights are averages of periods. The income from work of entrepreneurs is included in the share of labour. This increases the growth contribution of labour input.

The method of Denison can be written according to the above used presentation to the form[1]

$$\frac{\dot{Q}}{Q} = (1+\delta)\left[\sum_h v_h \frac{\dot{x}_h}{x_h} + \sum_y \frac{\dot{y}_y}{y_y} + \frac{\dot{f}}{f}\right]$$

where Q is production, $(1+\delta)$ denotes the effects of economics of scale, v_h is the income share of production factor x_h, y_y contains various disequalibrium factors and other specified factors and f is the final residual. h = 1,...,N and as subindex y = 1,...,m. In his empirical applications, Denison uses national income y, in more detail net national income at factor cost. This includes net factor income from abroad, and in inputs one takes into account the use of domestic factors of production abroad in net terms. The factors included vary somewhat in the various Denison studies. However, the basic starting point is shown from the above equation.

We obtain total input x by using aggregation of production factors by the same ways as in basic growth accounting equation. When now M is labour input including quality of labour LQ and quantity of labour measured as working hours, R is land, rM is compensation for labour including quality an rR is compensation for land factor, we obtain

[1] This is based on Tiainen (1994), because Denison himself didn't use mathematical presentation.

$$\frac{\dot{Q}}{Q} = (1+\delta)\left[\frac{r_M M}{Q}\frac{\dot{M}}{M} + \frac{r_K K}{Q}\frac{\dot{K}}{K} + \frac{r_R R}{Q}\frac{\dot{R}}{R} + \frac{\dot{y}}{y} + \frac{\dot{f}}{f}\right]$$

$$= (1+\delta)\left[v_L \frac{\dot{M}}{M} + v_K \frac{\dot{K}}{K} + v_R \frac{\dot{R}}{R} + \frac{\dot{y}}{y} + \frac{\dot{f}}{f}\right]$$

$$= (1+\delta)\left[v_L \frac{\dot{H}}{H} + v_L \frac{L\dot{Q}_L}{LQ_L} + v_K \frac{\dot{K}}{K} + v_R \frac{\dot{R}}{R} + \frac{\dot{y}}{y} + \frac{\dot{f}}{f}\right]$$

The last form is the basic equation of Denison's growth accounting in form based on continuous time, when subcomponents have not been specified.

The relative change of total input I is

$$\frac{\dot{X}}{X} = v_L \frac{\dot{M}}{M} + v_K \frac{\dot{K}}{K} + v_R \frac{\dot{R}}{R}$$

This analyses can be use also to sectoral level but Denison made his calculations at national economy level.

The neoclassical growth accounting of Jorgenson et al.

In the methodological tradition there is another central growth accounting approach, generated from the analysis of Jorgenson & Griliches (1967) (newer research see Jorgenson, et al., 1987). The aim was, in particular, to reduce the residual to a level as low as possible because no actual residual should be left when starting from the neoclassical theoretical frame of reference (aboat comments see Denison, 1969b, 1972b). If a residual was left, the alternatives were that either some factor had to be missing from the analysis or the measurement of inputs was faulty. The ordinary neoclassical hypotheses about competition, production function of fixed scale outputs and producer equilibrium were the starting points.

The model of output and technology changes is based on a production function for each sector i that is
where $\{Z_i\}$, $\{X_i\}$, $\{J_i\}$ and $\{M_i\}$ are sets of gross values of sector outputs, intermediate inputs, capital services and labour inputs respectively. Capital services includes capital K and quality of capital.

Here with fixed scale effects, the rate of technological change for each sector is obtained as the output growth rate for the sector minus the average sector input weighted by its growth rate. The output and factor indicies are obtained as logarithmic growth weighted averages. The weights are the sector product shares and the component value shares of the corresponding inputs.

The use of the discrete time series data in the calculation of Divisia indices, which are based on continuous time, requires approximation. Relative changes based on continuous time are replaced

by approximate values. The work of Jorgenson et al. is replete with logarithmic approximation. The rate of technologial change is now

$$\bar{v}_t^i = \ln Z_{i,t} - \ln Z_{i,t-1} - \bar{v}_X^i \sum_x \bar{v}_{Xx}^i \left[\ln X_{xi,t} - \ln X_{xi,t-1}\right]$$
$$- \bar{v}_J^i \sum_j \bar{v}_{Jj}^i \left[\ln J_{ji,t} - \ln J_{ji,t-1}\right] - \bar{v}_M^i \sum_c \bar{v}_{Mc}^i \left[\ln M_{ci,t} - \ln M_{ci,t-1}\right]$$

Here x, j and c refer to components of land, capital and labour and is time. Using the averages of new

and old value shares as weights

$$\bar{v}_{Xx}^i = \frac{1}{2}\left[v_{Xx,t} + v_{Xx,t-1}\right]$$

$$\bar{v}_{Mc}^i = \frac{1}{2}\left[v_{Mc,t} + v_{Mc,t-1}\right]$$

$$\bar{v}_{Jj}^i = \frac{1}{2}\left[v_{Jj,t} + v_{Jj,t-1}\right]$$

we obtain the Törnqvist indices found in common usage (see Törnqvist, 1936 and Vartia, 1976). When the weight coefficients of the input indices are written as

$$\bar{v}_X^i = \frac{1}{2}\left[v_{X,t}^i + v_{X,t-1}^i\right]$$

$$\bar{v}_J^i = \frac{1}{2}\left[v_{J,t}^i + v_{J,t-1}^i\right]$$

$$\bar{v}_M^i = \frac{1}{2}\left[v_{M,t}^i + v_{M,t-1}^i\right]$$

we obtain

$$\bar{v}_t^i = \left[\ln Z_{i,t} - \ln Z_{i,t-1}\right] - \bar{v}_X^i \left[\ln X_{i,t} - \ln X_{i,t-1}\right]$$
$$- \bar{v}_J^i \left[\ln J_{i,t} - \ln J_{i,t-1}\right] - \bar{v}_M^i \left[\ln M_{i,t} - \ln M_{i,t-1}\right]$$

Equation is a translog index of the sectoral rate of technological change applicable to discrete time. The brackets in the equation contain the intermediate, capital and labour input translog indices, i.e. Törqvist indices. Multilateral indices are applications of these indices, which give international comparisons instead of comparisons over time.

In the case of one input variable we obtain at aggregate level

$$v_t = \ln Z_t - \ln Z_{t-1} - \left[\ln x_t - \ln x_{t-1}\right]$$
$$= \ln\left[\left(Z_t / Z_{t-1}\right) \Big/ \left(x_t / x_{t-1}\right)\right]$$

Discussion and conclusions on total productivity

We see that the Solow, Denison and Jorgenson et al method are basing on same idea in measuring the contribution of input on growth and the factor which is not explained by inputs. That factor has different names in the literature. Its called residual, measure of our unknowledgement, output per input, total productivity, total factor productivity (TFP) and productivity of combined factors. The concept is depending on how we understand the phenomenon. The basic idea that shares of production factors in production or income are used as weigths in aggregation of input is the same in these measurements and is basing on marginal productivity of factors of production on which factor compensations are based. It can be discussed how right this method is but this is a way to operationalize the method. Actually earnings differ from marginal productivities and the influence of this should be taken care of in possible corrections and conclusions.

Then the applications differ and there are also other applications. If the contribution of production factors is measured by some other way still the basic issue is the same: different factors have different contribution on growth and when we analyze limits and possibilities of growth we need some way to analyze this these contributions quantitavily and qualitatively.

The demand side is an important issue because resources are underutilized less or more and it's necessary to analyze imbalances. So the basic equations can be based on actual and potential variables. It's necessary to analyze potential factors of production and actual use of them. So when we analyze labour input, potential labour force depending on population and participation in labour market is important issue.

There are many different names on total productivity as measure of ignorance, techn(olog)ical change, production per total input, Total Factor Productivity, combined productivity of factors depending on which aspect we weight. We use the concepts Total Factor Productivity or combined (factor) productivity which is quite descriptive and also in the form combined productivity or total productivity which are stressing that there are also other aspects than factor productivity.

Production per input can be separated to different concepts at special cases so that

-production per total input = total productivity
-production per labour input = labour productivity
-production per capital input = capital productivity
-production per land or natural resources = land productivity or natural resources productivity

In connection with Solow's equations, the productivity of labour was above presented as a sum of variation relationships of overall productivity and capital intensity weighted by the income part of the capital (capital per labour input) The productivity of capital, and also that of natural resources can be presented similarly. The concepts of partial productivity are useful when discussing the connection between a certain input and production, but we must take in consideration the factors that produce this partial productivity as their combined effect, or the fact that in practice other production factors influence the partial productivity of a single factor.

The productivity of capital is an important concept when talking about the efficiency of using capital. Eco-efficiency, similarly, refers to achieving the same production with a lower use of natural resources, and it thus is an indicator of natural resource productivity; in other words, by increasing the productivity of a natural resource, a greater production is achieved by means of given resources. Achieving the same production level with less resources is relevant to the environmental debate. The concept of the ecological footprint used in it contains the idea that production is achieved with a certain environmental loading, which is a wider issue than the productivity of natural resources. We can talk about the productivity of environmental resources. In this case, we use the inverse of this, or environmental resources per production, and environmental resources are used as an equivalent indicator for the land area needed for their use; in other words, the footprint is an equivalent unit of measure.

From the technical coefficient, the following equation can be derived:

Output = Productivity x Input,

which in total factor productivity analyses is in the form

Output = Total Factor Productivity x Total input

and in labour productivity analyses in the form

Output = Labour x Total input

When the resources are in full use, an increase in productivity and an increase of inputs will in time also increase the output. In case the resources are underused, an increase in the input use will also increase the output. Similarly, if the increase in productivity results in a reduced use of inputs, the output is not increased for this part.

In order to include underuse in the examination, the equations need to be processed so that we single out

Actual output = Productivity x Input in use
Potential output = Productivity x Potential input

and similarly for the concept of overall productivity and productivity of labour, in which case the number of the employed and the completed working hours measure the actual input, and the potential output is achieved in a situation of full employment; it can be higher, if productivity at the same time is higher. In practice, the use and productivity of inputs partially make up for one another. When we repeat this analysis for capital and natural resource productivity, the result is that by increasing these and making the resource use more efficient, we can ensure a better overall productivity, while the growth results in higher employment, meaning a lower increase in the productivity of labour.

IV Anticipation of middle and long term labour force and employment developments and skill needs

Long term labour force model LTM

The Long term labour force model of Finland[2] (PTM or LTM), developed at the Ministry of Labour by PhD Pekka Tiainen[3], has been in use since 1990. Model contains the demand for labour services and the supply of labour services. The supply side includes seven data sets: the population, persons in retirement, persons in education, household domestic workers and other persons not in the labour force, persons at work part-time, labour market participation rates and working time. The demand side includes two data sets: production and the employed by industry. There is a satellite model, LMT-regional, which is used for regionalization of the result benefiting regional level comments.

Long Term Labour Force Model
- Scenarios of labour force and employment by industry are based on both demand and supply factors of the economy; national economy is the framework
- Two scenarios: basic vs. target

[2] Tiainen, Pekka (1999), Labour Force and Employment in Finland 1860-2030. See further information at the end of the paper. See also Ministry of Labour/Tiainen, Pekka (2006), Anticipating Labour Supply and demand in the Long Term. Labour Force 2025 Project. Presented In Peer Review Meeting Forecasting Skills and Labour Market in Helsinki 6 – 8 June 2006.

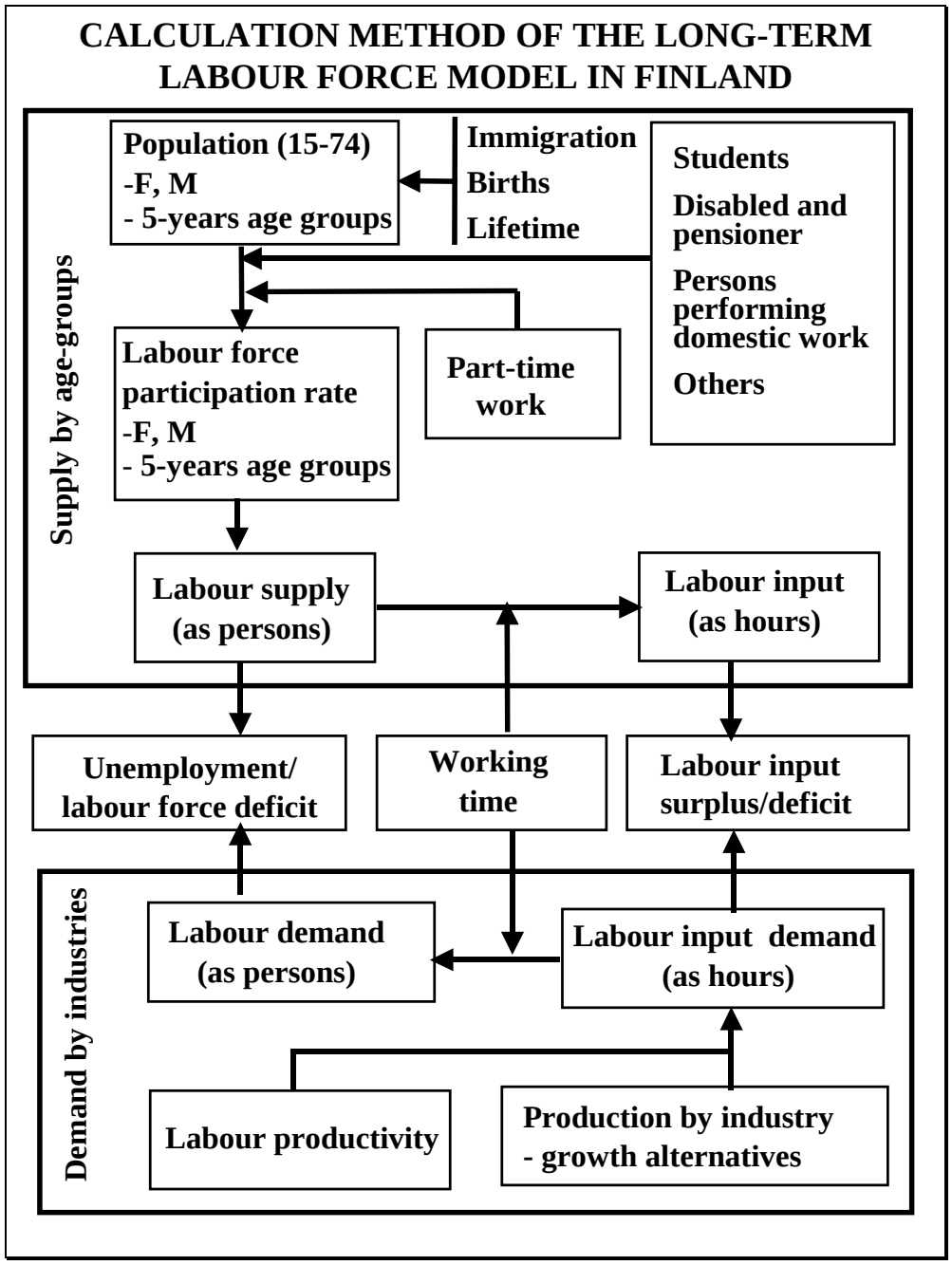
[3] See a presentation in CEDEFOP Meeting in Cypros but also reference to a Peer Review Meeting in 3 – 4 June 2006 concernin on Finnish anticipation method is increased.

•Two halves of the model: the demand for labour and the supply of labour; interaction between them Time series analyses at yearly bases

Macro module and macroeconomic input

Global and macro economic development is analyzed and also development if investment, consumption, export and import. OECD, World Bank, IMF and figures of different countries are used when export development is analyzed. This kind of analyzes is used in GDP growth alternatives. Secondly GDP growth in aggregated from industrial level figures using also labour supply and productivity limitations at aggregate level. Thirdly historical time series analyses is used especially for getting idea of long term developments. The future can be calculated by using historical developments (trends, changes in trends and business cycles) and then it's analyzed how new factors are changed the behaviour and development of the economy. Potential risks (imbalances and for instance technology risks on positive or negative sense) are analyzed and sensitivity calculations are used. Statistical consistency of figures in required (at national accounts sense).

DIAGRAM 1. Long Term Labour Force Model, LTM



Total demand, expansion demand and replacement demand

Expansion and replacement demand on labour are included to the model system so that LTM:ssä lasketaan alakohtaisesti työlliset aloittain ja stein expansion demand. Replacement demand includes replacement because of retirement and death and it's calculated at next step.

New jobs are increasing employment. Part of them are substituting job losses. A part of job losses happens when people are retiring and a part when aged people loose or leave their job. Tässä lasketaan työllisyyden alakohtainen kehitys, joka siten sisältää nettomuutoksen, mutta peruslaskennassa alojen sisäistä työpaikkojen syntymistä ja kuolemista ei ole mallinnettu vaan

sitä tulee tarkastella mahdollisuuksien mukaan erikseen.

The LT-model uses the national accounts statistics in forecasting economic development. The data sets are the production at fixed prices, the productivity, the hours worked and the number of employed, all by industry. Balancing the demand and the supply of labour, adjustment is needed between employment figures drawn from the national account statistics and labour force survey.

Demand for Labour
•Growth of production at national economy level (macro developments and demand) and at industrial level
•Labour productivity by industry
•Hours worked by industry: production divided by labour productivity.
- Labour input limited by supply labour
•Working time per employed

Employment: hours worked divided by working time by industry

The development of production and productivity is projected first in the model, using the latest forecasts of economic activity.

Production divided by productivity of labour by branch of economic activity yields the hours worked by branch of economic activity; summing up these hours gives us the aggregate hours worked. Restrictions might emerge from the supply side: if production grows too fast in relation to the available supply of working hours, it forces a decline, while in the opposite case it allows stronger growth in production. For instance, the trend correction might be used for the year 2030, the aggregate hours worked are replaced with the number of working hours available.

The employment data set of the demand side contains working time, hours worked and the employed by branch of economic activity. Working times vary by branch of economic activity. Technically, we have set the working times for all branches of economic activity at the same level for the year 2030 (in national account data sets), and the working time by branch of economic activity approaches this level using the coefficient of steady change computed for each branch of economic activity.

At demand side variables are at industrial level for period 1960-2030 at yearly bases and are related so that

PRODUCTIVITY OF LABOUR (HISTORY) = PRODUCTION : HOURS WORKED

HOURS WORKED (FUTURE DEVELOPMENT) = PRODUCTION : PRODUCTIVITY OF LABOUR

Supply side

Population data

The labour calculations are based on the population forecasts. The population forecasts can be modified by adjusting the assumptions about immigration, birth rate and mortality, which allows calculations to be made on an alternate basis. The forecasts of population includes consistent data at the regional and at the municipal level.

Supply of Labour
Population forecasts
Estimates of activity rates by 5-year age groups for both genders:
A. Factors affecting special age groups: education and training, domestic work at home, disability, retirement
B. Cohort effect: population cohort with its educational, fertility and health characteristics
C. Impact on the demand for labour: availability of jobs, discouragement effect, working time, share of part time work

Participation rates (activity rates)

The future supply of labour is the outcome of predicted labour force participation rates and populations forecasts by five-year-age-groups for men and women, covering the population of 15 – 74 years. Statistics and definitions are based on the Labour Force Survey (employed, unemployed, people not in the labour force).

Several aspects and sources are evaluated and used for predicting the future labour force participation rates:

- The history of the population cohort with its educational, fertility and health characters. The baby-boom cohorts (born in 1946-1950) are special in the Finnish population because of their size and an 'avantgard' societal behaviour. The life patterns regarding working life are different for cohorts before and after them. For instance, the baby boom cohorts have been better educated than the earlier cohorts and consequently their activity rates have been at the higher level.
  - ⇨ LFS time series, but there is a break in time series in 1989.

- The share of people in training and education. The plans and targets are considered.
  - ⇨ Plans, targets and estimates carried out by the Ministry of Education and the Board of Education.

- The share of people performing domestic work: taken into account the impacts of birth rate, child and family allowances, conciliation of work and family life and care for dependant people.
  - ⇨ Expected share of parents on parental leave and on other kind of family policy leaves and share of people caring elderly (dependant adults); calculations by the Ministry of Social Affairs and Health.

- The share of disabled people and pensioners.
  - ⇨ The calculations of the development of pensioners by the Ministry of Social affairs and Health, the Social Insurance Institution of Finland and the Finnish Centre for Pensions.

Anticipation Method of Supply
Time series analysis, trend extrapolation:

Plans, targets and estimates of Ministry of Education taken into account	
Estimates of parents on parental leave and on other kind of family leave (e.g. caring for the elderly); calculations by Ministry of Social Affairs and Health	
Proportion of pensioners among working age population; the Social Insurance Institution of Finland and the Finnish Centre for pensions	

In calculations variables are at yearly bases for the period 1960-2030 and are related so that:

$$\text{LABOUR FORCE PARTICIPATION RATE} = \frac{\text{LABOUR FORCE}}{\text{WORKING-AGE POPULATION}} \times 100$$

$$= \frac{\text{POPULATION - PERSONS NOT IN THE LABOUR FORCE}}{\text{WORKING-AGE POPULATION}} \times 100$$

so that working age population not in the labour force is

WORKING-AGE POPULATION IN RETIREMENT + STUDENT POPULATIONS + HOUSEHOLD DOMESTIC WORKERS AND PERSONS OTHERWISE NOT IN THE LABOUR FORCE

Additional labour force participation rates include standard rates and labour force participation rates from the previous peak of business cycle and the previous modelling. These labour force participation rates, calculated on a basis other than the number of persons not in the labour force, are needed for the evaluation and control of output, because the calculations concerning persons not in the labour force have been made separately from all others and the output thus has to be made compatible with the whole.

Working time

Working hours and the share of part-time work has to be taken into account, both at the supply and demand side of labour.

Demand and supply are changed to input in working hours by using working time. Interaction between supply and demand achieves imbalance and demand influences on supply (total and differently by age categories and supply on demand). Influences are differing during business cycle and at long term.

The working time data set first shows general working time factors that concern all age groups. Age-group-specific factors are presented separately by five year age groups for men and women. The figures are given as working days per employed person by five year age groups. Working days are then multiplied by projections of the number of people employed, yielding the aggregate number of working days. Multiplied by the number of working hours per working day, this yields the aggregate hours worked. The number of people employed is obtained here by taking as the basic data the labour force under conditions approaching low unemployment. The unemployment rate verges on full employment, and employment accordingly increases.

This method is aimed to give us the number of working hours available. The aggregate supply of working hours is copied into the production data set of the demand side, after adjusting the level to agree with the levels from the national accounts.

Interaction of demand and supply

The level of demand of labour affects the supply: the higher the demand, the higher the labour force participation rates. We were able to calculate the labour supply for a certain level of demand, i.e. a certain level of unemployment at baseline development. When demand is higher or lower, supply changes and demand elasticity in supply is used. Then this aggregate change in supply is transferred to age- and gender specific figures taken care of different age-gender-spesific elasticities.

The numbers of people employed, in line with the national accounts, are copied to the data set and adjusted to agree with the Labour Force Survey. We do adjustments with the demand and supply of labour: as the unemployment decreases, an effect will be a growth in supply of labour force participation.

Interaction between demand and supply of labour
•Demand oriented production growth limited by labour productivity (production growth elasticity) and supply of labour when unemployment becomes low
•Labour supply limit mitigates when domestic labour resources are in better use and by immigration labour supply elasticities of demand
•Basic demand side calculation at national account statistics level. Transformation of employment to labour force survey level used at supply side

Alternative scenarios

Standard analyses is basing on base line which is most probable development path. High and low growth line are useful and also sensitivity calculation are necessary so that we see what happens when there are alteration in central variables. Target line is useful for strategical and political and other decision making.

Alternative Scenarios
Basic scenario: most probable development path

Target scenario: high employment, high productivity, good jobs, low unemployment in context of sus
tainable development

Balancing of demand and supply in medium and long term

Sensitivity calculations
- higher and lower growth of production
- higher and lower productivity growth
- alternative population developments
- different developments of participation rates
- assessment of risks

LTM-regional model

Aluemalli rakentuu samoille elementeille kuin valtakunnallinen malli, jonka tulokset siirretään lähtökohdaksi aluetason analyysiin. Suomessa regional level calculations are made in cooperation with aluehallinto (vuoden 207 loppuun asti the Ministry of interior affairs) ja opetushallinnon kanssa siten, että ammattirakennelaskelmat on toteutettu opetushallinnon mallilla valtakunnallisella ja aluetasolla.

Occupational structure and educational needs

Next step is the calculation of occupational structure and the educational and skill needs by method which is called the labour force requirement method. In Finnish praxis **the forecast of demand for labour by industry** is taken from the LTM-model and now a days transferred to Mitenna model. This model is used in calculation of occupational strucuture, withdrawal from labour force and educational needs. The method applied in the anticipation of the National Board of Education[4]. In Finland, the labour force requirement method was first used as a tool for planning education and training at the end of the 1960's. The Planning Secretariat that operated under the auspices of the Ministry of Education developed the method further and used it to prepare several forecasts for demand for educated labour. In the anticipation project of the National Board of Education, this method has been developed further by adding new parts and by making the processing of the background material used in the model more precise. The impacts of the unemployed labour force and occupational transitions, for example, were taken into account more precisely than before. The method uses extensive statistics and calculations of the future demand for educated labour.

Employment results of former are transferred to latter. The model's structures and use are described below to the extent that they are relevant to this work.

Occupation and job openings
•Transformation of employment to population statistics level by industry
•Demand of labour by occupation by industry and at total economy level (national board of education)
•Job openings change of employment and exit form labour market (retirement)
•Base and target scenarious
•Educational needs (national board of education)
•Skill needs

The labour force requirement method in Mitenna is divided into two sections. The first focuses on the needs of working life, anticipating demand for new labour. This covers the amount of labour

[4] National Board of Education (2000), Demand for Educated Labour in Finland by the year 2010 and the Dimensioning of Education and Training. Abridged English version of an anticipation publication entitled Vocational education and training 2010. Demand for labour in 2010 and dimensioning of vocational education and training. Hakapaino Oy, Helsinki 2000, Finland. From the method a presentation in Hanhijoki Ilpo (2006), Anticipating educational needs in Finland. In Peer Review Meeting Forecasting Skills and Labour Market in Helsinki 6 – 8 June 2006.

required by economic life and the types of education it will need the labour force to have in the anticipation period. The calculation consists of forecasts of changes in demand for labour and estimates of labour wastage. The second section of the method concerns the supply of labour. The majority of the supply of new labour comes from new young age groups. In addition, the unemployed labour force will bring its own addition to the supply. Occupational transitions in working life will have an influence on the occupational structure and will increase or decrease labour supply in each occupational group according to whether the occupational group concerned is a net winner or loser after the transitions. In addition, the supply of labour will be influenced by labour force participation rates, i.e. the proportion of the working-age population included in the labour force.

Job openings and educational needs of working life

In the calculation of educational needs the starting point is the forecast of demand for labour by industry which is taked from the LTM-model. The next step is to anticipate the **future occupational structure in each industry**. This is accomplished by examining the present occupational structure and changes that have previously occurred in the structure and by anticipating future developments. The difference between the anticipated and present occupational structure indicates the change in the occupational structure during the forecasting period.

Along with changes in the occupational structure, **natural wastage of labour** because of retiring is investigated. This means the proportion of those in an occupational group, who will permanently leave the labour force due to retirement (through old age), disability or death. Consequently, the wastage data consists of age-related wastage and other permanent wastage.

Adding up the change in the occupational structure (expansion demand which can be positive or negative) and replacement natural wastage (**replacement demand**) results in the **total demand for new labour** or **job openings** during the forecasting period.

It's necessary t note that **new jobs** is diffferent concept. If there are more new jobs than **lost jobs** ("creative destruction") expansion demand or **net change of employment** is positive. Part of jobs are lost in the process retiring and another part in other restructuring. New jobs, lost jobs and net change in employment are concepts which can be used at aggragated level, at industry or sectoral level, occupational, level and regional level or also at firm or working place level. This demand side point of view which is linked to supply side and supply of labour as also need of new labour because of supply side retirement process which tightely related to ageing process and population development.

Forecasts by occupational group and data on changes concerning working life are converted into forecasting data conforming with the classification of fields of study by using a **correspondence key to match occupational groups and education**, which was specifically constructed for that purpose. The correspondence key is constructed by assessing the different types of education for each occupational group that make it possible to achieve the vocational competence necessary in this particular occupational group. In order for economic life to obtain a sufficient amount of appropriately educated labour, the intake to education should exceed the demand for new labour. Different types of education vary considerably in terms of popularity. Not all fields are able to attract as many students as their annual intake can accommodate. Conversely, there are other fields where demand exceeds supply. Some students interrupt their studies, whereas others complete several educational qualifications. Not all people who have completed a qualification will move into working life straight after they leave school. The proportion of people who have started a study

programme in relation to the number of student places available in the intake is known as the occupancy rate. The completion rate of education in turn means how many of those who have started a programme will complete the qualification. Multiple education means completing more than one educational qualification. When these factors – occupancy rates, completion rates, rates of multiple education and labour force participation rates – are taken into account, this will result in the intake needs in education from the perspective of working life. These are called the **educational needs of working life**.

There is neet to estimate the **intake needs of education for young people** and **the intake needs of adult education and training** which are estimated separately for the employed and the unemployed labour force.

Labour supply of unemployed people

The labour supply of unemployed people taken into account in the calculations comprises the number of unemployed people in the base year, after the figure for natural wastage has been subtracted (Figure 3). In addition, the calculations of labour supply also allow for the remaining working life of unemployed people. According to studies conducted in Finland, it is unlikely that unemployed people aged over 55 will return to work, which is why this group has not been included as part of the reserve labour force in the anticipation.

Concistency of supply of labour here and in LTM model is checked.

Calculations are regionalised so that LTM regional model employment by industries is transfered to Mitenna model and occupational calculations are made by using this employment data.

Summary on methodology and concepts and clarifications

We have now analyzed gowth accounting method, long-term labour force model (LTM) and labour force requirement method and clarified how they are interlinked in the approach in analyzing developments in growth, productivity, employment and job openings at demand side and population and labour force developments at supply side. Growth accounting can be made at yearly bases and for periods. LTM-analyses is made at yearly bases but calculations can be derived also for periods. Occupational prospects analyses are made for periods. Quantitative calculations are main task but also qualitative analyses is useful and necessary because then we can include to analyse aspects which are not quantifiable or difficult to quatify. Still good quantitative analyses is helping also qualitative analyses – both are needed and also conceptual and other clarifications.

Concepts and clarifications I

Methodological aspects

- Consistency because of calculation framework
- View on economical and social development in world and national economy, integration developments
- Time series trend analyses benefeted and modificated

•Non-linear development, ghange in trends and structural changes carefully analysed benefeting historical development and observating new features in development, new phenomen and weak signals
•Knowledge of experts benefited

Growth accounting as framework
•Production factors, total factor productivity, other productivity concepts and link to ecoefficiency (national resources productivity as the bridge)
•Unuse of resources and production factors
•Quality in products and production factors
•Strategy: future growth is based more on total factor productivity, skill and knowledge, quality, better use of resources and innovative dynamism

Concepts and clarifications II

•Change in employment and replacement demand
•Job openings (before) covers change in employment plus replacement because of retirement
•In retriment jobs are partly covered directly and – when lost - partly by new jobs
•New jobs cover lost jobs in process of retirement and other lost jobs (replacement demand) and ghange in employment (expansion demand)
•Ghange in employment is new jobs minus lost jobs (called creative destruction)
•Total demand tell quantity of jobs and change in employment. New demand (jobs), job openings and replacement demand tell the process

Clarification: open jobs are including job openings and flows from job to job or between job and household work or education

V Empirical results

Finland

For Finland the year 2010 will be an unprecedented turning point in terms of population, as the number of people of working age will begin to fall. This decline will continue throughout the whole review period despite anticipated immigration. The basic reason for this development is the ageing of the post-war baby boom generation and those born in the 1950s, which will have many different impacts on the economy and on society in general. It is essentially a question of how well the economy and society can adapt to the changes this will bring.

In terms of figures, the demographic changes will mean that in the years 2010-2025 the population aged between 15 and 64 will decrease by 265,000, i.e. by about 17,000 a year, even if net immigration averages 7500 persons a year. During the same period, the number of those in the prime of working life, between 20 and 49 years old, will fall by 80,000, or 5000 a year. The number of children born is still declining, as the age groups of childbearing age are smaller than in the past. On the other hand, the number of over 65 year olds in the population will increase from about 870,000 in 2006 by half a million to 1,370,000 in 2025.

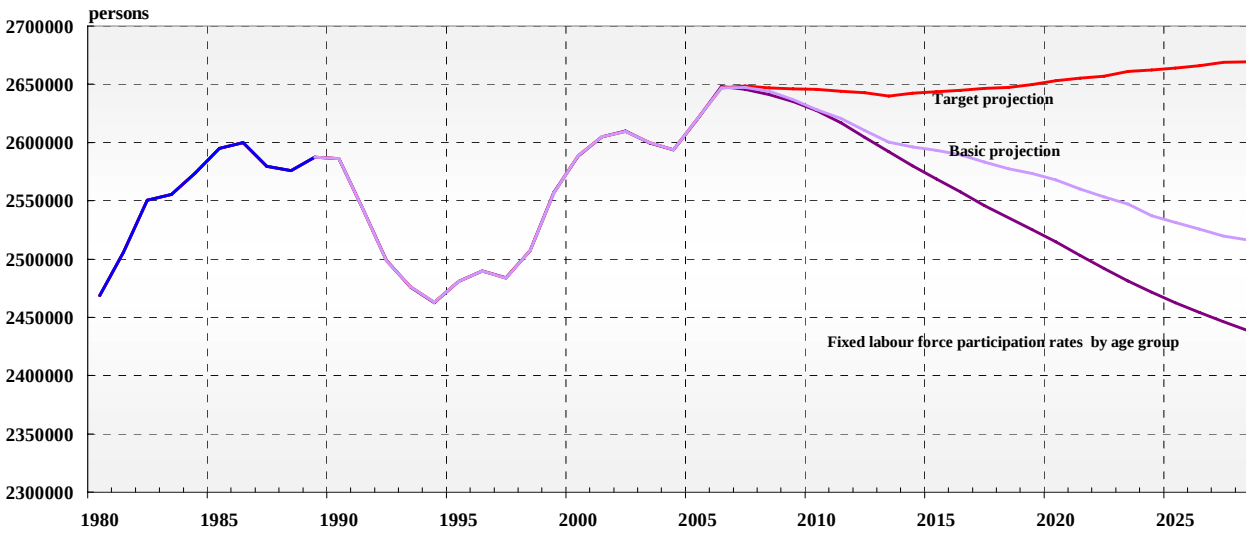
The most important objectives of economic and social policy are to maintain a high employment rate and a low unemployment rate. If achieved, they make it possible to build a sustainable foundation for financing the costs of a welfare state and for improving the well being of all population groups. High employment and low unemployment are also vital for ensuring that the decline in the working population does not lead to a shortage of labour.

The basic trend in the Labour Force 2025 report does not as such yet guarantee full employment, even though the general direction is towards lower unemployment. The employment rate will not rise above 70 per cent until the first half of the 2010s, when unemployment figures (according to the Labour Force survey) will approach 150,000, and the number of unemployed job applicants registered with employment offices will fall below 200,000.

In the target scenario, the employment rate would rise at the beginning of the 2010s to 72 per cent and by the mid-2010s it would come close to 75 per cent. Accordingly the unemployment rate would go down to 4 per cent, which is below the level it stood at before the recession of the 1990s. It is essential to eliminate structural long-term unemployment, which would mean that the unemployment connected with structural change would be short-term and would not cause the same problems as prolonged unemployment. Productivity and employment targets should be complementary but it’s difficult to achieve.

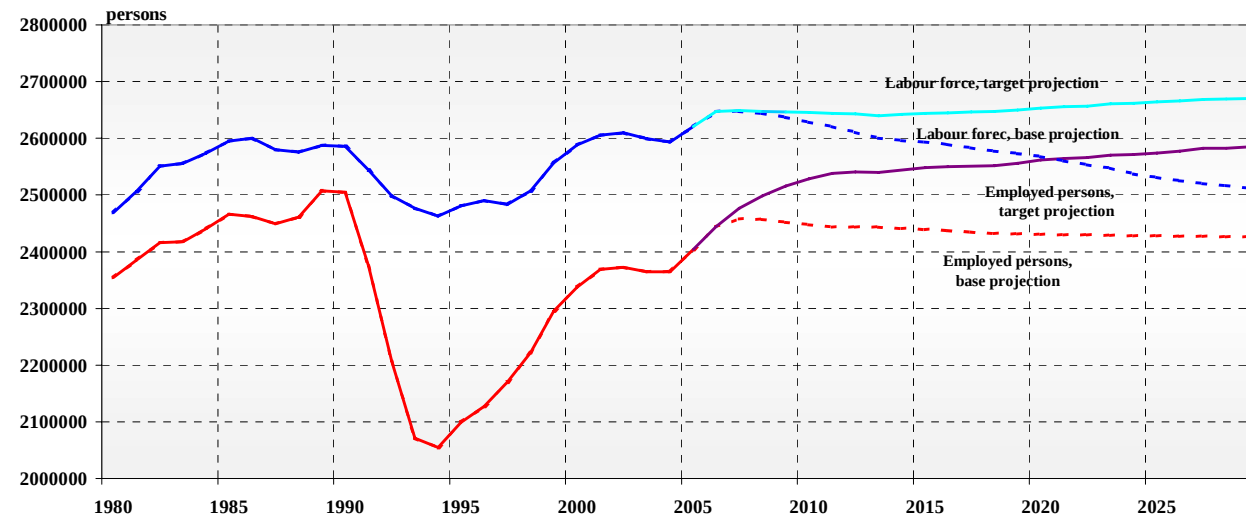
The contribution of total factor productivity had been large throughout the post-World War II period. In 1900-48 its share of total growth was 38 %, in 1948-85 60 %, and in the period of 1900-1985 its share was 51 %. In 1975-85 its share was 90 % but in 1985-90 only 40 % (Tiainen, 1994). In the recessions during the second half of the seventies and at the beginning of the nineties, the growth of the total factor productivity had not slowed down dramatically. After the recession at the beginning of last decennium the total factor productivity growth accelerated but employment also increased. In the future on knowledge, skills, total factor productivity and full employment basing growth is the target and give also possibilities to ecologically sustainable development.

Chart 3. Supply of labour



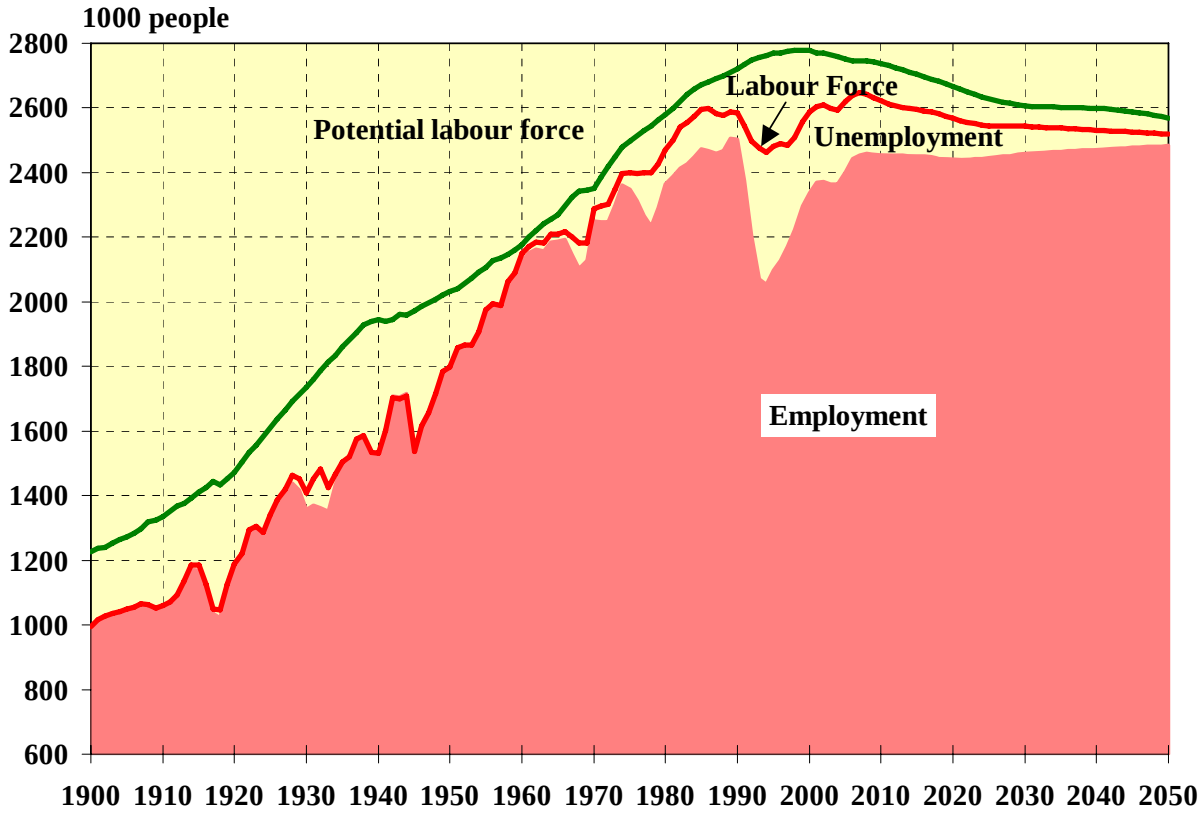
Labour Force 2025

Chart 4. Demand and supply of labour



Labour Force 2025

Chart 5. Employment and labour force in Finland between 1900-1950, base projection



Labour Force 2017, dated Labour Force 2025/Tiainen, Pekka 1999, 2007

Global

Below we will discuss a concrete example regarding the global economy and demographic growth. As basic figures, we will apply those used and presented in the Labour Force 2025 report. To make it more concrete, we will simplify the examination and focus on years 2005-2030, or a 25-year-period equalling one generation.

At the background of this is the population forecast estimating the world population in 2030 at 8.2 billion. In this estimate, the number of those aged less than 15 will grow little, the share of 15-64-year-olds in the total population will remain the same and the share of those aged 65 or over will grow. The share of population aged 15-59, which is monitored by the UN, in the total population will decrease, but this will be compensated by the increasing share of 60-64-year-olds.

The number of the employed in the world was 2.85 billion in 2005. An annual growth of 32-40 million in employment would mean that in 2030, the number of the employed would be 3.65-3.85 billion, or 800 million - 1 billion higher than today, in which case the growth of employment would be 1-1.2% annually.

The volume of labour force will increase from the 3.04 billion in 2005 to 4.07 billion in 2030. In that case, the number of the unemployed in the alternative based on lower employment increase will go up to 420 million and following the higher alternative increase only slightly to 220 million from the 190 million in 2005, and the employment rate, which was 6.25% in 2005 will be 10.3% in 2030, or in line with the more favourable development alternative 5.4%.

Next we need a link to growth and productivity, first the productivity of labour and then overall productivity. In this example, the higher employment level is linked to an average growth of 3.6% and the lower one to that of 2.9%. The former figure is the one based on the purchasing power parity in the Labour Force 2025 report, the latter the growth of GNP without purchasing power parity adjustment. The figure based on the purchasing power parity is greater, because the weighting of countries with lower income levels is higher, which increases the average growth, as the growth rates in these countries are faster. The idea here is that the GNP will approach the figure adjusted by purchasing power parity, when the global price and cost differences become smaller, which will increase the growth figure of the GNP, however not up to 3.6%. This is why 3.6% can be applied as the alternative of rapid growth and 2.9% as that of slower growth. Based on the current development, the growth may exceed the upper limit and, if we end up with the poorer development alternative, be lower than the lower limit. Based on estimates, however, the growth will with a significantly high probability be between these two figures.

As the increase of labour productivity will in this example be used 2.4% per each employed person in the faster growth alternative, and in the slower growth alternative 1.9% on the basis that there is a positive correlation between the growth in GNP and change in the productivity of labour, so that a change in the GNP growth is reflected by a third in the growth of labour productivity.

Based on these figures

Variation relationship in labour productivity x Variation relationship in employment = GNP variation relationship,

consequently

in the alternative of the most rapid growth

1.024 x 1.012 = 1,036 (2.4 + 1.2 = 3.6)

and

in the alternative of the slower growth

1.019 x 1.01 = 1.029 (1.9 + 1 = 2.9)

To make them more concrete, these figures have been rounded so that the products of the variation relationships and sums of percentage figures add up without a correction term. In accurate calculations, such roundings cannot be made in the calculation process, as they would produce an error that would cumulate over long term. Logarithmic applications are an alternative for avoiding these problems in scientific calculations.

In the Long-Term Model application, the concept of labour productivity is used in the global economy, also taking into account the working time factor, which in this simplification is kept constant over long term, in which case the number of completed working hours and the employed goes up at the same rate. The calculations concerning demand will be produced for each sector and aggregated. In the standard application, the change in the variation relationship of the GNP is reflected in the variation relationship of labour productivity by one half and in the case of more labour-intensive growth, by one third. In this global example, the change of GNP in the GNP variation relationship is reflected in labour productivity by two thirds, and consequently the employment development is not as sensitive to GNP changes as when using the standard starting point. In sensitivity calculations, the change between the variation relationships is varied, and the factors affecting it can be analysed and justified in greater detail in the different alternatives.

The next step in the analysis is applying growth accounting as a frame of reference and proceeding to quantification on this basis, in case it is possible to obtain adequate material. In addition to the factors discussed above, the income part of earnings, the quality factor of labour input and information on the capital input are needed. In case the country factor is specified, we also need data and calculations on the country input and its income share.

In this example, the share of earned income is 72.5% including the calculated earned income of entrepreneurs. This figure in the example is the same as the average for Finland in 1900-1985 according to Tiainen (1994). As the quality factor of labour input, one third of the change in employment is applied, in which case it corresponds to a growth in employment of 0.33 - 0.4% in the applied alternatives. As the growth in capital input will in this example be used a figure equalling the GNP growth, and consequently the productivity of capital GNP/capital input is a constant, similarly to the capital coefficient, as this is the inverse of capital productivity. Thus the capital input will grow in line with the GNP growth, and the country factor is not specified, as it is included in the capital input in this example.

With these basic figures, we obtain a total productivity of 1.2-1.5% and a share of 40% in GNP growth. The next step is to evaluate the figures based on the sensitivity analysis and then, based on incomplete or missing material, adjust the figures, as figures obtained from other studies have been used here, which are not necessarily applicable as such.

When the weighting of the labour input is varied between 55 - 80% in the sensitivity analysis, we obtain the range of overall productivity growth of 0.9 - 16% annually for the two growth alternatives, and a share in growth of 30% - 44%, whereas Tiainen (1994) obtains the average of 50% for Finland in 1900-1985, and an intensive growth would require a higher share.

This shows that if we aim for a higher share of overall productivity, the growth must be based less on the capital and country factors, in which case capital productivity and natural resource productivity, if analysed separately, will increase, or else the GNP growth will be faster without an increase in the capital and country input. This brings us to the core question of global development. A growth in GNP that would save resources, or reduce the use of both capital and natural resources, and highlight overall productivity, makes possible a growth in employment where the global increase in employment is adequate to prevent an increase in unemployment. Growth that is service and knowledge-intensive in its nature would reduce the pressures to increase resource use, and additionally working time development and the development of the amount of labour force, which is influenced by the expansion of education of young people in developing countries, play a role in a balanced development.

VI Conclusions

Growth accounting as a frame work and as part of it, a study of the demand for labour force based on the productivity of work and the supply of labour based on participation in labour force, is a useful approach in terms of national economy, regional economy, larger areas and the global level. This will help to gather essential variables in the same frame of reference and analyse past development and the alternatives of future evolvement.

Because of limitations of the material, it is useful to apply growth accounting as a frame of reference and to a conceptual study and quantification to the extent that material is available. A quantitative breakdown is easier to realise following the example of the Finnish Long-Term Labour Force Model analysis framework, based on the concept of productivity of work, matching demand and offer while also accepting the possibility of an imbalance. Additional calculations can be derived from this.

The sectoral demand for labour derived from the breakdown can be translated into development in individual professions. When the replacement of attrition due to retirements is added to this, we obtain calculations on job openings and based on that, needs for new labour and education.

As to demand, aggregation will be used in two senses: when reconciling sectoral calculations with the overall calculations and, similarly, regional calculations with calculations concerning larger areas. As regards supply, aggregation can be applied when reconciling the overall development of the population and supply with a categorisation by gender and age. The relationship between the aggregated and disaggregated levels is interactive and resolved in the modelling by making use of expert estimates and separate calculations.

The purpose of the analytic approach is to be able to discuss issues relevant to growth, employment, productivity, demographic development and the environment as parts of the same framework for analysis in order to seek a strategy and policies for reconciling the targets.

Demographic development plays a central role in this, as it creates pressures regarding growth, employment and the environment. Consequently, this represents a link between demographics and demographic research and the analysis of these issues, in which on the other hand the results and population forecasts of demographics are needed.

Even in a very simplified analysis, the results for global economy show that a good employment development while the global population keeps growing dramatically and economic growth can be best reconciled with the marginal conditions of the environment when the strategy of employment-

creating growth is emphasised, which saves resources and is based on overall productivity, knowledge-intensiveness and skills taking in consideration the whole population. This type of an approach is suited to examining an individual country, its regions, larger areas and also the global level.

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