Tiainen, Pekka (1999), Employment and Welfare in Finland in the Years 1860-2030. With application to European employment strategy.
-Appendix 3 Short description of the model used in Finnish medium and long-term projections (1991, 1995, 1999, 2003, 2007)

APPENDIX 3
Long term labour force model of Finland

1. Structure and use

The Long Term Labour Force Model (PTM or LTM), developed at the Ministry of Labour by PhD Pekka Tiainen, has been in use since 1990. The model's structure and use are described here to the extent that they are relevant to this work.

The calculation model for medium-term and long-term projections of the demand for labour services and the supply of labour services was developed in connection with the Labour Force 2000 project. The supply side of the model uses the levels from the Finnish Labour Force Survey and includes the population by five year age groups, the number of persons not in the labour force, labour force participation rates, the number of persons in the labour force and working time. The demand side uses the levels from the national accounts and includes productivity by branch of economic activity, production at fixed prices, the hours worked, the employed and the balance of manpower resources. The time series of the model, at the annual level, include short-term projections; any adjustment to them thus affects the medium-term and long-term results. These time series continue to the year 2030.

The model has since been updated at every opportunity and it has been used to make projections and calculations both for the Ministry of Labour's own purposes (medium-term and long-term growth projections and labour force projections, budgetary planning, employment effect estimates, the effects of integration on the labour market) and for other users. Among the very latest applications are the calculations for the Labour Force 2010 project; at the moment, employment figures from the LT-model are being used as part of the calculations for the Labour Force 2017 project. In the latter project, the figures are combined with earlier branch-specific figures

to outline economic growth factors over the period from 1860 to 2030.

The branch-specific projections of production, productivity, employment and the labour force have been adopted by various users as a basis for their own calculations: in the users' own specific calculations, the output from the LT-model has been modified for use at the regional level or used as the basis for calculations on occupational structure, educational needs and social expenditure. The Board of Educational Planning has taken the calculations one step further by computing labour wastage for each age group. By summing the change in demand for labour services with labour wastage, they obtained the need for new entrants to the labour market, from which they derived the need for new entrants by occupation and the need for vacant student places.

Projections of different integration alternatives and alternate labour market policies are obtained by introducing additional relevant factors to the model. Adjustments to the additional factors affect the other variables, which makes it possible to compute the effects of a single additional factor to e.g. the demand for labour services. Output from the model has also been used by other administrative branches and institutions for their own projections.

The model's usefulness stems from the fact that it allows various factors to be taken into consideration within the aggregate framework. It can also be updated with greater flexibility than earlier models: it takes into account the latest developments and user needs. At the same time, it is detailed enough to take into account various changes in population structure, social development policy and the development of various branches of economic activity.

2. Description of the model

The long-term 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. The contents of each data set and the connections of the sets are described in the following.

Supply of labour services

Population data set

The population data set contains five year age groups for men and women. The population forecast used is the most recent one by Statistics Finland. It can be modified by adjusting the assumptions about immigration, birth rate and mortality, which allows calculations to be made on an alternate basis. This data set also contains the labour force participation rates for men and women and the labour force by five year age groups. The labour force is the product of age groups and labour force participation rates, and the labour force participation rates are copied from the labour force participation data set. Labour force and labour force participation rates are adjusted to match the computed demand for labour services, for the demand affects the supply.

Persons not in the labour force

Each group of persons not in the labour force has a separate data set containing five year age groups for men and women. Persons in retirement are grouped in pension categories by five year age groups. The basic data are forecasts from the National Pensions Institute and the Central Pension Security Institute. The levels are adjusted to agree with the population forecast used here. As the population forecast changes, the number of persons in retirement changes accordingly. In order to eliminate duplicate objects, the number of persons receiving national pension is taken as the basis for calculations; the number of persons receiving employment pension but no national pension is then added to these figures.

In order to determine the number of persons not in the labour force, it is necessary to first compute the employment participation rate of persons in retirement. The appropriate ratio is obtained as the proportion of persons not in the labour force because of retirement - from the Finnish Labour Force Survey - to pensioners in these calculations, by five year age groups. The levels have been adjusted to agree with data from the employment register. Labour force participation rate is fixed to begin with, but it can later be adjusted on special grounds.

The data set of persons in education is divided into five year age groups by type of education. As basic data, we again use the standard participation rate in education or training for each age group. The standard rate is then adjusted to agree with e.g. the aims argued in educational planning. The employment participation rate of persons in education is computed and duplicate objects are eliminated from the figures as with persons in retirement.

The reasons behind household domestic work are classified by five year age groups. This data set also contains conscripts. Standard rates are assumed and adjusted on special grounds, participation rate in gainful employment is computed and duplicate objects are eliminated.

Labour force participation rate

The labour force participation rate data set contains the proportion of the population not in the labour force by five year age groups for men and women. Persons not in the labour force have been divided into three groups: in retirement, in education or not in the labour force for other reasons, e.g. household domestic workers. In order to compute the labour force participation rates, projections are made of the development of these groups by five year age groups. This process uses development projections from Central Pension Security Institute, the SII (Social Insurance Institution), education administration and the Ministry of Social Affairs and Health, made for their own sectors.

The labour force participation rate estimates thus obtained are used to adjust labour force participation rate estimates from earlier rounds of calculations. The resulting labour force participation rate equals 100 minus the percentage of the population not in the labour force, where the proportion not in the labour force equals the sum of proportions of the population not in the labour force due to retirement, education or other reasons.

The labour force participation rate data set contains other labour force participation rates obtained from different calculations. In labour force participation rates based on a cohort principle, the standard labour force participation rates are multiplied by the coefficient of cohort effect. The coefficient of cohort effect equals the labour force participation rate of the preceding five year age group five years earlier, divided by the corresponding participation rate six years earlier. This mirrors the assumption that the change in behaviour that took place when a five year age group belonged to the five year age group from one year earlier than the preceding five year age group is repeated when the age groups are older by five years. Herein lies a difficulty, as change in labour force participation rate always involves other reasons besides the cohort effect, and in this treatment, only cohort changes come out in the proper light.

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

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

= 100 - 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.

Part-time work

In the part-time work data set, persons at work part-time are in five year age groups for men and women. The extensive data set allows the grouping of persons at work part-time by their reason for doing part-time work. The amount of part-time work is one of the key factors explaining the difference in employment levels between the Labour Force Survey and the national accounts. In the Labour Force Survey, the number of persons at work part-time is simply added to the number of employed persons, while in the national accounts this is based on full time. The change in part-time work is useful in adjusting the levels from the national accounts to agree with the levels from the Labour Force Survey. This is done in the working time data set.

Working time

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.

Demand for labour services

Production

The production data set contains the productivity of labour, the Gross Domestic Product and the hours worked, all by branch of economic activity. The development of production and productivity is projected first, using the latest forecasts of low unemployment situation from different branches of economic activity and, for recent years, particularly calculations using the KESSU model. 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. The supply of working hours, copied from the working time data set, represents the long-term maximum for hours worked: if production grows too fast in relation to the supply of working hours, it forces a decline, while in the opposite case it allows stronger growth in production. Trend correction is used here: for the year 2030, the aggregate hours

worked are replaced with the number of working hours available. For the intervening years, a coefficient is used, gradually approaching the 2030 ratio of working hours available to hours worked. The number of hours worked, for each branch of economic activity, is multiplied by the series of ratios obtained. Next, the time series of production for each branch of economic activity are multiplied by the corresponding ratio, and a match is achieved between the level of production and the long-term restriction imposed by the number of working hours available. To achieve a match between aggregate GDP growth for the next few years and the growth projections of e.g. the Ministry of Finance, the production growth figures by branch of economic activity for the next few years are either adjusted or multiplied by the necessary ratio. Each time the situation changes, adjustments must be made to match the level of hours worked, in the long term, to the level of working hours available.

PRODUCTIVITY OF LABOUR (HISTORY) = PRODUCTION : HOURS WORKED

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

The population forecast is copied from the population data set, by five year age groups, into the data set of persons not in the labour force, the working time data set and the labour force participation data set. Changes in the population forecast thus affect the restriction imposed by working hours available and, thereby, also production growth. If e.g. immigration increases, production growth can become stronger, and vice versa. The change in population can also be taken into account in a rough manner through labour force time series, based on different population forecasts and situated in the production data set. The effect on production is obtained by multiplying their ratios to the labour force, based on the baseline population forecast, by the number of working hours available. A third technique would be to leave the restriction of working hours available unchanged even though there were changes to the projected production growth, for one reason or another. In this situation, the difference between hours worked and working hours available tells us whether the working hours required in production exceed or fall short of the number of working hours available, and by how much.

The employed and unemployment

The Employed data set on the demand side contains working time, hours worked and the

employed by branch of economic activity. Hours worked, by branch of economic activity, are copied from the production data set. If we divide them by the 'working time' time series, by branch of economic activity, we obtain the number of people employed by branch of economic activity at the national accounts level. Average annual working time per person is copied from the working time data set. 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, 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.

The Employed data set also contains the balance of manpower resources from the Labour Force Survey. 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. Labour force is calculated on the basis of labour force participation rates and population, and it is obtained from the population forecast. Part of the change in unemployment rate is eliminated by making an adjustment to the initial labour force. In the adjustment, the assumed elasticity can be e.g. one third: as unemployment falls, one third of the effect will be felt in the growth in supply of labour services. Using elasticity of change in

employment, the change in employment is reflected in the supply of labour services with a weight of one fifth. The weight is smaller than when using unemployment when changes in unemployment are smaller than changes in employment. The ratio varies with the business cycle, and it can be adjusted. Unemployment can be obtained similarly, as the difference between labour force and the employed.

NUMBER OF PEOPLE EMPLOYED	=	HOURS WORKED : WORKING TIME
NUMBER OF PEOPLE UNEMPLOYED	=	LABOUR FORCE - NUMBER OF PEOPLE EMPLOYED
	=	LABOUR FORCE - HOURS WORKED : WORKING TIME
	=	LABOUR FORCE - PRODUCTION : (PRODUCTIVITY OF LABOUR * WORKING TIME)

Balance of demand and supply

Feed back data to the population data set

The next step is to multiply the labour force in the population data set by the ratio of the adjusted labour force to the initial labour force used as the basis for calculations, by five year age groups. Labour force participation rates are similarly adjusted, as are the data sets for persons not in the labour force, when the calculations are completed. Adjustments are made either to all age groups and groups for persons not in the labour force, using a fixed ratio, or, if necessary, to a specific group. The Federation of Finnish Metal, Engineering and Electro technical Industries has taken the calculations even further in its own branch of economic activity by introducing a more precise occupational classification.

Updates and simulation

The data sets will, in time, be updated to carry new data based on actual developments. Calculations will be repeated to update the time series into the future. As long as the changes are relatively small, the end results will not become dramatically altered, only more defined. Major changes will, correspondingly, bring major adjustments to all parts of the model: in practice, the calculations will have to be repeated several times with greater and greater precision until the parts are in proportion to each other.

Correspondingly, when the developmental outlook changes for some branch of economic activity or for social development policy, adjustments are made to the model where necessary and an overall update is initiated. The same procedure is used to simulate the effects of any potential change: adjustments are made where necessary and otherwise the steps are the same as for updates. To calculate the effects of integration, the projections of production and productivity by branch of economic activity are adjusted to include coefficients representing the change. These coefficients are derived from various surveys and other projections. This method can also be used to simulate the effects of e.g. employment measures.

The different parts of the model are connected, and copying from one data set to another can be done manually. This is a time-consuming process, however: automatic data transfer using macros both facilitates and speeds up the process. This model therefore incorporates an application, based on Excel macros, which copies the necessary fields from one data set to another. The macros are built to ensure that all calculations are made all through from the same initial data. In feeding back data, the end result of the calculations is used as basic data in the next round of calculations. This is the rationale for copying labour force participation rates from the labour force participation rate data set to the population data set: the labour force participation rates introduced are a combination of the initial labour force participation rates and the labour force participation rates derived from the number of persons not in the labour force. The labour force participation rate computed in the employed data set and adjusted to the change in unemployment is also copied to the population data set.

Further calculations

The Ministry of Education uses the obtained employment needs by branch of economic activity to compute the demand for labour services by occupational category, taking into account changes in the number of people employed in each branch of economic activity and in occupational structure within each branch. This yields the change in

number of people employed by occupational category. Summing it with loss by occupation, projected at the Ministry of Education, gives us the need for new entrants to the labour market by occupation. These projections are used by the Board of Educational Planning in estimating the need for vacant student places. The Ministry of the Interior correspondingly adjusts the figures for people employed by branch of economic activity for use at the regional level. Other administrative branches have corresponding uses for the output: the Ministry of Social Affairs and Health uses the output for calculations of social expenditure and pensions and the Ministry of the Environment and the Ministry of Trade and Industry both have their own uses for the output. Eurostat and the OECD use the forecasts in their own projections of labour force participation rate and labour force. The data obtained from the calculations yield several key ratios, e.g. the dependency ratio.

DEPENDENCY RATIO = (WORKING AGE POPULATION NOT IN THE LABOUR FORCE + NON-WORKING AGE POPULATION + THE UNEMPLOYED) : THE EMPLOYED

The employment series from the labour force model, with adjustments made at the Ministry of the Interior, have been published in the Labour Force 2010 report. These series are useful, as they are in harmony with the baseline projections and they can be used as the basis for surveys at the regional level, e.g. in labour districts. In updates to the baseline projections, figures from the regional level can be adjusted using a fixed ratio unless there are major changes. Of course, if development at the regional level deviates from the projected development, this can be taken into account in later calculations at the regional level, as long as summings at the regional level correspond to the figures at the national level. Calculations at the regional level are also made for other purposes and using other methods. Difficulties arise if the levels are not adjusted to agree with the levels from the Labour Force Survey. Additional differences can be found in key ratios.

3. Summary

Growth accounts are one of the theoretical methods of analysis behind applied statistics on economic variables. It allows economic growth factors to be analysed up to a classification by branches of economic activity. The long-term model for labour force projections gives us projections of future demand for, and supply of, labour services. It can also be used to derive projections of the size and development of other economic variables, e.g. the balance of resources and expenditure, up to calculations by branch of economic activity. The PTM model's classification of branches of economic activity is slightly rougher than that used in growth accounts, but the correspondence between sum and sector branches enables the two calculations to be combined with little effort.

Growth of the Finnish economy has been studied extensively, but there has been very little examination of long-term economic growth. Neither growth accounts nor growth theories in general have been applied to long-term studies of the economy as a whole. Examinations have commonly been restricted to specific questions or branches of economic activity without attempting to achieve a more comprehensive or integrated interpretation of factors in the process of economic growth. Factors affecting technological development and the effect of technological development on growth may not have been studied from all available angles, either. Advances in theoretical thinking and the availability of better data have opened new prospects for the studying of factors that have a long-term effect on growth. The database at hand will enable these calculations to be made on uniform data beginning from the early days of industrialisation.

Appendix   Middle- and long-term labour force demand and supply in Europe, possible application 5.5.1999

The target

The target is to analyze sources of growth and employment in Europe at medium and long term by using an application of growth accounting used in Employment and Welfare in Finland in the Years of 1860-2030.

The main point developments and interaction between demand (growth, productivity, labour demand developments) and supply side (population, labour force participation rate, labour force, unemployment

developments).

Countries EU, EU states, Norway, Switzerland, possibly member candidates. Comparison with other OECD and other world.

The time interval 1990-2000-2005-2010-2015-2020-2025-2030 (calculation at yearly level). The aggregate level in the history and the future 1860-2030 at yearly level.

Variables, demand side: aggregate level 1860-2030 and industrial level 1990-2030
-Quantity of production (GDP) by industry and at aggregate level Q
-Employment by industry and at aggragate level L
-Working Time per employed by industry and at aggregate level WT
-Working Hours by industry and at aggregate level H
-Productivity by industry and at aggregate level Quantity of production per Employed Q/L
-Productivity and at aggregate level Quantity of production per Working Hours Q/H

Calculation level, if possible, at highly disaggregated level; results by industries as agriculture, forestry, industry (electronic, other metal, forest, other), construction, traffic, trade, financing, business services, education, welfare services.

If possible
-Capital input at aggregate level K
-Capital productivity Quantity of production per capital Q/K
-Nominal GDP N
-Labour costs W
-Labour share of production w=W/N
-Total Factor Input $TFI=\exp[(w_t + w_{t-1})/2 \ln H_t/H_{t-1}+(1-w_t - w_{t-1})/2 \ln K_t/K_{t-1}]$
-Total Factor Productivity TFP=Q/TFI

Variables, supply side and labour force balance: aggregate level 1860-2030, by age and sex 1990-2030

-Population POP
-Labour Force LF
-Unemployment U=LF-L

Projection method (simplified idea): Demand Approach: L=Q/[(Q/H)/WT], U=LF-Q/[(Q/H)/WT]. Q, Q/H and WT-forecasts as the starting point, LF from EU-projections but fluctuating with Q

Projection method (simplified idea): Supply Approach: Q=[Q/H]*H=[Q/H]*[LF-U]*WT. Q/H, LF, U and WT forecasts as the starting point

Basic scenario alternatives

-High: high GDP and labour productivity growth –
GDP +1 percentage point means Q/H +0,5 percentage

point, high population, high labour force level – $LF_{HIGH}=LF_{BASIC}+0,2*(L_{HIGH}-L_{BASIC})$; coefficients can be changed
-Basic, probable
-Low symmetric with high projection
Structural alternatives
-High labour productivity growth
-Low labour productivity growth
Other dimensios
-High/low projection with changes in domestic/foreign labour force. Possibly other population projections
-High/low labour productivity growth with capital productivity
Strategy alternatives

Other issues
-Connections to socio-cultural factors: Nordic welfare state cluster, Middle and Western European cluster, Southern family-oriented cluster, Anglo-Saxian individualistic cluster, Eastern Europe cluster
-Other chances in demography and interaction with labour demand and supply
-Changes in employment and social policy

Data

-Demand side: history national accounts, Eurostat, Maddison, Angus, OECD, Summers world tables, UN, World Bank, IMF
-Supply side history and future: eurostat and national labour force projections

Possible extensions/applications

-Connection with EU's employment guidelines and general performance indicators developed by employment and labour market committee and its specialist group

-Eastern Europe, other world at aggergate level (North America, Latin America, Japan, other Asia, Oceania, Africa). Basically by the same method as concerning Europe

-The same procedure at regional level
-Extension to the balance of demand and resources (demand: export, consumption, investment, storages; supply: production, import)

Table 1   Unemployment and production

Production   Q   Productivity   Q/H Working hours $H = Q/(Q/H)$ Working time T
Employment   L   = H/T   Labour Force   LF Unemployment $U = LF - L = LF - H/T = LF - Q/[(Q/H)*T]$

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