Pellervon taloudellisen tutkimuslaitoksen työpapereita

Pellervo Economic Research Institute Working Papers

No. 80 (January 2006)

PRODUCTION, PRIMARY, SECONDARY, AND TERTIARY:

FINNISH GROWTH AND STRUCTURAL CHANGE, 1860-2004

Jukka Jalava

Pellervon taloudellinen tutkimuslaitos PTT
Pellervo Ekonomiska Forskningsinstitut
Pellervo Economic Research Institute

Eerikinkatu 28 A, 00180 Helsinki
Puh. (09) 348 8844, fax (09) 3488 8500
E-mail: econ.res@ptt.fi
www.ptt.fi

Pellervon taloudellisen tutkimuslaitoksen työpapereita

Pellervo Economic Research Institute Working Papers

No. 80 (January 2006)

PRODUCTION, PRIMARY, SECONDARY, AND TERTIARY:

FINNISH GROWTH AND STRUCTURAL CHANGE, 1860-2004*

Jukka Jalava

Pellervo Economic Research Institute and Helsinki School of Economics

January 2006

* I wish to thank Janne Huovari, Arto Kokkinen and Petri Rouvinen for helpful comments and discussions without implicating them for any remaining errors. My research is partly supported by the EU KLEMS project "Productivity in the European Union: A Comparative Industry Approach", funded by the European Commission, Research Directorate General as part of the 6th Framework Programme, Priority 8, "Policy Support and Anticipating Scientific and Technological Needs" (www.euklems.net).

ISBN 952-5594-06-8 (PAP)
ISBN 952-5594-07-6 (PDF)
ISSN 1455-4623

Pellervon taloudellinen tutkimuslaitos PTT
Pellervo Economic Research Institute PTT
Eerikinkatu 28 A
00180 Helsinki

Helsinki 2006

JUKKA JALAVA. 2006. PRODUCTION, PRIMARY, SECONDARY, AND TERTIARY: FINNISH GROWTH AND STRUCTURAL CHANGE, 1860-2004. Pellervon taloudellisen tutkimuslaitoksen työpapereita n:o 80. 27 s. ISBN 952-5594-06-8 (PAP), ISBN 952-5594-07-6 (PDF), ISSN 1455-4623.

Tiivistelmä. Tässä työpaperissa tarkastellaan Suomen talouskasvua sekä talouden rakennemuutosta vuosina 1860–2004. Vuonna 1860 taloutemme oli pääsääntöisesti alkutuotantovaltainen, mutta vuoteen 2004 mennessä palvelujen BKT osuus oli kasvanut suurimmaksi. Leimallista Suomen pitkän aikavälin muutokselle oli, että teollistuminen alkoi myöhään ja että resursseja siirtyi alkutuotannosta samanaikaisesti sekä jalostukseen että palveluihin. Toimialojen sisäinen tuottavuuskasvu oli tärkeintä vaikkakin talouskasvu ja tuottavuuden muutos oli nopeinta jalostustoimialoilla. Analyysi vahvistaa käsityksen siitä, että talouskasvu tapahtuu vaiheissa. Ajatus jalostuksen roolista talouskasvun ainoana moottorina ei saa vahvistusta.
Avainsanat: talouskasvu, tuottavuus, rakennemuutos, Kaldor, alkutuotanto, jalostus, palvelut.

JUKKA JALAVA. 2006. PRODUCTION, PRIMARY, SECONDARY, AND TERTIARY: FINNISH GROWTH AND STRUCTURAL CHANGE, 1860-2004. Pellervo Economic Research Institute Working Papers No. 80. 27 p. ISBN 952-5594-06-8 (PAP), ISBN 952-5594-07-6 (PDF), ISSN 1455-4623

Abstract. In this paper Finnish economic growth and the evolvement of the structure of the economy is observed. In 1860 primary production still dominated, while by year 2004 the share of services was the greatest. Characteristic to the Finnish long run economic transformation was that industrialization started late and that services increased directly at the expense of primary production. Industries' internal productivity growth was more important than structural change although growth and productivity in secondary production was consistently highest. Our analysis confirms the idea of economic growth taking place in stages. Yet, the role of secondary production as the single engine of growth remains uncorroborated.
Keywords: growth, productivity, structural change, Kaldor, primary, secondary, tertiary.

SISÄLLYSLUETTELO

YHTEENVETO

Tässä työpaperissa kuvataan Suomen pitkän aikavälin (1860–2004) talouskasvua ja rakennemuutoksen roolia kasvussa. Suomi oli myöhään teollistunut maa joka muuntui alkutuotantovaltaisesta taloudesta moderniksi hyvinvointivaltioksi jossa on suuri palvelusektori. Leimallista Suomen pitkän aikavälin muutokselle oli, että resursseja siirtyi alkutuotannosta samanaikaisesti sekä jalostukseen että palveluihin.

Voimme lisätä asukasta kohden laskettua tuotantoa ja siten elintasoa joko kasvattamalla tuottavuutta tai lisäämällä työpanosta. Nykyisin teemme vähemmän töitä asukasta kohden kuin vuonna 1860 tehtiin, mutta silti elintasomme on 22-kertaistunut. Selitys on se, että työn tuottavuus on 23-kertaistunut. Erityisesti jalostustoimialoilla tuotannon- ja tuottavuuden kasvu on ollut keskimääräistä nopeampaa koko tarkastelujaksona. Tosin toisen maailmansodan jälkeen alkutuotanto on pystynyt lähes yhtä nopeaan tuottavuuskasvuun kuin jalostus. Toimialojen sisäinen tuottavuuskasvu on ollut tärkeämpää kuin työpanoksen siirtyminen korkeamman tuottavuuden toimialoille matalan tuottavuuden alkutuotannosta. Tarkasteluajan lopulla onnistuimme nousemaan kolmen neljäsosan tasolle Yhdysvaltain bruttokansantuotteesta asukasta kohden.

Analyysi vahvistaa käsityksen siitä, että talouskasvu tapahtuu vaiheittain, mutta ajatus jalostuksen roolista talouskasvun ainoana moottorina ei saa vahvistusta. Teollistumisen myötä taloutemme rakenne muuttui peruuttamattomasti. Rakennemuutos itsessään oli pikemminkin seurausta kasvusta kuin syy kasvulle. Huoli talous- ja tuottavuuskasvun hidastumisesta palvelualojen BKT-osuuden kasvaessa on historian valossa liioiteltu. Suomen talouden rakenne tullee jatkossakin muuttumaan, sillä palvelualojemme BKT-osuus oli vuosituhannen vaihteessa edelleen noin kymmenen prosenttiyksikköä alhaisempi kuin mitä se oli Yhdysvalloissa. Korkean osaamisen palvelualojen merkitys korostuu sillä kehittyneelle maalle ainoastaan muutos on pysyvää.

1. INTRODUCTION

In the 1800s Finland was a backward agrarian country where as late as 1867-8 a significant part of the population suffered death by starvation when the crops failed. Finland embarked on the road of industrialization utilizing her forest sector, her hydropower potential and the rural labour reserve. The role of electrification as an enabler of productivity boosting technical innovations was critical. Characteristic to the Finnish long run economic transformation was that industrialization started late and that services increased directly at the expense of primary production. The share of secondary production in Gross Domestic Product (GDP) did not decrease until the 1970s. The classical view of structural change is that the main contributor to economic growth first shifts from primary production to secondary production during the process of industrialization, and subsequently from secondary production to tertiary production as the post-industrial stage is entered. What happens to growth when the gains from industrialization are depleted or the labour-saving nature of secondary production's productivity growth shifts the focus of the economy to services? Is it so as Baumol's (1967) hypothesis of unbalanced growth predicts that productivity growth in the whole economy will slow down when resources shift to service industries? Fortunately Oulton (2001) showed that that is only the case for those service industries which produce final goods, and not for the industries producing intermediate goods. What about Griliches' (1992) concern that when the difficult to measure industries' share of the economy grow, an inevitable slowdown in aggregate productivity is the result? The resolution of the quantification puzzle lies in better measurement, something which both the academic community and statistical institutes have focused on recently.

The Finnish share of services in GDP was only two thirds and the respective U.S. ratio close to three quarters in 2001 (OECD, 2003). Therefore, in an historical perspective, the challenges facing Finland in the 21st century are similar to those facing her when embracing the fruits of the second industrial revolution. It is inevitable that structural change will continue, and the role of service industries, particularly those using the fruits of the third industrial revolution, is paramount as our economy becomes increasingly weightless (Quah, 2001).

In this paper the evolvement of the present industrial structure will be observed and the impact of structural change on growth and productivity quantified. Special attention will be given to the hypothesis that manufacturing is the engine of total economy growth and that it exhibits increasing returns to scale; the Kaldor-Verdoorn growth laws. In the next section the growth of GDP per capita and its components are delineated from 1860 to 2004. Section three looks at the three main sectors and their development. The penultimate section tests whether Kaldor-Verdoorn laws stand the test of Finnish data and the final section concludes.

2. GDP PER CAPITA

A nation's economic standard of living is usually measured with Gross Domestic Product per capita. GDP is a flow measure that denotes the value of the goods and services produced during one year. GDP includes in its production boundary goods and services that have markets (or which could have markets) and products which are produced by general government and non-profit institutions. GDP is the best known and most widely used final product of national accounts. The system of national accounts, the current incarnation of which is SNA93, comprehensively connects flow accounts that capture various economic transactions taking place during the accounting period. Such activities as production, generation of income, and the distribution or use of income are all accounted for. These flows are linked with the balance sheets (stocks) of assets and liabilities. The flow accounts are also linked with each other so that the balancing item of each account, which is defined as the difference between total uses and resources, is carried forward to the following account. In that way each institutional sector's transactions are enumerated beginning with production and going all the way to the sector's financial status. That is, whether the sector is a net lender or net borrower with regards to other sectors.

Unfortunately national accounts do not measure the positive factors of the quality of life such as expected life length, health and clean environment. National accounts do not either measure the drawbacks on nature and human well-being due to negative externalities from production such as the pollution of the environment caused by spills or leaks from production plants. Furthermore, the production of "bads" like tobacco and pesticides is recorded as increases in output. An additional drawback with national accounts is that it is not designed to quantify income and wealth inequalities between social and economic classes.

Notwithstanding the aforementioned caveats GDP per person is the most valuable tool for measuring the economic well-being of a nation.[1] For an inter-temporal comparison of how a nation's living standards have evolved over time the impact of inflation needs to be subtracted. I.e., the GDP's per person in consecutive years must be expressed in the prices of some base year. The standard of living can be expressed as a product of its two components: labour productivity and labour input per capita. Labour productivity (GDP per labour input) is the more important one as it can grow without bounds. For the amount of work that can be done per person there is an upper limit. Therefore economic growth can in a long run perspective only be sustained by labour productivity change. Equation 1 shows GDP per person and its components:

[1] Development economists, such as Easterly (2001), have found strong positive correlations between the positive factors of the quality of life and GDP per capita.

$$(1) \qquad \frac{GDP}{population} = \frac{GDP}{labour\_input} \times \frac{labour\_input}{population}.$$

Labour input can be quantified either by using number of persons employed or by hours actually worked. The latter one is preferable as changes in the hours worked by employees due to longer vacations or shifts to atypical employment patterns otherwise distort the results. Hence the basic unit for labour productivity (LP) is GDP per hour worked. GDP per person is the higher the higher LP is, the larger the employment share of population is and the more each employee works. Economies can settle for a lower living standard by choosing to work less. This choice depends on how much society values leisure versus material well-being. A point in case can be discerned from the numbers compiled by the Groningen Growth and Development Centre.[2] Their purchasing power corrected GDP per capita figures for 2004 reveal that the United States had one of the highest living standards in the world. A result that is hardly surprising. Yet, countries such as Belgium, France, Ireland, the Netherlands, and Norway all simultaneously exhibited a higher level of LP and a lower level of GDP per capita than the US. Looking at equation 1 it is easy to figure out that these countries worked less per average person than what was done in the US.

Figure 2.1 shows the levels of Finnish GDP per capita and its components for the years 1860-2004. GDP at market prices is expressed in the constant prices of year 2000. The variables are in natural logarithms so that the logarithm of the material living standard is the sum of the logarithms of labour productivity and labour input per person:

$$(2) \quad \ln(GDP / population) = \ln(GDP / labour\_input) + \ln(labour\_input / population).$$

Two lessons can be learned from figure 2.1. First, it is obvious that the main contribution to the standard of living came from labour input. In 2004 each Finn worked on average 778 hours per year and GDP per hour worked was 35.3 euro. This means that GDP per capita was 27,400 euro. Second, the graph shows that the increase in material well-being stemmed from LP growth. In 1860 each Finn worked approximately 794 hours while LP was only 1.5 euro per hour. This amounted to 1,225 euro in the prices of year 2000. The standard of living grew 22-fold in less than a century and a half, even though fewer hours were worked in 2004 per capita compared to 1860. The explanation to this is that labour productivity increased 23-fold.

The labour input increased to approximately 1,000 hours per person in the 1940s. This

[2]See www.ggdc.net, Total Economy Database, January 2005.

level was kept until the late 1960s when the hours worked started to decline. The recession of the early 1990s brought the hours down to 700 per person from which level they rebounded to somewhat less than 800 hours. Interestingly, Finns are presently working less than ever before during their independence.

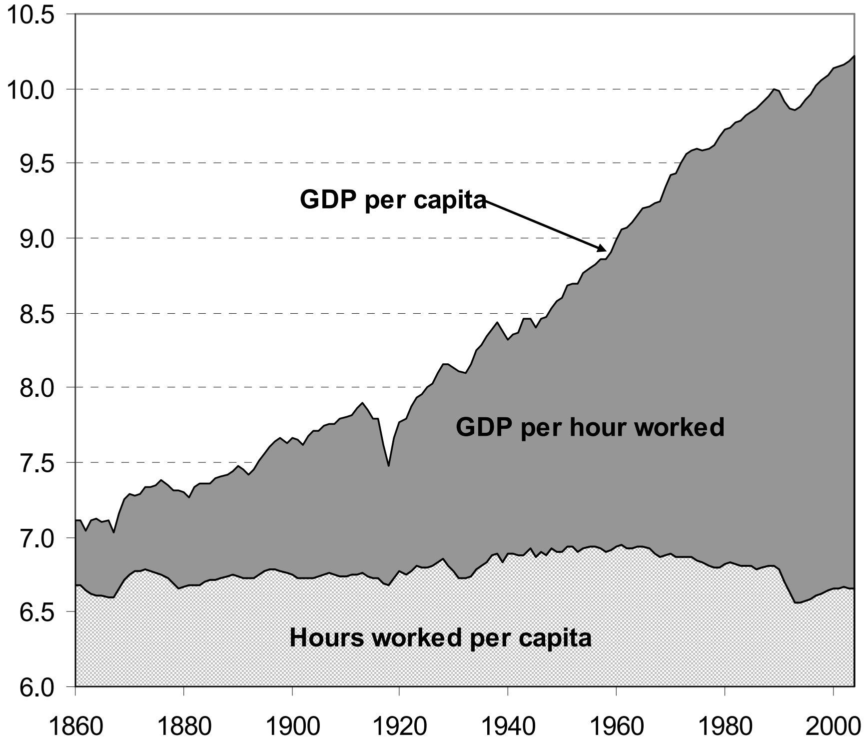


Figure 2.1 *GDP per capita and its components in Finland, 1860-2004 (LN, GDP at year 2000 prices)*

Source: Own calculations; data from Hjerppe (1996) and Statistics Finland.

Figure 2.2 shows the growth rates of figure 2.1's three level variables in the years 1861-2004. The annual observations often fluctuate quite much from year to year. Hence, a line from which short-term variations have been smoothed[3] out was added to the graphs. This simplifies the visual interpretation of the average growth rates. The top part of figure 2.2 depicts GDP per capita growth. The standard of living gradually increased its growth rate from the 1920s – with the exception of wartimes – until peaking in the 1960s at 4 per cent. This growth stemmed in the early years from both LP and hours worked. During the latest decades growth relied solely on LP. This changed once again after the recession of the early 1990s, when also labour input contributed to GDP per capita growth. The most recent average observations of GDP per capita change have shifted into slower gear - around 3 per cent per annum - due to a decline in LP growth. The decline in hours worked that began in the late 1960s stands out as negative growth in the lowest part of the graph. It did not turn positive until the 1990s. Also LP growth

[3] The Hodrick-Prescott (1997) filter was used with the smoothing parameter λ=100.

halved from the 1960s peak 4-5 per cent growth to somewhat more than 2 per cent per annum recently.

It is easy to show that the slowdown in LP growth - and not a decrease in labour input - poses a threat to the future growth of the Finnish standard of living. From equation 1 and figure 2.1 it can be seen that an increase in labour input has a level effect on GDP per capita. Productivity growth on the other hand acts through the interest on interest principle. Even a slight change in growth rates has significant long term implications.

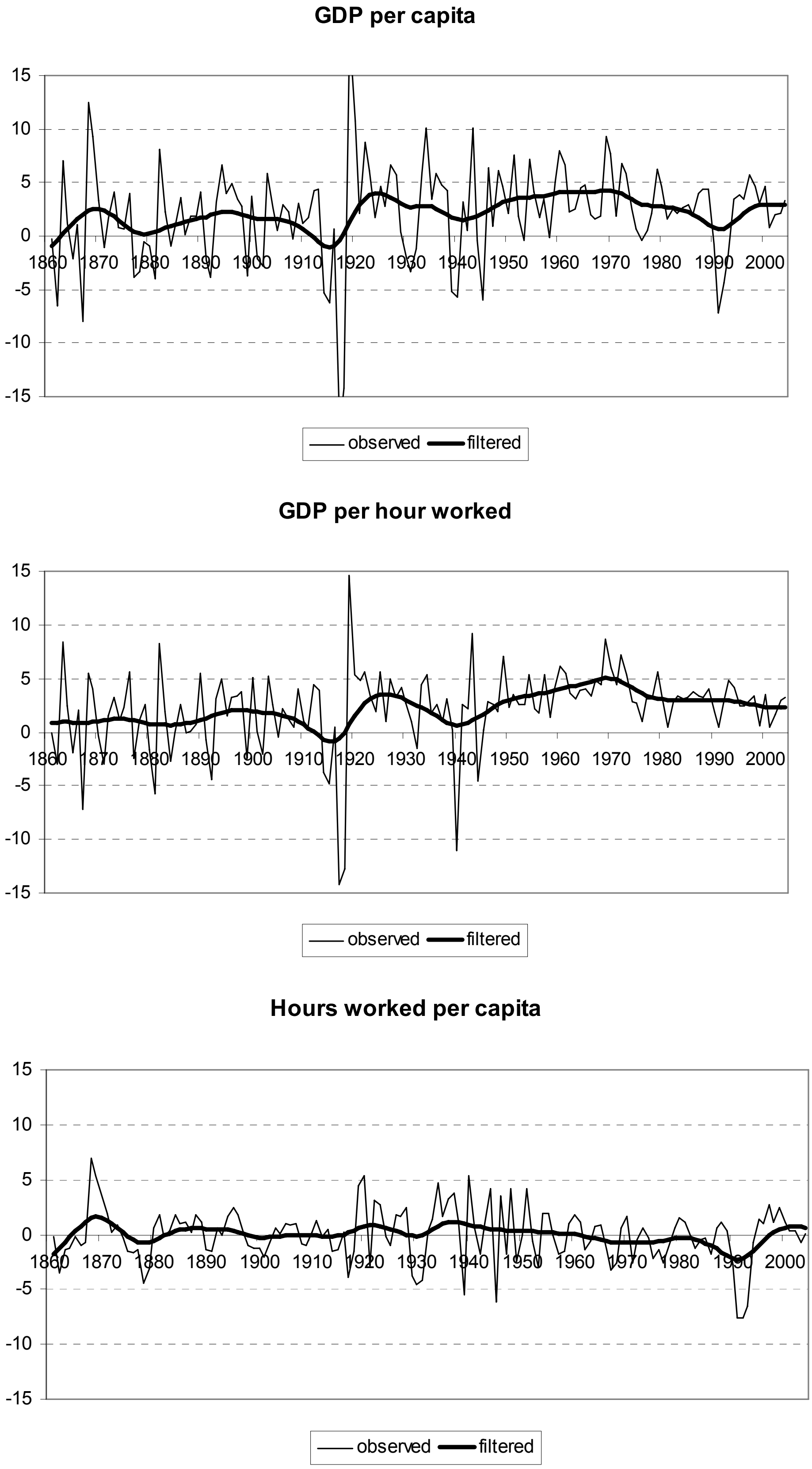


Figure 2.2 *Growth rates of the Finnish living standard, labour productivity and labour input, 1861-2004, LN%*

Source: Own calculations; data from Hjerppe (1996) and Statistics Finland.

3. STRUCTURAL CHANGE

Economic activity takes place in three major sectors. What is the difference between primary, secondary and tertiary production? Fisher (1939) called primary production something which is *"...concerned with satisfying the basic primary needs, in the absence of which any kind of activity would be impossible"*. Clark (1957)[4] defined primary production as depending on first-hand and instant use of natural resources. A distinguishing feature of primary production is that it can be carried out only where the natural resources are situated, and it can also be dependent on climatic and seasonal constraints. On that note one could also include mining and quarrying, as Kaldor (1967) did, because it is an extractive activity. In this paper, however, mining and quarrying is incorporated in secondary production since it requires considerable investments into fixed capital and is as an economic activity more similar to manufacturing than to agriculture or forestry, a point which Kuznets (1966) agreed with. Table 3.1 contains the used taxonomy.

Secondary production is not straightforwardly the refinement of primary products. Clark (1957) included into secondary production such large scale, capital intensive and continuous production that produces transportable goods. Fisher (1939) thought that secondary production contained such manufacturing activities that catered for the standardized demand for less than essential things. So by default tertiary production was according to him the production and distribution of new things which come about as a result of improving technology, i.e., items which could be called luxury goods and services. Kuznets (1966) wanted to include transport and communications into secondary production. Kaldor (1967) thought that secondary production encompassed industry, construction and public utilities. Hartwell (1973) defined the tertiary sector as the residual after subtracting agriculture, industry and construction. In this paper it was decided to classify transport and communications and public utilities in tertiary production or services as the SNA93 calls it. The justification for this decision is in SNA93's paragraph 6.8:

"Services are not separate entities over which ownership rights can be established. They cannot be traded separately from their production. Services are heterogeneous outputs produced to order and typically consist of changes in the conditions of the consuming units realized by the activities of producers at the demand of the consumers. By the time their production is completed they must have been provided to the consumers."

[4] The first edition appeared in 1940. The 1957 version was a third largely rewritten edition.

Table 3.1 *Taxonomy of primary, secondary and tertiary production by branch of economic activity*

Primary production	A	Agriculture, hunting and forestry
	B	Fishing
Secondary production	C	Mining and quarrying
	D	Manufacturing
	E	Electricity, gas and water supply
	F	Construction
Tertiary production	G	Wholesale and retail trade; repair of motor vehicles etc.
	H	Hotels and restaurants
	I	Transport, storage and communications
	J	Financial intermediation
	K	Real estate, renting and business activities
	L	Public administration and defence; compulsory social security
	M	Education
	N	Health and social work
	O	Other community, social and personal service activities
	P	Activities of private households as employers etc.

Source: Adaptation of the UN International Standard Industrial Classification of All Economic Activities, Revision 3.1 (ISIC Rev. 3.1).

As early as in the 17th century Sir William Petty (1676) wrote:

"There is much more to be gained by Manufacture than Husbandry, and by Merchandize than Manufacture…Now here we may take notice, that as Trades and curious Arts increase; so the Trade of Husbandry will decrease, or else the Wages of Husband men must rise, and consequently the Rents of Lands must fall."

Petty realized that shifting resources away from less productive sectors into more productive ones is not only beneficial but actually a prerequisite for increased growth. Clark (1957) was along the same lines as he described how primary production, which is dependent on local natural resources and climate, usually faces diminishing returns and that as economies become more advanced the share of the labour force employed in primary production shifts relative to secondary production, which in turn declines relative to tertiary production. How then is a nation able to avoid the Malthusian Trap[5] in the first place? Many authors agree that the first industrial revolution was THE watershed in human economic history after which we were freed from the Malthusian Trap (Hansen and Prescott, 2002, Komlos, 2003, Mokyr, 2003, and Clark, 2005). However, as Mokyr (2003) points out, societies with sound institutions and active trading enjoyed growth even prior to the industrial revolution. The point is that after the

[5] If the size of the population grows, i.e. births outnumber deaths, the material living standard declines in a pre-industrial society due to diminishing returns to land (Clark, 2005).

industrial revolution the importance of technology[6] to growth became paramount. Hansen and Prescott (2002) described this as a shift from a pre-industrial land-intensive Malthusian technology, with decreasing returns to labour, to a modern era Solowian constant returns to scale technology, with both capital and labour as inputs. This shift is of relatively recent origin as modern economic growth as we know it today has actually existed only for the last two centuries.

Kuznets (1966) stressed four arguments which cause a declining share of primary production in total output. Firstly, as incomes per capita grow there might be a proportionately larger demand for non-agricultural products. Secondly, as an increasing agricultural output volume goes hand in hand with increased population and incomes (as it must in a non-Malthusian economy) the widening domestic markets provide more opportunities for non-agricultural import competing industries. Thirdly, Kuznets noted declining primary production shares in developed countries especially after they began trading with less developed countries and fourthly, he observed that technological change was an important factor; he actually stated that the rapider the technical change the faster the change in sectoral shares. In secondary production the fruits of technological change are most readily harnessed for productive use, so although its relative share first increases at the expense of primary production the rapid productivity increases potentially makes its labour share decrease in favour of the tertiary sector. This classic view is not unchallenged as e.g. Broadberry (1998) argued that Germany and the United States surpassed Britain's level of aggregate labour productivity by shifting resources out of agriculture and improving the productivity of services rather than manufacturing.

[6] Technology is here widely interpreted to include all knowledge and ideas of how to produce goods and services.

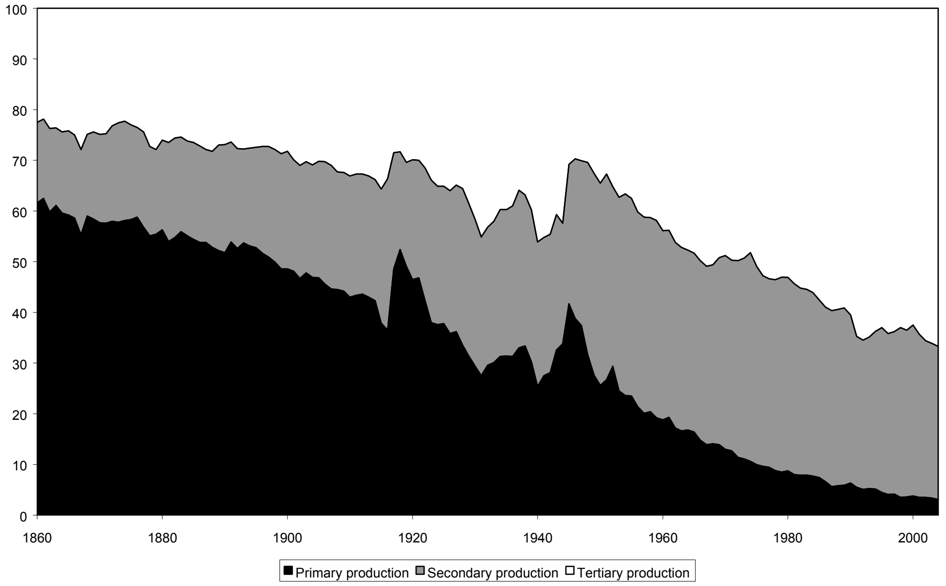


Figure 3.1. *Shares of primary production, secondary production and tertiary production in Finnish GDP, 1860-2004, %*

Source: Own calculations; data from Hjerppe (1996) and Statistics Finland.

What about Finland? Characteristic to the Finnish long run economic transformation was that industrialization started late and that services increased directly at the expense of primary production, since the share of secondary production in GDP did not decrease until the 1970s (figure 3.1). Finland embarked on the road of industrialization utilizing her forest sector, her hydropower potential and the rural labour reserve. The role of electrification as an enabler of productivity boosting technical innovations was critical. In the 1860s only a fraction of the Finnish populace was employed in industry or industrial handicrafts. Fifty years later a tenth of the workforce was employed in industry, with a share in total output of one fifth by 1913. At the eve of WWII industry's share in GDP amounted to nearly one in four.

In 1860 four out of five persons were employed in primary production. As productivity was low they managed to generate only 60 per cent of value added. Less than 15 per cent were working in secondary production and their value added shares and employment ratios were approximately on par. The labour share of services was low: just 7 per cent. Yet their share of GDP was one in five. This high productivity was to a significant extent explained by the large share of ownership of dwellings in services: two fifths of services' value added with no labour input in 1860 (Hjerppe, 1996).[7]

Tertiary production's labour share caught up with that of secondary production during

[7] These extraordinary figures do raise a question of the correctness of the deflators of services; a topic which goes beyond the scope of this paper.

and after the civil war of 1918, during the turbulent early 1930s and during the Second World War. Employment in industry and construction rebounded each time (Hjerppe, 1996). From 1955 onwards services permanently employed more persons than secondary production and three years later even more than primary production. The share of secondary production in GDP peaked both in 1951 and 1974 at more than 40 per cent. By the beginning of the 21st century industry and construction‘s share of GDP was 30 per cent and primary production's only three per cent. The rest originated from services. The Finnish economy had in Quah's (2001) terminology become increasingly weightless. Since the U.S. share of services in GDP was close to three quarters in 2001 (OECD, 2003) it does not take a crystal ball to predict that the Finnish economy will become even more weightless in the future. Increased globalization has already shifted secondary production to countries with lower unit labour costs and close proximity to developing markets.

During the whole 1860-2004 period GDP grew on average by almost 3 per cent, the value added of primary production by one per cent, secondary production by 4 per cent and services by three (table 3.2). Growth was especially rapid in the 1920s and 1930s and in the post -WWII pre-oil crisis era. As a result of this consistent growth Finland's GDP per capita converged to 77 per cent of its U.S. equivalent in 2004.[8]

Value added growth can be decomposed into the contributions of a change in labour input and a change in labour productivity. More formally:

(3) $$\Delta \ln(GDP) = \Delta \ln(labour\_input) + \Delta \ln(GDP / labour\_input),$$

where Δ refers to a first difference. Tables 3.3 and 3.4 contain average yearly growth rates of labour input and LP. Tables 3.2-4 can be interpreted in the following way: of the average yearly 2.9 per cent GDP growth in services in 1861-1949 2.7 percentage points stemmed from increases in labour input and 0.2 percentage points from LP change. Of the overall average GDP growth of 2.9 per cent in 1861-2004 only 0.7 percentage points were the result of increased labour input and 2.2 percentage points came from LP improvement.

The growth of labour input in primary production was consistently slower than in the other sectors in 1861-1949. Growth turned negative after WWII. The decline accelerated from period to period until it was more than 5 per cent in 1995-2004. Labour input in secondary production grew faster than the national average in the observation period. In the latter period it was close to zero. The labour input in services increased at a pace above average in every period. LP growth was faster than average

[8] See Groningen Growth and Development Centre and The Conference Board, Total Economy Database, August 2005, http://www.ggdc.net.

every period in industry and construction. LP change in agriculture and forestry was more than average in 1950-2004 thanks to extensive labour shedding – and not due to rapid growth of value added.

.

Table 3.2. *Growth rates of value added at 2000 prices, LN%*

	1861–1949	*1950–2004*	*1861–2004*
Primary production	1.1	0.6	0.9
Secondary production	4.0	4.0	4.0
Tertiary production	2.9	3.9	3.3
Total	2.6	3.5	2.9

Source: Own calculations, data from Hjerppe (1996) and Statistics Finland.

Table 3.3. *Growth rates of labour input, LN%*

	1861–1949	*1950–2004*	*1861–2004*
Primary production	0.4	-3.2	-1.0
Secondary production	2.1	-0.1	1.3
Tertiary production	2.7	1.7	2.3
Total	1.2	0.1	0.7

Source: Own calculations, data from Hjerppe (1996) and Statistics Finland.

Table 3.4. *Growth rates of labour productivity, LN%*

	1861–1949	*1950–2004*	*1861–2004*
Primary production	0.6	3.8	1.9
Secondary production	1.9	4.0	2.7
Tertiary production	0.2	2.2	1.0
Total	1.4	3.4	2.2

Source: Own calculations, data from Hjerppe (1996) and Statistics Finland.

A shift-share analysis was performed in order to find out what the impact of structural change, that is of labour shifting to industries with either a higher level of or higher growth rate of LP was on labour productivity growth (see Syrquin, 1984). The relative change in labour productivity can be expressed as:

(4)
$$\frac{LP_t - LP_{t-1}}{LP_{t-1}} = \frac{\sum_{i=1}^{n}\left(LP_{i,t} - LP_{i,t-1}\right)S_{i,t-1} + \sum_{i=1}^{n}\left(S_{i,t} - S_{i,t-1}\right)LP_{i,t-1} + \sum_{i=1}^{n}\left(S_{i,t} - S_{i,t-1}\right)\left(LP_{i,t} - LP_{i,t-1}\right)}{LP_{t-1}}$$

where *LP* is the level of labour productivity, S_i is sector *i*'s share of all hours worked (the sectors used are primary production, secondary production and tertiary production) and *t* is time. The first term on the right side of the equation is the industries' internal (within) productivity effect, i.e., sub-industries impact on aggregate productivity change. The second term on the right is the static shift effect of labour, that is, the contribution of a shift of labour to industries with a higher level of LP. The third term on the right captures the dynamic shift effect of labour, i.e., the contribution of labour shifting to industries with a higher than average LP growth rate.

Table 3.5. *The impact of structural change on labour productivity growth, %*

	1861–1949	*1950–2004*	*1861–2004*
Within	48.3 %	81.6 %	69.2 %
Static	55.1 %	18.2 %	31.9 %
Dynamic	-3.4 %	0.1 %	-1.2 %
Total	100.0 %	100.0 %	100.0 %

Source: Own calculations, data from Hjerppe (1996) and Statistics Finland.

It can be seen from table 3.5 that one half to eight tenths of LP growth emanated from internal productivity increase. The rest was due to structural change. The effect of structural change was largest in the 1800s when labour shifted from primary production to industry and construction. In the years between the two world wars Finnish manufacturing was fully electrified (Jalava, 2004). The impact of static shift diminished when there was a step-up in LP growth across all sectors in the post-WWII period (table 3.4). The dynamic shift has slowed productivity growth in the first observation period whereas it was negligible in the latter period. All in all the dynamic effect’s impact has been minor. Table 3.5 shows us that internal productivity growth is more important than structural change and that productivity change was more concentrated than ever before in the latest period.

4. PHASES OF GROWTH

Hartwell (1973) defined successive stages of economic development according to the share employed in services. First, agricultural countries with a small industrial sector exhibit slow growth rates of services. Second, industrialising nations display declining agricultural employment and industry and services that grow at similar rates. The third stage is industrial nations with minimum agricultural and maximum industrial employment. The final stage is a service economy where services grow at the expense of secondary production. Hartwell (1973) found phase one to have ended in Western Europe between 1800 and 1850. Stage two took place between 1840 and 1910, and stage three between 1920 and 1970. Writing in the early 1970s he concluded that stage four was just beginning. Hjerppe (1990) defined stage one to have lasted in Finland until the mid-1880s. She found stage two to have continued until the 1950s. A similar development as portrayed by Hartwell's stage three was not found by Hjerppe (1990) for Finland at all. She concluded that the employment share of primary production was still high in the 1950s and that it subsequently diminished directly in favour of services. At the time of writing Hjerppe (1990) found the employment share in secondary production to have decreased only mildly. It is easy to concur with Hjerppe that Hartwell's stage three as such did not take place in Finland. Industry's employment did not peak simultaneously with a trough in primary production employment. The employment of secondary production is presently in a post-peak declining phase whereas employment in agriculture and forestry has failed to reach a bottom as yet.

What is the role of the three sectors in overall growth? Kaldor (1967) stressed that a precondition for the growths of the secondary and tertiary sectors is that primary production produce a surplus over the bare subsistence minimum. As a nation passes from economic immaturity to maturity, by which Kaldor (1978) meant a state where real incomes per head in each sector are comparatively similar, the role of secondary production is crucial due to increasing returns to scale. Kaldor (1967, 1978) suggested that aggregate economic growth is related to growth in manufacturing, that manufacturing productivity growth is related to manufacturing output growth and that manufacturing productivity increases the productivity of the other sectors. These observations are often called Kaldor's growth laws[9] (e.g. Stoneman, 1979; Bairam, 1990; Mamgain, 1999; Wells and Thirlwall, 2003).

Ordinary Least Squares (OLS) regressions were carried out to cast some light on the applicability of Kaldor's laws' on Finnish historical economic development. As a proxy for the first proposition GDP growth was explained with secondary production's real

[9] Not to be confused with Kaldor's stylized facts.

value added growth (and as checks also with value added of primary production and services).[10]

(5) $$\Delta Y_{GDP} = \alpha_1 + \beta_1 \Delta Y_{SEC} + \varepsilon_1 ,$$

(6) $$\Delta Y_{GDP} = \alpha_2 + \beta_2 \Delta Y_{PRIM} + \varepsilon_2 ,$$

(7) $$\Delta Y_{GDP} = \alpha_3 + \beta_3 \Delta Y_{TERT} + \varepsilon_3 ,$$

(8) $$\Delta Y_{GDP} = \alpha_4 + \beta_4 \Delta Y_{SEC} + \beta_5 \Delta Y_{PRIM} + \beta_6 \Delta Y_{TERT} + \varepsilon_4 ,$$

where ΔY_{GDP} is volume growth of GDP and ΔY_{SEC} , ΔY_{PRIM} , and ΔY_{TERT} are respectively secondary production, primary production and tertiary production real value added change. The error term is ε. The error term is often called the residual as it captures all that is left unexplained. The index for time *t* has been suppressed for the economy of notation. The results are shown in table 4.1 and table 4.2 (the numbers in brackets are the t-statistics).[11]

Table 4.1. *Regression results for equations 5 and 6*

	1861–1949	*1950–2004*	*1861–2004*	*1861–1949*	*1950–2004*	*1861–2004*
N	89	55	144	89	55	144
equation	5	5	5	6	6	6
constant	0.012**	0.010**	0.015***	0.021***	0.035***	0.026***
	(2.84)	(3.31)	(6.71)	(4.55)	(7.33)	(7.36)
β_1 (ΔY_{SEC})	0.306***	0.671***	0.345***			
	(5.27)	(14.26)	(6.71)			
β_2 (ΔY_{PRIM})				0.296*	0.223***	0.272**
				(2.15)	(3.77)	(2.67)
Adj. R^2	0.391	0.863	0.434	0.198	0.165	0.184
D.W.	2.35	1.76	2.12	1.99	1.00	1.72
F	27.79***	203.48***	45.00***	4.62*	14.24***	7.12**

***= significant at the 0.1% level. **=significant at the 1% level. *=significant at the 5% level. +=significant at the 10% level. Source: Own calculations, data from Hjerppe (1996) and Statistics Finland.

[10] See Appendix for graphs of all variables and their unit root tests.

[11] The t-statistics and F-statistics have been obtained using the Newey-West (1987) regression procedure in the software Intercooled Stata 8.2 for Windows. The idea is that the error structure is expected to be heteroskedastic and autocorrelated up to some predetermined lag. We chose the lag length to be $N^{1/3}$, this means 4 for each of the both sub-periods and 5 for the whole period.

Table 4.2. *Regression results for equations 7 and 8*

	1861–1949	*1950–2004*	*1861–2004*	*1861–1949*	*1950–2004*	*1861–2004*
N	89	55	144	89	55	144
equation	7	7	7	8	8	8
constant	0.008+	-0.001	0.009+	-0.002+	0.001	0.000
	(1.76)	(-0.46)	(1.97)	(-1.87)	(0.99)	(0.39)
β_4 (ΔY_{SEC})				0.116***	0.305***	0.155***
				(5.87)	(14.56)	(7.94)
β_5 (ΔY_{PRIM})				0.341***	0.071***	0.253***
				(8.21)	(5.03)	(6.67)
β_3 or β_6	0.555***	0.963***	0.615***	0.621***	0.595***	0.607***
(ΔY_{TERT})	(4.91)	(16.19)	(5.17)	(35.78)	(20.93)	(34.23)
Adj. R^2	0.509	0.875	0.563	0.963	0.992	0.931
D.W.	1.77	1.84	1.75	1.62	1.87	1.74
F	24.13***	262.12***	26.72***	555.93***	6061.23***	569.16***

***= significant at the 0.1% level. **=significant at the 1% level. *=significant at the 5% level. +=significant at the 10% level. Source: Own calculations, data from Hjerppe (1996) and Statistics Finland.

Looking at table 4.1 it does seem that our basic regressions, where GDP growth is explained with secondary production value added (equation 5), are highly significant. All of the explanatory variables are significant at the 0.1 per cent level. This means that the likelihood that the beta coefficients equal zero is very low. The highest adjusted[12] R^2, our measure for goodness-of-fit, is for the post-WWII period at 0.86 and the beta coefficient more than doubles to 0.67. The implication is that 86% of GDP growth is accounted for by equation 5 in 1950-2004 and that it according to the model takes on average 1.5 units (=1/0.671) of industry and construction growth per unit of GDP increase. The significance of agriculture is also very high in the latter period although the explanatory power of equation 6 is rather low. The R^2:s fail to rise above 0.2 and the beta coefficients vary between 0.2-0.3. Agriculture does explain GDP slightly better in the first period, 1861-1949, than in the latter which corresponds with intuition. Interestingly equation 7 is very significant with good linear fits (table 4.2). Especially in 1950-2004 the R^2:s are close to 0.9 and the beta coefficient is very near unity. Kaldor (1978) also found similar results for twelve industrial countries in 1953-1964 and interpreted them the other way round; i.e. as the rate of GDP growth determining growth in services. We would not go as far as to claim anything definitive about causation based on these regressions. It is, however, interesting to observe that GDP and services have over the past half-century grown hand-in-hand. As all of the explanatory variables in equations 5-7 are significant they are combined in equation 8 to explain GDP growth with primary, secondary and tertiary production value added. The results

[12] Adjusted means that it is corrected for the degrees of freedom lost when estimating the regression parameters.

reinforce those of equations 5-7 except for agriculture in 1950-2004; the drop in the beta coefficient to 0.07 from 0.34 is quite dramatic. Furthermore, the F-tests reject for all periods for equations 5-8 the likelihood that the linear relationship is nonexistent. The weakest rejection is for agriculture in the earlier period. Kaldor's first law holds in the Finnish case for industry and construction. Especially the latter period shows strong correlations. The regressions for primary production and services also pass the statistical tests.

Kaldor's second law is about increasing returns to scale in manufacturing. In testing Kaldor's second proposition (which is also known as Verdoorn's law), we used industry and construction LP growth which was explained by its value added growth (and as checks similar regressions were performed also for primary production and services). It is clear from figure 2.1 that most of long-run economic growth comes from LP growth. So there would be little point in applying regressions 9-11 at the level of the total economy.

(9) $\Delta LP_{SEC} = \alpha_5 + \beta_7 \Delta Y_{SEC} + \varepsilon_5$,

(10) $\Delta LP_{PRIM} = \alpha_6 + \beta_8 \Delta Y_{PRIM} + \varepsilon_6$,

(11) $\Delta LP_{TERT} = \alpha_7 + \beta_9 \Delta Y_{TERT} + \varepsilon_7$,

where ΔLP_{SEC} , ΔLP_{PRIM} and ΔLP_{TERT} are respectively secondary, primary and tertiary production labour productivity growth. The results for equations 9 and 10 are in table 4.3 and the results for equation 11 are in table 4.4.

Table 4.3. *Regression results for equations 9 and 10*

	1861–1949	*1950–2004*	*1861–2004*	*1861–1949*	*1950–2004*	*1861–2004*
N	89	55	144	89	55	144
equation	9	9	9	10	10	10
constant	0.003	0.029***	0.011*	-0.002	0.033***	0.011**
	(0.47)	(4.94)	(2.16)	(-0.86)	(6.64)	(2.60)
β_7 (ΔY_{SEC})	0.416***	0.283***	0.401***			
	(6.24)	(3.38)	(5.73)			
β_8 (ΔY_{PRIM})				0.821***	0.876***	0.829***
				(24.80)	(11.07)	(21.68)
Adj. R^2	0.490	0.302	0.448	0.875	0.726	0.753
D.W.	2.00	1.43	1.74	1.55	1.50	1.05
F	38.92***	11.43**	32.79***	615.17***	122.52***	470.05***

***= significant at the 0.1% level. **=significant at the 1% level. *=significant at the 5% level. +=significant at the 10% level. Source: Own calculations, data from Hjerppe (1996) and Statistics Finland.

Observing tables 4.3 and 4.4 it would seem that there is statistical support for secondary production, for tertiary production in 1950-2004 and surprisingly for agriculture and forestry the whole period; both for the equations as a whole according to the F-tests and for the explanatory variables individually according to the t-tests.

As a specification for Kaldor's third proposition aggregate LP growth was explained by secondary production's value added growth and the non-secondary sectors' labour input growth.

(12) $$\Delta LP_{GDP} = \alpha_8 + \beta_{10}\Delta Y_{SEC} + \beta_{11}\Delta E_{PRIM\&TERT} + \varepsilon_8$$,

where ΔLP_{GDP} is total economy LP change and $\Delta E_{PRIM\&TERT}$ is change in non-manufacturing labour input. The results are in table 4.4. In the latter period the R^2:s climb to 0.71. Aggregate LP growth is explained by industry and services' value added growth; beta coefficient 0.43 and by the decrease in non-secondary production value added, beta coefficient -0.43 (both are significant at the 0.1% level). This means that our results suggest that a one unit increase in secondary production's value added increased aggregate LP by 0.43 units and a one unit increase in non-manufacturing's labour input decreased aggregate productivity by 0.43 units. We must keep in mind that 29 per cent of productivity growth was left unexplained and that the scope of general government increased in the same period.[13] This latter relation was in 1861-1949 only -0.14 (although statistically insignificant). Kaldor's third law does seem to hold for Finland in 1950-2004. The unfortunate implicit implication of equation 12 is that it supports Baumol's unbalanced growth hypothesis given the facts that the beta coefficient is much larger in the second period and the only sector that has increased its labour input after the oil crisis is services. Taking a second look at figure 2.2's middle panel we see that LP growth has nearly halved from what it was in the 1960s and 1970s.

[13] As modern national accounts computes the output of general government using the sum of costs principle the implication is that the calculated productivity increase is virtually zero (with the exception of an increase in labour quality).

Table 4.4. *Regression results for equations 11 and 12*

	1861–1949	*1950–2004*	*1861–2004*	*1861–1949*	*1950–2004*	*1861–2004*
N	89	55	144	89	55	144
equation	11	11	11	12	12	12
constant	0.000	0.007+	0.005	0.006	0.019***	0.014***
	(-0.01)	(1.67)	(0.65)	(1.25)	(9.10)	(4.02)
β_{10} (ΔY_{SEC})				0.199***	0.428***	0.226***
				(3.58)	(11.20)	(4.21)
β_9 (ΔY_{TERT})	0.072	0.377***	0.131			
	(0.36)	(4.53)	(0.66)			
β_{11}				-0.138	-0.429***	-0.261
($\Delta E_{PRIM\&TERT}$)				(-0.49)	(-4.07)	(-1.14)
Adj. R^2	0.002	0.461	0.036	0.236	0.708	0.260
D.W.	1.60	1.28	1.48	2.10	1.75	1.78
F	0.13	20.48***	0.44	6.86**	76.83***	10.08***

***= significant at the 0.1% level. **=significant at the 1% level. *=significant at the 5% level. +=significant at the 10% level. Source: Own calculations, data from Hjerppe (1996) and Statistics Finland.

5. CONCLUSIONS

In this paper we set out to describe Finnish long run economic growth and the role structural change played in this transformation. Finland was a late industrialized country that managed to transform herself from a predominantly primary production based economy to a modern welfare state with a large service sector. In raising the level of Finnish GDP per capita to three quarters of the US level the role of labour productivity was cardinal. Secondary production was the leading sector in LP change due to rapid technical progress. Until the first oil crisis the labour input in secondary production grew faster than the national average, whereas the labour input in services increased at a pace above average in every period. In the late 1800s and early 1900s labour shifting out of primary production contributed at best half of overall LP growth. Recently productivity growth has been more concentrated than before as the rural surplus labour has long since shifted to secondary production and services.

What did our number crunching efforts reveal of the Kaldor-Verdoorn laws in the Finnish case? Was it so that secondary production and its productivity was the engine of economic growth in Finland? Yes and no. Our regressions support the role of industry and services as explaining GDP growth to a large part. However, the first law holds also for primary production and services; for primary production only barely in the early years. Services actually explained GDP growth better than secondary production. Did economic growth cause growth of services or vice versa? Unfortunately our regressions cannot give a definitive answer to the direction of causation. Kaldor's second law, which he used to test for increasing returns to scale, holds for secondary production (although more so in the first period than in the latter), for services in 1950-2004 and surprisingly for agriculture and forestry for the whole observation period. The equation we used as a proxy for Kaldor's third law - explaining aggregate labour productivity change with secondary production value added and non-manufacturing labour input - did corroborate the theory for 1950-2004. Inopportunely this meant, given the fact that only services increased their labour input after the first oil crises, rending implicit support for Baumol's theory of aggregate LP growth slowing down as the share of services in the economy grew.

In conclusion we can say that our numbers confirmed Hartwell's basic idea of economic growth taking place in different phases. Finland's industrialization changed her economic structure irrevocably. Structural change in itself was more an effect of rather than the cause for Finnish economic growth. In the light of history the concern for the growth and productivity impacts of increased services is exaggerated. It does not take a crystal ball to realize that the Finnish economic structure will continue evolving, since

Finland's share of secondary production in GDP still exceeded its US equivalent by approximately ten percentage points at the turn of the millennium. The role of knowledge-intensive services will increase. For a developed nation change is the only thing that is constant.

REFERENCES

Bairam, E. (1990): 'Verdoorn's Original Model and the Verdoorn Law Controversy: Some New Empirical Evidence Using the Australian Manufacturing Data', *Australian Economic Papers,* Vol. 29, pp. 107-112.

Baumol, W.J. (1967): 'Macroeconomics of unbalanced growth: The anatomy of urban crises', *American Economic Review,* Vol. 57 (3), pp. 415-26

Broadberry, S.N. (1998): 'How did the United States and Germany Overtake Britain? A Sectoral Analysis of Comparative Productivity Levels, 1870-1990', *Journal of Economic History*, Vol. 58 (2), pp. 375-407.

Clark, C. (1957): *The Conditions of Economic Progress,* London: Macmillan.

Clark, G. (2005): *The Conquest of Nature: A Brief Economic History of the World*, manuscript.

Easterly, W. (2001): *The Elusive Quest for Growth. Economists' Adventures and Misadventures in the Tropics*, Cambridge MA: The MIT Press.

Fisher, A.G.B. (1939): 'Production, Primary, Secondary and Tertiary', *Economic Record,* Vol. 15 (June), pp. 24-38.

Griliches, Z. (1992): 'Introduction', in Griliches, Z. (ed.), *Output Measurement in the Service Sectors*, NBER Studies in Income and Wealth, Volume 56, Chicago/London: University of Chicago Press.

Hansen, G.D. and Prescott, E.C. (2002): 'Malthus to Solow', *American Economic Review,* Vol. 92 (4), pp. 1205-1217.

Hartwell, R.M. (1973): 'The Service Revolution: The Growth of Services in Modern Economy' in Cipolla, C.M. (ed.), *The Fontana Economic History of Europe: The Industrial Revolution,* Glasgow: Fontana/Collins.

Hjerppe, R. (1990): *Kasvun vuosisata,* Helsinki: VAPK-kustannus.

Hjerppe, R. (1996): *Finland's Historical National Accounts 1860–1994: Calculation Methods and Statistical Tables,* Jyväskylän yliopisto historian laitos, Suomen historian julkaisuja 24, Jyväskylä: Kopi-Jyvä Oy.

Hodrick, R.J. and Prescott, E.C. (1997): 'Postwar U.S. business cycles: An empirical investigation', *Journal of Money, Credit and Banking*, Vol. 29 (1), pp. 1-16.

Jalava, J. (2004): 'Electrifying and digitalising the Finnish manufacturing industry: Historical notes on diffusion and productivity' in Heikkinen, S. and van Zanden, J.L. (eds.), *Explorations in Economic Growth*, Amsterdam: Aksant Academic Publishers.

Kaldor, N. (1967): *Strategic Factors in Economic Development,* Ithaca, New York: New York State School of Industrial and Labor Relations, Cornell University.

Kaldor, N. (1978): *Further Essays on Economic Theory,* London: Gerald Duckworth & Co. Ltd.

Komlos, J. (2003): 'The Industrial Revolution as the Escape from the Malthusian Trap', Discussion Papers in Economics 57, Department of Economics, University of Munich.

Kuznets, S. (1966): *Modern Economic Growth. Rate Structure and Spread,* New Haven and London: Yale University Press.

Mamgain, V. (1999): 'Are the Kaldor-Verdoorn Laws Applicable in the Newly Industrializing Countries?', *Review of Development Economics,* Vol. 3 (3), pp. 295-309.

Mokyr, J. (2003): 'Long-term Economic Growth and the History of Technology', manuscript.

Newey, W.K. and West, K.D. (1987): 'A Simple, Positive Semi-definite, Heteroscedasticity and Autocorrelation Consistent Covariance Matrix', *Econometrica,* Vol. 55 (3), pp. 703-708.

OECD (2003): *National Accounts of OECD Countries, Main Aggregates, Volume I, 1990-2001*, Paris: OECD.

Oulton, N. (2001): 'Must the Unbalanced Growth Rate Decline? Baumol's Unbalanced Growth Rate Revisited', *Oxford Economic Papers*, Vol. 53 (4), pp. 605-627.

Petty, W. (1676): *Political Arithmetick.*

Quah, D. (2001): 'The Weightless Economy in Economic Development' in Pohjola, M. (ed.), *Information Technology, Productivity and Economic Growth: International Evidence and Implications for Economic Development*, Oxford: Oxford University Press.

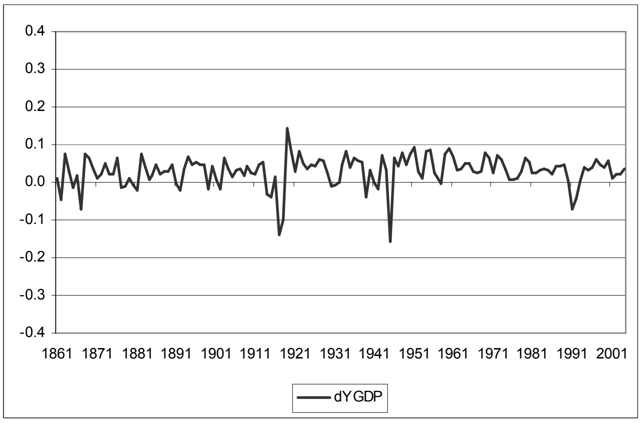
SNA93 (1993): System *of National Accounts 1993*, UN, OECD, EU, IMF, World Bank, Series F, No. 2, Rev. 4, New York: United Nations.

Stoneman, P. (1979): 'Kaldor's law and British economic growth: 1800-1970', *Applied Economics,* Vol. 11, pp. 309-319.

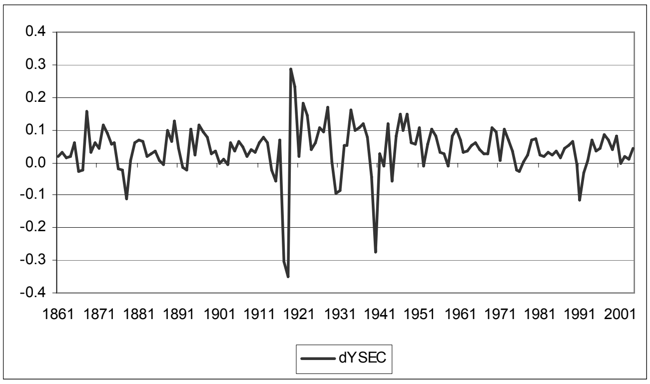
Syrquin, M. (1984): 'Resource Reallocation and Productivity Growth' in Syrquin, M., Taylor, L. and Westphal, L.E. (eds.), *Economic Structure and Performance – Essays in Honour of Hollis B. Chenery*, Orlando: Academic Press Inc.

Wells, H. and Thirlwall, A.P. (2003): 'Testing Kaldor's Growth Laws across the Countries of Africa', *African Development Review,* Vol. 15 (2-3), pp. 89-105.

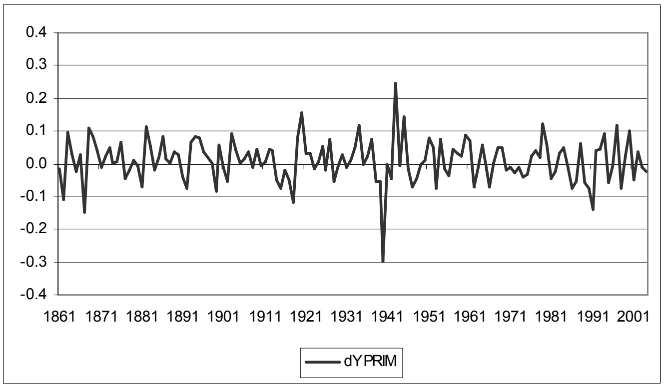
APPENDIX



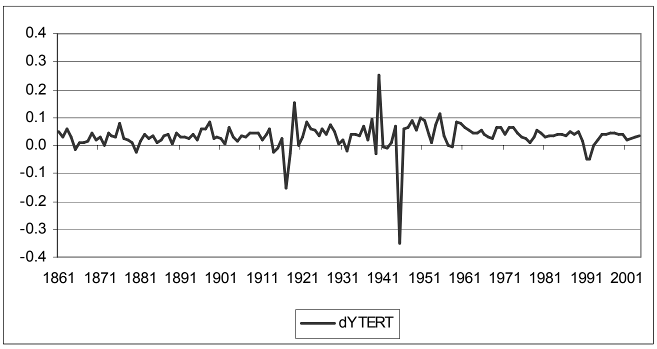
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
1861 1871 1881 1891 1901 1911 1921 1931 1941 1951 1961 1971 1981 1991 2001
dYGDP



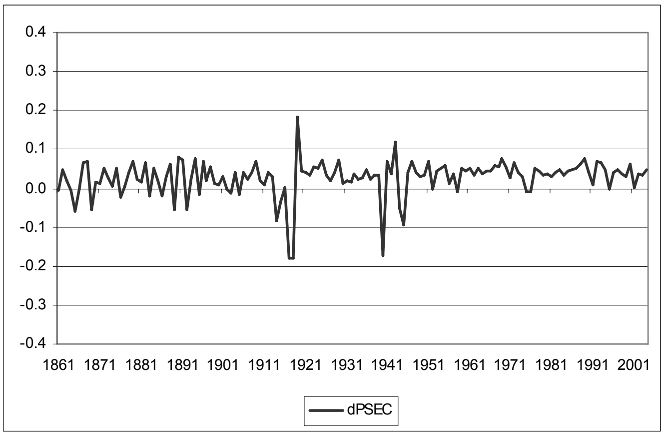
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
1861 1871 1881 1891 1901 1911 1921 1931 1941 1951 1961 1971 1981 1991 2001
dYSEC

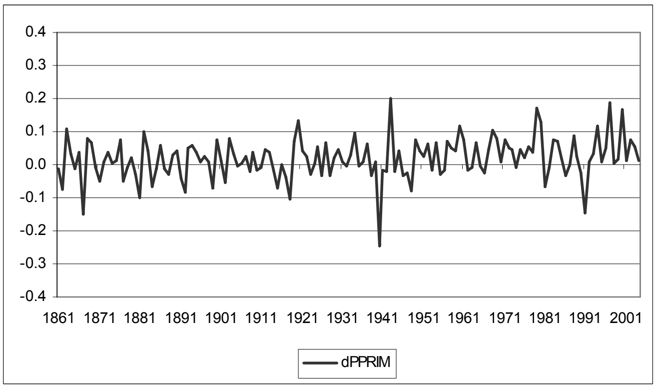


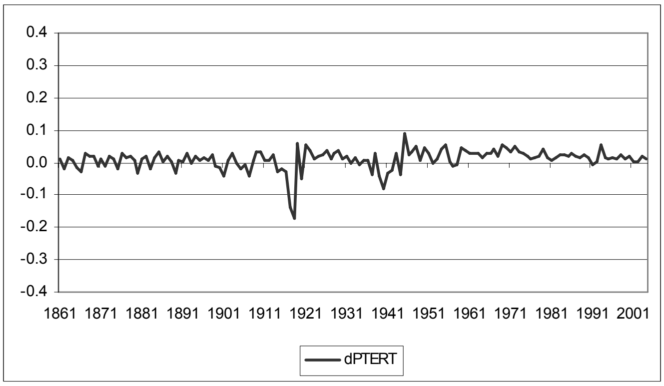
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
1861 1871 1881 1891 1901 1911 1921 1931 1941 1951 1961 1971 1981 1991 2001
dYPRIM

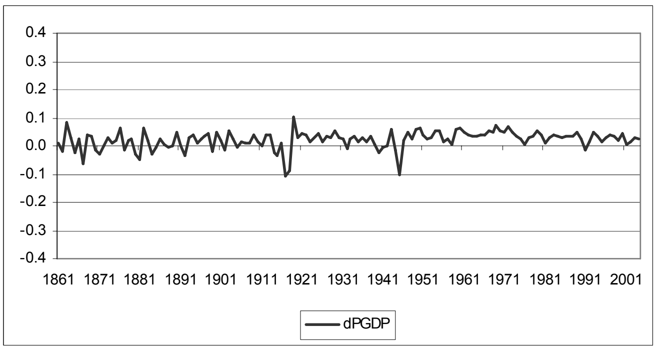


0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
1861 1871 1881 1891 1901 1911 1921 1931 1941 1951 1961 1971 1981 1991 2001
dYTERT


0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
1861 1871 1881 1891 1901 1911 1921 1931 1941 1951 1961 1971 1981 1991 2001
dPSEC


0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
1861 1871 1881 1891 1901 1911 1921 1931 1941 1951 1961 1971 1981 1991 2001
dPPRIM


0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
1861 1871 1881 1891 1901 1911 1921 1931 1941 1951 1961 1971 1981 1991 2001
dPTERT


0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
1861 1871 1881 1891 1901 1911 1921 1931 1941 1951 1961 1971 1981 1991 2001
dPGDP

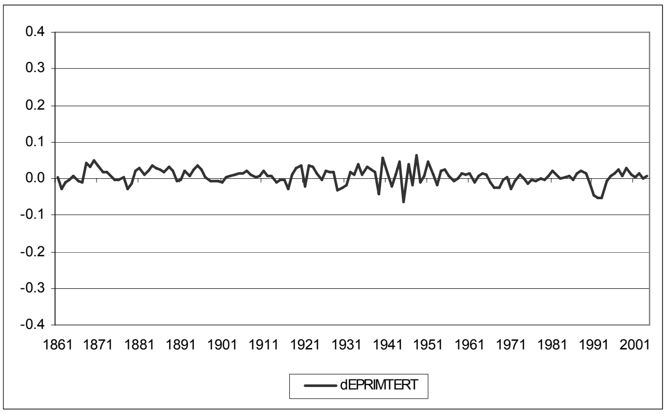


Figure A.1. *Series of ΔY_{GDP}, ΔY_{SEC}, ΔY_{PRIM}, ΔY_{TERT}, ΔLP_{SEC}, ΔLP_{PRIM}, ΔLP_{TERT}, ΔLP_{GDP}, and $\Delta E_{PRIM\&TERT}$, 1861-2004, LN%*
Source: Own calculations; data from Hjerppe (1996) and Statistics Finland.

The augmented Dickey-Fuller (ADF) test was used to test for a unit root in the time series. As the graphs contain no visible trend we felt comfortable in omitting a trend-term from the tests. The null hypothesis of the ADF test is that of a unit root and the results are in table A1. To our convenience it would seem that the existence of a unit root is rejected for most series and most time periods. The null hypothesis is not rejected for services' labour productivity in 1950-2004 and is significant only at the 10 per cent level for total economy LP in the same period. Overall the rejections in 1950-2004 are weaker than in 1861-1949 or the whole period.

Table A1. *Results for the Augmented Dickey-Fuller tests with no trend and four lags in the sub-periods and no trend and five lags in the whole period*

	1861–1949	*1950–2004*	*1861–2004*
ΔY_{GDP}	-5.01***	-3.29*	-5.23***
ΔY_{SEC}	-5.52***	-3.13*	-6.28***
ΔY_{PRIM}	-6.27***	-3.42*	-6.90***
ΔY_{TERT}	-6.82***	-3.47**	-5.81***
ΔLP_{SEC}	-4.06**	-2.95*	-4.17***
ΔLP_{PRIM}	-6.37***	-3.18*	-4.66***
ΔLP_{TERT}	-4.31***	-2.06	-4.15***
ΔLP_{GDP}	-4.14***	-2.76+	-3.60**
$\Delta E_{PRIM\&TERT}$	-5.51***	-3.42*	-5.55***

***= significant at the 0.1% level. **=significant at the 1% level. *=significant at the 5% level. +=significant at the 10% level. Source: Own calculations, data from Hjerppe (1996) and Statistics Finland

PELLERVON TALOUDELLINEN TUTKIMUSLAITOS PTT
Pellervo Ekonomiska Forskningsinstitut
Eerikinkatu 28 A, 00180 Helsinki, Finland
puh. (09) 348 8844, telefax (09) 3488 8500, sähköposti: econ.res@ptt.fi

Pellervon taloudellisen tutkimuslaitoksen julkaisuja, publikationer, Publications

18. Vesa Silaskivi. 2004. Tutkimus kilpailuoikeuden ja maatalouden sääntelyn yhteensovittamisesta
17. Aki Kangasharju. 1998. Regional Economic Differences in Finland: Variations in Income Growth and Firm Formation.
16. Pertti Kukkonen. 1997. Rahapolitiikka ja Suomen kriisi

Pellervon taloudellisen tutkimuslaitoksen raportteja, forskningsrapporter, Reports

194. Marko Mäki-Hakola – Mikko Toropainen. 2005. Metsien suojelun vaikutukset tuotantoon ja työllisyyteen – Alueellinen ja valtakunnallinen panos-tuotosanalyysi
193. Ari Peltoniemi. 2005. Työllisten työkyky vuonna 2004. Työpoliittinen tutkimus 273, Työministeriö, Pellervon taloudellisen tutkimuslaitoksen raportteja n:o 193.
192. Terhi Latvala – Antti Suokannas. 2005. Automaattisen lypsyjärjestelmän käyttöönotto: kannattavuus ja hankintaan vaikuttavat tekijät
191. Anna-Kaisa Rämö – Tapio Tilli – Ritva Toivonen – Pekka Ripatti – Karoliina Lindroos – Hanna Ruohola. 2005. Metsäverojärjestelmän muutos ja yksityismetsänomistajien puunmyyntiaikeet vuosina 2004 -2007
190. Janne Huovari – Raija Volk. 2004. Ikääntyminen ja maaseudun työmarkkinat
189. Martti Patjas. 2004. Production costs of milk, beef and pig meat in Finland, Sweden, Denmark and Germany
188. Tapio Tilli – Sten-Gunnar Skutin. 2004. Roundwood markets in the Baltic Sea region
187. Päivi Mäki – Ritva Toivonen – Raija-Riitta Enroth. 2003. Puutuotteiden vientimahdollisuudet Kiinaan

Pellervon taloudellisen tutkimuslaitoksen työpapereita, diskussionsunderlag, Working Papers

79. Meri Virolainen. 2005. Venäjän maatalous- ja elintarvikesektori muutoksessa
78. Heikki Lehtonen – Perttu Pyykkönen. 2005. Maatalouden rakennekehitysnäkymät vuoteen 2013
77. Janne Huovari – Raija Volk. 2005. Alueellisten asuntomarkkinoiden kehitys vuoteen 2008
76. Karoliina Lindroos. 2005. Metsänomistajien tavoitteet sekä tieto- ja neuvontatarpeet
75. Tapio Tilli. 2005. Itämeren alueen ja Venäjän metsäsektorin kehitysskenaariot vuoteen 2010 mennessä
74. Janne Huovari – Mikko Pakkanen – Raija Volk. 2005. Alueellisten asuntomarkkinoiden kehitys vuoteen 2007
73. Marko Mäki-Hakola. 2004. Metsien suojelun vaikutukset puumarkkinoilla - Mallitarkastelu
72. Erikka Peltonen . 2004. Korkeakoulusta valmistuneiden alueellinen sijoittuminen
71. Jaakko Pulli – Marko Mäki-Hakola. 2004. Metsien suojelun taloudelliset vaikutukset. Kirjallisuuskatsaus.
70. Arto Luoma – Jani Luoto – Marko Taipale. 2004. Threshold cointegration and asymmetric price transmission in Finnish beef and pork market