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Identification of Liechtenstein‘s Historic Economic Growth and Business Cycles by Econometric Extensions of Data Series

Andreas Brunhart

November 2012

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Identification of Liechtenstein's Historic Economic Growth and Business Cycles by Econometric Extensions of Data Series

Andreas Brunhart[♠]

November 2012

Abstract[*]

Several economic data series of Liechtenstein are backwardly estimated in order to achieve consistent historic time series. The generated series consist for instance of the national income for the years 1954 to 1992 (by regressive inter- and retropolation with indicators) and 1993 to 1997 (by approximative computation after national accounting scheme). Also, the sectoral and total employment of some missing years in the 70s, 80s and 90s is complemented and the gross domestic product from 1972 until 1997 is provided by an approximative computation/estimation relying on the identity of the generation of income account as part of the national accounts. These methods and the presented series are being evaluated with respect to their accuracy, which turns out to be satisfying, and can be linked with the released results from the official national accounts, which were introduced for the year 1998 and have been published until 2009 so far. Along with the provision of these figures, Liechtenstein's economic growth pattern is being identified, the business cycles are detected and first analytical insights are obtained.

Keywords: Economic Growth; Business Cycles; Liechtenstein; Regressive Interpolation and Retropolation; National Accounts

JEL-Classification: C1, C22, C32, E01, E32, N1, O47

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Identification of Liechtenstein's Historic Economic Growth and Business Cycles by Econometric Extensions of Data Series

1. Introduction

The first chapter of this contribution deals with the fact that there exist some special issues in Liechtenstein in the field of economics or economic history, but especially when it comes to business cycle and growth research or econometric forecasting. These issues concern the scarce data base of economic time series: The short time coverage of national aggregates, such as GDP or (gross) national income, complicate business cycle analysis and prediction, but also economic research in general. Officially published national accounts for these aggregates only exist for the years 1998-2010 (see OFFICE OF STATISTICS [2011 and 2012b]). Detailed official annual employment figures are only on hand from 1980 on. In most applications so far, time serial and econometric methods could only be applied to a limited extent to examine economic matters due to the shortness of the time series. Hence, the main aim and contribution of this paper is the prolonging of important economic time series for Liechtenstein, the filling of data gaps, the adjustment for outliers.[1]

There have been earlier estimations for gross domestic product and national income of Liechtenstein, at least for some years: KNESCHAUREK AND GRAF [1990] and KNESCHAUREK AND PALLICH [1982] have approximated real and nominal GDP for the years 1960, 1970, 1975, 1980-1988 and 1991. Also, BECK [1961 and 1963], SCHNETZLER [1966] and KRANZ [1973] have published estimates of national income for the years 1959-1963 and 1966-1970.

However, for any deep econometric analysis of economic matters, the time series need to be consistent and without data gaps. That is why there is an additional need, beyond the analytical interest in the time series themselves, for a new series with estimated GDP figures, which are computed in this contribution for the years 1997 back to 1972. Along with this project, coherent total and sectoral employment figures for the 70s have been supplied. Also, a historical adherent time series of the national income (1954-1997) is being generated.

There are three reasons why not only Liechtenstein's GDP is calculated for earlier years than the official figures currently available but also the time series of national income is

[1] A rise of the frequency of Liechtenstein's GDP from annual to quarterly figures took place in chapter 2.4. of BRUNHART [2012b].

backwardly extended: First, national income is a required component in the chosen computation process of the backward calculations of Liechtenstein's GDP. Secondly, national income has a long tradition in Liechtenstein (with existing estimates for the late 50s, the 60s and the early 90s) and is a main pillar of the official national accounts. Thirdly, a generation of linked time series back covering years until 1954 is possible, while the new computations of GDP only reach back until 1972. Even though, these days the national income is not quoted as often as GDP or gross national income, it is still an important indicator in economic analyses and international comparisons and is not obsolete as it is strongly related and highly correlated to the commonly used gross national income (the exact differences between the two related aggregates are explained in chapter 2. and the beginning of chapter 3.).

The next chapter will deal with the structure of Liechtenstein's official national accounts (Volkswirtschaftliche Gesamtrechnung, VGR FL). In chapter 3., the national income figures from 1954 until 1997 are being generated and methodically explained. Further on, the GDP figures 1972-1997 and their computation approach are presented in the fourth chapter. Chapter 5. will conclude this contribution.

2. National Accounting for Liechtenstein

Before dealing with the applied approach for generating a coherent and accurate GDP-series (and national income), it is worth paying some attention to the system of national accounts[2], especially to the case of Liechtenstein.

OEHRY [2000] has elaborated and introduced the national accounts for Liechtenstein.[3] Along with the official national accounts, Liechtenstein's GDP is being calculated from the production and the income sides and is supplemented by two further accounts, which are the gross national income account ("Nationaleinkommenskonto") and the national income account ("Volkseinkommenskonto"). These two latter accounts are adopted from the old System of National Accounts (SNA58, OECD [1958]) and link the income side with the production side. The principles of the detailed transactions of all the accounts rely on ESA95, the European System of Accounts of EUROSTAT [1995], which essentially was the European version of the SNA93 (System of National Accounts 1993 by UNITED NATIONS [1993]). The results are therefore directly comparable with national accounts from other countries. The lack of important data, such as national balance of payment (especially the missing capital account) makes the usual direct way from gross domestic product (GDP) to gross national income (GNI) impossible. But the two already mentioned accounts gross national income account and national income account ensure that the calculation of the GDP also occurs from the income side. This accompanies the calculation of GDP from the production side and makes reconciliation of the sub-aggregates and sub-accounts possible. The "Volkseinkommenkonto" ascertains the "Volkseinkommen", further on denoted as national income (NI), which is then adjusted via the "Nationaleinkommenskonto" to obtain the "Bruttonationaleinkommen", further on denoted as gross national income (GNI).

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[2] Early pioneers in the field of national accounts were William Petty (1623-1687) and Gregory King (1648-1712). They computed aggregated population, labour input, capital stock and consolidated wealth/income accounts for England and Wales. Colin Clark produced the first integrated accounts for the UK (income, expenditure, production at constant/current prices), and linked his estimates 1913 with those of King and acted together with John Maynard Keynes, who was somehow the "father" of the British national accounts, promoting the importance of national accounts as a tool of economic policy (see CLARK [1940] and KEYNES [1940]). Clark was the first who estimated comparable real income levels of different countries taking differences in purchasing power of currencies into account. International standards for national accounting were set by Richard Stone (he designed the standardized system of national accounts, for which he was awarded the Nobel Prize in Economics), Simon Kuznets (who introduced national accounts in the US), and Milton Gilbert (being responsible for US accounts during World War II and the Marshall Plan accounts). Angus Maddison has contributed pioneering comparable computations and historic estimates of national economic aggregates for countries worldwide and over a long period back in time. For more information about the history of national accounts and important contributions see MADDISON [2007], TILY [2009] and OEHRY [2000, p.32-40].

[3] For more details on Liechtenstein's national accounts see also KELLERMANN AND SCHLAG [2005].

The following table summarizes the systematic of Liechtenstein's official national accounts, which has been compiled and published by Liechtenstein's national Office of Statistics since 1998 on an annual base:

Production Account (Produktionskonto):
Output (Produktionswert)
- Intermediate Consumption (Vorleistungen)
+ Taxes on Products (Gütersteuern)
- Subsidies on Products (Gütersubventionen)
= Gross Domestic Product/Gross Value Added (Bruttoinlandsprodukt)
- Consumption of Fixed Capital (Abschreibungen)
= Net Value Added (Nettoinlandsprodukt)

Generation of Income Account (Einkommensentstehungskonto):
Gross Domestic Product (Bruttoinlandsprodukt)
- Compensation of Employees (Arbeitnehmerentgelt)
- Taxes on Production and Imports (Produktions- und Importabgaben)
+ Subsidies (Subventionen)
= Gross Operating Surplus (Bruttobetriebsüberschuss)

Allocation of Income Account (Einkommensverteilungskonto):
Gross Operating Surplus (Bruttobetriebsüberschuss)
+ Compensation of Employees (Arbeitnehmerentgelt)*
+ Taxes on Production and Imports (Produktions- und Importabgaben)*
- Subsidies (Subventionen)*
+ Property Income (Vermögenseinkommen)*
= Gross National Income (Bruttonationaleinkommen)*

Gross National Income Account (Nationaleinkommenskonto):
Gross National Income (Bruttonationaleinkommen)*
- Taxes on Production and Imports (Produktions- und Importabgaben)*
+ Subsidies (Subventionen)*
- Consumption of Fixed Capital (Abschreibungen)*
= National Income (Volkseinkommen)*

National Income Account (Volkseinkommenskonto):
National Income (Volkseinkommen)*
- Compensation of Employees (Arbeitnehmerentgelt)*
- Entrepreneurial Income of Self-Employees (Selbständigeneinkommen)*
- Property Income of Private Households (Vermögenseinkommen der privaten Haushalte)*
- Undistributed Income of Corporate Enterprises (Unverteilte Einkommen der Kapitalgesellschaften)*
- Direct Taxes of Corporated Enterprises (Direkte Steuern der Kapitalgesellschaften)*
- Property and Entrepreneurial Income of Public Sector (Vermögenseinkommen des Staates)*
= 0

TABLE 1: Systematic of Liechtenstein's official national accounts

The first two accounts in TABLE 1 are compiled after the domestic principle (domestic production and income), while the remaining three accounts are denoted by an asterisk to highlight that they are accounted using the residents concept (income of residents of Liechtenstein that was generated in Liechtenstein and abroad).

3. Coherent Historic Time Series of National Income

There are several reasons why not only Liechtenstein's GDP is calculated for earlier years than the official figures currently available but why also the time series of national income is backwardly extended. These reasons have been noted in the introduction. The three most important aggregates for Liechtenstein, namely gross domestic product, gross national income and national income, are defined and compared in the following.

In short terms, the distinction between GDP and GNI can be made in such a way that gross national income focusses on the income (domestic and from abroad) of residents while the gross domestic product captures the domestic production of residents and non-residents. Especially for small countries and very open economies the distinction between gross domestic product and gross national income may be very important, since there are a lot of workers commuting across the borders and these small countries usually exhibit high levels of foreign trade (possibly causing high foreign investments which increase the annual net capital income[4]) and a high amount of cross-border capital flows. The exact difference of the gross national income and the old national income is explained in the next section (the latter is compiled in the official accounts of Liechtenstein as well and plays an important role in the following chapters). The aggregate national income, yet having been very important in earlier national account schemes and often mentioned in older economic literature, has been replaced by the national aggregate gross national income, which is essentially the national income plus taxes on production and imports, minus subsidies and plus consumption of fixed capital. Both aggregates are strongly related. Inspecting the official national accounts of Liechtenstein (1998-2009), one can conclude that national income and gross national income are highly correlated: The correlation coefficient of their level is 0.98 and of their growth rates 0.99.

[4] This reasoning can be illustrated for the case of Liechtenstein: The principality had highly positive net exports in the previous decades. The fact that the exports were continuously higher than the imports led to high amounts of positive net foreign investments leading to positive net capital income in each year (this is also the case for Switzerland). The identity that net foreign investment must equal net exports is a fundamental principle in economics (see for example MANKIW [2004, p.375]). However, the huge amount of daily inward commuters in Liechtenstein induces negative net (cross-border) labour income which compensate for the positive net capital income (official figures for 2010: Of the domestic employment of 34'334 people in Liechtenstein, 17'570 were inward commuting non-residents, while only 1'516 residents commuted to abroad). Until 2000, GNI and GDP in Liechtenstein were roughly of the same level, while afterwards the GNI rose slower than the GDP due to the fast growing amount of inward-commuters. This compensation channel does not appear in Switzerland, since the commuters play only an important role in very small countries, of course. Thus, the GNI of Switzerland is traditionally higher than the GDP.

As already noted, in the official national accounts by the Liechtenstein Office of Statistics, the GDP is calculated from production and income sides (according to ESA95), supplemented by the two accounts "Nationaleinkommenskonto" and "Volkseinkommenskonto", which are both according to the old scheme after OECD [1958]. These two additional accounts link the income side with the production side, since the direct way from GNI to GDP is not possible due to the lack of important base data. There exists no detailed balance of payments for Liechtenstein. The Swiss National Bank does not publish detailed results on the balance of payments for Liechtenstein, which can be seen as regional part of the monetary and customs union of Switzerland and Liechtenstein. However, especially the capital account would be of specific interest in this context to determine the cross-border returns on capital and transnational transfers of commuters' labour income.

The full list of the five accounts was illustrated in the previous chapter (2.). Important here is the so called national income account, that derives the national income. In order to clarify the exact definition of the term "national income" which has been used here, the derivation of the different classifications of the national income is listed below. Especially the distinction to the frequently used gross national income is of strong relevance.

	Compensation of Employees
plus	Entrepreneurial Income of Self-Employees
plus	Property Income of Private Households
plus	Undistributed Income of Corporate Enterprises
plus	Direct Taxes of Corporate Enterprises
plus	Property and Entrepreneurial Income of Public Sector
minus	Interest on Debt of Public Sector
plus	Property and Entrepreneurial Income of Social Insurances
=	National Income (NI)
plus	Taxes on Production and Imports
minus	Subsidies
=	Net National Income (NNI)
plus	Consumption of Fixed Capital
=	Gross National Income (GNI)

TABLE 2: National income account and the difference between NI and GNI

After the rough valuation of Liechtenstein's national income for the year 1942 by the Statistical Office of Switzerland, several estimates of national income were made by different authors or institutions applying differing methods, even though they all mainly relied on the system of the table listed before. So, figures for Liechtenstein's national income have been calculated for different years and can be obtained from different sources. Even though the

detailed routines for the calculation of the sub-aggregates and the used data series differ between the different authors, the procedures of the estimated figures are fairly comparable throughout the years. SCHNETZLER [1966] introduced the national income account in line with OECD [1958] and therefore set the basement procedure for the following estimates by KRANZ [1973] or the unpublished figures by the governmental financial unit (Stabstelle Finanzen). The two latter authors maintained the approach proposed by SCHNETZLER [1966], only gradually changing the calculation method of the sub-aggregates, using different data-sources, or introduced appropriate modifications. Also the official national accounting involves this account to calculate national income (and in a later step the gross national income), but in a more sophisticated way and also taking advantage of a larger data base. This data base consists also of publicly non-accessible data sources or figures that have been compiled exclusively for the objective of national accounting. BECK [1961 and 1963] calculated national income figures for the years 1959, 1961 and 1962: Even though these calculations followed the structure of OECD [1958] as well, the level of the calculated figures is not directly comparable. Nonetheless, these estimates serve as a good additional reference for the interpolation later on.[5]

TABLE 3 shows all the years for which national income figures are available (up-to-date), differentiating after the two concepts national income I and II (the difference between both concepts is explained in OEHRY [2000, p.67] and SCHNETZLER [1966, p.12]).

[5] For a detailed explanation of the all the mentioned methods for the calculation of the national income, see BECK [1961 and 1963], SCHNETZLER [1966], KRANZ [1973] and OEHRY [2000, p.64-70].

	National Income I	National Income II	Calculated and published by
	Nominal figures, in Mio. CHF		
1942	19.3		Statistical Office Switzerland (1945)
1959		89.0	BECK [1961]
1960	84.7	89.1	SCHNETZLER [1966]
1961		117.8	BECK [1963]
1962		130.3	
1963	122.9	133.1	SCHNETZLER [1966]
1966	167.0	184.1	KRANZ [1973]
1967	184.5	205.4	
1968	219.9	239.7	
1969	257.2	279.2	
1970	308.2	333.1	
1993	Not published		Governmental Financial Unit
1994	Not published		
1995	Not published		
1996	Not published		
1997	Not published		
1998	2'877.5		Office of Economic Affairs
1999	3'138.7		
2000	3'307.5		
2001	2'989.1		
2002	2'880.9		
2003	2'746.7		
2004	2'761.3		
2005	3'094.9		
2006	3'571.5		
2007	4'043.4		Office of Statistics
2008	3'901.4		
2009	3'221.6		

TABLE 3: Different estimates of Liechtenstein's national income

The national income figures, which exhibit a certain comparability, are plotted in FIGURE 1. These values are the starting point for the further calculation of additional national income figures, finally leading to the chained time series from 1954 to 2009. Again, the figures by the governmental financial unit (1993-1997) cannot be displayed as they are unpublished and confidential.

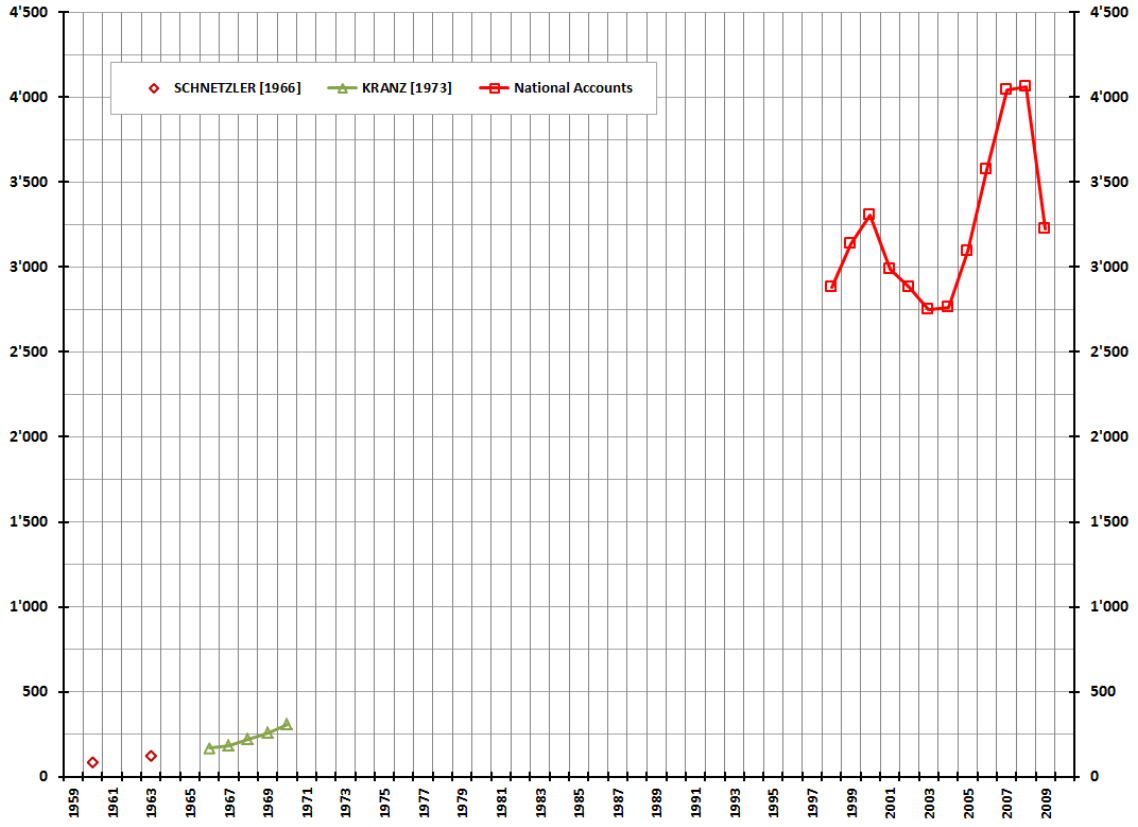

FIGURE 1: Available data points of Liechtenstein's national income

3.1. Backward Calculations: 1993-1997

Beginning with the year 1993, Liechtenstein authorities started to calculate the national income, mainly to get a better foundation for the division of the pool concerning several taxes and tariffs, which are collected for Switzerland and Liechtenstein collectively (for example the value added tax). As a big achievement, Gerold Matt of the financial unit of the government (Stabstelle Finanzen) set up a national income account adopting and adjusting the accounting scheme of KRANZ [1973] and SCHNETZLER [1966] and therefore the systematic of accounts after OECD [1958] (in a simplified manner). This method was also the starting point for the national income account along with the introduction of the national accounting system in Liechtenstein beginning with the year 1998 (see OEHRY [2000]). Of course, for the official national accounts the method was again adjusted and improved (and additional data sources were introduced and compiled), but the mentioned procedures all share the scheme of the national income account of OECD [1958] and are roughly comparable.

As the early national income figures were calculated for the years 1993 to 1997 but unfortunately not published, an attempt to recalculate the figures has been made here. This could have been done since the basic needed data sources were officially collected for 1993 until 1998 and were still accessible to the author yet to be treated confidentially (by decision of the government). As already outlined, the national income is needed for the chosen approach of the calculation of the GDP figures for Liechtenstein (1972-1997). In addition to that, the calculation project of the national income 1993-1997 in this chapter had four main additional goals:

- *Open access*: The recalculation and reconciliation of the already existing but not publicly accessible national income figures for the regarded years makes sure that a public access to these pieces of important data is guaranteed and these values may expand Liechtenstein's economic historical data series fund.

- *Consistence among years*: The original calculation method by the financial unit of the government has been divergent for different years. Especially for the more recent years, the exact computation of sub-components has been modified by the financial unit and new data sources (also in more detail) have been utilized. Thus, it was

pursued in the project of this chapter to exactly unify the method for all the five years in order to gain a better comparability among the years.

- *Chaining with national accounts*: The chosen approach allows a direct conjunction with the officially published national income of the national accounts 1998-2009. For this purpose, also the year 1998 has been computed through the examined approximation method in order to get a level benchmark to the first year of the national accounts. The chosen strategy to chain both sources 1993-1998 and 1998-2009 will be explained in more detail later on.

- *Addition of observation points*: There are additional advantages of the extended data series (2009-1993) beyond the direct economic insights. The number of observation points for the national income can be increased. The currently available data points are shown in FIGURE 1. The extended observation sample constructed here diminishes statistical problems due to the originally small sample size along with the regressions. It also improves the quality of the results of the econometric interpolation mode, which generates national income estimates for the data gaps and supplies a continuous time series from 1954 to 2009. It therefore links and harmonizes national income estimates from the 60s with the current years. This will be done in the next sub-chapter.

The whole computation process for the years 1993 to 1997 is a challenging task, which cannot always be completely explicated and unveiled in full details since this would contradict the confidentiality agreement the author has signed.[6] Nevertheless, it is permitted to at least highlight almost all of the structure and the calculation methods, since it has been the base for the estimation of the national income in this paper. Also, some modifications in the method of the financial unit of the government have been introduced in order to achieve full consistence throughout the whole time span. Unfortunately, these modifications cannot be stated explicitly and major discrepancies in the calculation results will not be mentioned and explained, since this would also contradict the signed confidential agreement. Though, an explicit and detailed comparison of the newly estimated national income figures (annual totals) with the already existing results is not possible because of the same reasons. But one

[6] However, please contact the author of the paper (andreas.brunhart@kofl.li) if there are remaining questions of general nature about the compilation method of parts that could not have been highlighted in detail due to confidential concerns. Of course, detailed confidential figures may not be revealed.

remark is allowed: The recalculation of the national income 1993-1997 has not only the advantage that there exist publishable figures now. Also, the pursuit of consistency has had a notable effect on the annual national income figures compared to the original (unpublished) figures. Also the chaining with the official national accounts considerably adjusted them in their levels.

Besides the consistency within the regarded time span 1993-1997, it is the main ambition to obtain national income figures that are directly comparable with figures from other time spans, mainly the ones by the official national accounts. To be precise, the calculated national income figures serve as indicators for the actual level of the national income (1993-1998) to attain a better comparability with the level of the national accounts' national income data beginning by the year 1998. The calculated national income figures are transposed into percentage changes, which are applied to the 1998-value that was published by the official national accounts. This is a methodological option that several national statistical offices use to compromise figures from varying accounting principles over time. The adjustment process will be explained later on in more detail when the sub-components of the national income account are aggregated and adjusted. The sub-accounts of the national income account shall be repeated here in TABLE 4, as the following explanations are structured according to these components:

	Compensation of Employees
plus	Entrepreneurial Income of Self-Employees
plus	Property Income of Private Households
plus	Undistributed Income of Corporate Enterprises
plus	Direct Taxes of Corporate Enterprises
plus	Property and Entrepreneurial Income of Public Sector
minus	Interest on Debt of Public Sector
plus	Property and Entrepreneurial Income of Social Insurances
=	National Income (NI)

TABLE 4: National income account

3.1.1. Compensation of Employees

The compensation of employees within the national income account include all incomes that have been earned by residential employees. It also includes payments of the employers for the employees' social insurance.

The sum of all incomes relevant for income taxes can be obtained from data of Liechtenstein's Tax Administration (Liechtensteinische Steuerverwaltung). As it is aimed to calculate the compensation of employees in a first step, the division of the sum of all incomes into employees' income and self-employees' income is needed. To obtain the employees' income share one needs to apply an appropriate indicator. For this reason, another important data source, namely the public pension insurance (Alters- und Hinterlassenenversicherung, AHV), is used. All employees have to contribute to AHV (currently 3.8% of the income)[7]. All employees' aggregated incomes, which are subject to these contributions, are collected and published by AHV. Also self-employees have to contribute to the public pension system. These aggregated self-employees' incomes are collected and published as well by AHV. These two annually published figures give a very good proxy for the share of employed income and self-employed income within the economy.

	CHF	1993	1994	1995	1996	1997	1998
	Labor Income	1'001'122'000	1'048'656'000	1'094'324'000	1'131'949'000	1'200'275'000	1'248'350'101
*	Share Employees	0.9487	0.9562	0.9555	0.9557	0.9575	0.9607
=	Income Employees	949'793'429	1'002'712'604	1'045'670'784	1'081'782'378	1'149'213'580	1'199'289'942

TABLE 5: Income of employees

In a next step, the payments of the employers for the employees' social insurance have to be estimated and added to the just calculated incomes of employees. This is done using an indicator called "social mark-up". The social mark-up sums up all the average contributions by the employer for the employee's social insurance (in percentage of employee's income): This includes pension insurance, widow(er) and orphan insurance, invalidity insurance, family benefits, unemployment insurance, obligatory health insurance and occupational accident insurance. The aggregated incomes of all employees are adjusted by this social mark-up, which is simply the total of percentage points of all the just mentioned contributions, which the employer in average contributes as a percentage of the employee's income:

*Income of employees * social mark-up = compensation of employees*

The total of all compensation of employees as the product from the income of employees and the social mark-up is listed in TABLE 6.

[7] Also the employers have to contribute to the AHV with 3.8% of the employee's salary.

	CHF	1993	1994	1995	1996	1997	1998
	Income Employees	949'793'429	1'002'712'604	1'045'670'784	1'081'782'378	1'149'213'580	1'199'289'942
*	Social Mark-Up	1.1657	1.1670	1.1667	1.1686	1.1705	1.1717
=	Compensation of Employees	1'107'149'506	1'170'189'674	1'220'025'931	1'264'149'251	1'345'131'511	1'405'167'249

TABLE 6: Income of employees and social mark-up

3.1.2. Entrepreneurial Income of Self-Employees

Besides the income of employees, self-employees are also of relevance. Again, the sum of all incomes collected by Liechtenstein's national tax administration serves as the base quantity. To figure up the share of income of self-employees' the AHV-proxy is applied. The same proxy as explained in the previous sub-chapter yields the ratio of labour income of employed versus self-employed people. It basically is the difference of the total labour income and the compensation of employees, the latter has been calculated earlier. TABLE 7 displays the calculated figures of the entrepreneurial income of self-employees.

	CHF	1993	1994	1995	1996	1997	1998
	Labor Income	1'001'122'000	1'048'656'000	1'094'324'000	1'131'949'000	1'200'275'000	1'248'350'101
*	Share Self-Employees	0.0513	0.0438	0.0445	0.0443	0.0425	0.0393
=	Income Self-Employees	51'328'571	45'943'396	48'653'216	50'166'622	51'061'420	49'060'159

TABLE 7: Entrepreneurial Income of self-employees

3.1.3. Property Income of Private Households

Not only the labour income but also the property income is an important part of the national income account. The property income of private households consists of four components: interest income plus dividend income plus rental income minus interest on debts from consumption loans. Most important data sources are the national income statement in the annual governmental report, the income statement in the annual reports of the municipalities, the income statements of the social insurances, the Statistical Yearbook and figures compiled by the national tax administration.

To obtain an approximative estimate of the *interest income*, the interest income of the municipalities, the state and the social insurances have to be subtracted from the interest income of the residents in order to obtain the interest income of the private households (as

listed in TABLE 8)[8]. While the interest incomes of the state, of the municipalities and of the social insurances can be simply summed up from their income statements, the computation of the residents' interest income is more involved (as explained in the appendix A.1.). The returns on capital of the following social insurances are accounted for: Public pension, widow(er) and orphan insurance (Alters- und Hinterlassenenversicherung, AHV), invalidity insurance (Invalidenversicherung, IV), family benefits (Familienausgleichskasse, FAK), unemployment insurance (Arbeitslosenversicherung, ALV), obligatory health insurance (Obligatorische Krankenversicherung, OKV), occupational compensation insurance (Berufsunfallversicherung, BUV) and private pension insurances. The interest income of the private pension insurances was compiled by the Office of Economic Affairs but is, however, confidential. So, the detailed compilation of the interest income of the insurances quoted before cannot be displayed here.

	Interest Income (in CHF)	1993	1994	1995	1996	1997	1998
	Residents	367'395'195	328'303'656	304'583'958	184'824'464	168'843'224	154'437'092
-	**Municipalities**	*3'000'000*	2'918'069	2'163'650	1'810'182	2'334'620	1'849'386
-	**State**	13'473'236	4'561'944	10'741'152	13'294'457	11'477'091	18'646'877
-	**Social Insurances**	34'500'450	31'468'097	30'889'544	48'033'045	57'458'438	42'794'603
=	**Interest Income TOTAL**	316'421'509	289'355'546	260'789'612	121'686'781	97'573'075	91'146'225

TABLE 8: Interest income of private households

The *dividend income* is calculated by subtracting the undistributed entrepreneurial income (undistributed profits) from the corporation's total profits, as visible in TABLE 9. Also the dividends of the shares of Liechtensteinische Landesbank (LLB) owned by the state have to be subtracted, since it is a part of the income of the state (property and entrepreneurial income of public sector, which is explained later on). The undistributed income and the profits are compiled by the tax administration and the dividend of the LLB is mentioned in the annual governmental report.

	Dividend Income (in CHF)	1993	1994	1995	1996	1997	1998
	Corporations' Profits	553'179'000	557'988'155	560'044'098	591'180'138	735'580'950	761'409'832
-	**Undistributed Profits**	277'862'000	249'137'278	220'802'209	244'527'706	267'892'194	319'821'584
-	**Dividend LLB**	28'800'000	28'800'000	32'000'000	35'200'000	36'250'000	36'400'000
=	**Dividend Income TOTAL**	246'517'000	280'050'877	307'241'889	311'452'432	431'438'756	405'188'248

TABLE 9: Dividend income of private households

[8] From now on, all the figures in *italics* denote rough approximations by the author due to gaps in the data sources.

The *rental income* of private households has to be approximated, since data on the real estate market in Liechtenstein is scarce. The census that is carried out every ten years by the Office of Statistics provides data such as the number of flats and the average rental price. Both figures are linearly interpolated between 1990 and 2000 and then multiplied in order to get the estimated aggregate rental income. The results are shown in TABLE 10.

	Number/CHF	1993	1994	1995	1996	1997	1998
	Number of Flats	3'364	3'467	3'571	3'675	3'778	3'882
*	Average Rental Price	11'810	12'223	12'636	13'049	13'462	13'874
=	Rental Income	39'727'824	42'382'724	45'123'156	47'949'120	50'860'617	53'857'646

TABLE 10: Rental income of private households

The interests on debts from consumption loans have to be subtracted, after the interest income, the dividend income and the rental income have been compiled and summed up. These interests are not known and must be approximated, the numbers here are taken from the original approximation of the financial unit of the government.

Property Income (in CHF)		1993	1994	1995	1996	1997	1998
	Interest Income	316'421'509	289'355'546	260'789'612	121'686'781	97'573'075	91'146'225
+	Dividend Income	246'517'000	280'050'877	307'241'889	311'452'432	431'438'756	405'188'248
+	Rental Income	39'727'824	42'382'724	45'123'156	47'949'120	50'860'617	53'857'646
-	Interests on Debts	5'340'000	4'728'000	4'149'000	4'267'000	4'287'000	*4'200'000*
=	Property Income	557'098'509	564'678'423	563'882'501	428'872'213	524'724'831	492'134'473

TABLE 11: Property income of private households

All the relevant components that have just been outlined are aggregated and shown in TABLE 11 above.

3.1.4. Undistributed Income of Corporate Enterprises

After having compiled the labour and property income of private household, also the corporations have to be considered. The undistributed income of corporate enterprises consists of both private and public corporations. It is essentially the private corporations' profits minus the private corporations' payouts plus the public corporations' profits. The difference of private corporations' profits and the undistributed incomes of private

corporations represent the same amount which has also been implemented in the calculation of the dividend income of the private households earlier.

The data for the privately owned corporations can be obtained from the national tax administration while the figures referring to the publicly owned corporations are taken from Liechtenstein's income statement in the annual governmental report. As shown in TABLE 12, the considered public corporations are: the national gas supplier (Liechtensteinische Gasversorgung, LGV) and the national energy supplier (Liechtensteinische Kraftwerke, LKW).

CHF	1993	1994	1995	1996	1997	1998
Undistributed Income Corporate Enterprises	278'984'125	250'468'175	222'133'415	246'602'758	269'610'542	322'697'337

TABLE 12: Undistributed income of corporations

3.1.5. Direct Taxes of Corporate Enterprises

The direct taxes of the corporate enterprises have to be added to their undistributed income. The position "direct taxes of corporate enterprises" can be determined by simply considering the aggregated raised taxes on capital and on profits (Kapital- und Ertragssteuern), which are annually published by Liechtenstein's tax administration. TABLE 13 shows the direct taxes for each year.

CHF	1993	1994	1995	1996	1997	1998
Direct Taxes	43'296'273	59'702'706	69'000'786	70'753'592	74'219'418	86'008'162

TABLE 13: Direct taxes of corporate enterprises

3.1.6. Property and Entrepreneurial Income of Public Sector

The property and entrepreneurial income of the public sector includes all interest incomes from leasing, renting and capital received by the state and the municipalities. They are published in the individual income statements of the municipalities and in the national income statement along with the annual governmental report. The different book-entry items referring

to any kind of property and entrepreneurial income are summed up for each municipality and for the state. This is shown in TABLE 14.

	CHF	1993	1994	1995	1996	1997	1998
	Income on Leasing/Renting (Municipalities)	*4'000'000*	4'111'247	4'737'086	5'399'820	5'769'025	*6'000'000*
+	**Income on Leasing/Renting (State)**	681'053	734'409	664'520	632'990	652'157	633'224
+	**Income on Capital (Municipalities)**	*3'000'000*	2'918'069	2'163'650	1'810'182	2'334'620	1'849'386
+	**Income on Capital (State)**	42'933'236	34'021'944	43'401'152	49'154'457	49'911'765	55'706'877
=	**Income of Public Sector**	50'614'290	41'785'669	50'966'408	56'997'449	58'667'567	64'189'486

TABLE 14: Property and entrepreneurial income of public sector

3.1.7. Interest on Debt of Public Sector

From the interest incomes (previous position from the sub-chapter 3.1.6.) all the interests on debt by the public sector have to be subtracted. Again, relevant figures can be obtained and aggregated from the individual income statements of the municipalities and the national income statement in the annual national governmental report. TABLE 15 lists the interest on debt of the public sector.

	CHF	1993	1994	1995	1996	1997	1998
	Interest on Debt (Municipalities)	*1'600'000*	1'532'107	1'716'379	1'374'475	924'974	627'860
+	**Interest on Public Debt (State)**	5'788'724	5'689'900	5'527'091	4'602'358	3'984'373	3'905'472
=	**Interest on Debt of Public Sector**	7'388'724	7'222'007	7'243'470	5'976'833	4'909'347	4'533'332

TABLE 15: Interest on debt of public sector

3.1.8. Property and Entrepreneurial Income of Social Insurances

Also the interests gained and paid by the social insurances are to be considered within the national income accounts. These included social insurance institutions are public pension/widow(er)/orphan insurance, invalidity insurance, family benefits, unemployment insurance, obligatory health insurance, occupational accident insurance, pension funds for employees of the state and private pension funds.

The relevant numbers can be found in the income statements of the annual reports of the respective social insurances. TABLE 16 may not be broken down into more detailed figures, since some of the data are confidential, for example the detailed data regarding the private pension funds.

	CHF	1993	1994	1995	1996	1997	1998
	Income on Leasing/Renting	*4'009'864*	4'586'792	5'302'871	6'605'808	6'403'047	6'085'118
+	Interest on Capital	*115'001'358*	104'893'656	102'965'262	160'110'148	191'528'160	142'648'678
-	Interest on Debt	*5'065'721*	5'029'206	6'456'588	5'759'248	7'822'112	2'912'551
=	Property and Entrepreneurial Income of Social Insurances	113'945'501	104'451'242	101'811'545	160'956'708	190'109'095	145'821'245

TABLE 16: Property and entrepreneurial income of social insurances

3.1.9. Addition to Entire National Income Account

After having compiled all the sub-components, they can be totalled to the first approximation of national income, which serves as an indicator to chain both periods 1993-1998 and 1998-2009 (the latter provided by the national accounts) to one continuous time series. The following table summarizes all the sub-components and their annual totals outlined earlier.

	Sub-Accounts (in CHF)	1993	1994	1995	1996	1997	1998
	Compensation of Employees	1'107'149'506	1'170'189'674	1'220'025'931	1'264'149'251	1'345'131'511	1'405'167'249
+	Entrepreneurial Income of Self-Employees	51'328'571	45'943'396	48'653'216	50'166'622	51'061'420	49'060'159
+	Property Income of Private Households	596'826'332	607'061'147	609'005'657	476'821'333	575'585'448	545'992'119
+	Undistributed Income of Corporate Enterprises	278'984'125	250'468'175	222'133'415	246'602'758	269'610'542	322'697'337
+	Direct Taxes of Corporate Enterprises	43'296'273	59'702'706	69'000'786	70'753'592	74'219'418	86'008'162
+	Property/Entrepreneurial Income of Public Sector	50'614'290	41'785'669	50'966'408	56'997'449	58'667'567	64'189'486
-	Interest on Debt of Public Sector	7'388'724	7'222'007	7'243'470	5'976'833	4'909'347	4'533'332
+	Property/Entrepreneurial Income of Social Insurances	113'945'501	104'451'242	101'811'545	160'956'708	190'109'095	145'821'245
=	National Income (Indicator)	2'234'755'873	2'272'380'001	2'314'353'487	2'320'470'881	2'559'475'655	2'614'402'426

TABLE 17: Summing up the indicator for national income

The annual percentage change of the national income indicator is used for the backward-calculation starting with the national income of the year 1998 that is issued by the official national accounts. The underlying reasonable assumption is that the relative change of the actual national income can be approximated by the national income indicator.[9]

[9] It is not possible to evaluate this (yet very reasonable) claim, since some important data sources needed are confidential or not accessible. Otherwise, the calculation method could also have been carried out for the years 1999-2009 in order to compare the growth rates with those from the official national accounts.

Mio. CHF	1993	1994	1995	1996	1997	1998
National Income (Indicator)	2'234.8	2'272.4	2'314.4	2'320.5	2'559.5	2'614.4
%-Change (Retropolation)		+1.68%	+1.85%	+0.26%	+10.30%	+2.15%
National Income	2'459.6	2'501.1	2'547.3	2'554.0	2'817.0	2'877.5

TABLE 18: Backward computation of national income by applying the derived indicator

FIGURE 2 gathers the five annual observations that have just been derived (and listed in TABLE 18) together with the already existent official figures by the national accounts from 1998 to 2009 into one combined time series for Liechtenstein's national income, as well in real (deflated with Swiss consumer price index) as in nominal terms.

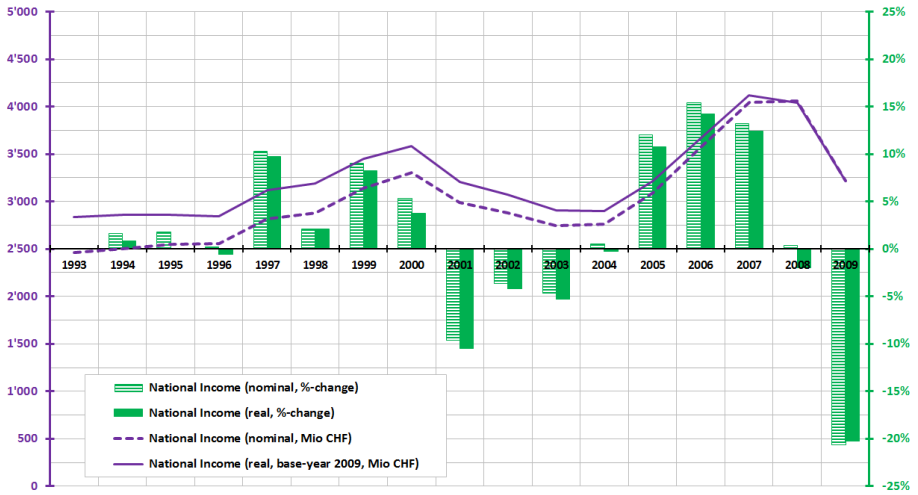

FIGURE 2: Real and nominal national income of Liechtenstein

A short economic interpretation supports the plausibility of the calculated growth rates of national income from 1994 to 1998. Influences worth mentioning and potentially leading to the observed business cycle pattern are the Asia-Crisis in 1998, the world-wide boom by the end of the 90s and the world recession in the first half of the 90s (which was accompanied by a restrictive monetary policy of the Swiss National Bank).

Besides the economic plausible interpretation of the absolute and relative values, also other indicators, such as the foreign sales of Liechtenstein's industry, Liechtenstein's exports of goods and the Swiss national income show a similar pattern: very moderate growth until 1996 and two considerable peaks of percentage growth in the successive years. As it turns out, the generated growth rates of national income also correspond well with the final estimates of Liechtenstein's gross domestic product, which will be derived for the years before 1998 (in

Additionally, carrying out the method also for the years 1999-2009 would be highly time-consuming and even more complex if not impossible than for the years 1993-1997, where at least some of the data sources have already been compiled and been exceptionally made accessible to the author by national authorities.

chapter 4.). FIGURE 3 shows the evolution of the national income and the gross domestic product in Liechtenstein, both in nominal terms.

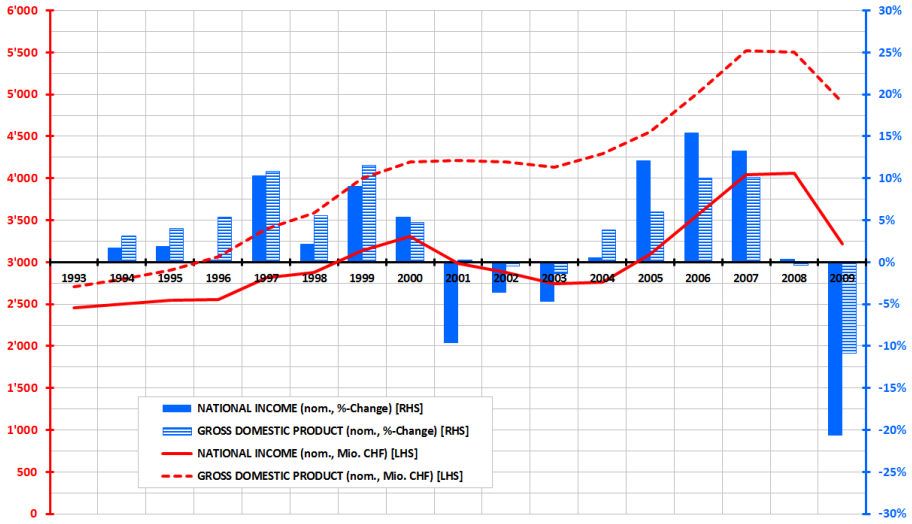

FIGURE 3: Nominal GDP and nominal national income of Liechtenstein

3.2. Backcasting: 1954-1992

As national income[10] figures are required in the calculation process for the GDP's sub-account "taxes on production and imports", the missing values are estimated here to fill the data gaps. FIGURE 4 displays the already available data points. The estimations are also valuable from an economic view as they generate an important economic time series for Liechtenstein from 1954 to 2009 without missing data for particular years.

As already noted, national income figures are required for some parts of the taxes on production and imports, according to the executed procedure of the official national accounts of Liechtenstein. This requirement holds for some of the different kinds of taxes on production and imports that are raised and processed by Swiss authorities. Liechtenstein shares a monetary and economic union with Switzerland in various aspects, for example the custom treaty with Switzerland and the Swiss Franc as common currency. The share of Liechtenstein out of the common pool of both countries regarding the relevant taxes and tariffs is calculated by different measures such as the number of inhabitants and/or the national income.

The previous chapter dealt with the direct calculation of national income figures for the years 1993-1997. Unfortunately, important data sources needed for this computation method are not available anymore or not accessible for the public. Thus, annual figures for the years before 1993 have to be obtained econometrically, applying a statistical model. The chart in FIGURE 4 visually gathers the different sources of national income figures which are available for the statistical estimation model. Four different data sources are disposable so far: The official national accounts (OFFICE OF STATISTICS [2011]), the figures by SCHNETZLER [1966] and KRANZ [1973] and the calculations done in the previous section.

[10] The exact definition of Liechtenstein's national income and the difference to the gross national income are explained in chapter 2. and 3.'s beginning.

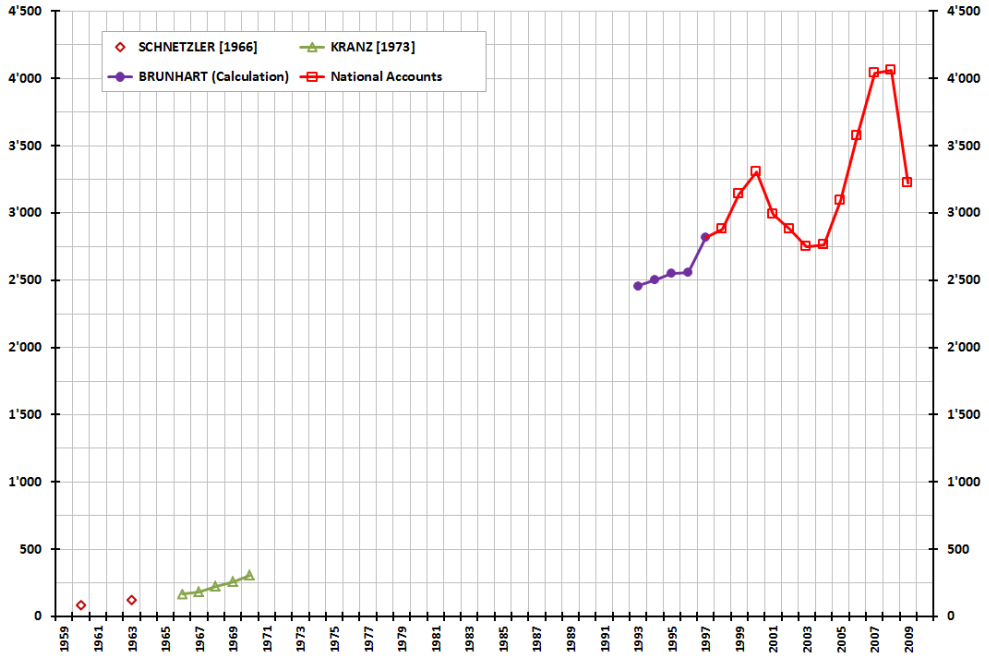

FIGURE 4: Observations for Liechtenstein's national income

Once all the figures of national income for all the available years are gathered (1960, 1963, 1966-1970, 1993-2009), there are 27 years remaining for which estimated values shall be generated via the three following steps:

[1] *Approximative interpolation* (1959, 1961-1962, 1964-1965): There exist national income figures for 1959 and 1961-1962, which were calculated by BECK [1961 and 1963]. His approach is also outlined in OEHRY [2000, p.64-65]. Even though they principally follow the systematic of OECD [1958], the level of these numbers is not directly comparable with the numbers from SCHNETZLER [1966]. Yet, they are not heavily divergent. Additionally, it is well-grounded to assume that the relative annual percentage changes are comparable with the figures by Schnetzler. Therefore, the figures of Beck are adjusted and both sources combined. This is done in a heuristic-iterative manner finding a balance between linear interpolation and the relative difference of the raw values for 1959, 1961 and 1962. The two years 1964 and 1965 are linearly interpolated in order to attain a complete sub-sample from 1959-1970. These interpolated values are being replaced later on by the fitted values resulting from step [3].

[2] *Econometric estimation* (1954-1958, 1964-1965, 1971-1992): There are several economic data series, which are eligible as indicators for the backward-estimation of

Liechtenstein's national income. The used series were chosen due to their correlation with national income in their levels and percentage changes (measured for those years with existing national income figures). The definitive decision whether a variable is included into the model or not mainly depends on its contribution to the predictive accuracy of the model. The applied estimation modelling approach shall be outlined in more detail later in this chapter. For the retropolation of the years 1954 until 1958 the predicted figures are directly applied by the backward application of the fitted values (differenced logarithms). For the interpolation of the other two time periods 1964-1965 and 1971-1992, the fitted values are subject to adjustments, as explained in step [3].

[3] *Interpolative correction of estimation* (1964-1965, 1971-1992): The estimated values from the estimation model of step [2] are now weighted by an adjustment factor to assure a better corresponding with the difference of the level (thus, the long-term growth) of the observed values of 1963 compared to 1966 and 1970 relative to 1993. These adjustment factor weights are generated by the linear interpolation of the ratios at the beginning and at the end of both time frames 1964-1965 and 1971-1992. The ratios are calculated by dividing the fitted value from [2] with the observed values of SCHNETZLER [1966], KRANZ [1973] and of the computed figures from the previous chapter.

For the steps [2] and [3] several indicator series, which are related to national income, are involved. The four chosen indicator series are the wages in Liechtenstein[11], the banking assets in Liechtenstein[12], the foreign sales of Liechtenstein's main industrial companies[13] and the gross national income of Switzerland. These data series have been selected out of about 30 economic time series according to their correlation to Liechtenstein's national income (for the years with national income data available). They are obtained from the annual Statistical Yearbook by the national statistical office (OFFICE OF STATISTICS [2012a]), except for the

[11] All the wages and self-employed incomes in Liechtenstein, which are relevant for the public pension insurance (Alters- und Hinterlassenenversicherung, AHV) are included. All employees have to contribute to the AHV. All employees' aggregated incomes, which are subject to these contributions, are collected and published by the AHV. Also self-employees have to contribute to the public pension system. These aggregated self-employees' incomes are collected and published as well by AHV.

[12] These numbers are collected by Liechtenstein Bankers Association (Liechtensteiner Bankenverband, LBV) and include the assets of the balance sheets of all banks located in Liechtenstein.

[13] The foreign sales are compiled by Liechtenstein Chamber of Commerce and Industry (Liechtensteinische Industrie- und Handelskammer, LIHK). The members of the chamber are included, they consists of all the companies in Liechtenstein of significant size and importance.

Swiss national income[14] which is published by Swiss Statistics (http://www.bfs.admin.ch). Some of the series have been corrected by the author for structural changes or outliers. Also, some data gaps have been filled using other archived data sources.

There are two main reasons, why the nominal national income is used instead of the real national income: In the official national accounts, only nominal values are published, since no official price indices exist for Liechtenstein. Also, all the considered indicator series are measured in nominal terms (Swiss Francs), too.

Correlation (1959-1970, 1993-2009)		Wages	Banking Assets	Foreign Sales	GNI Switzerland
National Income Liechtenstein	Level (log)	0.9967	0.9987	0.9953	0.9978
	Growth Rates (dlog)	0.5907	0.7836	0.8115	0.4242

TABLE 19: Correlation of national income and indicators

The table above shows the correlation coefficients of the included independent variables with the dependent variable (national income), in levels and growth rates (logarithms and differenced logarithms). The rather low correlation of Liechtenstein's national income and Switzerland's gross national income is due to an outlier in the year 2009. However, the correlation of the growth rates exceeds 0.7 if that particular year is excluded.

For the five considered series, unit root tests have been conducted. An augmented Dickey-Fuller test (DICKEY AND FULLER [1979]) with one-sided p-values after MACKINNON [1996] was applied using the test strategy proposed by ELDER AND KENNEDY [2001] and the information criterion by AKAIKE [1974] for the determination of the lag order in the estimation setting shown below:[15]

$$X_t = \alpha + \delta \cdot t + \phi \cdot X_{t-1} + \gamma_1 \cdot \Delta X_{t-1} + ... + \gamma_p \cdot \Delta X_{t-p} + \varepsilon_t$$

The deterministic regressors are the constant α and the linear time trend t, whereas the coefficient ϕ from the autoregressive component is of main importance and is equal to one in the case of a unit root. The lags of the differenced dependent variable (ΔX_{t-i}) represent the augmentation of the augmented test. The estimated test equation below can be derived by subtracting X_{t-1} from both sides of the equation above:

[14] Different sources for different years have been harmonized and chained by the author.
[15] For the justification of the chosen approach also see NEUSSER [2006, p.112-115].

$$\Delta X_t = \alpha + \delta \cdot t + \underbrace{(\phi - 1)}_{\beta} \cdot X_{t-1} + \gamma_1 \cdot \Delta X_{t-1} + \ldots + \gamma_p \cdot \Delta X_{t-p} + \varepsilon_t$$

$$H_0: \ \phi = 1 \ \text{(tested via } H_0: \ \beta = 0\text{)}$$

TABLE 20 shows the results of the conducted unit root tests. The null-hypothesis of the existence of a unit root cannot be rejected for the level of all the series, but for the annual differences of all the series.

ADF-Tests	Constant α	Trend t	Lags (AIC)	β (t-Value / p-Value)	I(d)
log(*NATIONAL INCOME*)	Yes	Yes	4	0.1749/0.9956	**I(1)**
dlog(*NATIONAL INCOME*)	Yes	Yes	3	-7.0380/0.0001	
log(*WAGES*)	Yes	Yes	5	-0.5812/0.9759	**I(1)**
dlog(*WAGES*)	Yes	Yes	4	-5.3906/0.0003	
log(*FOREIGN SALES*)	Yes	Yes	4	0.4582/0.9989	**I(1)**
dlog(*FOREIGN SALES*)	Yes	No	3	-3.8929/0.0040	
log(*BANKING ASSETS*)	Yes	Yes	4	-0.4822/0.9814	**I(1)**
dlog(*BANKING ASSETS*)	Yes	Yes	4	-6.4019/0.0000	
log(*GNI CH*)	Yes	Yes	2	-2.3884/0.3813	**I(1)**
dlog(*GNI CH*)	Yes	Yes	1	-6.5487/0.0000	

TABLE 20: Unit root tests for the applied variables

The unit root tests show that all the used series are I(1), meaning that they are integrated of order one. These findings are also supported by other unit root/stationarity tests, such as the tests after PHILLIPS AND PERRON [1988] and KWIATKOWSKI ET AL. [1992]. Thus, in order to avoid the danger of spurious regression, variables are being differenced to obtain stationarity.

GRANGER AND NEWBOLD [1974] pointed out the potential problem and consequences of spurious regression. According to them, it may lead to falsely low p-values and high R^2. The Durbin-Watson test checks the presence of serial correlation of first order among the errors of the model and was introduced by DURBIN AND WATSON [1950]. Especially the high R^2 indicates the likely presence of spurious regression if the variables are used in log-levels. But then again, the main purpose is the interpolation-task and not the decision about the significance of individual variables (the latter is of main concern along with spurious regression).

Since this project mainly serves as an interpolation method, models are chosen in order to maximize the predictive accuracy and do not deal with the individual variables and their individual significance and the linked economic hypotheses and conclusions. Therefore, different specifications applying the variables also in log-levels are evaluated, as well. The

log-level models include a linear trend and a lagged term for the dependent variable in order to remove the residual's autocorrelation. Still, the results from the regression in log-levels of the non-stationary data should be handled with care since the predictions in the interpolated sub-sample are dynamic and not static forecasts, because coefficients of the lagged dependent variable corresponds to the national income figure one period ago (that has also been fitted). To a certain extent, this remark also holds for the model in log-differences, as the reference value of the dependent variable's level, to which the estimated value in differences relates, consists of an already forecasted value.[16] The chosen models of both kinds and their estimated parameters are shown in TABLE 21 and TABLE 38.

Another approach to deal with non-stationary data would be to use an error-correction model[17], either in a univariate framework after ENGLE AND GRANGER [1987] or in a multivariate setting in the tradition of JOHANSEN [1988]. These models incorporate a stationary cointegrating relationship between the variables in levels. They also include some error correction adjustment term if the system temporarily deviated from the long-term equilibrium and also short-term dynamics modelled as a vector autoregression of the differenced variables (and possibly some deterministic regressors in the different components within the whole error-correction model). But, in the application here, there are only few degrees of freedom for the estimation of the rather complex error-correction model and there is no continuous sample. This is why no error-correction model has been executed.

The following measures played an important role in the decision about the potential inclusion of variables and deterministic regressors (trend and time dummies) but also in the context of choosing the appropriate lag length of the independent and dependent variables:[18]

- *Goodness-of-fit*: The adjusted R^2 and information criteria such as the ones after AKAIKE [1974] or SCHWARZ [1978] have been consulted in the model specification process. Yet, the main focus has been on Akaike's information criterion.

[16] Even though the chosen dlog-model can only produce static and no dynamic forecasts (no lagged terms are involved), it generates dynamic predictions in the interpolated sub-sample when the values are transformed from log-differences into log-levels.

[17] For more details on (vector) error-correction models see LÜTKEPOHL [2005] or ASTERIOU AND HALL [2007].

[18] Due to the small sample size, the upper bound for the applied individual lag lengths of the variables was chosen to be two. As it turns out, the lags of any of the variables do not improve the model according to the here mentioned measures in the setting using log-differenced variables. One lag of the dependent variables has been included into the setting with log-levels of the variables.

- *Significance of coefficients*: The significance of the included variables and the additional deterministic regressors has been checked, whereas the insignificance of a coefficient was in general not yet a sufficient reason for excluding this lag or variable.

- *Residuals*: The residuals have been checked for severe outliers and if there is remaining autocorrelation of the model's residuals left. The examination of the autocorrelation is done via plotting the residual's correlogram and through the residual tests of LJUNG AND BOX [1978] and of BREUSCH [1978] and GODFREY [1978].

- *Prediction error*: The mean percentage prediction error (in-sample) has also been considered. For each predicted value, the percentage deviation from the actual value has been computed and squared. The average of the square roots of these deviations represents the (mean) absolute prediction error. This evaluation is, of course, related to the Akaike's information criterion that was mentioned before. The percentage error was given the main priority compared to the significance of the coefficients or the goodness-of-fit measures.

- *Confidence interval*: The average of the size of the confidence intervals, measured as standard errors relative to the predicted value of each year, for all the fitted values has been calculated and serves as an additional judgement of predictive accuracy.

These measures have been considered in the specifications for both of the models in logs and in dlogs. Comparing the predictive accuracy of the best specifications of both types, it turns out that the dlog-specification is superior to the log-specification. Indications leading to this conclusion are that the dlog-model features a considerably lower prediction error (1.92% versus 2.36%) and that the average confidence interval is smaller (average reliability indicator[19] of 6.16% against 8.05%).[20] Even though information criteria can be applied for the comparison of the accuracy of different nested and non-nested models, they may not be used to compare equations with different dependent variables. Thus, while these criteria are used for finding the best specification within the two kind of models (log and dlog), they are not used for the comparison of the best log-specification versus the best dlog-specification. Also,

[19] The reliability indicator for every time point is measured by the percentage size of the confidence interval relative to the point forecast.

[20] The predicted values of the model in logs and of the model in dlogs are both transformed into (non-logarithmic) levels before the comparison takes place.

the comparison of the adjusted R^2 is not of big use, since the log-model exhibits such a high R^2, because it incorporates non-stationary variables with a positive trend.

The estimation output of the chosen predominant model is shown in TABLE 21, whereas their fitted and actual values are illustrated in FIGURE 5:

Dependent Variable: dlog(*NATIONAL INCOME*)		Sample (adjusted): 1960-2009		
Method: Least Squares		Included Observations: 27 after adjustments		
Variable	**Coefficient**	**Standard Error**	**t-Statistic**	**p-Value**
LINEAR TREND	-0.0010	0.0002	-5.7714	0.0000
dlog(*WAGES*)	0.3936	0.1252	3.1437	0.0051
dlog(*FOREIGN SALES*)	0.6411	0.0793	8.0852	0.0000
dlog(*BANKING ASSETS*)	0.4362	0.1083	4.0266	0.0007
dlog(*GNI CH*)	-0.7458	0.1705	-4.3733	0.0003
D61	-0.1031	0.0308	-3.3468	0.0032
D0506	0.0909	0.0218	4.1693	0.0005
Measures of Fit				
R-squared	0.9338	Mean Dependent Variable	0.0626	
Adjusted R-squared	0.9140	S.D. Dependent Variable	0.0930	
S.E. of Regression	0.0273	Akaike Info Criterion	-4.1462	
Sum Squared Residuals	0.0149	Schwarz Criterion	-3.8103	
Log Likelihood	62.974	Durbin-Watson Statistic	2.4022	

TABLE 21: Applied model for the interpolation

In general, it is not useful to display the information criteria if the output of only one estimation equation is being inspected. Yet, it is still shown here in order to highlight their importance during the specification process picking the involved variables, the time trend and time dummies. The estimation output shows that all included parameters are highly significant. In addition, the Lagrange-Multiplier test of BREUSCH [1978] and GODFREY [1978] and also the Q-test after LJUNG AND BOX [1978] do not reject the null-hypothesis of the non-existence of residuals' serial correlation. The estimation output also shows that two time dummies have been introduced, for the year 1961 and the time span 2005-2006. Also, a linear time trend is included. These inclusions are supported by lower prediction errors, better information criteria, significant coefficients, higher adjusted R^2 and visual economic discovery of outliers (regarding the time dummies) and by the fact that the growth rates are diminishing in average over time (regarding the time trend). With respect to the just mentioned attributes, no constant has been incorporated.

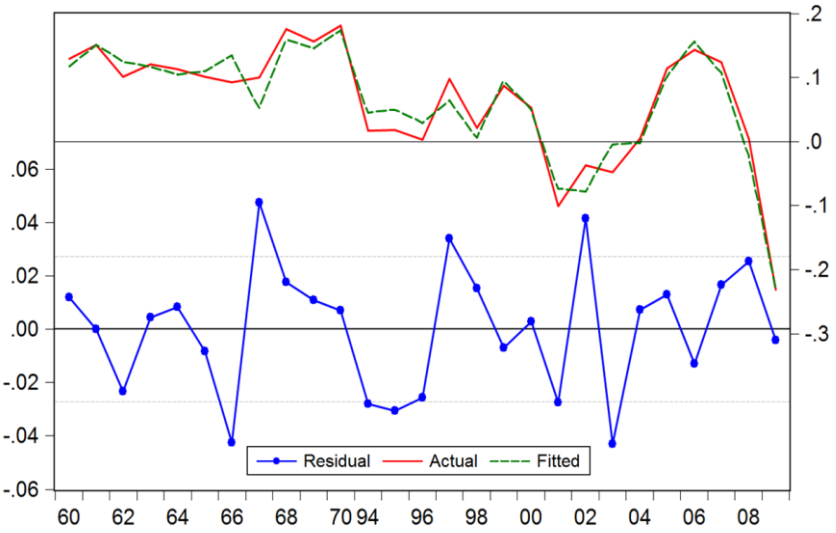

FIGURE 5: Actual and fitted values of national income (dlogs)

The following three plots of FIGURE 5 and FIGURE 6 show the actual observations (1959-1970 and 1993-2009) of Liechtenstein's national income, the estimated fitted values of the model and the resulting residuals. The predictive accuracy is satisfactory and does not indicate that the model should not be used for the interpolation. Also, the confidence band of the predictions is continuously narrow during the whole time span of the forecasted sample.

The differenced logarithms of the fitted and actual values that are plotted in FIGURE 5 can be interpreted as growth rates, because they are approximately the percentage changes of the original series. FIGURE 6 shows the model's predicted and actual figures transformed into levels.

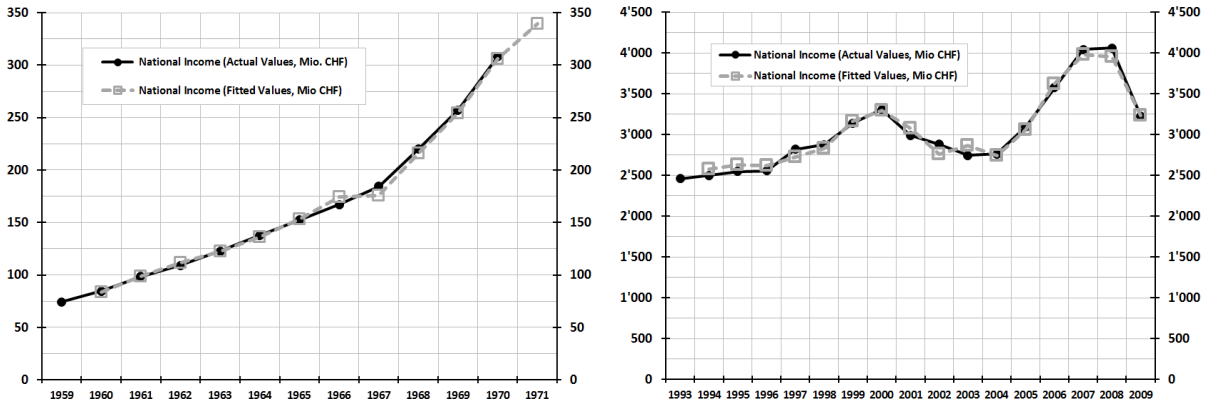

FIGURE 6: Predicted and actually observed national income

As the predominant estimation model has been found, the years with data gaps are now to be interpolated by the predicted values and weighted by the adjustment factor. TABLE 22 exhibits the already available data of Liechtenstein's national income and the newly generated values.

The bold figures represent the final, chained time series for Liechtenstein's national income, the digits in *italics* are estimations by a heuristic interpolation or an econometric model. Those not in italics represent approximative calculations according to the national income accounting scheme or represent official figures. The figures in the light-grey-layered cells are data gaps that have been filled by this sub-project (during the current and the previous chapter). The table also shows the fitted values of the econometric model and the derived adjustment factors which were applied as weights for the dynamic interpolative adjustment.

National Income	Actual Value	Fitted Value	Adjustment Factor	Final Series	National Income	Actual Value	Fitted Value	Adjustment Factor	Final Series
1954		*35.3*		***35.3***	1982		*786.0*	*1.5634*	***1'203.3***
1955		*42.0*		***42.0***	1983		*873.1*	*1.6098*	***1'265.3***
1956		*52.7*		***52.7***	1984		*83.7*	*1.6561*	***1'445.9***
1957		*61.2*		***61.2***	1985		*916.6*	*1.7025*	***1'560.5***
1958		*69.2*		***69.2***	1986		*980.8*	*1.7489*	***1'715.3***
1959	*74.4*	*83.7*		***74.4***	1987		*990.9*	*1.7953*	***1'779.0***
1960	84.7	*98.5*		**84.7**	1988		*1'040.8*	*1.8416*	***1'916.7***
1961	*98.5*	*111.5*		***98.5***	1989		*1'155.0*	*1.8880*	***2'180.6***
1962	*109.0*	*122.3*		***109.0***	1990		*1'146.8*	*1.9344*	***2'218.3***
1963	122.9	*136.5*	1.0047	**122.9**	1991		*1'147.6*	*1.9807*	***2'273.2***
1964	*137.6*	*153.6*	*0.9891*	***135.0***	1992		*1'237.6*	*2.0271*	***2'508.8***
1965	*152.3*	*174.3*	*0.9737*	***149.5***	1993	2'459.6	*1'186.3*	2.0735	**2'459.6**
1966	167.0	*175.9*	0.9583	**167.0**	1994	2'501.1	*2'572.1*		**2'501.1**
1967	184.5	*216.1*		**184.5**	1995	2'547.3	*2'626.7*		**2'547.3**
1968	219.9	*254.4*		**219.9**	1996	2'554.0	*2'620.5*		**2'554.0**
1969	257.2	*306.1*		**257.2**	1997	2'817.0	*2'722.9*		**2'817.0**
1970	308.2	*339.4*	1.0070	**308.2**	1998	2'877.5	*2'833.7*		**2'877.5**
1971		*357.3*	*1.0534*	***357.5***	1999	3'138.7	*3'160.7*		**3'138.7**
1972		*389.3*	*1.0997*	***392.9***	2000	3'307.5	*3'297.7*		**3'307.5**
1973		*424.9*	*1.1461*	***446.2***	2001	2'989.1	*3'072.7*		**2'989.1**
1974		*433.5*	*1.1925*	***506.7***	2002	2'880.9	*2'763.8*		**2'880.9**
1975		*481.8*	*1.2388*	***537.0***	2003	2'746.7	*2'867.6*		**2'746.7**
1976		*537.1*	*1.2852*	***619.3***	2004	2'761.3	*2'741.3*		**2'761.3**
1977		*550.2*	*1.3316*	***715.2***	2005	3'094.9	*3'055.4*		**3'094.9**
1978		*608.9*	*1.3779*	***758.2***	2006	3'571.5	*3'617.7*		**3'571.5**
1979		*695.6*	*1.4243*	***867.3***	2007	4'043.3	*3'977.2*		**4'043.3**
1980		*718.2*	*1.4707*	***1'023.0***	2008	4'058.7	*3'956.8*		**4'058.7**
1981		*769.7*	*1.5170*	***1'089.6***	2009	3'221.6	*3'235.0*		**3'221.6**

TABLE 22: Estimation of Liechtenstein's national income (nominal, Mio. CHF)

The visual expression of the previous table is shown in FIGURE 7. The provided chained time series for Liechtenstein's nominal and real (deflated with the Swiss consumer price index) national income can now be used as important data series within the backward calculation of Liechtenstein's GDP and delivers important economic insights for Liechtenstein's growth characteristics and business cycle pattern.

The following empirical facts are evident at first sight when FIGURE 7 is inspected: Two phases with longer real stagnation can be detected during the first half of the 1970s and the first years of the 1990s. Both stagnations were consequences from deep and longer lasting recessions and not so much due to decreasing long-term growth. But, lower economic long-run growth tendencies can be identified beginning with the end of the 1980s. This finding is supported by structural breakpoint test after CHOW [1960] and the approach using a time dummy (which happens to be negative and highly significant) from 1990 to 2009 in an

ARIMA(2,1,1)-model on Liechtenstein's real national income (in logarithms). Also, the sharp decreases can be traced at the start of the new millennium and also along with the financial crisis and the related global recession combined with the high insecurity in Liechtenstein's financial sector (Liechtenstein Tax Affair) in 2008 and especially in 2009.

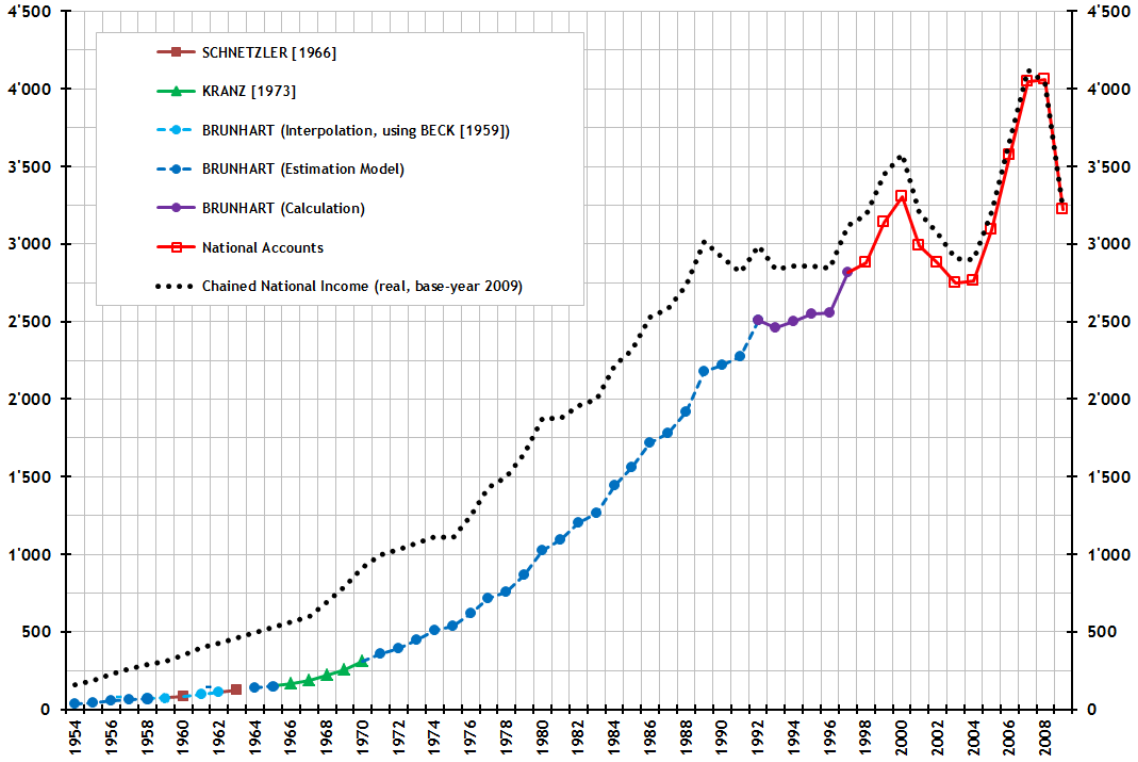

FIGURE 7: The finally chained time series for Liechtenstein's national income

The impression that the volatility has increased very much is mainly a result of the high change in the level of the national income over the time-span of the sample. Examining the growth rates, as shown in FIGURE 8, it becomes a priori unclear whether the volatility has increased or not. However, the cyclical amplitude measured as the percentage deviation from the real trend presumably has increased, as shown in FIGURE 12. Additionally, it seems that the sharpness of recessive down-turns has increased over time, even relative to the first oil-crisis in the mid-1970s.

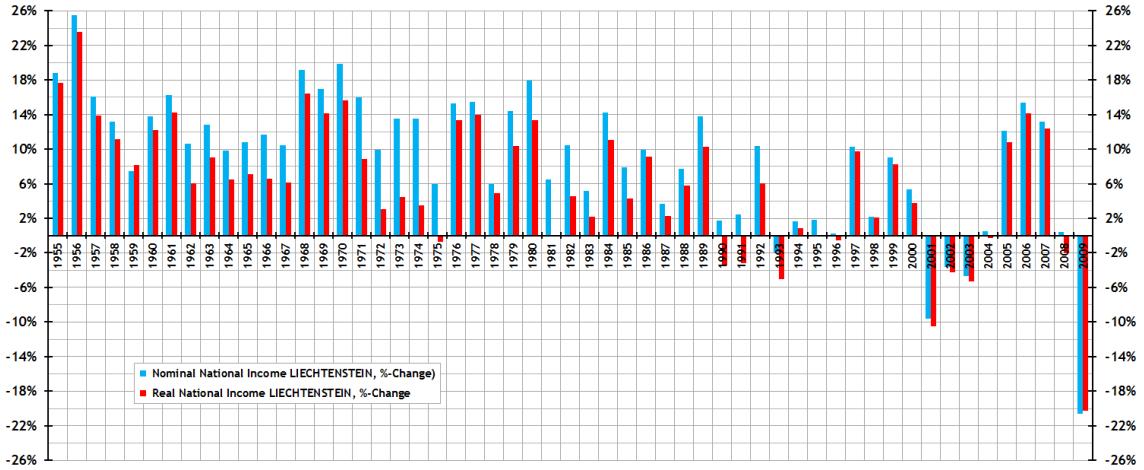

FIGURE 8: Nominal and real growth rates of Liechtenstein's national income

The visual inspection of the two previous figures supplies some economic insights: The first oil-price shock in the mid-70s and the restrictive monetary policy of the Swiss National Bank[21] in the first half of the 1970s are accompanied by weak economic performance. The economic recovery was slowed in 1978, when a strong over-shooting of the Swiss Francs real-exchange rate took place, which affected Liechtenstein's export industry. The Iranian Revolution and second oil-shock by the end of the 70s and the beginning of the 80s led to further recessive tendencies worldwide, which also influenced Liechtenstein's economy. Furthermore, the shocks on the stock markets in 1987 can be seen in the relatively low real growth rates. The war in Iraq and its consequences (sometimes labelled as „third oil-price shock") combined with the appreciation of the Swiss Franc led to a recession in the first half of the 90s in Switzerland and obviously also in Liechtenstein (see HARTWIG AND SCHIPS [2010]). The Asia-crisis temporarily deteriorated the high economic growth during the last years of the 90s. Also clearly visible are the two world recessions of the new millennium. It is therefore reasonable to argue that the estimates generate an economically feasible business cycle pattern, which in addition is very similar to the business cycle pattern of Liechtenstein's GDP (as shown later on). The plausibility of the estimated business cycle pattern is also confirmed when the growth rates and the de-trended business cycle of Liechtenstein and Switzerland are compared.

A comparison of Liechtenstein's nominal national income time series with the time series of Switzerland also supports the plausibility of the growth pattern of the interpolated values (beyond the already verified cyclical archetype). This comparison not only yields

[21] Liechtenstein is also part of the Swiss monetary system and has the Swiss Franc as official currency. The principality is therefore highly affected by the Swiss National Bank's decisions, regulations and policies.

methodological but also economic insights: Nominal national income in Switzerland rose between 1959 and 2009 from approximately 23'000 CHF per capita to 57'000 CHF, while it increased in Liechtenstein from about 16'000 to 90'000 CHF. In real terms, national income per inhabitant in Switzerland approximately doubled in the regarded time period and it increased approximately fourfold in Liechtenstein during the same time span. Especially the 80s were characterized by very strong real growth of Liechtenstein's potential output, as evident in FIGURE 9.

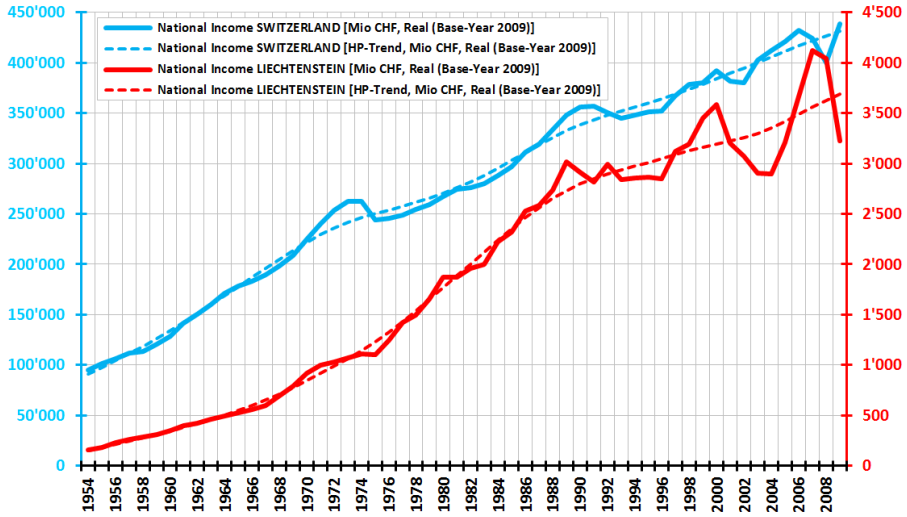

FIGURE 9: Real national income of Switzerland [LHS] and Liechtenstein [RHS] and their trend

If the ratio of Swiss national income per capita and Liechtenstein's national income per capita, then it can be deduced that national income per capita rose faster in Liechtenstein after the second world war and was higher in Liechtenstein than in Switzerland for the first time by the end of the 60s.[22] Liechtenstein's national income continued to grow faster until the end of the 80, where it was about double the amount of the per capita income in Switzerland. In the past twenty years, a convergence of both nations' national income growth can be discovered, apart from strong short-term fluctuations due to strong cyclical decrease (2003-2004, 2009) and increase (2007) of Liechtenstein's national income.

[22] This overtaking by the end of the 60s can also be observed if the average wage per employee over time are compared between the two countries.

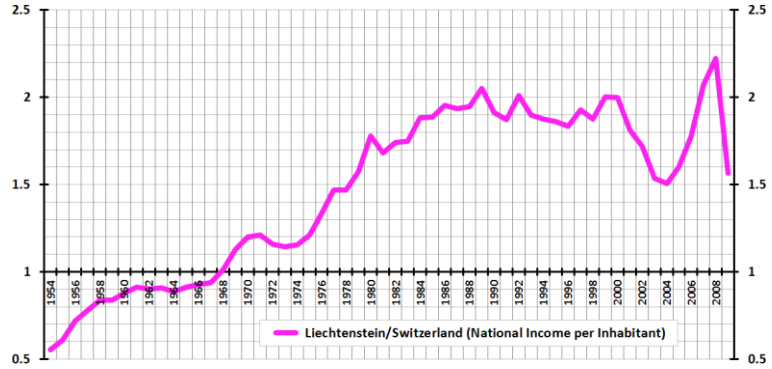

Figure 10: Ratio of Liechtenstein's and Switzerland's national income per capita

The long-term trend in FIGURE 9 is derived using the filter after HODRICK AND PRESCOTT [1997], which is usually called HP-filter.[23] As already said, the traditionally relatively poor principality could overtake its bigger neighbour in economic performance per capita. This took place during the 60s and the difference grew larger in the following decades, while the trend-growths of both nations seem to have converged to approximately the same level during the previous twenty years. This is also visible, if the percentage growth of the long-term trend (also called trend-drift) of both countries are computed and plotted as done in FIGURE 11. The timing of the structural breaks (mid/end of 70s and beginning/mid of 90s) is very similar to the structural breaks in the trend-drift of Liechtenstein's GDP (visible in FIGURE 27).[24]

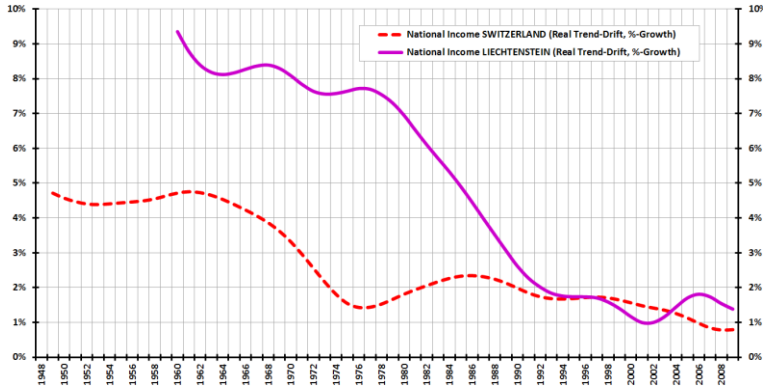

FIGURE 11: Trend-drifts of Liechtenstein's and Switzerland's real national income

Calculating the percentage difference of the observed values and the filtered series, the cyclical component, which captures the business cycle, can be identified. FIGURE 12 incorporates the business cycle pattern of both countries. Both cycles are quite similar when it

[23] For more explanations on the HP-filter see BRUNHART [2012b, pp. 160-163].

[24] One often hears the term „les trente glorieuses" to label the economic boom years in Europe (for example France Germany or Switzerland) during the three decades after the World War Two until the Oil Crisis in the 70s. In this context one could speak of „les cinquante glorieuses" in Liechtenstein, since the very high growth lasted until the 90s. This observation can be made for Liechtenstein's national income and GDP.

comes to locating the economic troughs and peaks. Yet, Liechtenstein's amplitude of the cycle is considerably higher than Switzerland's.[25]

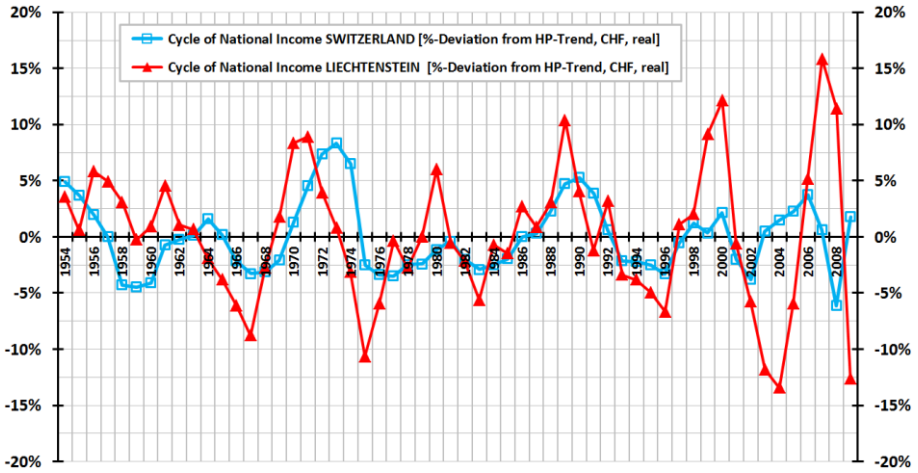

FIGURE 12: Cyclical Component of real national income in Switzerland and Liechtenstein

Another way of inspecting the reliability of the generated business cycle properties of the estimated and chained national income series is to compare it with the business cycle pattern of Liechtenstein's GDP, since both are highly correlated on theoretical grounds, which can also be regarded as a stylized fact in the empirics. The following graph in FIGURE 13 compares the growth rates of Liechtenstein's GDP and national income. The data for the growth rates originate from (preliminary)[26] estimates by the author, which have already been applied in BRUNHART, KELLERMANN AND SCHLAG [2012]: The GDP-years from 1954 to 1971 were estimated and retropolated applying an econometric model using indicators. The figures from 1972 until 1997 were calculated to be in line with Liechtenstein's national accounts. These figures were provisional and have been updated since and revised for the presentation of the finally revised estimates along with this dissertation (for details see chapter 4.). The growth rates of Liechtenstein's GDP and national income plotted in FIGURE 13 correspond to a very high extent. Assessed over the whole sample, they steadily correlate with a correlation coefficient of about 0.83. In this light, the estimated figures for the national income appear to be very plausible.

[25] It also seems that the volatility of Liechtenstein's national income has increased over time. In contrast to the frequently advocated "great moderation"-thesis one could speak of a "great agitation" in the case of Liechtenstein.

[26] The final GDP-estimates are the main goal of this part of the contribution.

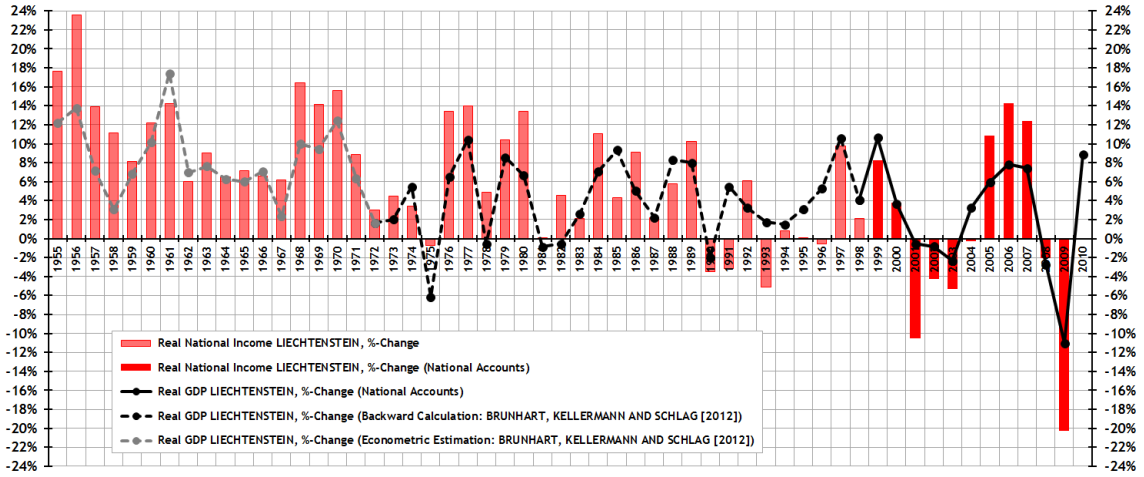

FIGURE 13: Real growth rates of Liechtenstein's national income and gross domestic product

Also, the de-trended cycles of both time series show that both business cycles are extremely similar. Again, the trend has been approximated by the HP-filter. The similarity in FIGURE 14 of the induced cyclical component of both aggregates, the national income and the gross domestic product, also supports the plausibility of the national income estimates.

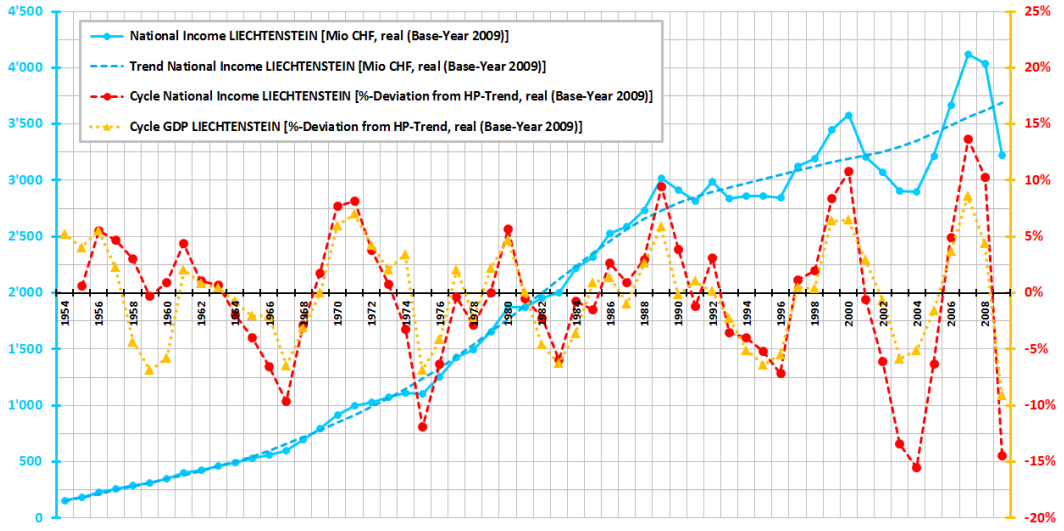

FIGURE 14: Cyclical component (deviation from HP-trend) of national income and GDP

It is valid to use both aggregates (which both also include approximated figures) for plausibility evaluations. Both series do not evolve from a similar econometric model and are not solely a main function of only few data sources or just dependent on a very similar (potentially false) computation method. Figures for the national income in the 1960s mainly rely on calculations by SCHNETZLER [1966], BECK [1961 and 1963] and KRANZ [1973], while the GDP-figures of that period result from an econometric model with indicators. As stated earlier, the GDP-data 1972-1997 is calculated in this PhD-project with a deliberate and

complex method approximating the GDP's income approach of the national accounts (as to be shown in chapter 4.). From 1971-1992, national income is estimated via the approach presented in this chapter and from 1993 until 1997 it is calculated to be approximately in line with the national accounting system, as explained in the previous chapter (3.1.). From 1998 on, both aggregates are published by the official national accounts. So, the estimation methods for both measures are independent from each other and are not dependent on a similar model with the same indicator series. The similarity is therefore not just an econometric artefact. Also, even though national income is one of dozens (or even hundreds) of sub-series included into the chosen calculation scheme of the GDP between 1972 and 1997, it only contributes very little to the final (total) GDP-figure.

The comparisons made here already confirmed at an already early stage the plausibility of the estimation/calculation for the removal of existing data gaps and the extension of the two important economic aggregates, the national income and gross domestic product of Liechtenstein.

4. Backward-Calculation of Liechtenstein's GDP

As mentioned earlier, official data for the GDP of Liechtenstein are available only for the years 1998 until 2009. These GDP-figures have been published along with the official national accounts of Liechtenstein, provided in OFFICE OF STATISTICS [2011]. The SGZZ (St.Galler Zentrum für Zukunftsforschung) has carried out estimations of real and nominal GDP for the years 1960, 1970, 1975, 1980-1988 and 1991, on behalf of Liechtenstein's government. These estimations can be considered as rough estimations, since they were just a small part in those studies (see KNESCHAUREK AND GRAF [1990] and KNESCHAUREK AND PALLICH [1982]). Furthermore, they were based on estimated data of aggregated value added for different sub-sectors of the Swiss economy. It is questionable whether these numbers can be transferred to Liechtenstein and if this holds throughout the very long time span from 1960 up to 1991. Also, needed detailed employment data were not available (and surely not in such a detailed manner considering subsectors) for Liechtenstein in the 70s and for the first half of the 80s. Hence, the applied employment structures must have been rough approximations. Though, the SGZZ's method is not transparently explained in the relevant documents. Also, for any econometric analysis of economic matters, the time series need to be coherent and without data gaps. That is why there is an additional need for a new time series with estimated GDP figures. However, the figures by the SGZZ can still serve as a useful reference benchmark for the level of GDP in the 70s and 80s to the current GDP-estimation project carried out in this chapter.

There is a publication lag of almost two years in the official national accounts of Liechtenstein. This is due to the fact that Liechtenstein's government and authorities chose the least time-consuming procedure for the compilation and did not want to bother the companies with further bureaucracy. Doing so, the most important data is gathered from the national tax administration that in turn needs some time to annually collect the relevant tax information. That is why the Liechtenstein Economic Institute (Konjunkturforschungsstelle Liechtenstein, KOFL) not only forecasts the GDP but also generates a "nowcast" of the missing past years (see SCHLAG [2012]). TABLE 23 lists all the available GDP-values for Liechtenstein.

	Gross Domestic Product (Nominal, in Mio. CHF)	**Calculated and published by**
1960	*136*	SGZZ
1965	*226*	SGZZ
1970	*394*	SGZZ
1975	*636*	SGZZ
1980	*896*	SGZZ
1981	*1'005*	SGZZ
1982	*1'060*	SGZZ
1983	*1'100*	SGZZ
1984	*1'181*	SGZZ
1985	*1'300*	SGZZ
1986	*1'402*	SGZZ
1987	*1'570*	SGZZ
1988	*1'700*	SGZZ
1991	(Not published)	SGZZ
1998	3'595.1	Office of Economic Affairs
1999	4'001.9	Office of Economic Affairs
2000	4'194.8	Office of Economic Affairs
2001	4'208.5	Office of Economic Affairs
2002	4'190.3	Office of Economic Affairs
2003	4'135.3	Office of Economic Affairs
2004	4'295.6	Office of Economic Affairs
2005	4'556.4	Office of Economic Affairs
2006	5'015.4	Office of Economic Affairs
2007	5'523.5	Office of Statistics
2008	5'495.0	Office of Statistics
2009	4'906.4	Office of Statistics
2010	*5'289*	KOFL
2011	*5'384*	KOFL

TABLE 23: Data and different sources of Liechtenstein's GDP

All the available years for the nominal GDP of Liechtenstein shown in TABLE 23 are visually displayed in FIGURE 15. The observations of 2010 and 2011 are estimations by KOFL and the value for 2012 is the most recent forecast (also by KOFL).

The subsequently proposed method for the backward calculation of Liechtenstein's GDP requires annual (sectoral) employment figures, which are estimated along with this project. This contribution therefore also removes severe data gaps in this special context. These new employment data series also enhance the base for economic investigations in analytical terms.[27] The detailed estimation process and the results of the employment data can be found in the appendix (A.3.). Additionally, as the newly computed GDP-values make a long and consistent time series for Liechtenstein's GDP available for the first time, a prediction model

[27] These newly estimated sectoral and total employment figures have already been applied in BRUNHART, KELLERMANN AND SCHLAG [2012], where they played a role in the analysis of Liechtenstein's economic fluctuations and growth (in terms of potential output) over the past decades.

(that serves as "cheap" benchmark-model to the very demanding official GDP-forecast by the KOFL) will also be proposed in the last section of the first chapter of BRUNHART [2012b].

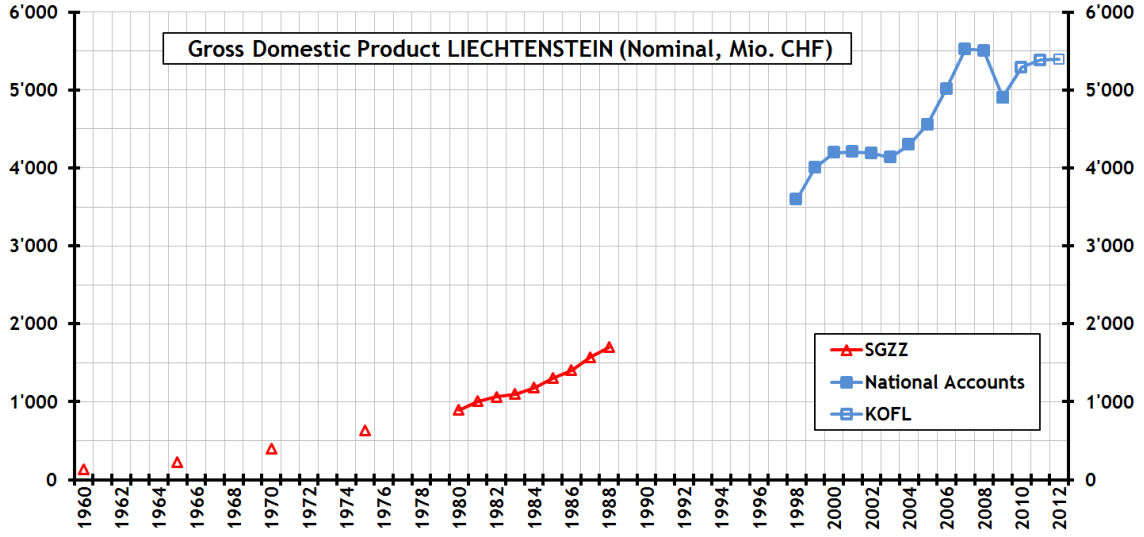

FIGURE 15: Available data points for Liechtenstein's GDP

Apart from the fact that national accounting is a very demanding, delicate and time-consuming task, even for a very small country such as Liechtenstein, additional problems arise when it comes to the backward calculation of aggregates: On the one hand, many important series have not been compiled before the establishment of national accounting. In the context of Liechtenstein this problem is even worse, since the base of economic data is very scarce, especially before 1998, which was the first year of national accounts. Hence, serious problems for many sub-accounts appear when one tries to replicate the results for 1998 until 2009 or especially to carry out calculations for the time before the introduction of Liechtenstein's official national accounting system (Volkswirtschaftliche Gesamtrechnung Liechtenstein, VGR FL) in 1998: Either relevant data had not been collected before the national accounts were introduced in 1998, or they exist but are for some reason not available anymore or they are simply not accessible for the public.

It must be stated at this point that no method can be adopted here from examples of other countries. First of all, for every country, the method needs to be developed as a function of the existing series. It is not very pragmatic to simply transfer a method, if the pool of available indicator series is incomparable. Additionally, the methods quoted in the scientific literature usually cover time-periods that go further back in history. Also, the already existing number of GDP-observations is too small for regression-based retropolation.

The chosen approach for the computation of Liechtenstein's gross domestic product figures for the years from 1972 until 1997 relies on the identity of the so-called "generation of income account":

	Compensation of Employees
plus	Gross Operating Surplus
plus	Taxes on Production and Imports
minus	Subsidies
=	Gross Domestic Product (GDP)

TABLE 24: Generation of income account

Even though the approach seems short, clear and elegant at first sight, it takes a very deliberate and time-consuming proceeding. In almost every sub-account and sub-component a lot of improvisation is necessary, heuristic talent needed and sometimes even an iterative line of action required. These pitfalls can originate from the relevant series themselves: They might exhibit data gaps or massive outliers or they might not be available for all the respective years. Sometimes a proxy is needed, because the data series does not exist or it exists but was not made accessible to the author (which unfortunately was the case on several occasions). Or it was a-priori unclear what strategy was optimal, because there was no reference procedure to rely on.[28] One example is the aggregated gross operating surplus by the companies. The adequate calculation of this component was crucial, since the gross operating surplus has an important share in GDP and exhibits a very high volatility. This component in turn is fundamental for the determination of the business cycle of the whole economy, measured for example by GDP-growth. There is no method for the direct computation of the gross operating surplus. Also, in the official national account it is determined in an indirect way as it is a residual to compromise, as a balancing item, the two sides of the compilation of the gross domestic product. But fortunately, the just mentioned pitfalls could be circumvented, as will be shown and explained later on in accurate detail.

[28] Even the official national accounts are only approximations to the true but unknown aggregates and sub-aggregates. This also holds for the special case of Liechtenstein.

4.1. Compensation of Employees

Generally speaking, the compensation of employees consists of all incomes that are earned by domestic employees. Payments of the employers for the employees' social insurance are also included.

In contrast to the following components (the subsidies and the taxes on production and imports), it is not possible to calculate the component compensation of employees in the exact same way as it is done in the official national accounts. The sum of all incomes received in Liechtenstein is officially released by the public pension insurance (Alters- und Hinterlassenenversicherung, AHV). The AHV collects and publishes the sum of all employees' aggregated incomes.[29] These annual aggregated total incomes serve as a valuable proxy to obtain a good estimate for the compensation of employees which is matchable with the official national accounts.

In an additional step, the payments of the employers for the employees' social insurance have to be added to the incomes of employees. These contributions by the employers to the employees' social security concern the following types of social insurances: Pension, widow(er) and orphan insurance (AHV), invalidity insurance (Invalidenversicherung, IV), family benefits (Familienausgleichskasse, FAK), unemployment insurance (Arbeitslosenversicherung, ALV), obligatory health insurance (Obligatorische Krankenversicherung, OKV) and mandatory occupational accident insurance (Berufsunfallversicherung, BUV) und contributions to the companies' pension funds by public and private employers. While the necessary data of the AHV, IV, FAK, ALV and OKV can be easily obtained in their public annual reports, the employers' payments to BUV are not published explicitly (at least not for some of the relevant years) and must be obtained indirectly by approximative calculations. Also, for the companies' pension funds, approximative calculations have to be applied.

Employers and employees are obligated to pay the equal share of the employee's obligatory health insurance. Therefore, the employers' payments can be deduced by taking half of the

[29] Employees have to pay 3.8% of their wages to the AHV. That is why the AHV gathers, knows and publishes the total of all wages/incomes. Also the employers have to contribute to the AHV with 3.8% of the employee's salary. This is one type of employers' contribution to the employees' social security. These contributions have to be added in a next step to the "ordinary" compensation (salaries) of the employees, since it is also a special form of compensation.

total amount of paid contributions. The total amount is found in the obligatory health insurance statistics and the Statistical Yearbooks issued by the national Office of Statistics.

The employers have to pay a share to the occupational accident insurance of the employees. Official figures for the mandatory accident insurance, published by the Office of Statistics, are available for the years 1975-1985 and from 1996 to the present. The problem is that there exist only consolidated figures for the occupational (Berufsunfallversicherung, BUV) and the non-occupational accident insurance (Nicht-Berufsunfallversicherung, NBUV) altogether. Values for the missing years can be well calculated by using indicator ratios: The percentage change of BUV and BUV+NBUV over time is almost the same between the two amounts. As the sum BUV+NBUV is known for the whole time period, the data gaps for BUV can be filled using the indicator ratio. Unfortunately, official figures for the payments of the companies to the pension funds of their staff (published in the Statistical Yearbooks by the national Office of Statistics) do not exist for each of the years within the regarded time span. Therefore, missing data must be approximated using interpolations. As the pension payments are proportional to the salaries, it makes more sense to use the percentage ratio (pension funds payments relative to total salaries) rather than just interpolating the absolute amount of pension fund payments. The ratio of the years 1970 (3.23%), 1974 (3.15%), 1979 (3.36%), 1996 (6.63%) and from 1997 to the present are known. The values between these years are linearly interpolated and then used for the approximation of the total annual payment of the companies to the workers' pension fund. Again, as in chapter 1.3., figures in *italics* in TABLE 25 (which displays the compensation of employees) and in the following tables rely on approximative calculations or estimations by the author of this dissertation.

		1972	1973	1974	1975	1976	1977	1978	1979	1980
Gross Wages and Salaries		230.5	270.9	318.6	322.0	344.9	395.2	406.9	451.7	503.0
Employers' Social Contributions	Pension/Widow(er)/Orphan Insurance; Invalidity Insurance; Family Benefits	13.0	19.3	22.7	22.9	23.8	27.7	28.5	31.6	35.2
	Unemployment Insurance	*1.4*	*1.4*	*1.4*	*1.4*	1.4	1.5	1.6	1.7	2.0
	Obligatory Health Insurance	*1.4*	*1.6*	*1.8*	*2*	2.2	4.1	4.3	4.9	5.1
	Occupational Accident Insurance	4.0	4.4	5.4	5.4	5.1	5.2	5.4	6.8	6.2
	Companies' Pension Funds	*7.3*	*8.6*	9.2	*10.3*	*11.2*	*12.9*	*13.5*	13.2	*17.8*
Compensation of Employees		**258.4**	**307.0**	**359.8**	**365.5**	**390.2**	**448.5**	**462.2**	**511.9**	**571.3**
		1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Gross Wages and Salaries		517.7	579.1	593.5	643.7	686.5	751.9	780.6	881.6	947.0
Employers' Social Contributions	Pension/Widow(er)/Orphan Insurance; Invalidity Insurance; Family Benefits	36.3	40.6	41.6	45.1	48.1	52.7	54.7	61.8	66.3
	Unemployment Insurance	0.9	0.9	1.1	1.2	1.3	1.4	1.4	1.6	1.6
	Obligatory Health Insurance	5.3	5.9	6.8	7.9	9.6	10.0	10.4	11.3	12.1
	Occupational Accident Insurance	3.2	3.2	3.3	3.8	3.9	4.1	4.2	4.4	4.1
	Companies' Pension Funds	*19.2*	*22.5*	*24.1*	*27.3*	*30.3*	*34.4*	*37.2*	*43.5*	*48.4*
Compensation of Employees		**585.1**	**655.6**	**674.2**	**733.2**	**784.2**	**860.2**	**893.5**	**1'009.8**	**1'085.5**
		1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	
Gross Wages and Salaries		1'029.0	1'103.5	1'151.0	1'197.9	1'246.2	1'347.1	1'338.9	1'406.9	
Employers' Social Contributions	Pension/Widow(er)/Orphan Insurance; Invalidity Insurance; Family Benefits	72.1	77.3	80.6	83.9	87.3	92.0	92.8	97.5	
	Unemployment Insurance	*2.0*	2.2	2.1	2.6	3.0	3.1	3.1	3.1	
	Obligatory Health Insurance	21.5	13.7	14.9	16.1	17.4	17.8	16.9	19.2	
	Occupational Accident Insurance	4.4	4.6	6.0	6.1	6.4	8.4	8.7	8.7	
	Companies' Pension Funds	*54.4*	*60.2*	*64.9*	*69.6*	*74.6*	*75.2*	76.7	81.1	
Compensation of Employees		**1'180.8**	**1'268.1**	**1'326.5**	**1'383.1**	**1'442.3**	**1'551.4**	**1'545.1**	**1'625.1**	

TABLE 25: Computed compensation of employees (in Mio. CHF)

4.2. Gross Operating Surplus

The accurate calculation of this component (gross operating surplus) is very important as it features a high amount of volatility which contributes to the whole fluctuation in the national gross domestic product. The other three components (compensation of employees, subsidies, and taxes on production and imports) feature a lower volatility. The gross operating surplus is therefore the key to identifying and analysing the business cycle of Liechtenstein's economy.

Unfortunately, it is not possible to calculate the gross operating surplus in a direct mode: First, the needed data from the national tax administration are either not accessible for the public or not available back until 1972. Secondly, in the official national accounts, this component is not directly calculated, but obtained as remaining residual from different sides of the accounting system (see TABLE 1). The theoretical definition of the gross operating

surplus consists of the operating profits of the firms within the economy. Since the data base is very scarce in Liechtenstein or simply not accessible to the public, the author of this paper has contacted the biggest companies (about 30 corporations) in Liechtenstein in order to obtain a good indicator for the development of the gross operating surplus in the whole economy. Those companies (about half of the contacted corporations, fortunately in most cases very important companies) who were willing to provide data granted access to balance sheets and profit and loss statements for the years 1972 until 2008,[30] in the majority of cases under the condition of complete discretion.[31] Out of the compiled data pool ten companies have been chosen to serve as proxy for the whole economic due to their high their size and high importance for Liechtenstein's economy.

While the considered financial institutions exhibit data back until their years of foundation, the inspected industrial companies usually started an accounting which is sufficient for the calculation of the gross operating surplus by the first half of the 1970s. The author has tried to obtain (from each company and each year, beginning with 1972) a measure which comes close to the definition of the national accounts. The targeted figure was the EBITDA (earnings before interest, taxes, depreciation, and amortisation). Thus, for each year and each company this figure has been calculated, in many cases through a deliberate process of gathering and processing all the relevant information within the companies accounting books. Though, the standards of companies' accounting differ among the companies and have also been changing over time. Hence, the needed target figures have been calculated in the most comparable and coherent manner. Sometimes, if some desired elements of the earnings statement had not been disposable, the EBITDA was estimated using for example indicator ratios or other kinds of approximations.

Also, to build a good indicator and to weigh the various corporations within their sector, the number of employed people has also been collected for each year. For some companies, some years were missing and heuristic interpolation was needed, considering external information such as the judgement of the companies' contact person, personal costs of the companies as indicator or additional facts from the annual reports. These employment figures of each

[30] When the compilation process took place, the most recent year with detailed national accounting figures was 2008. In December 2011, official figures for the year 2009 were published by the Office of Statistics. Though, the time period 1998-2008 suffices for evaluation matters.

[31] For this reason, all the used data were deleted after the calculations had been executed and revised. Also, the results are only displayed here in a degree of disaggregation that does not unveil any information about single companies.

company were used to weigh their EBITDA and to multiply them to the surplus of the whole sector. The hereby captured shares of employment by the included companies as percentage of the whole sector are around 35% in the industry sector and around 38% in the financial services sector. The shares of the gross operating surplus are presumably even higher. In order to be able to do so, national employment figures from 1970 on have been estimated and differentiated after the four sectors "industry and manufacturing", "financial services" (without financial intermediation services indirectly measured), "other services" and "agriculture and households", since official figures in such a detailed level only exist for around twenty years back from now (the procedure and the detailed results are outlined in the appendix A.3.).[32]

The two other sectors (besides the sectors "industry/production" and "financial services") "other services" and "agriculture/private households" have to be retropolated statistically, since it is impossible to gather data about the gross operating surplus of corporations which could be seen as being representative for the whole sector. Fortunately, these two sectors are considerably less volatile and feature a more continuous growth than the two sectors "industry/manufacturing" and "financial services". Thus, their evolution over time can be well approximated by deterministic growth models. Also, they are less important for the business cycle amplitude of the GDP in Liechtenstein compared to the other two sectors. They feature a smoothing effect on the cyclical fluctuations, especially in recessions.

The annual gross operating surplus of the sector "other services" is estimated using a linear trend of the gross operating surplus per employed person within this sector over time (with the years 1998 to 2009 as reference years for the regression). The exponential shape of the retropolated regression line evolves because the observed number of employed persons has also strongly increased. In contrast, the aggregated operating surplus of agriculture/households is regressed on an exponential function of the total surplus and not on a per-capita base. The regression equations of the sector "agriculture/private households" are:

$$\textit{gross operating surplus (agriculture/households)} = 57.021 \cdot e^{0.0494 \cdot t}$$

[32] Very small revisions for the years 1999-2008 compared to the gross operating surplus presented in BRUNHART [2012b] took place here, due to slight adjustments of the sectoral employment estimates (sectors financial services and other services for the years 1998 and 1999). However, this did affect the sapid backward estimations of GDP (1972-1997) in a negligible magnitude and also to a very small extent the evaluation of the generated values by the computation approach here compared to the actual GDP-figures by the official nation accounts (1998-2008).

For the sector other services, the regression results are:

$$\textit{gross operating surplus per employee (other services)} = 426.63 \cdot t + 20'821$$

The retropolated figures from these two regressions are displayed in FIGURE 16, which also charts the gross operating surplus of industry/production and financial services (the dotted lines are computed values, the figures from 1998-2009 are results by the official national accounts).

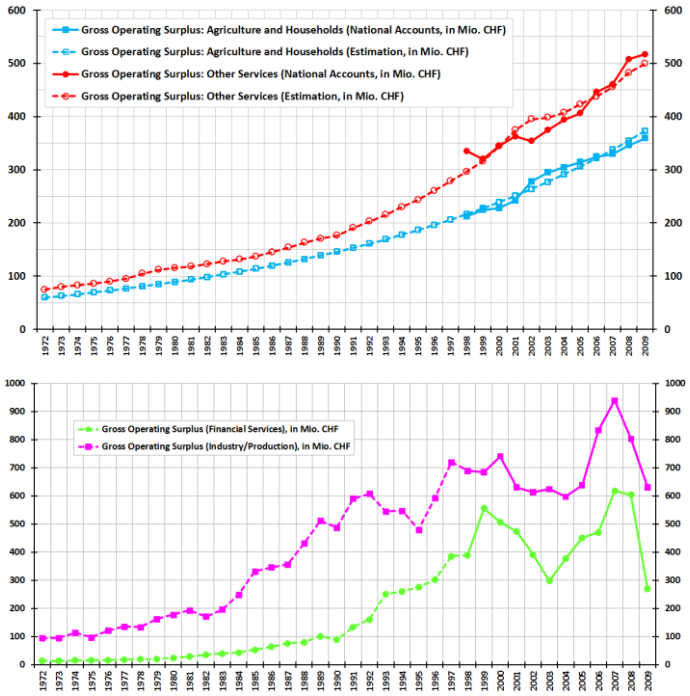

FIGURE 16: Gross operating surpluses of the four regarded sectors of the economy

TABLE 26 shows the total of the gross operating surplus compiled as the sum of sectoral gross operating surpluses of the four sectors "industry/manufacturing", "financial services", "other services" and "agriculture/households".[33]

Gross Operating Surplus	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
	241.6	250.8	276.3	267.9	299.6	324.7	336.9	378.3	405.5
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
	432.8	426.9	464.7	530.1	634.2	673.0	709.2	802.9	918.8
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	
	894.6	1'062.7	1'126.4	1'171.9	1'204.5	1'176.6	1'340.6	1'576.6	

TABLE 26: Computed total gross operating surplus as total of the four sectors (in Mio. CHF)

[33] The financial intermediation services indirectly measured (FISIM) was not included into the gross operating surplus of the financial sector, since it is usually deducted again from the total of all sectors' gross operating surplus.

4.3. Taxes on Production and Imports

The sub-account "taxes on production and imports" can be calculated in the manner of the official national accounts of Liechtenstein. The relevant data sources are the national income statement, the annual governmental report, the national tax administration and also Swiss authorities such as the Swiss Federal Customs Administration, the Swiss Federal Tax Administration and the Swiss Alcohol Board. Since Liechtenstein and Switzerland share a monetary and economic union (custom treaty and Swiss Franc as common currency), some of the various taxes on production and imports are raised and processed by Swiss authorities. Thus, the actual paid tariffs and taxes by inhabitants and companies in Liechtenstein must be approximated on the base of economic reasoning. In OEHRY [2000, p.139 and pp.257-267], the detailed approach (also adopted here) within the national accounts is outlined. Liechtenstein's monetary shares of these taxes and tariffs are calculated by different measures such as the number of inhabitants and/or the national income. Either only the ratio of both countries' national incomes is used as the ratio for the distribution of the share between the nations. Or the average of the ratios of inhabitants and national income is applied. The data provided by Liechtenstein's tax administration can be misleading in this context, since all the shares for the actual division of money between the countries are calculated using data from earlier years. Liechtenstein's tax administration publishes annual figures for most of these tariffs and taxes. But these are the actual amounts paid from Switzerland to Liechtenstein in that particular year (and not a measure of the actual economic share). So for example, Liechtenstein's earnings for the value added taxes in the year 1996 are not the real value added taxes paid in the year 1996, but result from Switzerland's payment to Liechtenstein from the common pool. This payment depends on the calculated share in 1996 which is a function of national income and population from weighted years before 1996.

In the application here, in a first step, the compilation of the population and of the national income of both countries is necessary in order to be able to calculate the figures for each type of tax or tariff, which is divided between the two countries and needed for this part of the national accounts. While population figures are provided by the official statistics of both nations it is more difficult to obtain national income figures. Even though Swiss national income is available for the whole period, the rules of national accounting and calculation have changed several times. In order to obtain a coherent series of the Swiss National Income, a chained series which is comparable and coherent through the whole time span has been

generated along with this project.[34] In Liechtenstein only official figures of national income from 1998 onwards exist. For this reason, as outlined in the previous sub-chapter dealing with the national income's backward calculation, annual figures from 1997 back to 1954 have been established.

TABLE 27 shows the considered data and their sources. In this table, the words in *italics* depict those taxes or tariffs, which are distributed between Switzerland and Liechtenstein.

Taxes on Production and Imports	Authority/Source	Distribution Key
Value Added Tax (Mehrwertsteuer, Warenumsatzsteuer)	*Swiss Federal Tax Administration (Eidgenössische Zollverwaltung)*	*National Income*
Petroleum Tax (Mineralölsteuer)	*Swiss Federal Tax Administration (Eidgenössische Zollverwaltung)*	*National Income*
Tobacco Tax (Tabaksteuer)	*Swiss Federal Tax Administration (Eidgenössische Zollverwaltung)*	*National Income, Population*
Beer Tax (Biersteuer)	*Swiss Federal Tax Administration (Eidgenössische Zollverwaltung)*	*National Income, Population*
Vehicle Tax (Automobilsteuer)	*Swiss Federal Tax Administration (Eidgenössische Zollverwaltung)*	*National Income, Population*
Import Tariff (Einfuhrzoll)	*Swiss Federal Tax Administration (Eidgenössische Zollverwaltung)*	*National Income, Population*
Tobacco Tariff (Tabakzoll)	*Swiss Federal Tax Administration (Eidgenössische Zollverwaltung)*	*National Income, Population*
Agricultural Tariffs (Zolleinnahmen in der Landwirtschaft/Weinbau)	*Swiss Federal Tax Administration (Eidgenössische Zollverwaltung)*	*National Income, Population*
Tax on Speciality Brandy (Steuer auf Spezialitätenbranntwein)	*Swiss Alcohol Board (Eidgenössische Alkoholverwaltung)*	*National Income, Population*
Tax on Sales of Pomes Brandy (Selbstverkaufsabgabe auf Kernobstbranntwein)	*Swiss Alcohol Board (Eidgenössische Alkoholverwaltung)*	*National Income, Population*
Alcohol Monopoly Fee (Alkoholmonopolgebühren)	*Swiss Alcohol Board (Eidgenössische Alkoholverwaltung)*	*National Income, Population*
Taxes on Sales of Drinking Spirits and Brandy (Verkauf Trinksprit und Kernobstbranntwein)	*Swiss Alcohol Board (Eidgenössische Alkoholverwaltung)*	*National Income, Population*
Special Tax on Foreign Insurance Companies (Bes. Gesellschaftssteuer ausl. Versicherungen)	Liechtenstein Tax Administration (Liechtensteinische Steuerwaltung)	
Stamp Duties (Stempelabgaben)	Liechtenstein Tax Administration (Liechtensteinische Steuerwaltung)	
Property Gain Taxes (Grundstückgewinnsteuer)	Liechtenstein Tax Administration (Liechtensteinische Steuerwaltung)	
Taxes on Vehicles Used for Production (Motorfahrzeugssteuer, Fahrzeuge Produktion)	Liechtenstein Tax Administration (Liechtensteinische Steuerwaltung)	

TABLE 27: Components of taxes on production and imports

[34] Basically, there have been three kinds of accounting regimes concerning the Swiss national income: the old Swiss national accounting (Schweizerische Nationale Buchhaltung) with annual figures from 1948 to 1995, the national accounting after the rules of ESA78 with annual figures from 1990 to 2001 and the national accounting relying on ESA95 with annual figures from 1990 to 2007. To obtain a coherent series from 1972 until 2008, which is needed for the calculation of the taxes on production and income, the ESA95 series serves as foundation. For the years before that, growth rates of the old Swiss national accounting figures have been used here as an indicator for annual growth and applied to the ESA95-series in order to generate backward estimates for the years before 1990. A similar procedure was also applied by Seco to generate an official historic time series for the Swiss GDP.

Regarding the special tax on foreign insurance companies and the different kinds of stamp duties, some weights are applied in Liechtenstein's national accounts.[35] For the different kinds of stamp duties the individually applied share weights are in line with the rules of thumb of the practice of Liechtenstein's official national accounts.

Unfortunately, some official data sources, which are used in the official national accounts, relating to some of the commissions on production are not publicly accessible. Yet, their quantitative importance is rather small. They are therefore approximated, also taking into account the evolution of other taxes on production over time in Switzerland.

TABLE 28 includes the computed figures for the aggregate taxes on production and imports, which is a sub-component of the gross domestic product.

Taxes on Productions and Imports	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
	33.9	37.5	38.9	40.3	46.4	53.2	55.9	63.2	72.9
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
	75.2	84.9	86.0	100.4	112.5	125.8	130.1	131.4	165.5
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	
	156.5	157.8	161.7	162.3	164.7	191.5	193.4	207.7	

TABLE 28: Computed figures for taxes on production and imports (in Mio. CHF)

4.4. Subsidies

After adding the taxes on production and imports to the sum of gross operating surplus and the compensation of employees, the subsidies have to be subtracted to obtain the national gross domestic product as a total. Regarding the whole time span of the official GDP figures of Liechtenstein (1998-2009), the subsidies contribute between 1.3% and 2.1% to the total absolute sum. Thus, they are clearly the least important component of the generation of income account which yields the GDP as a total.

Almost all of the relevant data concerning the subsidies are publicly accessible and can be obtained from official statistics such as the national income statement.[36] This enables the

[35] The applied weighting factors are taken from the national accounts: Special tax on foreign insurance companies (1/3) and the different kinds of stamp duties. These stamp duties are: "Effektenumsatzabgabe" (0.2), "Emissionsabgabe" (0.9), "Abgaben auf Versicherungsprämien" (1/3) and "Gründungs- und Wertstempelgebühr" (0.25).

[36] The municipalities' subsidies are also included in the total subsidies of the official national accounts. Nonetheless, they are neglected here due to the highly time-consuming compilation process compared to

subsidies to be calculated for the whole time-span (1972-2008) according to the rules of the official national accounts of Liechtenstein. The years 1998-2008 can then be used to compare the estimated values with the official values in order to determine the accuracy (this will be investigated in further detail in section 4.6.). The considered subsidies consist of the subsidies of products and other subsidies on production (for further details see OEHRY [2000, pp.144-147]). In the following, the components of both groups are listed, along with the German terms used in the national income statement of the annual governmental report (in brackets).

The *subsidies on products* included into the computations are: Subsidies for milk producers (Beitrag für die Milchwirtschaft), subsidies for sheep wool (Subventionen für Schafwolle), subsidies for cattle insurance (Beitrag an die liechtensteinische Viehversicherung), subsidies for health insurance (Krankenkassensubventionen), subsidies for accident insurance (Subventionen für Unfallversicherungen), deficit guarantee for the national publisher of teaching aids (Defizitabdeckung des amtlichen Lehrmittelverlags) and subsidies of public transportation (Beitrag an die Liechtensteinische Bus Anstalt).

The *other subsidies on production* that are included in the calculation process are: Subsidies for summering expenses (Alpungskostenbeitrag), subsidies for the maintenance of hillside locations (Beitrag zur Förderung der Berglandschaft), subsidies for the improvement of agricultural income (Beitrag zur Verbesserung des landwirtschaftlichen Einkommens), subsidies for the compensation of ecological and animal friendly services (Beitrag zur Abgeltung ökologischer und tiergerechter Leistungen), subsidies for the inspection of milk yield (Beitrag für die Milchleistungskontrolle), subsidies for hail insurance (Beitrag an die Hagelversicherung), interest subsidies for the promotion of agricultural buildings (Zinszuschüsse zur Förderung des landwirtschaftlichen Bauwesens)[37], subsidies for public producers (staatliche Beiträge an öffentliche Produzenten), subsidies for adult education (staatliche Beiträge an die Erwachsenenbildung), subsidies for national foundation for care of elderly and patients (staatliche Beiträge Stiftung liechtensteinische Alters- und Krankenhilfe), subsidies for the national post (staatliche Beiträge an die Liechtensteinische Post), subsidies for the national hospital (staatliche Beiträge an das Landesspital), state share of foresters' wages (Landesanteil an den Försterlöhnen der Gemeinden), state share of day nursery

their small quantitative relevance. Additionally, the income statements of some of the municipalities are not accessible back to 1972 anymore.

[37] Only 50% of the amount of the interest subsidies is considered in the summation of the total subsidies.

expenses (Landesbeiträge an Kinderhorte der Gemeinden), subsidies for broadcasting (Beiträge an den Rundfunk).

Subsidies	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
	4.2	5.3	6.5	6.9	7.9	9.3	10.3	10.7	12.1
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
	13.2	13.7	14.3	16.3	17.2	18.6	20.4	20.9	23.2
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	
	26.6	26.7	29.6	30.9	34.5	37.9	41.7	45.6	

TABLE 29: Computed subsidies (in Mio. CHF)

In TABLE 29, the calculated subsidies for the whole time span from 1972 until 1997 are listed and show a rather smooth and continuous growth over the regarded time-span.

4.5. Addition of the Four Components to GDP

After having obtained annual figures for the four sub-accounts of the generation of income account that determinate the annual GDP, all the four sub-accounts can be totalled. These calculations are shown in TABLE 30.[38]

	1972	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
Compensation of Employees	258.4	307.0	359.8	365.5	390.2	448.5	462.2	511.9	571.3
Gross Operating Surplus	241.6	250.8	276.3	267.9	299.6	324.7	336.9	378.3	405.5
Taxes on Production and Imports	33.9	37.5	38.9	40.3	46.4	53.2	55.9	63.2	72.9
(minus) Subsidies	4.2	5.3	6.5	6.9	7.9	9.3	10.3	10.7	12.1
Gross Domestic Product	529.7	590.0	668.5	666.8	728.4	817.1	844.7	942.7	1'037.6
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Compensation of Employees	585.1	655.6	674.2	733.2	784.2	860.2	893.5	1'009.8	1'085.5
Gross Operating Surplus	432.8	426.9	464.7	530.1	634.2	673.0	709.2	802.9	918.8
Taxes on Production and Imports	75.2	84.9	86.0	100.4	112.5	125.8	130.1	131.4	165.5
(minus) Subsidies	13.2	13.7	14.3	16.3	17.2	18.6	20.4	20.9	23.2
Gross Domestic Product	1'079.9	1'153.9	1'210.7	1'347.5	1'513.6	1'640.4	1'712.4	1'923.2	2'146.6
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	
Compensation of Employees	1'180.8	1'268.1	1'326.5	1'383.1	1'442.3	1'551.4	1'545.1	1'625.1	
Gross Operating Surplus	894.6	1'062.7	1'126.4	1'171.9	1'204.5	1'176.6	1'340.6	1'576.6	
Taxes on Production and Imports	156.5	157.8	161.7	162.3	164.7	191.5	193.4	207.7	
(minus) Subsidies	26.6	26.7	29.6	30.9	34.5	37.9	41.7	45.6	
Gross Domestic Product	2'205.4	2'461.9	2'585.0	2'686.4	2'776.9	2'881.6	3'037.5	3'363.8	

TABLE 30: Addition of computed sub-accounts to GDP

[38] See footnote 32 since it is also of relevance here, when the sub-accounts are summed up to the gross domestic product.

In FIGURE 17, the complete chained GDP-series is visible, in nominal and real terms. The official figures start by the year 1998, all the years before that year originate from the estimation just outlined in the prior sub-chapters. The years 2010 until 2012 are nowcasts and one forecast by KOFL, published in SCHLAG [2012, p.39]. The real GDP-values were deflated by using the Swiss GDP-deflator. The usage of Swiss deflators for Liechtenstein's economy is the applied practice by KOFL and also proposed by OEHRY [2000, p.345] and the national statistical office. It is reasonable also from a logical point of view, since Liechtenstein shares a monetary and economic union and a customs treaty with Switzerland.

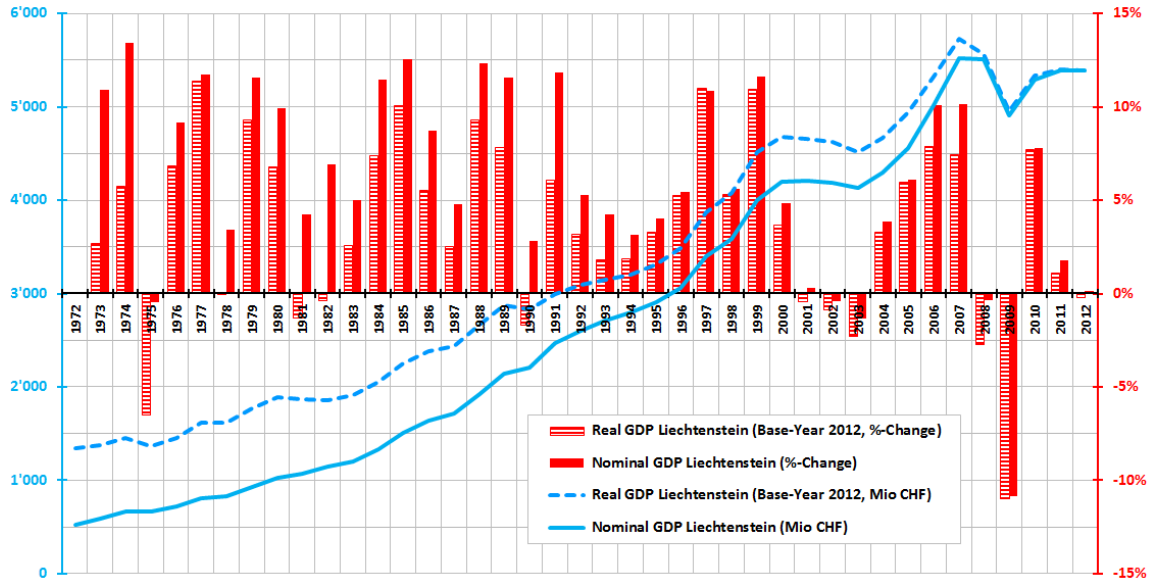

FIGURE 17: Computed (real and nominal) GDP-figures chained with the official GDP

For a deeper analysis of Liechtenstein's past long-term growth path, see BRUNHART, KELLERMANN AND SCHLAG [2012] who apply a preliminary version of the GDP-series that was estimated here. After having examined Liechtenstein's business cycle using the national income, the same can be done for the gross domestic product. So, the main findings shall be repeated here to document the similarity to FIGURE 8. Inspecting Liechtenstein's business cycle, it can be seen that major economic fluctuations generally have a strong impact on Liechtenstein's economy: the first oil-price shock and the restrictive monetary policy of the Swiss National Bank in the first half of the 1970s. Then there are recessive developments in 1978 (over-shooting of the Swiss Franc) and the early 1980s detectable (Iranian Revolution and second oil-shock). Other downturns in economic growth can be traced in 1987 ("Black Monday"-crash on international stock markets) and first half of the 1990s (war in Iraq, „third oil-price shock", appreciation of the Swiss Franc). The high economic growth during the last years of the 90s was temporarily diminished by the Asia-crisis that affected important

exporting companies and also financial institutes in Liechtenstein. Similarly striking are the two world recessions of the new millennium, especially the heavy downturn in 2008 and 2009, when the international financial crisis was accompanied with the Liechtenstein Tax Affair, which led to high insecurity and a transformation process in Liechtenstein's financial sector.[39] These mentioned economic events are also visible in the cyclical component (output gap) after removal of the positive growth trend over time by applying the filter of HODRICK AND PRESCOTT [1997] on the real GDP-series. This cyclical component (as percentage deviation from the HP-trend) of the real GDP is visible in FIGURE 18 and FIGURE 23. On the latter mentioned figure, the close movement to the cyclical component of Liechtenstein's national income can also be noted (but this will be dealt with later on, when the accuracy of the computed GDP-series is evaluated).

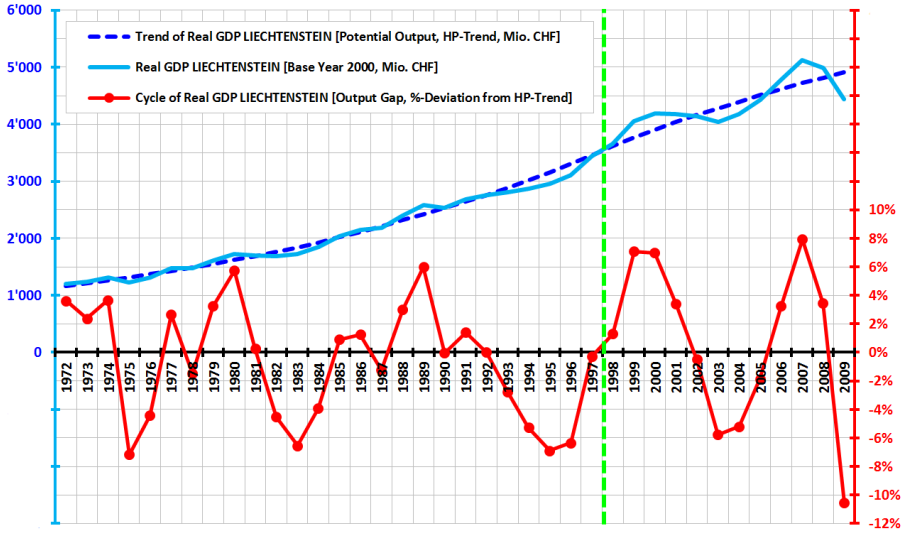

FIGURE 18: Potential output and output gap of Liechtenstein (derived by HP-filter on real GDP)

The four components adding to GDP and their evolution over time are illustrated in the following graph, the estimated figures from 1972 to 1997 and the official figures 1998 until 2008 have been linked.

[39] The different impacts of the financial crisis and the tax affair (a whistle blower sold data of thousands of tax evaders) on Liechtenstein's economy, especially on the stock values of Liechtenstein's quoted companies, have been investigated in BRUNHART [2012a]. As flash-estimates (OFFICE OF STATISTIC [2012b]) and nowcasts of GDP (SCHLAG [2012]) show, Liechtenstein's economy featured a strong real recovery through the year 2010 while stagnating in 2011 (visible in FIGURE 25).

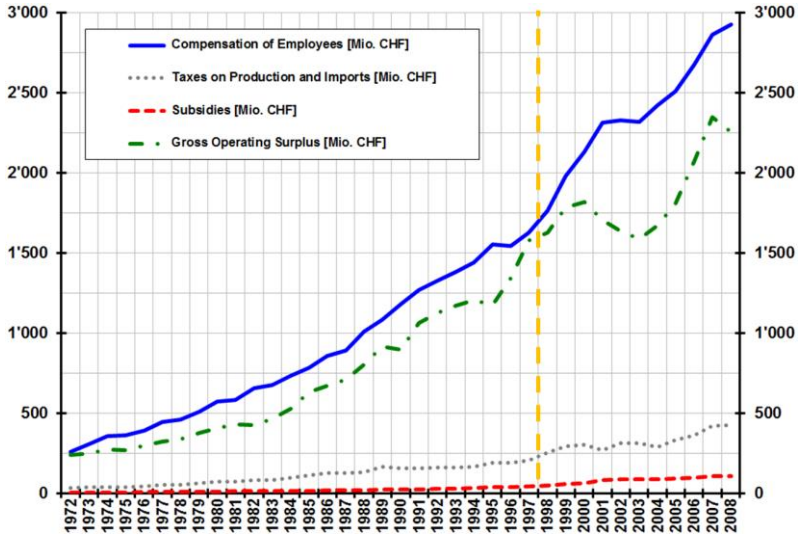

FIGURE 19: The four computed components of GDP over time

It is also interesting to identify the real percentage growth contribution of the four different sub-components of Liechtenstein's GDP in order to better understand the driving forces behind the business cycle. As FIGURE 20 illustrates that especially the real growth contribution of the gross operating surplus is very volatile acrross the business cycle.

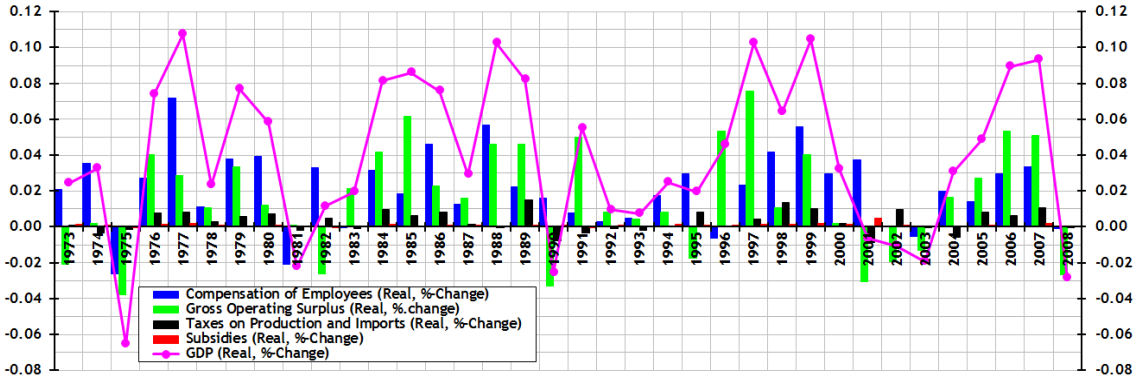

FIGURE 20: Real percentage growth contribution of four components of Liechtenstein's GDP

4.6. Evaluation of Computed GDP-Figures

It is now of central importance to evaluate the estimated GDP-series. A first step would be to compute and compare GDP-values of the years 1998 to 2008 with the official GDP-figures that have been published since 1998.[40]

[40] There exist national account figures also for 2009 (including GDP), but they are still provisional and will be revised in December 2012, when the official national account figures for 2010 are going to be published by the Office of Statistics. Also, the compiled data from the private companies only include the time span 1972-2008. Therefore, only the years 1998-2008 are taken into account for this evaluation.

	Mio. CHF	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	Compensation of Employees	*1'747.4*	*2'005.7*	*2'064.3*	*2'199.1*	*2'285.3*	*2'244.9*	*2'312.3*	*2'438.8*	*2'597.6*	*2'755.8*	*2'932.0*
+	*Gross Operating Surplus*	*1'591.5*	*1'746.5*	*1'976.3*	*1'853.1*	*1'733.5*	*1'684*	*1'852.6*	*2'057.4*	*2'326.2*	*2'614.7*	*2'396.0*
+	*Taxes on Production/Imports*	*221.4*	*264.9*	*314.8*	*283.1*	*271.5*	*239.5*	*245.4*	*277.0*	*321.1*	*368.5*	*394.5*
-	*Subsidies*	*59.5*	*63.7*	*69.6*	*89.4*	*94.3*	*95.0*	*93.3*	*102.1*	*102.3*	*109.6*	*113.8*
=	*GDP (computed)*	*3'500.9*	*3'953.4*	*4'285.8*	*4'245.8*	*4'196.0*	*4'073.4*	*4'317.0*	*4'671.1*	*5'142.7*	*5'629.5*	*5'608.8*
	GDP (official)	3'595.1	4'001.9	4'194.8	4'205.2	4'190.3	4'135.3	4'295.6	4'556.4	5'015.4	5'523.5	5'503.7

TABLE 31: Computed and official GDP in the evaluation period (1998-2008)

TABLE 31 shows the results for the four components and their totals and contrasts them with the official GDP. The figures in *italics* denote computations of this chapter, while the values not in italics are official releases. When the official and the computed (nominal) GDP-figures are plotted in FIGURE 21, a close fit can be visually observed. The average absolute deviation from the official number during these eleven years is only 1.63%. This is low and clearly below the target by the national Office of Statistics, that calculates the official national accounts. The OFFICE OF STATISTICS [2012b, p.4] aspires an absolute deviation of less than 3% of their published flash-estimate of GDP compared to the finally revised figures.

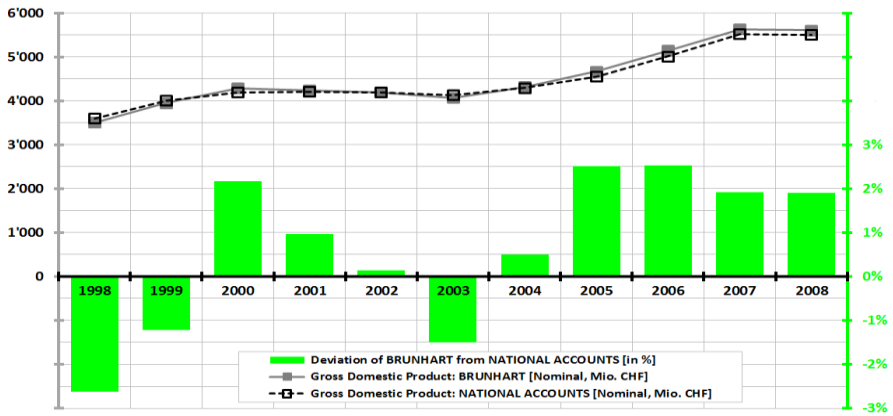

FIGURE 21: Evaluation of computed versus official GDP-figures

Also, a visual comparison of the nominal growth rates, which are very important to capture the business cycle pattern, unveils the good fit of the estimated series. In FIGURE 22, also the nominal GDP-estimates of the SGZZ, which were explained in the introduction of chapter 4., are displayed. As expected, those estimates are a bit lower than the estimations proposed here. The author has carried out a similar technique to the one of the SGZZ for the years 1990-2008 and transposed the sectoral added value figures from Switzerland (which are publically available from 1990 on) to Liechtenstein and has found out (as a-priori expected) that this strategy underestimated the actual GDP by about 10% to 25%. One can therefore get the idea

that the GDP values estimated here and those by the SGZZ correspond well with the impression of underestimation by the SGZZ-method.

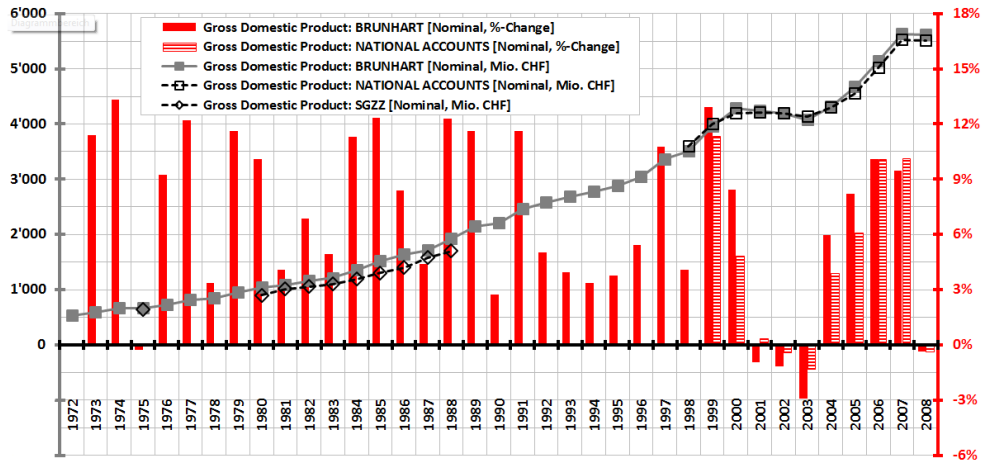

FIGURE 22: Different sources of nominal GDP of Liechtenstein

We also observe again the close fit of the computed values with GDP-figures of the official national accounts.

Additional insights can be drawn from calculating the correlation of the four components of GDP (and of their total) with the official numbers, as shown in TABLE 32. The correlation coefficients of the estimated and the actual GDP are very high: 0.9974 in levels and 0.9608 for their annual percentage growth. Fortunately, the estimates of the gross operating surplus are very satisfying; this component has been the big challenge, since it contains a big share of GDP's volatility and because there was no benchmark method for its generation, neither in the literature nor in the official national accounts of Liechtenstein (as they are calculated as residual from other accounts).

CORRELATION	Compensation of Employees	Gross Operating Surplus	Taxes on Production and Imports	Subsidies	Aggregated Total (GDP)
Level	0.9915	0.9634	0.8911	0.9978	0.9974
%-Change	0.7676	0.8765	0.7768	0.9495	0.9608

TABLE 32: Correlation of estimated and actual figures (1998-2008)

The generated business cycle pattern seems very plausible, features no incomprehensible outliers and can be supported by economic interpretations (as has been done in the previous sub-chapter). Also, the four sub-components of the GDP show no severe outliers, without interpretation by economic reasoning. They are displayed in the FIGURE 19 and FIGURE 20.

If the two most important national accounting aggregates, which are now available in Liechtenstein over a longer time span, are compared then it is evident that both feature a very close cyclical pattern. Both time series, the aggregates real gross domestic product of Liechtenstein and real national income of Liechtenstein, were de-trended by the filter after HODRICK AND PRESCOTT [1997] in order to obtain a widely applied measure for the business cycle. The very high similarity of both backwardly estimated aggregates is evident.[41] Hence, the computed GDP-figures from 1972 to 1997 are also plausible in this light.

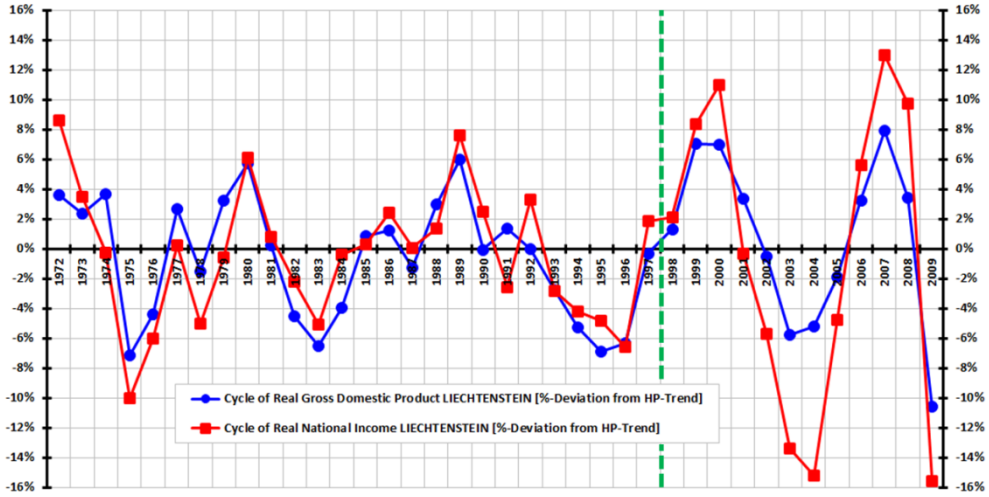

FIGURE 23: Cyclical components of Liechtenstein's real GDP and real national income

As observable from other countries (like Germany, Austria or Switzerland), the ratio of the compensation of employees to GDP has remained pretty stable over the past four decades. Thus, this fact can serve as a good evaluation test to find out whether this is also true for the Liechtenstein. If this also holds for the estimated values from 1972 to 1997, then an additional hint is obtained that the estimated GDP-figures are plausible. FIGURE 24 shows the ratios for the four quoted countries. The ratio has remained between 0.5 and 0.6, during both periods 1972-1997 (estimated values) and 1998-2009 (official figures).

[41] It is reasonable to compare both aggregates, which also imply approximated figures, for evaluations. Both series do not evolve from a similar econometric or computational model and are not solely a main function of only few data sources or just dependent on a very similar computation method.

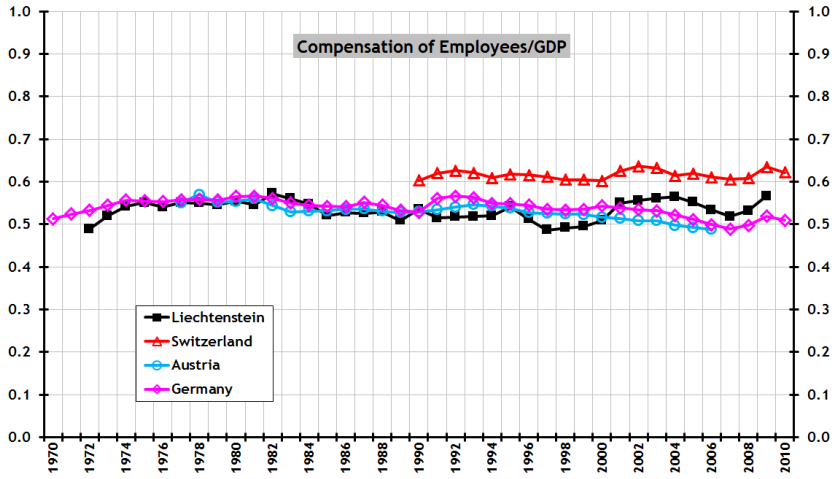

FIGURE 24: Ratio of Compensation of Employees relative to GDP

Also the ratio of the other very important component of GDP, the gross operating surplus, has been quite stable within a bandwidth of ranging from 0.35 to around 0.45 and shows no strong outliers.

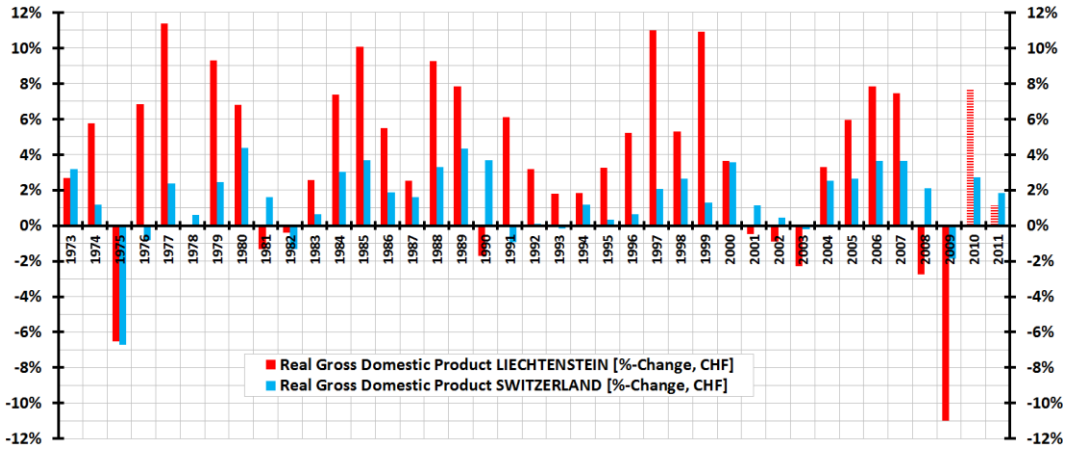

FIGURE 25: Real growth rates of Liechtenstein's and Switzerland's GDP

It is interesting to see that the business cycle of Liechtenstein has very similar characteristics to the Swiss economic short-term fluctuations. This impression applies to both the growth rates of real GDP (see FIGURE 25) and the output gap measured as the percentage deviation from the long-run trend of GDP (HP-filter), as shown in FIGURE 26. Though, the amplitude is much higher, Liechtenstein is therefore characterized by a higher volatility.[42]

[42] Reasons could be the very high share of exports (due to the small size of the country): Exports are usually very volatile in the business cycle. Additionally, the smaller diversification across the production and provision of different goods and services compared to bigger countries may play an important role leading to higher volatility. As it has already been observed regarding national income also the gross domestic product featured no visible moderation of volatility over time.

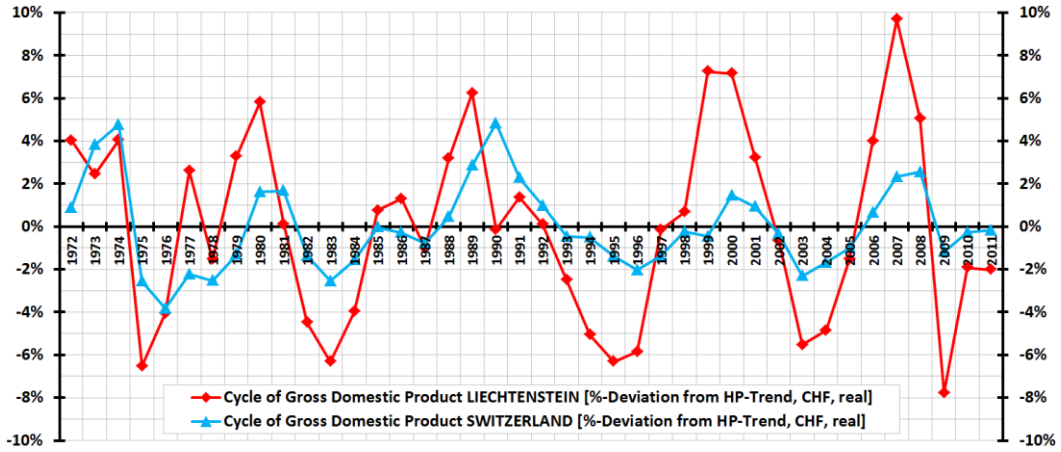

FIGURE 26: Cyclical amplitude of real GDP in Liechtenstein and Switzerland

After having applied a trend-filter to Liechtenstein's real GDP and inspected the cyclical behaviour (output gap), it is also worthwhile to concentrate on long-term growth (potential output) to compare the drift of the real GDP. A preliminary version of Liechtenstein's GDP's historic time-series is used that as well consists of the official values from 1998-2009 and computed values from 1972 until 1997 plus an econometric backward extension (1971-1954). In that preliminary version the same computation method was executed via the same procedure as in the paper here, but as already mentioned, the figures were not the finally revised ones from this thesis. This preliminary time series was already applied in the contribution of BRUNHART, KELLERMANN AND SCHLAG [2012]. However, the preliminary estimated GDP-figures for 1972-1997 show almost completely the same cyclical pattern as the final ones in this paper. The time series of Liechtenstein's GDP in the just quoted paper was in addition econometrically extended by the author for the years 1971-1954 (applying a multiple regression model with indicators). These figures are now used in order to have a maximum number of observations. FIGURE 27 shows the growth of Liechtenstein's potential output, this growth is also called trend drift (violet line in FIGURE 27, whereas the real percentage growth of the raw GDP is marked by the dashed blue line). The trend drift is measured by the percentage growth of the trend of real GDP derived by the method of HODRICK AND PRESCOTT [1997]. There are clearly observable three phases, the two main breaks being in the middle of the 70s and by the middle/end of the 90s.[43] Especially the interesting period for evaluation reasons (1972-1997) shows a very similar development to the growth of potential output in Switzerland (red line in FIGURE 27). This also supports the reasonability of the estimated GDP-values for Liechtenstein provided in this dissertation. Yet,

[43] See also the remarks of footnote 24 in this context.

by the end of the sample, the continuous convergence between Switzerland and Liechtenstein seems to be completed.

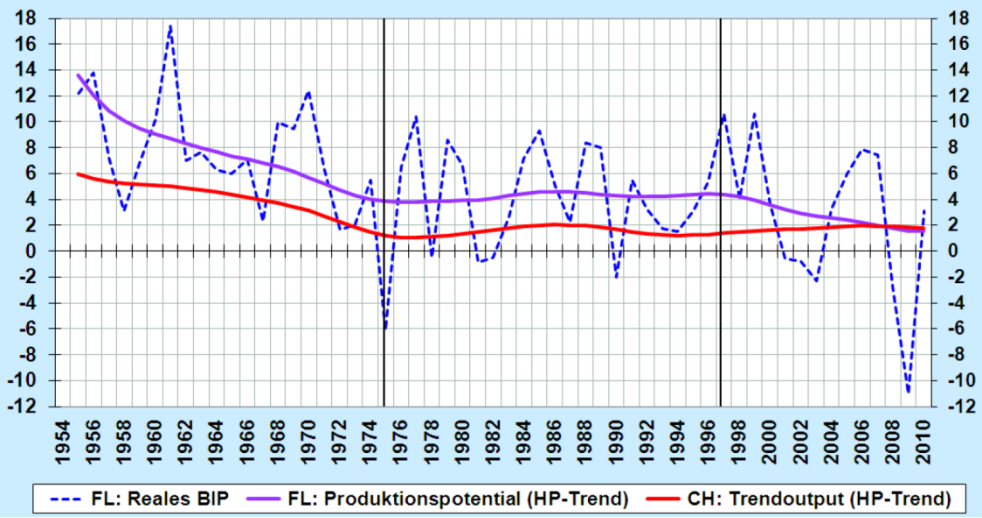

FIGURE 27: Growth of potential output (drift) of Liechtenstein and Switzerland (Source: BRUNHART, KELLERMANN AND SCHLAG [2012, p.10])

Also, KELLERMANN [2005] has detected two main structural breaks in Switzerland's economy for different important aggregates (such as GDP, GNI, production, employment) in the middle of the 70s and in 1997. This corresponds perfectly with the two observed structural breaks in the growth of potential output (drift), measured by the annual percentage growth of the trend (of Liechtenstein's real GDP) that was determined applying the HP-filter on the newly estimated GDP-figures applying the method proposed in this dissertation (and already used in a preliminary version in BRUNHART, KELLERMANN AND SCHLAG [2012]). Hence, additionally to the findings considering the business cycle pattern the newly generated GDP-figures have again an intuitive economic interpretation that supports their accuracy, also in the context of structural breaks in the long-term growth path.

5. Conclusions

In chapter 1 of this contribution, several economic data series of Liechtenstein have been backwardly estimated and linked in order to obtain consistent historic time series. The series include the national income from 1954 to 1997, the sectoral and total employment in the 1970s and some years of the 1980s and 1990s and most importantly the gross domestic product from 1972 to 1997. These series can be chained with the official results from the national accounts, which were introduced for the year 1998 and have been published until 2009 so far.

As the GDP-series and the employment have now been definitely computed, one could consider re-estimating and potentially revising the data points of national income that have been determined by the use of a regression, when more official figures regarding the national income will be available in the future years. A next step would be to retropolate gross domestic product in a similar estimative manner as the retropolation model for the national income. In BRUNHART, KELLERMANN AND SCHLAG [2012] the approach developed in this dissertation has already been applied and GDP-figures for the years 1954 until 1971 have been obtained and used for the analysis of Liechtenstein's long term-growth. The reference series for this retropolation (using indicator series) was computed in a preliminary version of results applying the computation method developed and introduced in chapter 1.4. for the years from 1972 to 1997. Now, as definite estimates of GDP-figures (which were very slightly revised compared to the prementioned paper) have been presented in this project, the estimation model may be updated and fully methodically outlined in the near future.

Also very interesting in the context of the analysis and prediction of Liechtenstein's business cycle and the inspection of other economic matters would be sub-annual figures of Liechtenstein's GDP that only annually exist so far. A method for the generation of quarterly GDP-figures and first results from 1999Q1 until 2011Q4 has been presented in BRUNHART [2012b, pp.128-137].

A nowcasting model for Liechtenstein's gross national income would be an important supplement to the existing nowcasts of gross domestic product. The gross national income is also of high economic and analytical relevance. Gross national income figures are for example required by Liechtenstein's Office of Foreign Affairs in order to calculate the annual

percentage share of Liechtenstein's Official Development Assistance (ODA) usually measured in relation to the gross national income. [44] Also, several national contributions to international organisations are based on gross national income (see KELLERMANN AND SCHLAG [2005]). Earlier accessible GNI-figures (with a shorter publication lag) could also be interesting for preliminary calculations related to the division of certain kinds of taxes and tariffs between Switzerland and Liechtenstein (this division has been outlined in chapter 4.1.3.).

Other examinations, that are now possible with the prolonged GDP-series and which have been started but have not had space in this dissertation, are: the suspected leading behaviour of Liechtenstein's economy relative to its neighbours and the analysis whether a synchronization of business cycle with its neighbouring nations has taken place or not (with respect to the long-run growth path, the evolution of the volatility, and a potential convergence), also checking for structural breaks in the historic economic time series.[45]

[44] That is why the author has provided the Office of Foreign Affairs provisional nowcasts for the year 2010 by setting up a first version of a nowcasting model with two linked regressions, which takes advantage of the now five observations longer time span of computed national income figures (1993-1997 after the national accounting scheme and 1998-2009 official figures) and the correlation of national income with gross national income. Before this model might be presented to the public, it will be assessed in a third run, when new official results are released in December 2012, or the author simply going to wait until some new annual observations are available.

[45] It has already been found that there is certain persistence of shocks, as all the inspected time series for Liechtenstein's economy follow a unit root process (random walk), also the newly estimated GDP.

Appendix

A.1. National Income Account: Interests of Residents

The interests of residents are an important element of the private households' property income. These interests have to be roughly approximated due to the lack of appropriate detailed statistics. This was also done by the governmental financial unit and in the first preliminary versions of the official national accounts. In a first stage, the interest rates for different kinds of creditors (deposits, savings, obligations) have to be collected and averaged. The interest rates are published in the official banking statistics of the Office of Statistics. These figures are on a quarterly base. The mean is being calculated in order to get averaged annual interest rates.

Interest Rates							
In percentage		1993	1994	1995	1996	1997	1998
Fixed Deposits	3 months	4.29	3.23	2.40	0.95	0.87	1.00
	6 months	4.14	3.27	2.55	1.03	0.97	1.06
	12 months	3.86	3.36	2.69	1.12	1.05	1.18
	Average	4.10	3.28	2.55	1.03	0.96	1.08
Savings Book	Savings Deposits	4.17	3.33	3.01	1.94	1.55	1.29
	Young People's Savings	4.65	3.79	3.47	2.54	2.09	1.77
	Old People's Savings	4.63	3.67	3.30	2.34	1.84	1.52
	Building Society's Savings	4.81	4.00	3.69	2.25	1.88	
	Average	4.56	3.70	3.37	2.27	1.84	1.53
Deposits		3.22	2.25	1.97	1.03	0.80	0.55
Creditors at Sight		0.50	0.50	0.80	0.59	0.51	0.30
Obligations	3-4 years	4.48	4.10	4.02	2.81	2.29	2.19
	5-6 years	4.71	4.30	4.32	3.39	2.82	2.60
	7-8 years	4.79	4.44	4.55	3.87	3.27	3.01
	Average	4.66	4.28	4.29	3.36	2.79	2.60

TABLE 33: Interest rates for different creditors

The monetary amounts of all the relevant types of creditors have to be gathered as well. The interest rates are listed in TABLE 33 and the amounts of creditors are shown in TABLE 34. These compiled figures concern values on the 31st of December of each considered year. As the components of the national income rely on the gained income only of residents (in contrast to the gross domestic product), domestic interests in Liechtenstein of non-residents need to be deducted. Hence, one is mainly interested in the second part of TABLE 34. Unfortunately, the official statistics do not separate the interests of Liechtenstein and Swiss citizens (denoted by CH+FL in the table).

Interest-Bearing Liabilities								
By end of year, in 1'000'000 CHF		1992	1993	1994	1995	1996	1997	1998
All	Creditors at Sight	3'075.9	3'883.0	2'695.4	3'092.5	5'182.5	6'436.4	7'688.2
	Creditors Payable on Maturity	11'875.3	10'723.8	12'519.8	11'255.4	10'867.1	10'876.9	10'897.5
	Savings Deposits	1'311.3	2'307.3	2'845.0	3'699.6	4'588.5	4'792.8	4'631.3
	Deposits	118.8	183.641	159.5	268.9	330.1	4512.0	427.3
	Sub-Total	*16'381.3*	*17'097.7*	*18'219.7*	*18'316.5*	*20'968.2*	*22'558.1*	*23'644.2*
	Medium Term Bonds	1'656.1	1'784.9	1'717.4	2'101.0	2'157.1	1'756.1	1'640.9
CH+FL	Creditors at Sight	2'293.0	2'859.1	2'022.6	2'331.3	3'630.2	4'651.8	5'402.3
	Creditors Payable on Maturity	8'099.0	6'672.9	7'649.7	6'653.3	6'001.1	6'050.5	5'844.2
	Savings Deposit	957.3	1'755.7	2'211.5	2'887.5	3'604.0	3'714.0	3'650.4
	Deposits	87.9	144.3	119.4	210.2	252.9	365.3	320.8
	Sub-Total	*11'437.1*	*11'432.1*	*12'003.1*	*12'082.2*	*13'488.2*	*14'781.6*	*15'217.8*

TABLE 34: Amount of creditors

The amounts of creditors are published annually on due date 31st of December. Yet, as the amount trough-out the year is more interesting, the annual average is calculated by simply taking the mean of the precedent and the current year.

Interest-Bearing Liabilities FL+CH (Yearly Average, in 1'000 CHF)	1993	1994	1995	1996	1997	1998
Creditors Payable on Maturity, Fixed Deposits	11'299'551	11'621'759	11'887'587	11'061'296	10'872'029	10'887'212
Savings Deposits	1'356'514	1'983'600	2'549'475	3'245'727	3'659'001	3'682'192
Deposit	116'113	131'850	164'805	231'570	309'113	343'068
Medium Term Bonds, Bonds	1'720'501	1'751'186	1'909'234	2'129'094	1'956'615	1'698'477
Creditors at Sight	3'479'440	3'289'178	2'893'944	4'137'517	5'809'434	7'062'253

TABLE 35: Interest bearing liabilities

After having derived the annual averages of the interest bearing liabilities the average received interests for the five different groups of liabilities can now be calculated by making use of the compiled interest rates of TABLE 33. The received interests by citizens of Liechtenstein and Switzerland (occurred in Liechtenstein) can then be obtained:

Interests FL+CH (Yearly Average, in 1'000 CHF)	1993	1994	1995	1996	1997	1998
Creditors Payable on Maturity, Fixed Deposits	462'717	381'581	302'539	114'208	104'371	117'854
Savings Deposits	61'891	73'368	85'854	73'556	67'143	56'276
Deposits	3'733	2'967	3'243	2'374	2'465	1'878
Medium Term Bonds, Bonds	80'132	74'936	81'986	71'484	54'638	44'175
Creditors at Sight	17'397	16'446	23'152	24'204	29'628	21'187

TABLE 36: Interests of interest bearing liabilities

The second main step is now to calculate the amount of interests of Liechtenstein's residents. As the annual shares are unknown, the financial unit of the government used approximations of the shares, which are labelled in the following table and used for the last step in the determination of the interest income of residents.

Domestic Shares of Interests FL (Yearly Average, in 1'000 CHF)	Assumed Shares	1993	1994	1995	1996	1997	1998
Creditors Payable on Maturity, Fixed Deposits	55%	254'494	209'870	166'396	62'814	57'404	64'820
Savings Deposits	85%	52'607	62'363	72'976	62'523	57'071	47'835
Deposits	85%	3'173	2'522	2'756	2'018	2'095	1'597
Medium Term Bonds, Bonds	55%	44'073	41'215	45'092	39'316	30'051	24'296
Creditors at Sight	75%	13'048	12'334	17'364	18'153	22'221	15'890
TOTAL: Interest Income of Residents		367'395	328'304	304'584	184'824	168'843	154'437

TABLE 37: Domestic shares of interests

The interests of residents are now determined and can then be used as main element of the property income of the private households as a sub-account in the computation process of the national income account.

A.2. Table of Log-Model (Retropolation of National Income)

As outlined in chapter 3.2., the regression model used for the interpolation of the national income is estimated with the variables in logarithms and in differenced logarithms and then both types are comparatively evaluated. The estimation output in dlogs is displayed in chapter 3.2., while the output of the inferior log-model is presented in the following, in TABLE 38.

Dependent Variable: log(*NATIONAL INCOME*)		Sample (adjusted): 1960-2009		
Method: Least Squares		Included Observations: 27 after adjustments		
Variable	**Coefficient**	**Standard Error**	**t-Statistic**	**p-Value**
LINEAR TREND	-0.0171	0.0073	-2.3313	0.0316
log(*NATIONAL INCOME*(-1))	0.3454	0.1416	2.4389	0.0253
log(*WAGES*)	0.3285	0.1809	-1.8156	0.0861
log(*FOREIGN SALES*)	0.3741	0.1301	2.8764	0.0100
log(*BANKING ASSETS*)	0.6419	0.1519	4.2261	0.0005
log(*GNI CH*)	-0.0908	0.0477	-1.9019	0.0733
D60	0.1627	0.0500	3.2533	0.0044
D61	0.1044	0.0409	2.5514	0.0200
D09	-0.1797	0.0477	-3.7675	0.0014
Measures of Fit				
R-squared	0.9997	Mean Dependent Variable	6.8069	
Adjusted R-squared	0.9995	S.D. Dependent Variable	1.5145	
S.E. of Regression	0.0340	Akaike Info Criterion	-3.6638	
Sum Squared Residuals	0.0208	Schwarz Criterion	-3.2319	
Log Likelihood	58.4614	Durbin-Watson Statistic	1.8981	

TABLE 38: Estimation output of the model in log-levels

A.3. Generating Consistent Time Series of Employment

As a consequence of the chosen approach of the retrospective estimation of Liechtenstein's GDP, annual employment figures for the years 1972-2008 are required, regarding both total and sectoral figures divided into the sectors "agriculture/households", "industry/manufacturing", "financial services" and "other services".

The official statistics of Liechtenstein's national Office of Statistics provide total employment figures for the years 1930, 1941, 1950, 1955, 1960, 1965, 1970, 1975 and 1980-2009. Sectoral employment is only available for the years 1955, 1960, 1965, 1970, 1975 and 1980-2010, whereas only for the years 1955, 1965, 1975, 1986-1991 and 1995-1996 and 1998-2010 the service sector has been divided into financial and other services. The official employment figures for the year 1955, 1965 and 1975 are compiled via the census of enterprises and are therefore not perfectly comparable to the ordinary employment statistics. However, they still serve as important indicators. In the following explanations, the focus will be mainly on data from 1970-2009.

Along with this contribution, consistent time series for sectoral and total employment are generated, which not only enable the backward estimation of Liechtenstein's GDP, but also extend, as a side-product of the backward estimation, the database for future economic (historical) analyses. Additionally, an obvious mistake or misprint featured in the official statistics concerning the sectoral employment in the 1981 is being revised: The reason for the implausible jumps in the share of employment between industry and financial services could not be traced back by the national Office of Statistics after a request by the author, but these jumps seem to be rather of mistaken nature than being just an unusual (but correct) outlier.

The estimation procedure differs for periods of years, usually employing interpolation and reconciliation (with respect to the total constraints) and usage of different data sources serving as indicators, control reference or benchmark. Thus, the constructed figures result from a deliberate and iterative proceeding combining interpolation, reconciliation and use of indicators. The thereby used information sources, both official and scientific documents, but also other archived data resources, were subject to an extensive and long-lasting gathering process from information sources and should therefore reflect all appropriate data, which are

arguably accessible to the public. TABLE 39 shows the relevant data sources, which have been used for compiling the consistent employment time series.

Issuer and source of data	Provider of data	Data	Years
National Office of Statistics (1980): Survey of companies on development of employment[46]	National Office of Statistics	Sectoral and total employment (domestic)	1974, 1976, 1978, 1980
National Office of Statistics (2010): Employment statistics	National Office of Statistics	Sectoral and total employment (domestic)	1980-2009
National Office of Statistics (1980): Statistical yearbook	National Office of Statistics	Sectoral and total employment	1980
National Office of Statistics (1977, 2010): Statistical yearbook	Liechtenstein Chamber of Commerce and Industry	Employment of industrial companies	1965-1979, 1992-2008
National Office of Statistics (2008): Banking Statistics	Liechtenstein Bankers Association	Employment of banks	1970-2007
Liechtenstein government: Annual governmental report (several years)	National Office of Statistics	Inward commuters	1980-1985
BATLINER [1966]	Liechtenstein Chamber of Commerce and Industry	Employment of industrial companies	1955-1964
National Office of Statistics (several years): Statistical yearbook	National Office of Statistics	Sectoral and total places of employment according to census of enterprises (domestic)	1965, 1975, 1985, 1991, 1995
National Office of Statistics (1987-1999): Places of employment	National Office of Statistics	Detailed sectoral and total employment (domestic)	1987-1999

TABLE 39: Sources for the estimation of total and sectoral employment

A.3.1. Employment Industry/Manufacturing

The starting point of generating figures for the employment in industry/manufacturing is to compile consistent annual figures of employment in the industrial (production) sector from 1970 until 1980. As already stated earlier, for industrial employment the only missing years in Liechtensteins official statistics are 1971-1979 and the year 1981 has to be revised. Fortunately, there is a data series, which can serve as a good indicator for the development of industrial employment: The Liechtenstein Chamber of Commerce and Industry (German abbreviation: LIHK for Liechtensteinische Industrie- und Handelskammer) supplies annual figures covering their member companies. It was possible to obtain annual figures of employment of the industrial member companies back to the year 1950. These figures include the most important industrial companies, which cover more than two third of the whole industrial employment in Liechtenstein. Thus, they are an ideal proxy for industrial employment.

To estimate appropriate figures for the industrial employment by the usage of the LIHK-proxy a special interpolation-method is developed, introduced and used here: In a first step,

[46] See OFFICE OF ECONOMIC AFFAIRS [1980].

the available industrial employment figures of the years 1950 (3'363 employees), 1960 (5'479), 1970 (7'097), and 1980 (8'203) are being linearly interpolated. The same linear interpolation is carried out as well for the indicator series (figures by the LIHK) and applied for the same benchmark years.

In a second step, for each year (1951-1959, 1961-1969, 1971-1979) the percentage deviation of the linearly interpolated figures from the actual indicator series' figures is being calculated. These percentage deviations are then used to revise the interpolated reference series (the estimated industrial employment), assuming a similar relative movement of the reference and the indicator series.

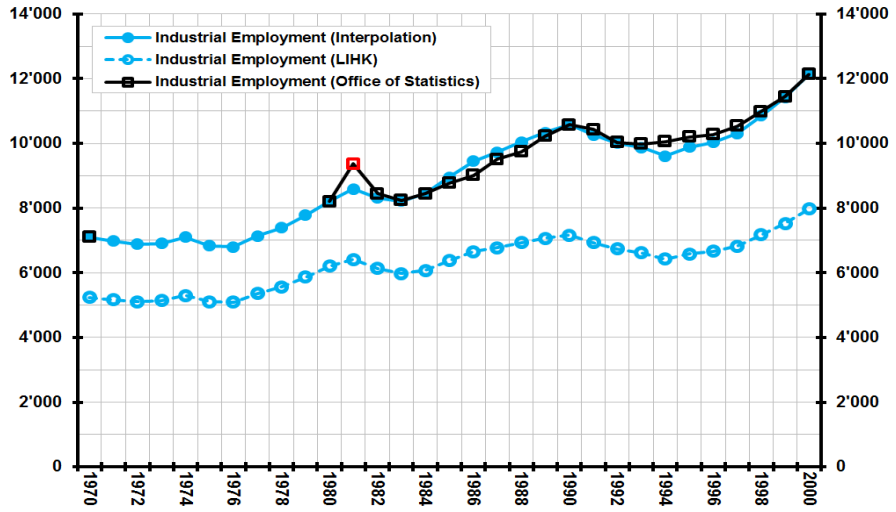

FIGURE 28: Industrial employment in Liechtenstein (employed people by the end of year)

In a third step, in order the get an idea of the adequacy of the estimates, the same procedure is done for the years 1980 until 2000, using 1980, 1990 and 2000 as the benchmark years for the interpolation.

In a fourth step, these estimates are evaluated in comparison to the official figures available from 1980 on. FIGURE 28 shows the estimated sectoral employment figures in the industry sector together with the official figures. By visually inspecting the time period from 1980 to 2000, it is evident that the chosen estimation procedure is reliable. This result is also supported by the fact that the absolute difference between the official and the present estimates is on average 1.86% (for the evaluated years 1982-1989 and 1991-1999). The figure also shows the inaccurate outlier in the year 1981 in the official statistics already mentioned

earlier, which has been replaced here by the estimated value (the outlier to be revised is marked by the red casket).

A.3.2. Employment Financial Services and Other Services

After having obtained a consistent series of industrial employment (1970-2009), the next goal would be to derive a series which features employment figures in the service sector separated for financial services and other services. While figures for total services are available for the years 1970 and 1980-2009 (the few covered years before 1970 are left aside), separated values are only available for the years 1986-1991, 1995-1996 and 1998-2009.

To attain consistent results, the definition of the sub-sectors included into the financial sectors has been kept consistent for the whole time span. These sub-sectors are: banking services, insurance services, legal and tax advice services and accounting services. The procedures chosen for the estimation of detailed figures of the service sector differ for different considered time periods:

- *1986 until 1991 and 1995 until 1997*: There are archived statistics accessible from 1986 until 1997 which involve employment of about 17 sub-sectors despite the fact that in the official national statistics the services sector is only available as total. Thus, employment within the sectors financial services and other services can be directly calculated. For the years 1992-1994, some minor additional approximations had to be made, because the exact classification of the sub-sectors varied in the documents.

- *1980 until 1985*: For these six years total employment, agricultural employment, industrial employment and total service employment are known. Therefore, the only aspired additional information would be how total service employment is distributed between financial services and other services. For this estimation purpose, two additional data sources are used: statistics on inward commuters (by sub-sectors) and on employed Liechtenstein residents (by sub-sectors).[47] The total of both serves as a

[47] Sources are the annual report of Liechtenstein's Government (1980-1985) and the Statistical Yearbook of the national Office of Economic Affairs (1980-1985).

good measure for the sub-sectoral domestic employment mix.[48] Aggregating the relevant sub-sectors as well to all other services and all financial services, and adding up inward commuters and employed residents, the relevant percentage ratio of financial services relative to other services can be obtained.

- *1970 until 1979*: For these ten years only industrial employment is known. Industrial employment has been estimated earlier and exhibits the largest employment share of all sectors. Total employment, agricultural employment and total service employment are only available for 1970, 1975 and 1980. In a first step, total employment is being estimated, since it serves as the summation constraint in the reconciliation process. In doing so, a survey of the OFFICE OF ECONOMIC AFFAIRS [1980] regarding total and sectoral employment for the years 1974, 1976, 1978 and 1980 is taken into account. Even though this survey is not perfectly comparable to the official figures (this is visible in 1980, when both figures, official and those coming from the survey, exist), it supplies a good indicator for the development of total employment since around 75% of all domestic workplaces are covered in the survey. It is therefore justified to calculate the percentage difference (of total employment) between 1980 and 1978, 1980 and 1976, and 1980 and 1974 and to apply these differences to the official figure in 1980, in order to obtain approximated values for 1978, 1976, and 1974. The remaining years 1979, 1977, 1975, and 1973-1971 are linearly interpolated. Then, in a second step, agricultural employment is estimated. Official and consistent agricultural employment figures are disposable for the years 1970 and 1980-2009. Inspecting the data, two basic remarks can be stated: The share of agricultural employment against total employment is on the one hand small and on the other hand monotonically decreasing (in linear shape): From 4% in 1970 to 1.25% in 1998. It is therefore appropriate to linearly interpolate the years between 1970 and 1980. Having already derived consistent series of total employment, industrial employment and agricultural employment (all for the years 1970-1980), employment in the services sector can be calculated as residual. The remaining task is now to segment employment in the services sector into financial services and other services, assuming a monotonous change of the employment mix between the two sectors. The ratio financial

[48] To be very precise, the outward commuters should have been deducted from the sum of inward commuters and residents. Yet, the number of inward commuters is not available for these years, but this fact should be rather neglectable: The number of outward commuters plays a comparably minor role (1985: 12’800 employed residents, 4’290 inward commuters, 850 outward commuters) and does not seem to have a substantial different sub-sectoral employment mix anyway.

services/other services is 0.3145 in 1980 and 0.2830 in 1970. The ratio in the year 1975 is also known: 0.2934.[49] The ratios for the remaining years 1971-1974 and 1976-1979 are linearly interpolated.

Subsequently, the annual total and sectoral employment figures (which relate to the 31st of December for each year) are modified into yearly averages. These yearly averages are computed by taking the average of the figure regarding the end of the considered year and the figure regarding the end of the previous year.

A.3.3. Employment Agriculture and Sum of Sectors

Liechtenstein's official employment figures concerning the agriculture sector exist on an annual base from the year 1980 on. Since the share of employment in agriculture is also known the numbers of employed people in the agricultural sector for the years 1971-1979 are obtained by linearly interpolating the percentage share agricultural employment/total employment. This proceeding is fairly reasonable as the share of agricultural employment has diminished in a very continuous fashion during the previous decades and can be approximated well by a linear time trend. Additionally, the share in agricultural employment is relatively low and not of primary interest regarding the investigations and estimations in the course of this doctoral project.

In TABLE 40, the already available figures from various official sources and the approximated ones are listed, showing the number of employed people by the end of the respective year. Newly generated figures within the table are written in light-grey *italics*. It should be noted that annual averages (mean of current and previous year) have been calculated before they were applied in the computation process of Liechtenstein's GDP for 1972 until 1997. Figures for the total and the sectoral employment (divided into these four sectors) of more recent years from 1998 on are easily accessible via the official national accounts (Volkswirtschaftliche Gesamtrechnung Liechtenstein, VGR FL) published by the Office of Statistics.

[49] Sectoral and total working places of employment regarding 1975 are according to the census of enterprises (domestic), carried out by the national Office of Economic Affairs. The working places figures of the census of enterprises are not perfectly identical with those of the employment figures in the employment statistics but comparable (especially the share of the different sectors).

Employment (31.12.)	Industry and Manufacturing	Financial Services	Other Services	Agriculture	TOTAL
1970	7'097	835	3'172	465	11'569
1971	*6'986*	*915*	*3'401*	*460*	*11'762*
1972	*6'886*	*994*	*3'620*	*454*	*11'955*
1973	*6'909*	*1'048*	*3'741*	*449*	*12'148*
1974	*7'107*	*1'065*	*3'726*	*442*	*12'340*
1975	*6'834*	*1'142*	*3'919*	*428*	*12'323*
1976	*6'800*	*1'163*	*3'929*	*414*	*12'306*
1977	*7'142*	*1'268*	*4'217*	*425*	*13'052*
1978	*7'394*	*1'396*	*4'574*	*435*	*13'799*
1979	*7'775*	*1'445*	*4'663*	*435*	*14'319*
1980	8'203	1'484	4'718	435	14'840
1981	*8'594*	*1'559*	*4'703*	429	15'286
1982	8'446	*1'594*	*4'906*	377	15'323
1983	8'242	*1'607*	*4'925*	389	15'163
1984	8'451	*1'745*	*5'034*	385	15'615
1985	8'769	*1'897*	*5'197*	377	16'240
1986	9'012	2'214	5'477	375	17'078
1987	9'514	2'542	5'656	396	18'108
1988	9'737	2'554	5'958	351	18'600
1989	10'221	2'699	6'022	354	19'296
1990	10'581	2'807	6'166	351	19'905
1991	10'435	2'847	6'807	355	20'444
1992	10'037	*2'847*	*6'817*	336	20'037
1993	9'982	*3'008*	*7'419*	347	20'756
1994	10'052	*3'119*	*7'590*	348	21'109
1995	10'199	3'303	8'080	350	21'932
1996	10'273	3'442	8'464	344	22'523
1997	10'545	*3'351*	*8'994*	301	23'191

TABLE 40: Official and approximated number of employed people (total/sectoral) in Liechtenstein

Calculating the annual averages in TABLE 40 and linking these values with the data of the national accounts from the years 1998 until 2009, one obtains the graphical representation of Liechtenstein's sectoral (left hand scale of FIGURE 29) and total employment (right hand scale of FIGURE 29).

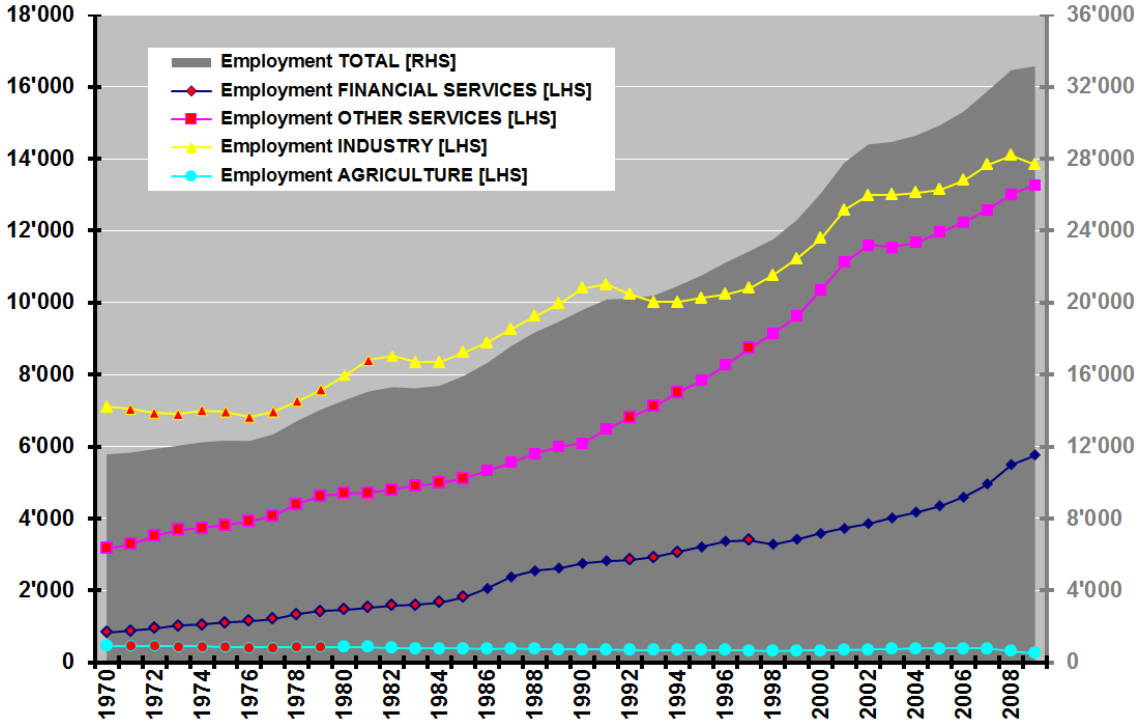

FIGURE 29: Sectoral/total employment in Liechtenstein (annual averages of employed people)

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