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THE SWISS BUSINESS CYCLE AND THE LEAD OF SMALL NEIGHBOR LIECHTENSTEIN

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ABSTRACT

This contribution investigates the business cycles of Switzerland compared to its five neighboring countries Germany, Austria, Italy, France and Liechtenstein. In contrast to the widespread notion of small countries "importing" the business cycle from bigger neighbors, it is shown that the real GDP of the very small neighboring country Liechtenstein is a leading indicator for Switzerland's economy, regarding the growth rates as well as the output gap. This finding is based on cross correlation analyses and univariate and multivariate Granger causality tests, applying annual data from 1972 until 2013. The significant lead of one year is robust across all the various country-samples, time frames and model specifications. This conclusion indicates the possibility that small nations are not only more opposed to foreign shocks, react more sensitively to international economic fluctuations, and are more volatile than big nations – all stylized facts from small state economics literature –, but that their business cycles are also affected earlier.

Keywords: Business Cycles; Leading Indicators; Switzerland; Liechtenstein; VAR; Granger Causality

JEL classification: C22, C32, E32, O52

Der vorliegende Beitrag untersucht den schweizerischen Konjunkturzyklus vergleichend mit den fünf angrenzenden Staaten Deutschland, Österreich, Italien, Frankreich und Liechtenstein. In Kontrast zu der weitverbreiteten Auffassung, dass kleine Staaten ihren Konjunkturzyklus von Grossstaaten „importieren", kann gezeigt werden, dass das reale BIP des Klein(st)staates Liechtenstein einen Vorlaufindikator für die Volkswirtschaft der Schweiz darstellt, sowohl was die Wachstumsraten als auch die Trendabweichung (Produktionslücke) betrifft. Diese Schlussfolgerung, auf Jahresdaten für 1972 bis 2013 gestützt, beruht auf Kreuzkorrelationsanalysen sowie univariaten und multivariaten Granger-Kausalitätstest. Der statistisch signifikante Vorlauf von einem Jahr ist robust für alle verwendeten Länder-Samples, Zeitfenster der vorliegenden Jahresbeobachtungen und Modellspezifikationen. Dieses Ergebnis deutet die Möglichkeit an, dass Mikrostaaten nicht nur ausländischen Schocks stärker ausgesetzt sind, empfindlicher auf internationale Fluktuationen reagieren und volatiler als Grossstaaten sind – alles stilisierte Fakten der Literatur der Kleinstaaten-Ökonomie –, sondern dass deren Konjunkturzyklen auch früher betroffen sind.

Schlüsselwörter: Konjunkturzyklus; Vorlaufindikatoren; Schweiz; Liechtenstein; VAR; Granger-Kausalität

JEL-Klassifikation: C22, C32, E32, O52

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1. INTRODUCTION[1]

Switzerland represents an interesting case, especially when it comes to growth and business cycle issues, not only because its remarkable economic growth history but also due to many of its special characteristics: It is a small open economy with an internationally important and connected financial sector, it has maintained monetary autonomy along with a strong currency, and exhibits a very high degree of international trade. Not only the financial crisis revealed that also Switzerland, which is sometimes considered a "safe haven", is subject to international business cycle fluctuations; this has raised questions on how strongly international negative shocks translate into the Swiss economy. INDERGAND, LEIST AND ZHA [2013] show the strong dependence of Switzerland on the international business cycle development and attribute this dependence to the export channel. The integration of the Swiss economy into the international business cycle has deepened during the last twenty years (GRAFF [2011]), this despite the fact that it is not a member of the Euro area, the European Union or the European Economic Area.

In this context it is worth investigating whether the Swiss business cycle features a different timing, namely if there is a potential time lag or lead in comparison to international fluctuations. Doing so, this contribution includes Switzerland and its five surrounding countries Austria, Germany, Italy, France, and Liechtenstein and explores the timing of their business cycles, measured by both real GDP growth and output gap (annual data 1972-2013), targeting potential statistically significant lags or leads between them. This is carried out by applying cross correlation analyses and Granger causality tests in a univariate and multivariate fashion.

From ex-ante considerations, Switzerland is not expected to have a lag to the business cycle of its very small neighbor state Liechtenstein, as small states are regarded as importers of the business cycles from big neighbor countries. But, if one considers the stylized facts that small states are more volatile and feature a higher responsiveness to international economic fluctuations than bigger nations (see e.g. EASTERLY AND KRAAY [2000], THORHALLSSON [2010, p. 200], and BRUNHART [2013, pp. 16–17 and 23–24]), then it could also be the case that they not only react more sensitively but also earlier. This would imply a business cycle lead of the microstate Liechtenstein to its bigger neighbor Switzerland, with which it shares the strongest economic connections.[2]

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[1] This paper represents a fraction of various objects of investigation within the research project "European Micro-States Facing International Economic Challenges" at Liechtenstein Institute and is a translated, data updated, revised and methodologically extended version of chapter 5 of BRUNHART [2013]. In the paper at hand, it will sometimes be referred to the mentioned document, which is in German, for detailed results and methodical explanations. Please contact the author if a translation or explanation of a certain passage is required.
The author would like to thank Martin Kocher (Ludwig Maximilian University of Munich) and Wilfried Marxer (Liechtenstein Institute) for useful comments.

[2] Switzerland and Liechtenstein share a monetary union (with the Swiss Franc as common currency) along with a mutual economic area, a customs treaty and other strong political relations.

There is a huge body of international literature on the development of synchronicity of business cycles between countries over time and the respective determinants, such as globalization and economic and financial integration (e.g. BERGE [2012], TONDL AND TRAISTARU-SIEDSCHLAG [2006]), or the introduction of the Euro (e.g. GOGAS [2013]). For an extensive summary see GRAFF [2011, pp. 5–8]. Also a lot of contributions on size and volatility of nations exist and even more are devoted to detecting variables or composite indexes that can be utilized as leading indicators for the business cycle within economies. Yet, at least to the knowledge of the author, there is no study specifically investigating the general relation of country size and the business cycle lead or lag to other nations. In this paper, not the change of business cycles' synchronicity over time or its determinants are analyzed but instead the entire focus is on the timing of the cycles' phases, namely if there is a lag or a lead in the synchronous movement.

GRAFF [2005] explores the business cycle synchronicity as well as leads and lags between 26 countries using annual data on the capacity utilization from 1960 to 2003 and concludes that Switzerland exhibits rather lagging tendencies. As outlined in GRAFF [2011], Switzerland features a lagging pattern compared to at least some of the countries when cross correlations of the quarterly output gaps in an unbalanced panel of 40 countries from 1960 to 2011 are inspected. But according to the author, the evidence seems to be rather weak, also when economic interpretation is considered. INDERGAND, LEIST AND ZHA [2013], applying a SUR-VAR model and quarterly data from 1992 to 2013, find that the Swiss economy fluctuates in unison with the international cycle and does not lag the international economy. MÜLLER AND WOITEK [2012, pp. 130–174] examine the Swiss business cycle's international connection on the base of annual GDP data from 1960 to 2000, but do not investigate the possibility of differences in the countries' phases (leads or lags). All the studies on the Swiss business cycle's international relation mentioned in this paragraph did not include Liechtenstein into their data set, which is done in this paper.

Related studies on the other countries examined in this paper are manifold.[3] Especially the business cycle connection between Germany and Austria has attracted scientific attention.[4] PRETTNER AND KUNST [2010] reveal large effects on Austria caused by shocks to the German economy, while the transmission is weak for the other direction. CHEUNG AND WESTERMANN [1999] find that the monthly German industrial production is leading Austria's. FENZ AND SCHNEIDER [2006] on the other hand argue that Germany's economy was leading Austria's in the 1970s by one quarter, but Austria has been leading by one quarter more recently. SCHEIBLECKER [2007] examines the lead and lag of various German and European time series to the Austrian gross value added, BOFINGER ET AL. [2009] explore the international business cycle connection of Germany and the related shock transmissions.

[3] So far, there exists no study on the business cycle timing of Liechtenstein apart from BRUNHART [2013], chapter 5 of which was the starting point to this translated, methodically extended and data updated version.

[4] German indicators are often applied for the prediction of Austria's business cycle. The OECD Composite Leading Indicator of Austria for instance contains the IFO Business Climate Index of Germany as an individual leading indicator.

DUEKER AND WESCHE [1999] explore the synchronization and leading pattern of Germany, UK, USA, Italy, and France. CROWLEY AND MAYES [2008] discover a high commonality of the business cycle phases of France, Germany and Italy, applying wavelet analysis. ALTISSIMO, MARCHETTI AND ONETO [2000] identify a lagging pattern of Italy's business cycle (measured as a composite indicator consisting of almost 200 indicator variables) compared with US, UK, Germany and France, while PELAGATTI AND NEGRI [2010] find a lead of four to six months of Milan's industrial production to Italy's as a whole.

Since small countries are usually seen as business cycle takers and big nations as business cycle givers in terms of causal links (GRAFF [2005, p. 4]), the significant and robust one-year lead of the microstate Liechtenstein to its large neighbor Switzerland is surprising. But, rather than the unrealistic assumption of a transmission channel with a causal impact from Liechtenstein to Switzerland, it seems as if Liechtenstein simply captures international business cycle influences earlier, which is potentially important for understanding and predicting the Swiss business cycle. Some possible reasons for the statistical lead are discussed in the conclusions but their detailed examination is subject to future research. Also the questions whether other microstates might as well serve as leading indicators for their big neighbors remains to be answered in future studies.

After this introduction, section two deals with descriptive statistics (such as correlations and cross correlations) and visual impressions of the used data series leading to preliminary conclusions. Section three covers the explanation of the methodology and the regression results and their interpretation with a special focus on the apparently significant lead of Liechtenstein to Switzerland. The last section consists of conclusions, additional methodological remarks and future research questions arising from this paper.

2. TRACING THE LEAD: DESCRIPTIVE IMPRESSIONS

The data sample that is used in this econometric analysis consists of the annual real GDP of the six countries Switzerland, Liechtenstein, Austria, Germany, Italy and France from 1972 until 2013.[5] For eyeballing and the correlation and cross correlation analysis, real GDP growth rates are applied, while the differenced natural logarithms of real GDP are used in the univariate and multivariate time serial models, as the real GDP growth rates of the included countries are integrated of order one and therefore non-stationary[6]. Additional-

[5] The reason for this is that GDP data on Liechtenstein exists only from 1972 until 2013 so far (with a publication lag of more than one year) and only in annual frequency. Sources of the applied data series are given in TABLE A5 in the appendix. The used time series are downloadable on the webpage http://andreas.brunhart.com/data.

[6] The real GDP series and output gap series of all the six countries have been tested whether they are stationary or not by the augmented unit root test of DICKEY AND FULLER [1979], the unit root test of PHILLIPS AND PERRON [1988], and the stationary test of KWIATKOWSKI ET AL. [1992]. It has been concluded that the real GDP series are all integrated of order one (the tests delivered contradictory results only in the case of Switzerland). In order to circumvent the risk of spurious regression the series have been transformed into annual differences of the natural logarithms. The output gap series are integrated of order zero (stationary).

ly, as an alternative perception of capturing business cycle fluctuations, the output gap is as well investigated in the graphical examinations, the cross correlation analysis and the time serial models. In the tradition of OKUN [1962] the output gap as a measure for the cyclical amplitude, is defined as the real GDP's percentage deviation from the potential output, while the latter represents the normal production level. This "normal" production level depicts the long-term growth trend of an economy and is estimated here by applying the HP-filter of HODRICK AND PRESCOTT [1997] to the real GDP.[7] The output gap series of all the six included countries, the growth rates of the used series and the data sources are given in FIGURE 1, FIGURE A1 and TABLE A5 (the latter two can be found in the appendix).

If the real GDP growth rates of FIGURE A1 in the appendix are compared as a first descriptive impression, then it becomes graphically evident that the six countries share a certain common international business cycle factor. TABLE 1 shows the correlation coefficients between the six nations regarding their real GDP growth rates and output gaps from 1972 to 2013.

TABLE 1: Correlations of Growth Rates and Output Gaps

Correlation Real GDP (1972-2013)	Austria	France	Germany	Italy	Liechtenstein	Switzerland
	Growth Rates / Output Gap					
Austria		0.78*** / 0.79***	0.78*** / 0.82***	0.72*** / 0.72***	0.62*** / 0.58***	0.45*** / 0.44***
France			0.74*** / 0.69***	0.88*** / 0.87***	0.56*** / 0.58***	0.50*** / 0.60***
Germany				0.75*** / 0.65***	0.57*** / 0.49***	0.49*** / 0.47***
Italy					0.59*** / 0.63***	0.43*** / 0.63***
Liechtenstein						0.57*** / 0.63***
Switzerland						

The relevant p-values are indicated by stars (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01).
The growth rates are modelled as absolute annual differences of the real GDP's logarithms, the output gap is the percentage deviation of real GDP from the trend obtained by a HP-filter.

The two-sided significance tests reveal that all considered correlations are clearly different from zero (all with p-values below 0.01), both for real GDP growth as well as the output gap. Also, there is a positive sign for all correlations, which lie in the range from 0.45 to 0.88. Thus, the business cycles are very synchronous, especially between France and Italy or Germany and Austria.

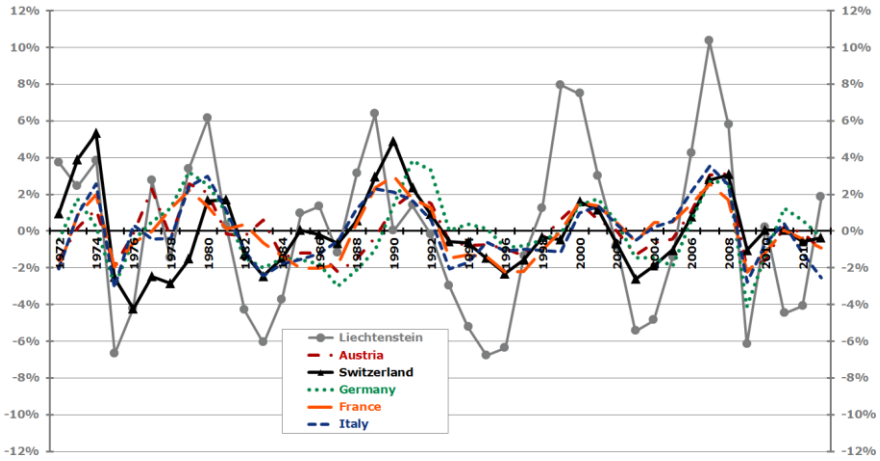
Besides other stylized facts of the growth paths and the business cycle patterns of the investigated countries, such as the trend growth convergence and the continuous synchronization of the cyclical amplitude (both discussed in BRUNHART [2013, pp. 11–20 and 38–40])[8], another very crucial insight can be obtained if the output gap is plotted, as done

[7] The terms "output gap", "trend deviation", "cyclical amplitude", "business cycle component" and "cyclical component" are treated as synonyms.

[8] Another finding in BRUNHART [2013] worth to be mentioned here is the considerably higher average growth of Liechtenstein's economy compared to the other nations during the last four decades (with a growth slowdown towards the end of time sample leading to growth convergence). Additionally, Liechtenstein's volatility is about twice as high as in the other mentioned countries. Also, a "great agitation" could be detected in Liechtenstein (rising volatility that started by the end of the 80s) contrasting the other countries, which experienced a great moderation that lasted until the recent financial crisis.

in FIGURE 1: It seems that Liechtenstein's output gap is leading, especially evident when compared with Switzerland.

FIGURE 1: Business Cycle Amplitude (%-Deviation from HP-Trend of Real GDP)



This graphical impression is complemented by the cross correlations (one year lead) of the inspected nations' real GDP growth rates and output gaps, which are shown in TABLE 2 and TABLE A1. The only lead with a p-value below 0.05 is the one of Liechtenstein's real GDP growth rates to the Swiss economy. The two-sided test delivers a p-value of 0.0474, the cross correlation coefficient is 0.32. A-priori, there is no clear economic reasoning to theoretically support France's business cycle lead to Austria's, the countries are not neighboring and it is not easy to think of a special link between these two countries. The p-value of 0.0512 displays that the null hypothesis of a correlation of zero is rejected in about one out of twenty cases, even though there is no correlation present. Yet, the lead is also persistent in the upcoming regressions (applying the real GDP growth rates as well as the output gap), as it is the case for Liechtenstein's lead to Switzerland, whereas the latter finding will be of primary interest in the following.

TABLE 2: Cross Correlations of Real GDP Growth Rates

Cross Correlation Real GDP (1972-2013)		**Austria**	**France**	**Germany**	**Italy**	**Liechten-stein**	**Switzerland**
		Growth Rate in t					
Austria	**Growth Rate in $t-1$**	0.01	0.22	0.00	-0.00	-0.07	0.00
France		0.31*	0.29*	0.12	0.23	0.06	0.08
Germany		0.21	0.11	0.13	0.10	0.01	0.12
Italy		0.25	0.25	0.08	0.28*	0.09	0.05
Liechtenstein		0.14	0.26	0.17	0.16	0.09	0.32**
Switzerland		-0.15	-0.11	-0.10	-0.24	-0.20	0.26

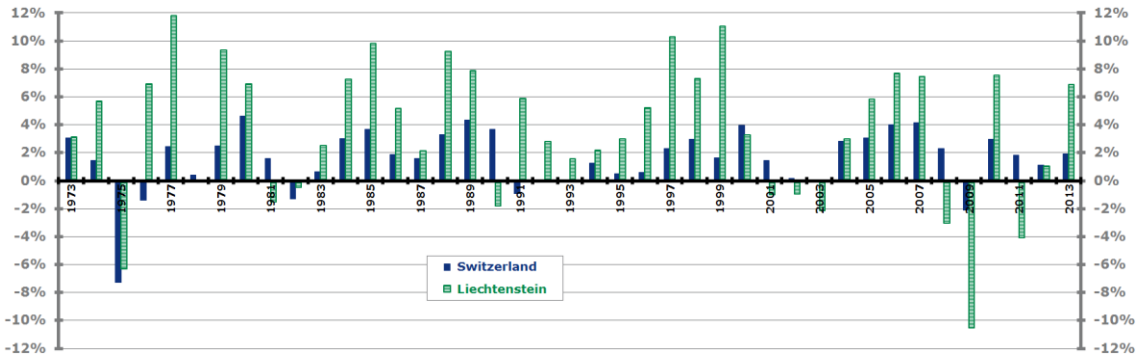
The relevant p-values are indicated by stars (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01).
The growth rates are modelled as absolute annual differences of the real GDP's logarithms.

Also when the output gaps are compared, then Liechtenstein's lead to Switzerland is clearly the strongest of all inspected combinations, the correlation is 0.61 and highly significant

with a p-value, obtained from a two-sided significance test, of far below 0.01 (see TABLE A1 in the appendix).[9]

Since the cross correlation structure indicates a significant lead of Liechtenstein's economy to the Swiss economy of one year, higher attention is now paid to those two countries. FIGURE 2 concentrates on the annual real GDP growth rates of the two neighbors. It is visible that sudden contractions or expansions of economic output tends to start earlier in Liechtenstein. Especially changes in the sign of the growth rates often occurred before they did in Switzerland, examples are the years 1976, 1981, 1990, 2001, and 2008. Also the peaks and troughs of the growth rates are one year are earlier in the years 1979, 1981, 1988, 1990, 1999, 2006, and 2011.

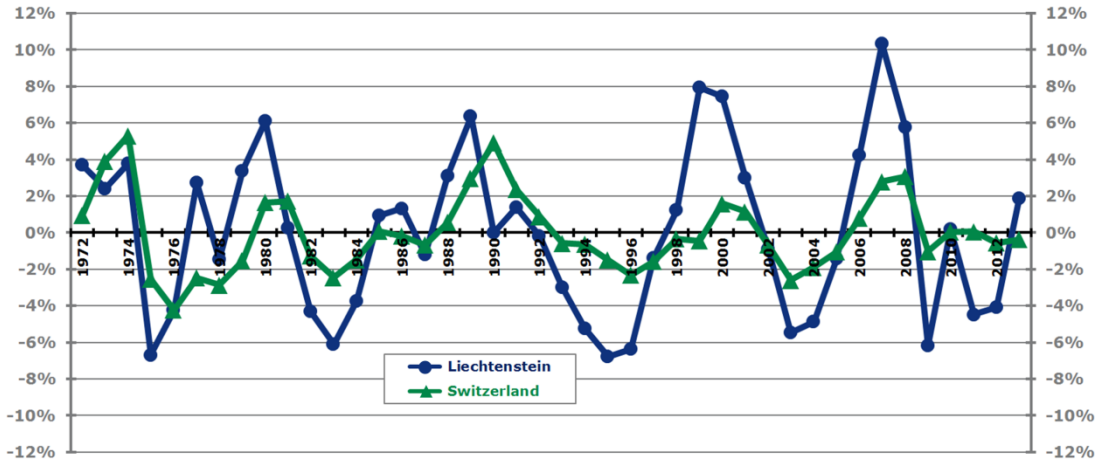
FIGURE 2: Real GDP Growth Rates of Switzerland and Liechtenstein



Additionally to the real GDP growth rates one can also examine the business cycle lead if the business cycle patterns of both countries are explicitly compared with the output gaps of both countries. The output gaps of Switzerland and Liechtenstein are shown in FIGURE 3, which indicates well visible leading characteristics of Liechtenstein's business cycle. Turnarounds in Liechtenstein's business cycle often occur before Switzerland's, for example in 1976, 1981, 1990, 1996, 2000, 2008, and 2011.

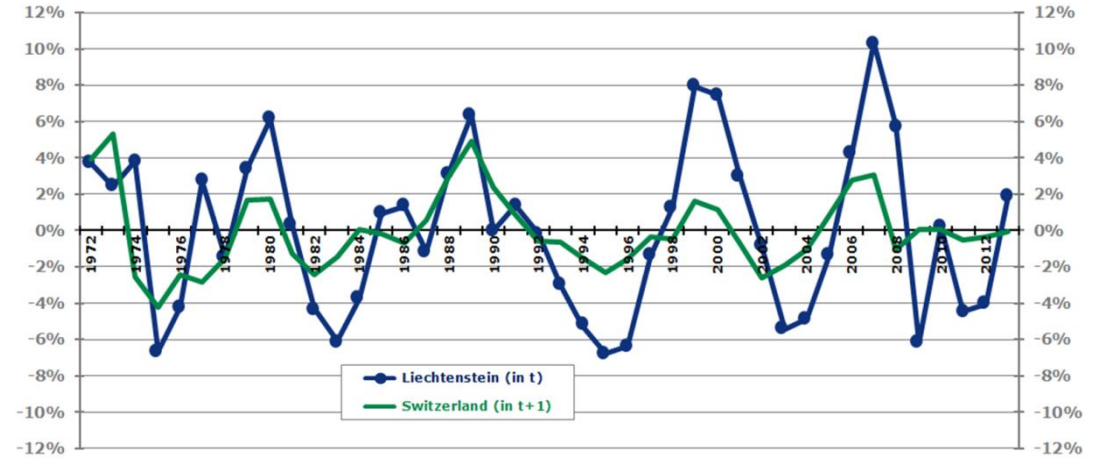
[9] The cross correlation coefficient that corresponds to the lead of Liechtenstein to Switzerland is even higher than the Swiss autocorrelation itself, this applies to both the real GDP growth rates and the output gap (see TABLE 2 and TABLE A1). Also note that the generally higher cross correlations of the output gaps compared to the real GDP growth rates arise from the high degree of autocorrelation in the output gap series.

FIGURE 3: Business Cycles of Switzerland and Liechtenstein, Real GDP's Trend Deviation (Output Gap)



If Liechtenstein's output gap is graphically shifted one year forward then the lead gets even more evident: Both business cycle patterns are now synchronous, at least when it comes to the timing of their peaks and troughs (as visible in FIGURE 4).

FIGURE 4: Business Cycle of Switzerland (in t) and Shifted Business Cycle of Liechtenstein (in t-1), Real GDP's Trend Deviation (Output Gap)



3. CAPTURING THE LEAD: REGRESSION RESULTS

After having spotted a visible lead of Liechtenstein's economy to Switzerland, a first step is to conduct causality tests after GRANGER [1969] in a univariate frame, only including the real GDP of Switzerland (abbreviated by $GDPS_t$) and Liechtenstein ($GDPL_t$):

$$\Delta\log[GDPS_t] = \mu + \delta \cdot t + \alpha_1 \cdot \Delta\log[GDPS_{t-1}] + \cdots + \alpha_p \cdot \Delta\log\left[GDPS_{t-p}\right] + \beta_1 \cdot \Delta\log[GDPL_{t-1}] + \cdots + \beta_p \cdot \Delta\log\left[GDPL_{t-p}\right] + \gamma_1 \cdot d_{1975} + \gamma_2 \cdot d_{2009} + \varepsilon_t$$

Besides the lagged terms of both countries' GDP growth rates (differenced natural logarithms of real GDP), the model additionally allows for a potential inclusion of the intercept μ, a linear trend coefficient δ and two time dummies' coefficients for the years 1975 (γ_1)

and 2009 (γ_2). The economic motivation of the two time dummies 1975 and 2009 is as follows: The oil crisis in the mid 70s and the recent financial crisis can be seen as exogenous shocks, both had their origins outside the countries investigated here. However, to incorporate only the dummy 1975 makes more sense a-priori, as the oil shock was a sequence of sudden crushes caused by immediate decisions of OPEC that affected all the examined countries at roughly the same time while the financial crisis slowly evolved and spread all over the globe. And indeed, it can be observed that in Liechtenstein the financial crisis had a deep impact already one year earlier than in Switzerland while the impact in the first oil-crisis was coincidental. Of primary interest is the coefficient β_1, whose significance indicates Granger causality, as the lead of one year is inspected. This nested form of the Granger causality test with the lag length 1 can be carried out by an ordinary t-test. As the emphasis is on Granger causality testing, no contemporaneous variables (such as $\Delta\log[GDPL_t]$ on $\Delta\log[GDPS_t]$) are included.

Various specifications with respect to the inclusion or exclusion of an intercept and a linear trend have been applied, the results are listed in TABLE 3. All the specifications indicate the existence of a Granger causal lead of Liechtenstein's real GDP growth. Only the setting [2], as explained in footnote 1 of TABLE 3, shows no significant lead, an individual conclusion which is mitigated by the fact that the other model settings exhibit a clearly better model fit (except for [1]), according to the corrected Akaike Information Criterion[10] (AIC_C) and the adjusted R^2. The model with the best fit features a positive Granger causal lead of Liechtenstein's real GDP growth, with a p-value of 0.0058, regarding the relevant coefficient. The inclusion of the lagged variable of Liechtenstein's real GDP growth rate (β_1) improves the AIC_C, increases the adjusted R^2 and lowers the mean prediction error (root mean squared error).[11]

[10] The AIC_C was proposed by HURVICH AND TSAI [1989] and is given by the following formula: $-2l + 2k + 2k\,(k+1)/(T-k-1)$. The number of observations is T, the number of parameters is k and l depicts the log likelihood of the estimated model. A low AIC_C is desired. The first two summands represent the original information criteria by AKAIKE [1974]. Thus, an additional penalty term for additional parameters k is included, which is beneficial in the application dealing with small samples as it is the case here.

[11] Granger tests with higher lag lengths than one were applied as well for the optimal settings [3], [7], and [11] (optimal according to AIC_C). The significance of β_1 is confirmed, yet with insignificant coefficients β_p (for $p > 1$).

TABLE 3: Univariate Granger-Tests of Liechtenstein's real GDP to Swiss Real GDP as Dependent Variable (Both in dlogs, Lag-Length 1, Annual Data 1972-2013)

	Intercept μ	Time Trend δ	Time Dummies	Liechtenstein's Lead $\Delta\log[GDPL_{t-1}]$		AIC_C
				Coefficient	p-Value(2)	
[1]	No	No	No	0.1622	0.0630	-188.0024
[2]	Yes	No	No	0.1100	0.2000(1)	-190.4490
[3]	No	Yes	No	0.1569	0.0499	-193.9515
[4]	Yes	Yes	No	0.1744	0.0567	-191.6731
[5]	No	No	1975	0.2039	0.0039	-207.0681
[6]	Yes	No	1975	0.1434	0.0205	-217.7113
[7]	No	Yes	1975	0.1978	0.0013	-217.9395
[8]	Yes	Yes	1975	0.1695	0.0119	-216.3847
[9]	No	No	1975, 2009	0.1830	0.0107	-206.2017
[10]	Yes	No	1975, 2009	0.1046	0.0833	-220.4959
[11]	No	Yes	1975, 2009	0.1626	0.0058	-221.5097
[12]	Yes	Yes	1975, 2009	0.1342	0.0363	-219.9779

(1) The non-significant coefficient in this setting is an exception and in all probability originates from the fact that the respective model features a weak fit. The other models with linear trend and one or two time dummies are to be preferred here (much better adjusted R^2 and information criteria).
(2) The p-values are obtained applying a t-distribution (and a degree of freedom adjustment of the standard error).
See the appendix for more detailed results.

Of course, wider country samples and more sophisticated model frames, such as univariate Augmented Distributed Lag Models and multivariate Vector Autoregressive Models, should be examined to broaden the methodological base, which is done both for the real GDP growth rates (dlog of real GDP) and the output gaps. Now, also the real gross domestic products of Germany ($GDPG_t$), Austria ($GDPA_t$), Italy ($GDPI_t$), and France ($GDPF_t$) are also included. TABLE 4 lists the best specification of each model type regarding business cycle concepts (growth rates or output gap), samples (two, four or six countries) and model frames (univariate or multivariate).[12] The best specification of each model type, namely picking the optimal combination of deterministic regressors (linear trend and time dummies) in the VAR- and ARDL-models and lagged variables in the ARDL-models, was again influenced by the consideration of the AIC_C and the adjusted R^2. The country combination Switzerland, Liechtenstein, Austria, and Germany turned out to be the optimal one for the purpose of investigation here, which is why TABLE 4 shows this combination as a separate sub-sample. Thus, the main attention is on the four-country case (see TABLE A4 for the regression output). Still, the lead of Liechtenstein is also inspected in VAR-models with all the six countries, the relevant regression results are displayed in TABLE 4 and TABLE A8. Across all the mentioned model types, it appears that Liechtenstein is Granger causally leading Switzerland, all the relevant p-values highlight a high significance with magnitudes between 0.0833 and 0.0012.

[12] Information criteria and lag exclusion tests do not support longer lag lengths than one, both in the ARDL and the VAR models. Yet, estimation results with VAR-models with two or three lags reveal that the one year lead of Liechtenstein to Switzerland is still significant in most of the settings.

TABLE 4: The Lead of Liechtenstein's Real GDP versus Switzerland across Different Models and their Coefficients and Significance

Sample (Countries)	Business Cycle Concept (Real GDP)	Regarded Dependent Variable	Model Type	Sample (Period)	Regarded Lagged Independent Variable: Liechtenstein (in $t-1$)		Detailed Output-Table
					Coefficient	p-Value(2)	
Switzerland, Liechtenstein	Growth Rates (1)	Switzerland	Univariate (ARDL)	1972-2013 (N=40)	0.1427	0.0047	TABLE A6
		Switzerland	Multivariate (VAR)	1972-2013 (N=40)	0.1046	0.0833	TABLE A2, TABLE A7
	Output Gap	Switzerland	Multivariate (VAR)	1972-2013 (N=41)	0.1800	0.0062	TABLE A3
Switzerland, Liechtenstein, Austria, Germany	Growth Rates(1)	Switzerland	Multivariate (VAR)	1972-2013 (N=40)	0.1759	0.0126	TABLE A2, TABLE A4
	Output Gap	Switzerland	Multivariate (VAR)	1972-2013 (N=41)	0.2365	0.0014	TABLE A3
Switzerland, Liechtenstein, Austria, Germany, France, Italy	Growth Rates(1)	Switzerland	Univariate (ARDL)	1972-2013 (N=40)	0.2126	0.0012	TABLE A6
		Switzerland	Multivariate (VAR)	1972-2013 (N=40)	0.1822	0.0094	TABLE A2, TABLE A8
	Output Gap	Switzerland	Multivariate (VAR)	1972-2013 (N=41)	0.2241	0.0035	TABLE A3

(1) The growth rates are modelled as absolute annual differences of the real GDP's logarithms, the output gap is the percentage deviation of real GDP from the trend obtained by a HP-filter.
(2) The p-values are obtained applying a t-distribution (and a degree of freedom adjustment of the standard error).

The same deterministic regressors as already considered in the multiple Granger tests are allowed for in the ARDL and VAR models, depending on their impact on the model fit. Hence, various combinations of the intercept/linear trend and the two time dummies for the years 1975 and 2009 have been explored. The dummies improve the quality of the models considerably. Various specifications of the two time dummies within the specific model groups were applied and are also shown in the appendix, whereas only the optimal specification of each model group is listed in TABLE 4.

It turns out that the main conclusions with regard to the leading property of Liechtenstein in relation to Switzerland are insensitive to the selection and combination of the time dummies, both for the growth rates or the output gap conceptions. This also applies to the choice of intercept with or without linear trend in the growth rate models, while they both were abandoned in the output gap models as the output gap fluctuates around a zero mean by definition. The solid conclusion that Liechtenstein's economy exhibits a highly significant Granger causality and therefore a lead to Switzerland is also robust across all the various country samples and time samples (the latter is shown by the recursive estimates[13] in FIGURE A2). Moreover, if heteroskedasticity robust standard error estimates

[13] FIGURE A2 shows that the coefficient of Liechtenstein's real GDP growth rate ($\Delta\log[GDPL_{t-1}]$), with the Swiss real GDP growth rate ($\Delta\log[GDPS_t]$) as dependent variable in a VAR-model with all the six countries, is very stable regarding the recursive regression (from the sample period 1974–1982 stepwise to 1974–2013). Hence, Liechtenstein's significant lead to Switzerland is independent of the chosen sample period. The entire confidence interval is constantly in the positive spectrum if more than 20 observations are included (models below that number of observations are neglected for the interpretation purpose here due

after WHITE [1980] or NEWEY AND WEST [1987] are applied, then no notable changes occur: The p-value of the lagged variable of Liechtenstein's real GDP growth rates or output gap remains low throughout the various settings. Also the abandonment of the degree of freedom adjustment yields no changes in the results worth mentioning.[14]

The regression results suggest that Switzerland is not systematically lagging the international business cycle. This is in line with GRAFF [2011] and INDERGAND, LEIST AND ZHA [2013]. But, if Liechtenstein is also included into the country sample, it turns out that Liechtenstein's real GDP might serve as a leading indicator, and this even on an annual base. Apart from Liechtenstein's lead to Switzerland only very few significant positive leads appear across all various VAR models and specifications, and only in a sporadic manner across various specifications of the regression equations. The only lead with economic plausible interpretation, a positive sign of the coefficients and some stability across specifications are those of Germany to Austria in the four country sample, but the evidence and stability across equation specifications is rather weak even there (the samples are listed in TABLE 4, for regression results see TABLE A4 and TABLE A8). Also, a robust significant and positive one-year lead of France to Austria appears. However, the economic implication is unclear and the VAR model with six countries and three or four deterministic regressors – but only 40 observations – should be interpreted with care.

The regression models with variables in growth rates might involve the shortcoming that they neglect potential long-term relationships between the variables in levels (for example a similar long-run growth path). If such relationships exist then another way to cope with non-stationary data should be taken, namely the estimation of error correction models to capture both the short-run dynamics between the differences of the data and the long-term equilibria (cointegration) between the variables in levels. To check whether such equilibria exist multivariate cointegration tests of JOHANSEN [1988 and 1992] and univariate versions of ENGLE AND GRANGER [1987] and PHILLIPS AND OULIARIS [1990] have been carried out. Yet, all the generated test results do not indicate cointegrating relationship between Switzerland and Liechtenstein. Due to the small number of observations, vector error correction models and related cointegration tests do not make much sense in the four or six country samples. Thus, no error correction models are introduced (detailed explanations of all models and tests mentioned above and some detailed results are given in BRUNHART [2013, p. 4 and pp. 70–81]).

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to their reduced validity). For this recursive evaluation the time dummy for the year 2009 had to be excluded from the regression, so a model with intercept and the time dummy 1975 was fit. The coefficient of $\Delta\log[GDPL_{t-1}]$ applying the entire time sample is 0.2037 with a p-value of 0.0062. See TABLE A8 for the respective regression output.

[14] Note that the Liechtenstein GDP figures from 1972 to 1997 are backward estimations published in the official Statistical Yearbook of Liechtenstein (see AMT FÜR STATISTIK [2014a, p. 168]). See Appendix A.2. for an evaluation of possible consequences on the results.

4. CONCLUSIONS

The econometric analysis provided in this contribution suggests that the Swiss economy is not lagging the general international cycle tendencies, but it also reveals that the very small economy of Liechtenstein exhibits leading tendencies to the business cycle of its bigger neighbor Switzerland. This main finding is visible in graphical examinations and can be consolidated by cross correlation analyses and the applied time serial models and tests. The statistical conclusions are insensitive to various alternations of the applied frame: They are independent from the applied conception of the business cycle and hold for both the real GDP growth rates and the output gap concept. The finding is also robust throughout all the applied statistical settings and the inclusion of various additional regressors, both in a univariate and multivariate setting. Also, the main conclusion remains firmly in place if additional countries (Austria, Germany, France, Italy) are added to the sample. The main finding can be considered an even more surprising result as only annual data are inspected in this study. Thus, there exists a comparably long lead, as only low frequency business cycle leads can be detected in a yearly frame (see GRAFF [2005, p. 17]).

Unfortunately, more sophisticated models are not advisable because of the annual frequency and the small sample size. Enhanced systems such as structural VAR or Seemingly Unrelated Regression (SUR) with imposed restrictions based on theoretical considerations could be taken into account. However, it is questionable if a priori restrictions are advisable at all in the context of the analysis of the two countries in focus: Structural equation system modelling would probably have led to the decision to restrict the lead of Liechtenstein versus Switzerland to zero by the a priori reasoning that Liechtenstein "imports" its business cycle. This justifies the non-theoretical application beyond the mere fact of the methodological constraints of the small sample size.

This paper's main result appears somewhat counter-intuitive, if one has the conception of small countries usually "importing" the business cycle from abroad (coincident or lagging behavior) in mind. But, on the other hand, also GRAFF [2005, p. 17] detects that some small countries, such as Greece and Denmark, can have leading patterns. This is against theoretical reasoning as well. Also FENZ AND SCHNEIDER [2006] claim that Austria has leading business cycle properties compared with its bigger neighbor Germany, at least in the recent past.

It is not trivial to identify possible reasons for Liechtenstein's lead to the Swiss business cycle at this early stage. While there is no argument for a causal effect of Liechtenstein's economy on Switzerland it rather seems that the principality just reacts earlier to international fluctuations. Potential arguments could be the extremely high level of trade[15], but also the export goods pattern. A high proportion of the domestic production are goods for

[15] Already the goods exports without services are usually more than 70% of GDP (author's approximations based on official export figures and the foreign sales structure as a proxy for exports to Switzerland, which are not included in the official export figures). The exports are almost twice as high as the imports.

the construction sector, investment goods or intermediate goods for the production of investment or durable goods. Or, if one considers the stylized fact broadly discussed in the literature and mentioned in the introduction that small states are more volatile than bigger nations, then it could also be the case that they not only react more sensitively to shocks but also earlier. Also, the high importance of the financial services sector compared to other services in Liechtenstein could be a source of explanation. But, then again, this high importance is also the case for Switzerland.

A deeper time serial analysis of other economic time series of Liechtenstein and the investigation of their lead patterns to their Swiss counterpart might be helpful to detect possible reasons for the Granger causality in real GDP. Unfortunately, the official trade data of Liechtenstein does only regard goods exports and imports (no services) and does not include the trade with Switzerland as both countries share a customs treaty.[16] Also, Liechtenstein is part of the Swiss balance of payment, so no detailed figures separately on Liechtenstein are obtainable in that context. Additionally, a detailed national accounting system for Liechtenstein is only available back until 1998. But still, a further analysis of the existing data base might shed further light on the issue.

It would be interesting to extend the analysis to other very small states in order to check whether similar leading patterns can be detected for those small countries in relation to their big neighbors. Examples in the European context could be Luxembourg to Belgium and the Netherlands, Andorra to Spain and France, or San Marino to Italy.

Unfortunately, Liechtenstein's GDP exhibits an official publication lag of almost two years, so the use as a quantitative indicator for Swiss GDP prediction models is limited. KOFL Liechtenstein Economic Institute provided rough flash estimates of Liechtenstein's GDP during the previous years along with their GDP prediction. Still, a flash estimate of Liechtenstein's GDP may serve as a qualitative signal in Swiss forecasting. In BRUNHART [2012b, pp. 119–172], a quarterly composite business cycle indicator, consisting of twenty individual sub-annual coincident indicators with a low publication lag, has been elaborated for Liechtenstein's economy. Future work could deal with the question if this quarterly index also shows leading properties to Switzerland (similar to SILIVERSTOVS [2011] where the KOF Economic Barometer is used for predicting Swiss quarterly GDP). Of course, it would also be an interesting task to examine whether individual regions, cantons or cities in Switzerland have leading tendencies to the entire national economy, as it is done in PELAGATTI AND NEGRI [2010] for the industrial production of Italy and Milan, whereas the latter is used as leading predictor.

[16] Tentative Granger tests with approximated annual goods export figures (including exports to Switzerland) have not shown a statistical lead. Yet, if quarterly goods exports (official figures not including exports from and to Switzerland) figures from 1995 to 2012 are applied both in a VAR and a vector error correction model frame, a statistically significant lead of Liechtenstein versus Switzerland of three quarters appears.

APPENDIX

A.1. Graphs and Tables

FIGURE A1: Real GDP Growth Rates of all the Investigated Six Countries

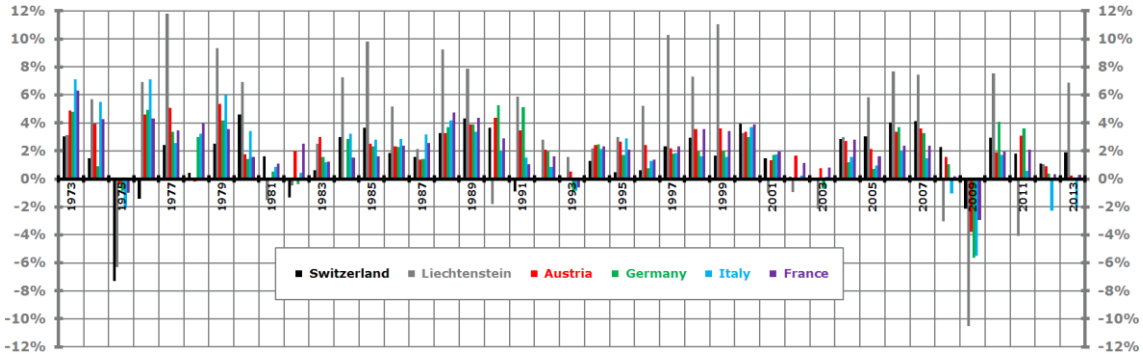

TABLE A1: Cross Correlations Output Gap (Percentage Deviation of Real GDP from HP-Trend)

Cross Correlation Real GDP (1972-2013)		Austria	France	Germany	Italy	Liechtenstein	Switzerland
		Output Gap in t					
Austria	**Output Gap in $t-1$**	0.36**	0.23	0.36**	0.11	0.10	0.15
France		0.54***	0.56***	0.44***	0.39**	0.18	0.37**
Germany		0.38**	0.21	0.49***	0.13	0.05	0.21
Italy		0.43	0.46***	0.30*	0.40***	0.21	0.41***
Liechtenstein		0.38**	0.51***	0.34**	0.43***	0.47***	0.61***
Switzerland		0.10	0.22	0.14	0.13	0.03	0.55***

The relevant p-values are indicated by stars (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01).

TABLE A2: VAR(1)-Models with Various Country Samples and Deterministic Regressors (Emphasis on Switzerland as Dependent Variable, Real GDP in dlogs)

1972-2013	Intercept μ	Time Trend δ	Time Dummies	Liechtenstein's Lead $\Delta\log[GDPL_{t-1}]$		AIC_C
				Coefficient	p-Value[2]	
Switzerland, Liechtenstein	Yes	No	No	0.1100	0.2000[1]	-190.4490
	Yes	Yes	No	0.1744	0.0567	-191.6731
	Yes	No	1975	0.1434	0.0205	-217.7113
	Yes	Yes	1975	0.1695	0.0119	-216.3847
	Yes	No	1975, 2009	0.1046	0.0833	-220.4959
	Yes	Yes	1975, 2009	0.1342	0.0363	-219.9779
Switzerland, Liechtenstein, Austria, Germany	Yes	No	No	0.2068	0.0418	-189.7349
	Yes	Yes	No	0.2454	0.0174	-190.1099
	Yes	No	1975	0.2179	0.0028	-217.5697
	Yes	Yes	1975	0.2268	0.0029	-214.9540
	Yes	No	1975, 2009	0.1759	0.0126	-220.3414
	Yes	Yes	1975, 2009	0.1873	0.0099	-218.0696
Switzerland, Liechtenstein, Austria, Germany, Italy, France	Yes	No	No	0.2388	0.0283	-185.2568
	Yes	Yes	No	0.2507	0.0200	-184.9002
	Yes	No	1975	0.2037	0.0062	-215.9056
	Yes	Yes	1975	0.2147	0.0028	-217.9142
	Yes	No	1975, 2009	0.1713	0.0194	-216.6082
	Yes	Yes	1975, 2009	0.1822	0.0094	-219.0552

[1] The non-significant coefficient in this setting is an exception and in all probability originates from the fact that the respective model features a bad fit. The other models with linear trend and one or two time dummies are to be preferred here (much better adjusted R^2 and information criteria) and show a significant coefficient.
[2] The p-values are obtained applying a t-distribution (and a degree of freedom adjustment of the standard error).

FIGURE A2: Recursive Parameter Estimates (Dependent Variable: dlog of Swiss Real GDP; See Footnote 13)

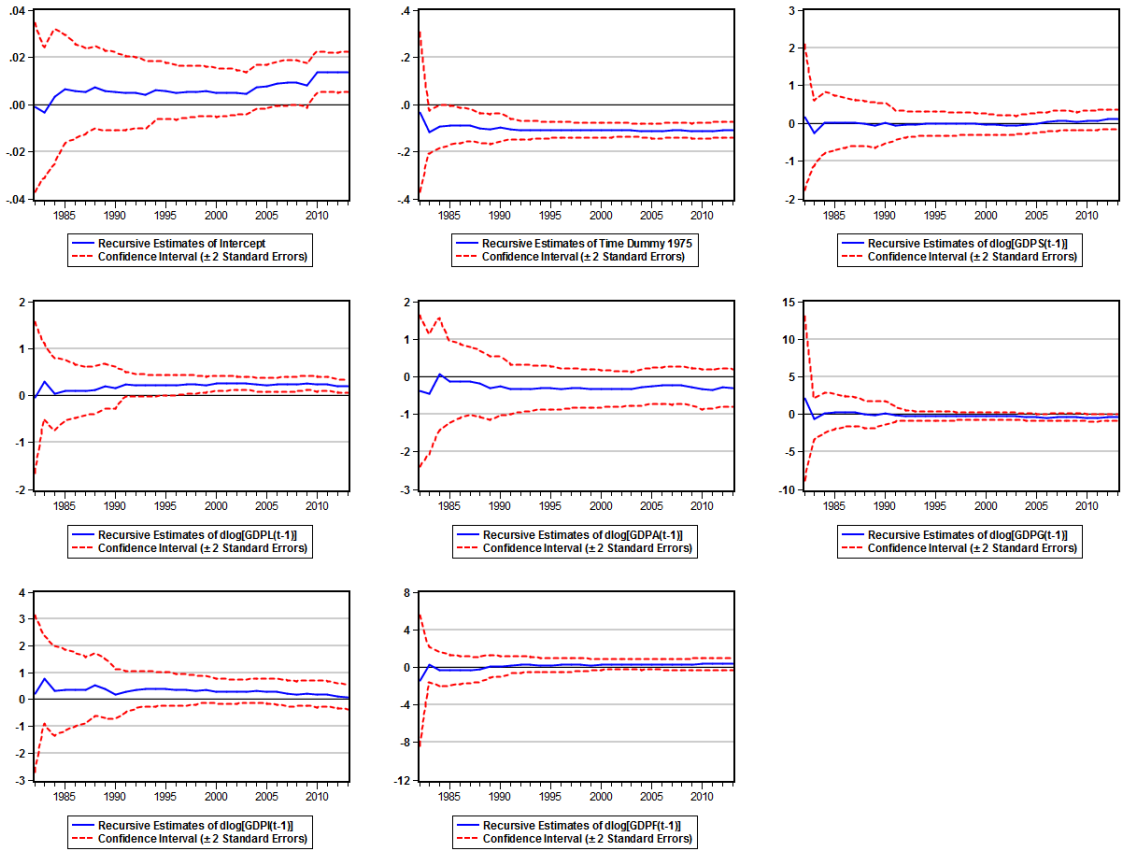

TABLE A3: VAR-Model with Output Gap

VAR (1972-2013)	**Dependent Variable: Switzerland (Output Gap in t)**					
Switzerland (Output Gap, $t-1$)	0.2725*	0.5429***	0.2812*	0.5807***	0.1997	0.5054***
Liechtenstein (Output Gap, $t-1$)	0.2072***	0.1800***	0.2999***	0.2365***	0.2987***	0.2241***
Austria (Output Gap. $t-1$)			-0.7273**	-0.2762	-0.9924**	-0.4768
Germany (Output Gap, $t-1$)			0.2013	-0.1052	0.1986	-0.1236
Italy (Output Gap, $t-1$)					-0.0426	0.1566
France (Output Gap, $t-1$)					0.4278	0.1787
Time Dummy 1975		-6.1015***		-6.1633***		-6.2330***
Time Dummy 2009		-3.7315**		-3.0336**		-2.7598*
Goodness-of-Fit Measures						
R^2	0.4153	0.6333	0.5011	0.6759	0.5254	0.6918
Adjusted R^2	0.4003	0.6035	0.4606	0.6296	0.4576	0.6264
AIC_C	160.6395	146.3300	158.9514	146.6265	162.2591	150.5849
AIC_C (whole VAR)	5.4439	5.0379	8.3996	7.8694	10.6011	10.2434

Deterministic regressors (intercept and trend) are excluded as the output gap fluctuates around a zero mean.
The relevant p-values are indicated by stars (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The p-values are obtained applying a t-distribution (and a degree of freedom adjustment of the standard error).

TABLE A4: Most Adequate VAR(1)-Models with Four Countries (dlog of Real GDP)

OLS (1972-2013, N=40)	Dependent Variable					
	$\Delta\log[GDPS_t]$			$\Delta\log[GDPL_t]$	$\Delta\log[GDPA_t]$	$\Delta\log[GDPG_t]$
Intercept	0.0253***	0.0156***	0.0164***	0.0468***	0.0250***	0.0221***
$\Delta\log[GDPS_{t-1}]$	0.1544	0.1412	0.1995	-0.6229	-0.2154*	-0.1653
$\Delta\log[GDPL_{t-1}]$	0.2068**	0.2179***	0.1759**	0.2169	0.0444	0.0679
$\Delta\log[GDPA_{t-1}]$	-0.6131*	-0.1566	-0.1221	-0.2715	-0.3105	-0.2777
$\Delta\log[GDPG_{t-1}]$	0.1503	-0.2188	-0.2305	0.1003	0.3897**	0.2531
Time Dummy 1975		-0.0973***	-0.0978***	-0.1055**	-0.0194	-0.0237
Time Dummy 2009			-0.0327**	-0.1344***	-0.0568***	-0.0727***
Goodness-of-Fit Measures						
R^2	0.2022	0.6289	0.6784	0.3959	0.4902	0.4630
Adjusted R^2	0.1110	0.5743	0.6199	0.2861	0.3975	0.3654
AIC_C	-189.7359	-217.5697	-220.3414	-130.3840	-221.7730	-206.5930

$GDPS_t$: Real GDP of Switzerland; $GDPL_t$: Real GDP of Liechtenstein; $GDPA_t$: Real GDP of Austria; $GDPG_t$: Real GDP of Germany.
The relevant p-values are indicated by stars (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The p-values are obtained applying a t-distribution (and a degree of freedom adjustment of the standard error). The p-values are obtained applying a t-distribution (and a degree of freedom adjustment of the standard error).
Austria's negative lead to Switzerland is only significant in the setting with lower model fit (according to adjusted R^2 and AIC_C), without time dummies but also without time trend.
The negative lead of Switzerland to Austria is weakly significant but not very plausible and disappears in the setting without time dummies or with the inclusion of a time trend, while the positive and (weakly) significant lead of Germany versus Austria carries some economic plausibility, which has already been explored by the authors mentioned in the introduction.

TABLE A5: Data Sources

Country	Time Series	Sample Years	Data Source
Liechtenstein(1)	Real GDP	1972-2013	National Office of Statistics (AMT FÜR STATISTIK [2014a, 2014b, 2015])
Switzerland(2)	Real GDP	1972-2013	National Accounts Main Aggregate Data Base of the United Nations (https://unstats.un.org/unsd/snaama)
Austria	Real GDP	1972-2013	
Germany(3)	Real GDP	1972-2013	
Italy	Real GDP	1972-2013	
France	Real GDP	1972-2013	

(1) Real GDP of Liechtenstein: Deflation is based on the author's own calculations applying the Swiss GDP deflator, since no official price index exists for Liechtenstein. This approach is reasonable since Liechtenstein shares a monetary union with Switzerland (with the Swiss Franc as common currency) along with a mutual economic area and a customs treaty resulting in a common collection of most of the indirect taxes. Also, Swiss price indexes that are compiled by the Swiss Federal Statistical Office are also published by Liechtenstein's national Office of Statistics indicating the high relevance. This procedure of using Swiss price indexes is also adopted by KOFL Liechtenstein Economic Institute (see SCHLAG [2012. p. 44]) and by OEHRY [2000, p. 345] in his standard book on Liechtenstein's national accounts. The approach of applying the Swiss Consumer Price Index (LIK) yields very similar real GDP figures.
(2) For the Granger test (sample 1998-2014) mentioned in appendix A.2. Swiss real GDP data for the year 2014 has been obtained from SECO (Swiss State Secretariat for Economic Affairs).
(3) The structural break in 1989/1990 due to the unification of East and West Germany was removed in the data source.
All data was retrieved in September 2014. An Excel-file with all the used time series is obtainable at: http://andreas.brunhart.com/data.

TABLE A6: Augmented Distributed Lag Models (dlog of Real GDP)

OLS (1972-2013, N=40)	Dependent Variable $\Delta\log[GDPS_t]$							
Intercept	0.0101**	-0.0032	0.0118***	0.0132***	0.0093**	-0.0034	0.0125***	0.0164***
Linear Time Trend		0.0006*				0.0006*		
$\Delta\log[GDPS_{t-1}]$					0.1223	-0.0162	0.1388	0.1751
$\Delta\log[GDPL_{t-1}]$	0.1413**	0.1698**	0.1632***	0.1427***	0.1100	0.1744*	0.1046*	0.2117**
$\Delta\log[GDPA_{t-1}]$								-0.4963*
Time Dummy 1975			-0.0964***	-0.0967***			-0.0959***	
Time Dummy 2009				-0.0303**			-0.0339**	
Goodness-of-Fit Measures								
R^2	0.0995	0.1883	0.5727	0.6177	0.1097	0.1884	0.6302	0.1949
Adjusted R^2	0.0758	0.1444	0.5496	0.5858	0.0616	0.1208	0.5880	0.1278
AIC_C	-192.3325	-194.1417	-219.8067	-221.7813	-190.4490	-191.6731	-220.4959	-191.9949

Austria's negative lead to Switzerland is only significant in the setting with lower model fit (according to adjusted R^2 and AIC_C), without time dummies but also without time trend.
The relevant p-values are indicated by stars (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The p-values are obtained applying a t-distribution (and a degree of freedom adjustment of the standard error).
The inclusion of Germany, France and Italy was skipped in the ARDL-approach for model-fit reasons but is examined in the VAR-models in TABLE A8.
(1) The non-significant coefficient in this setting is an exception and in all probability originates from the fact that the respective model features a bad fit. The other models with linear trend and one or two time dummies are to be preferred here (much better adjusted R^2 and information criteria) and show a significant coefficient.

OLS (1972-2013, N=40)	Dependent Variable $\Delta\log[GDPS_t]$						
Intercept	0.0168***	0.0170***	0.0164***	0.0173***	0.0042	0.0107	0.0096
Linear Time Trend					0.0005*	0.0002	0.0003
$\Delta\log[GDPS_{t-1}]$	0.1705	0.2480***					
$\Delta\log[GDPL_{t-1}]$	0.1691**	-0.4602*	0.2345***	0.2081***	0.2608***	0.2407***	0.2126***
$\Delta\log[GDPA_{t-1}]$	-0.3114*		-0.3107*	-0.2785	-0.4046	-0.2924	-0.2482
Time Dummy 1975	-0.0922***		-0.0929***	-0.0936***		-0.0890***	-0.0883
Time Dummy 2009	-0.0322**			-0.0281*			-0.0325
Goodness-of-Fit Measures							
R^2	0.6629	0.1743	0.6062	0.6443	0.2452	0.6194	0.6685
Adjusted R^2	0.6134	0.1297	0.5734	0.6037	0.1823	0.5759	0.6197
AIC_C	-221.4183	-193.4611	-220.5973	-222.0519	-194.0367	-219.3397	-222.0833

Austria's negative lead to Switzerland is only significant in the setting with lower model fit (according to adjusted R^2 and AIC_C), without time dummies but also without time trend.
The relevant p-values are indicated by stars (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The p-values are obtained applying a t-distribution (and a degree of freedom adjustment of the standard error).
The inclusion of Germany, France and Italy was skipped in the ARDL-approach for model-fit reasons but is examined in the VAR-models in TABLE A8.
(1) The non-significant coefficient in this setting is an exception and in all probability originates from the fact that the respective model features a bad fit. The other models with linear trend and one or two time dummies are to be preferred here (much better adjusted R^2 and information criteria) and show a significant coefficient.

TABLE A7: VAR(1)-Models with Switzerland and Liechtenstein (Real GDP in dlogs)

OLS (1972-2013, N=40)	Dependent Variable							
	$\Delta\log[GDPL_t]$	$\Delta\log[GDPS_t]$	$\Delta\log[GDPL_t]$	$\Delta\log[GDPS_t]$	$\Delta\log[GDPL_t]$	$\Delta\log[GDPS_t]$	$\Delta\log[GDPL_t]$	$\Delta\log[GDPS_t]$
Intercept	0.0427**	-0.0034	0.0548***	0.0058	0.0548***	0.0058	0.0440***	0.0125***
Linear Time Trend	0.0003	0.0006*	-0.0007	0.0003	-0.0005	0.0003		
$\Delta\log[GDPS_{t-1}]$	-0.7619	-0.0162	-0.7141	0.1970	-0.5224	0.0723	-0.6294*	0.1388
$\Delta\log[GDPL_{t-1}]$	0.2683	0.1744*	0.2618	0.1695**	0.1331	0.1342**	0.1807	0.1046*
Time Dummy 1975			-0.1221**	-0.0918***	-0.1184***	-0.0908***	-0.1102**	-0.0959***
Time Dummy 2009					-0.1319***	-0.0362**	-0.1357***	-0.0339**
Goodness-of-Fit Measures								
R^2	0.1034	0.1884	0.2445	0.5902	0.4034	0.6506	0.3929	0.6302
Adjusted R^2	0.0287	0.1208	0.1581	0.5434	0.3157	0.5992	0.3236	0.5880
AIC_C	-122.9854	-191.6731	-127.2125	-216.3847	-133.8791	-219.9779	-135.9631	-220.4959
AIC_C (whole VAR)	-12.0643		-12.7196		-12.9175		-12.8239	

$GDPS_t$: Real GDP of Switzerland; $GDPL_t$: Real GDP of Liechtenstein.
The relevant p-values are indicated by stars (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The p-values are obtained applying a t-distribution (and a degree of freedom adjustment of the standard error).
AIC_C of the equation with Swiss GDP growth as dependent variable and also the AIC_C of the whole VAR-system prefer the specification of an intercept plus a linear time over just an intercept.

TABLE A8: Most Adequate VAR(1)-Models with Six Countries (Real GDP in dlogs)

OLS (1972-2013, N=40)	Dependent Variable								
	$\Delta\log[GDPS_t]$				$\Delta\log[GDPL_t]$	$\Delta\log[GDPA_t]$	$\Delta\log[GDPG_t]$	$\Delta\log[GDPI_t]$	$\Delta\log[GDPF_t]$
Intercept	0.0143**	0.0138***	0.0149***	0.0012	0.0441***	0.0201***	0.0194***	0.0181***	0.0183***
Linear Time Trend				0.0006**					
$\Delta\log[GDPS_{t-1}]$	0.1204	0.1053	0.1630	0.0006	-0.7081*	-0.3170***	-0.2096	-0.5062***	-0.2923***
$\Delta\log[GDPL_{t-1}]$	0.2388**	0.2037***	0.1713**	0.1822***	0.1804	0.0604	0.0959	0.1086	0.1302**
$\Delta\log[GDPA_{t-1}]$	-0.6582*	-0.2956	-0.2322	-0.2913	-0.5465	-0.5979***	-0.3889	-0.4638	-0.3609**
$\Delta\log[GDPG_{t-1}]$	0.2337	-0.3915	-0.3633*	-0.4154**	-0.3764	0.2055	0.3083	-0.2354	-0.1946
$\Delta\log[GDPI_{t-1}]$	-0.3348	0.0926	0.0795	0.3816	0.4828	-0.1114	-0.2913	0.4382*	0.0270
$\Delta\log[GDPF_{t-1}]$	0.3445	0.3678	0.2721	0.2479	0.5636	0.8407***	0.4268	0.5541	0.7086***
Time Dummy 1975		-0.1077***	-0.1058***	-0.1046***	-0.1342**	-0.0306**	-0.0204	-0.0647***	-0.0466***
Time Dummy 2009			-0.0272*	-0.0273*	-0.1177**	-0.0456***	-0.0709***	-0.0466**	-0.0310**
Goodness-of-Fit Measures									
R^2	0.2269	0.6678	0.6999	0.7419	0.4375	0.6458	0.4883	0.6352	0.6477
Adjusted R^2	0.0863	0.5952	0.6224	0.6645	0.2948	0.5544	0.3562	0.5410	0.5567
AIC_C	-185.2568	-215.9056	-216.6082	-219.0552	-126.9172	-229.8402	-202.0196	-205.9316	-238.1482

$GDPS_t$: Real GDP of Switzerland; $GDPL_t$: Real GDP of Liechtenstein; $GDPA_t$: Real GDP of Austria; $GDPG_t$: Real GDP of Germany; $GDPI_t$: Real GDP of Italy; $GDPF_t$: Real GDP of France.
The relevant p-values are indicated by stars (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The p-values are obtained applying a t-distribution (and a degree of freedom adjustment of the standard error). The p-values are obtained applying a t-distribution (and a degree of freedom adjustment of the standard error).

A.2. Additional Remarks

Liechtenstein GDP figures from 1972 to 1997 are backward estimations published in the official Statistical Yearbook of Liechtenstein (see AMT FÜR STATISTIK [2014a, p. 168]). See Appendix A.2. for an evaluation of possible consequences on the results. The methodology of the backward estimation procedure and its evaluation are outlined in BRUNHART [2012a]. The main arguments for the adequacy of the backwardly estimated figures shall be summarized in the following: The applied backward estimation method is based on the structure of the official national account of Liechtenstein (generation of income account side). The cyclical pattern (timing and magnitude) and the turning points are well confirmed by the historical national income series and other time series of Liechtenstein. The comparison of the backward estimation method and the official figures for the years from 1998 until 2008 has revealed a convincingly good fit. The methodology was also inspected by the national account unit of the national Office of Statistics and then integrated as time series into their Statistical Yearbook. Moreover and in relation to the lead of Liechtenstein to Switzerland, if Figure 2 and Figure 3 are inspected it becomes evident that in the phase from 1998 on (after the official national accounts were introduced) three turning points were anticipated one year before Switzerland. A simple Granger test with the sample from 1998 till 2014, containing only official GDP data, also indicates a causal lead of Liechtenstein to Switzerland: The relevant coefficient has a positive sign and a p-value of 0.0582 for real GDP growth rates or 0.0621 for real GDP output gap (0.0383 and 0.0413 without degree of freedom adjustment). Hence, the lead is not just an artefact of the backward estimation method.

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