April 17th 2019, ETH Zürich

Composite Index *KonSens*: Coincident, Sub-Annual Business Cycle Sensor for Liechtenstein's Economy

Andreas Brunhart

KOF RESEARCH SEMINAR
Schedule for Today's Presentation

[1] Introduction:
- Distinction growth/business cycle
- Short description of KonSens project
- Prologue: Closer look at Liechtenstein's economy

[2] Motivation for KonSens:
- Status quo in Liechtenstein: Data situation/business cycle analysis
- Explicit and implicit benefits of KonSens

[3] Compilation method of KonSens: Included indicators and applied time serial methods


[5] Conclusions: Summary and outlook
Distinction between Growth and Business Cycle

**GROWTH**
Output ("natural" level):
Long run growth path, potential output

**BUSINESS CYCLE**
Output gap (capacity utilization):
Deviation from trend (in %)

- "Boom"
- "Recession"
KonSens: Short Description

- **Quarterly, coincident composite indicator** for Liechtenstein's business cycle consisting of 16 individual economic indicators

- Goal of KonSens: **Focus on state** of Liechtenstein's business cycle, **not on determinants/influences**

- Name „KonSens“:
  - Conception of „**Business Cycle as a Consensus**“ (Burns and Mitchell [1946]) of various individual business cycle impulses
  - „KonSens“ is also an abbreviation for „**Konjunktur-Sensor**“: Sensorium of Liechtenstein's business cycle situation

- First publication (in August 2019): KonSens for 2nd Quarter 2019 (most likely: www.liechtenstein-institut.li/konsens)

- Other composite indicators: **KOF Barometer** (leading ind., Abberger et al. [2018]), **SNB Business Cycle Index** (early ind., Galli [2018]), **CFNAI** (coincident ind.), [Konjunkturbarometer Ostschweiz, ifo-Geschäftsklimaindex], [Bodenseeklimaindex/CS-Barometer]
Some key facts on Liechtenstein:

- Population/employment:
  - **38'380 inhabitants** (2018, around 34% foreign population)
  - **39'660 employed people** (2018), inward commuter share of more than 55%. Unemployment rate 1.7% (324 people, 2018 average).

- Economic/sectoral structure:
  - By end of 2016, 17 largest companies employed 12'695 people (about 33% of total work force). But about 88% of the 4'567 companies have fewer than 10 employees (1 company per 8 inhabitants).

<table>
<thead>
<tr>
<th>Employed persons (2016)</th>
<th>Agriculture</th>
<th>Industry and manufacturing</th>
<th>General services</th>
<th>Financial services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liechtenstein</td>
<td>0.7%</td>
<td>37.9%</td>
<td>45.0%</td>
<td>16.4%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>3.2%</td>
<td>21.1%</td>
<td>69.4%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Austria</td>
<td>4.4%</td>
<td>25.6%</td>
<td>70.1%</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>1.4%</td>
<td>24.2%</td>
<td>74.4%</td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.9%</td>
<td>18.9%</td>
<td>62.9%</td>
<td>17.2%</td>
</tr>
</tbody>
</table>

Data source: OSL (Employment Statistics), FSO (Job Statistics, Employment Statistics), STATEC.

Source: BRUNHART AND FROMMELT [2018]
Prologue: Closer Look on Liechtenstein's Economy

- Introduction
- KonSens' Motivation
- Compilation Method
- KonSens Values
- Conclusions
Prologue: Closer Look on Liechtenstein's Economy

- Some key facts on Liechtenstein:
  - Gross value added (2016): Industry/manufacturing 43%, general services 27%, financial services 23%, (agriculture/households 7%)
  - International comparison:

<table>
<thead>
<tr>
<th>2016</th>
<th>Liechtenstein</th>
<th>Switzerland</th>
<th>Austria</th>
<th>Germany</th>
<th>Luxembourg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross domestic product (CHF billion)</td>
<td>6.1</td>
<td>659</td>
<td>385</td>
<td>3,427</td>
<td>58</td>
</tr>
<tr>
<td>Population (31 Dec)</td>
<td>37,810</td>
<td>8,419,550</td>
<td>8,722,865</td>
<td>82,521,653</td>
<td>590,667</td>
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<td>Employees (annual average)</td>
<td>37,104</td>
<td>4,899,550</td>
<td>4,220,300</td>
<td>43,638,000</td>
<td>418,400</td>
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<tr>
<td>Full-time equivalents (annual average)</td>
<td>31,861</td>
<td>3,829,823</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP/capita (population)</td>
<td>162,364</td>
<td>78,268</td>
<td>44,148</td>
<td>41,529</td>
<td>97,814</td>
</tr>
<tr>
<td>Productivity (GDP/employees)</td>
<td>165,454</td>
<td>134,498</td>
<td>91,248</td>
<td>78,534</td>
<td>138,086</td>
</tr>
<tr>
<td>Productivity (GDP/FTE)</td>
<td>192,681</td>
<td>172,065</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GDP is a measure of the income of persons resident in Liechtenstein and abroad, generated by work or assets in Liechtenstein (domestic principle), i.e. for domestic production whose value added is generated and accrued by persons resident in Liechtenstein and/or abroad.


Source: Brunhart and Frommelt [2018]
Prologue: Closer Look on Liechtenstein's Economy

Real GDP and Potential Output (Indexed, in Home Currency)
Prologue: Closer Look on Liechtenstein's Economy
Prologue: Closer Look on Liechtenstein's Economy

Output Gap (%-Deviation from Potential Output, Real GDP)

- Switzerland
- Liechtenstein

Prologue: Closer Look on Liechtenstein's Economy

- Some of the **stylized business cycle facts** on Liechtenstein:
  
  - **Amplitude:**
    - **Volatility very high** (growth rates, output gap) in international comparison
    - High volatility **not very surprising** for such a small country (see Easterly and Kraay [2000] or other literature on small state economics)
  
  - **Timing:**
    - Rather **leading** than lagging business cycle properties
    - Liechtenstein's **lead might be contra-intuitive** and in contrast to traditional notion of small countries as "business cycle importers". But, if small states are more sensitively affected by international business cycle shocks, why not earlier?

- Both stylized facts mentioned above make timely **business cycle analysis** (KonSens etc.) in Liechtenstein **even more important**
KonSens: Status Quo

- Liechtenstein's current economic data situation:
  - GDP only **annually available, long publication lag** (15 months)
  - **Scarce data base** (especially sub-annual): No separate balance of payments, no price indexes etc. But: Some **useful indicators** available!

- **Leading properites** of Liechtenstein's business cycle, particularly to **Switzerland** (BRUNHART [2017]): Focus on and extension of **domestic data base important**, rather than only observing foreign indicators/data!

- **Initial funding** of KonSens by Liechtenstein's government. Future development of business cycle and growth monitoring tools dependent on future funding of Liechtenstein Institute in general *(parliament decision, autumn 2019)*
KonSens: Explicit Benefits

- Timely gathering of various – sometimes contradicting – business cycle signals to a consistent picture (publication lag: around 6 weeks)

- Easy interpretation for politics, public administration, media, companies and general public

- Fills the some of the gap after KOFL closure

- Reduces reliance on Swiss data/indicators (which is not always efficient for reasons already discussed)

- Combines different data origins and dimensions

- Improves data base for economic analyses: Publication of KonSens and applied/modified time series to public, synergies to other planned tools planned at Liechtenstein Institute
KonSens: Implicit Benefits

- Good **effort/benefit** ratio of KonSens project!
- Useful variable for **nowcasting annual and/or estimating quarterly figures** for Liechtenstein's GDP
- Better **reporting, monitoring** and **surveillance** (e.g. Finanzmarktaufsicht Liechtenstein, Standard & Poor's)
- Could influence other small states, regions or even cities (with scarce data base) to introduce similar tools ➔ under such circumstances, **already coincident signal** can be big progress (before even thinking about prediction...!)
- KonSens could be useful **predicting Swiss business cycle**
KonSens: Indirect Benefits (Predicting CH Cycle)
## KonSens: Indirect Benefits (Predicting CH Cycle)

<table>
<thead>
<tr>
<th>VAR 1995Q1–2018Q4 (N=91)</th>
<th>Dependent Variable</th>
<th>[1a]</th>
<th>[1b]</th>
<th>[2a]</th>
<th>[2b]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Δlog[EXPS&lt;sub&gt;t&lt;/sub&gt;]</td>
<td>Δlog[EXPL&lt;sub&gt;t&lt;/sub&gt;]</td>
<td>Δlog[EXPS&lt;sub&gt;t&lt;/sub&gt;]</td>
<td>Δlog[EXPL&lt;sub&gt;t&lt;/sub&gt;]</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.0185***</td>
<td>0.0015</td>
<td>0.0220***</td>
<td>0.0090*</td>
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<tr>
<td>Δlog[EXPS&lt;sub&gt;t-1&lt;/sub&gt;]</td>
<td>-0.0497</td>
<td>1.1059***</td>
<td>-0.1776</td>
<td>0.3933**</td>
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<tr>
<td>Δlog[EXPS&lt;sub&gt;t-2&lt;/sub&gt;]</td>
<td>-0.4198***</td>
<td>0.1430</td>
<td>-0.3161***</td>
<td>0.2121</td>
<td></td>
</tr>
<tr>
<td>Δlog[EXPS&lt;sub&gt;t-3&lt;/sub&gt;]</td>
<td>-0.2625*</td>
<td>-0.1490</td>
<td>-0.2082*</td>
<td>-0.0119</td>
<td></td>
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<tr>
<td>Δlog[EXPS&lt;sub&gt;t-4&lt;/sub&gt;]</td>
<td>-0.3673**</td>
<td>-0.2136</td>
<td>-0.3034***</td>
<td>-0.1687</td>
<td></td>
</tr>
<tr>
<td>Δlog[EXPL&lt;sub&gt;t-1&lt;/sub&gt;]</td>
<td>0.1255*</td>
<td>-0.3422***</td>
<td>0.1326***</td>
<td>-0.2512***</td>
<td></td>
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<tr>
<td>Δlog[EXPL&lt;sub&gt;t-2&lt;/sub&gt;]</td>
<td>0.1777**</td>
<td>-0.0708</td>
<td>0.1425***</td>
<td>-0.0711</td>
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<tr>
<td>Δlog[EXPL&lt;sub&gt;t-3&lt;/sub&gt;]</td>
<td>0.2091***</td>
<td>-0.1289</td>
<td>0.1679***</td>
<td>0.0500</td>
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<tr>
<td>Δlog[EXPL&lt;sub&gt;t-4&lt;/sub&gt;]</td>
<td>0.1230*</td>
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<td>0.0977**</td>
<td>0.0009</td>
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<tr>
<td>Time Dummy 08Q4</td>
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<td>-0.1173***</td>
<td></td>
<td>-0.0526</td>
<td></td>
</tr>
<tr>
<td>Time Dummy 09Q1</td>
<td></td>
<td>-0.0999***</td>
<td></td>
<td>-0.3023***</td>
<td></td>
</tr>
</tbody>
</table>

### Goodness-of-Fit Measures

<table>
<thead>
<tr>
<th></th>
<th>[1a]</th>
<th>[1b]</th>
<th>[2a]</th>
<th>[2b]</th>
</tr>
</thead>
<tbody>
<tr>
<td>R²</td>
<td>0.1858</td>
<td>0.2902</td>
<td>0.4824</td>
<td>0.5690</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.1064</td>
<td>0.2210</td>
<td>0.4177</td>
<td>0.5151</td>
</tr>
<tr>
<td>AIC</td>
<td>-4.4064</td>
<td>-3.2587</td>
<td>-4.8155</td>
<td>-3.7135</td>
</tr>
</tbody>
</table>

*EXPS<sub>t</sub>: Goods Exports Switzerland (real quarterly figures, seasonally adjusted); EXPL<sub>t</sub>: Goods Exports Liechtenstein (real quarterly figures, seasonally adjusted).

The relevant p-values are indicated by asterisks (*: 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).
KonSens: Indirect Benefits (Predicting CH Cycle)

<table>
<thead>
<tr>
<th>Variables (Granger-Tests)</th>
<th>VAR-Length</th>
<th>Sample</th>
<th>Frequency</th>
<th>Leads (P-Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>dlog[GDPL] → dlog[GDPS]</td>
<td>12</td>
<td>1995–2018</td>
<td>Monthly</td>
<td>5 (p=0.08), 8 (p=0.03), 10 (p=0.05)</td>
</tr>
<tr>
<td>dlog[GVA] → dlog[GVAI]</td>
<td>4</td>
<td>1995–2018</td>
<td>Quarterly</td>
<td>1 (p=0.07), 2 (p=0.02), 3 (p=0.01), 4 (p=0.07)</td>
</tr>
<tr>
<td>dlog[EXPL] → dlog[EXPS]</td>
<td>4</td>
<td>1995–2018</td>
<td>Quarterly</td>
<td>3 (p=0.01)</td>
</tr>
<tr>
<td>d[KONSENS] → dlog[EXPS]</td>
<td>4</td>
<td>1998–2018</td>
<td>Quarterly</td>
<td>1 (p=0.05)</td>
</tr>
<tr>
<td>d[KONSENS] → dlog[GDPS]</td>
<td>4</td>
<td>1998–2018</td>
<td>Quarterly</td>
<td>1 (p=0.11)</td>
</tr>
</tbody>
</table>

All data are real figures and seasonally adjusted, except for monthly export figures (nominal, seasonally adjusted). Lead also appears for nominal and seasonally unadjusted data.
KonSens: 16 Included Indicators

- **Goods trade:**
  - Direct goods exports, direct goods imports (CH not included, EZV)

- **Employment data:**
  - Employed people, inward commuters (full time equivalents, AS)
  - Unemployed persons (AMS/AS)
  - Job openings (AMS)

- **Business survey** (43 companies in metal/non-metal/construction, ca. 70% of employment in industry/manufacturing sector):
  - Overall situation, capacity utilization, new orders, earnings (indexed, AS)

- **Other Indicators:**
  - Stock prices LLB/VPB (SIX)
  - Electric power consumption (kWh, LKW)
  - Newly registered cars (AS)
  - Overnight stays (AS)
  - Consumer sentiment CH/A (SECO/Eur. Com.), consumer prices (LIK, BfS)
KonSens: Applied Time Serial Procedures

- **Software applied ("4-eyes-principle"):** EViews, Excel, JDemetra+, R
Time Serial Procedures: Seasonal Adjustment

- Census X-13:

  Input: Raw Data Series

  regARIMA Modelling
  (Calendar Effects, Outliers, Struktural Breaks, Forecasts)

  Seasonal Adjustment
  (X-11 oder SEATS)

  Diagnostics
  (Tests, Sliding Spans, Revision History)

  Output: Time Series Adjusted for Seasonal/Calendar Effects
Time Serial Procedures: Aggregation

- Principal Components Analysis (PCA):
  - **Aim:** *Reduction of data dimension* by aggregation to a value that serves as proxy for business cycle tendency
  - **Methodical/formal aspects:**
    - PCA gathers KonSens' 16 individual indicators $X_j$ via 16 *uncorrelated linear combinations* (principal components $H_i$) with weights $a_{i,j}$:
      
      \[
      H_1 = a_{1,1} \cdot X_1 + a_{1,2} \cdot X_2 + \cdots + a_{1,16} \cdot X_{16}
      \]
      
      \[
      H_2 = a_{2,1} \cdot X_1 + a_{2,2} \cdot X_2 + \cdots + a_{2,16} \cdot X_{16}
      \]
      
      \[
      \vdots \quad \vdots
      \]
      
      \[
      H_{16} = a_{16,1} \cdot X_1 + a_{16,2} \cdot X_2 + \cdots + a_{16,16} \cdot X_{16}
      \]
    - **First PC** (principal component) $H_1$ captures *largest proportion of variation in data*, second PC accounts for largest proportion of remaining variance, ...
    - Squared weights $a_{i,j}$ build the *eigenvectors matrix* (loadings) and sum up to 1, for all 16 rows and columns
Principal Components Analysis (PCA):

- **Aim:** Reduction of the data dimension by aggregation to a value that serves as proxy for the business cycle tendency

- **Methodical/formal aspects:**
  - Now, the **eigenvectors (weights) and the eigenvalues** of each PC have to be derived. Eigenvalues $\lambda_i$ can be computed from the covariance matrix $CM$ by solving $|CM - \lambda I| = 0$.

\[
CM = \begin{bmatrix}
\text{cov}(X_1, X_1) & \text{cov}(X_1, X_2) & \cdots & \text{cov}(X_1, X_{16}) \\
\text{cov}(X_2, X_1) & \text{cov}(X_2, X_2) & \cdots & \text{cov}(X_2, X_{16}) \\
\vdots & \vdots & \ddots & \vdots \\
\text{cov}(X_{16}, X_1) & \text{cov}(X_{16}, X_2) & \cdots & \text{cov}(X_{16}, X_{16})
\end{bmatrix}
\]

$I$: Unit matrix with same dimension as $CM$ (KonSens: $16 \times 16$)

$\lambda$: Vector with all the eigenvalues of each PC (KonSens: $1 \times 16$)

- Eigenvalue of PC is the PC's variance. Sum of all 16 eigenvalues is equal to sum of diagonal covariances and equal to number of data series.
Time Serial Procedures: Aggregation

- Principal Components Analysis (PCA):
  - Interpretation:
    - Conception: The first PC (principal component) captures the most important common direction of the data (→ business cycle fluctuations)
      → Weighted sum in first PC ($H_1$): Business cycle signal (KonSens)
    - Magnitude of value somewhat arbitrary, only limited direct quantitative interpretation. But: Relative comparison over time possible!
    - Standardizing scores (mean 0, stand. dev. 1): Negative/positive value interpreted as business activity below/above average over time.
    - Eigenvalue of first PC allows judgement about to which extent the total data variation can be attributed to business cycle influence.

- PCA related to factor models, common/latent factors (and their factor loadings) comparable to principal components (eigenvector matrix). PCA/factor models yield similar results (see Stock and Watson [2002]), but originate from whole different statistical approaches.
KonSens: Latest Plot

KonSens: Coincident Composite Index for Liechtenstein's Business Cycle
KonSens: Different Trend Removal Methods

KonSens (with growth rates, q-o-q)
KonSens (trend removal with HP-Filter, output gap in %)
KonSens: Comparison with GDP

KonSens: Comparison with Composite Indicators

Introduction

KonSens' Motivation

Compilation Method

KonSens Values

Conclusions
KonSens: Comparison with Composite Indicators

KonSens KOF Barometer
KonSens: Summary and Outlook

- KonSens: *Quarterly, coincident composite indicator* for Liechtenstein's business cycle
- First publication in **August 2019** (KonSens of 2\textsuperscript{nd} Quarter 2019)
- Possible future *methodical improvements*: For example removal of indicator(s)? Settings seasonal adjustment? Dynamic factor model? Concentration on leading indicators?
- Planned extensions/modifications:
  - Inclusion of *new individual indicators*, when available?
  - KonSens as reference series for *qualitative prediction* of Liechtenstein's business cycle tendency (indirect way: e.g. ARDL-forecast with KonSens as dependent variable)
  - **Monthly** version of KonSens?
References


BRUNHART, A. AND C. FROMMELT [2019]: "Wirtschafts- und Finanzdaten zu Liechtenstein". Im Auftrag der Regierung des Fürstentums Liechtenstein.


Thanks for your attention!

Questions/Comments?

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Prologue: Closer Look on Liechtenstein's Economy

- Some key facts on Liechtenstein:

[Graph showing Bruttonationaleinkommen pro Kopf, CHF (2016) and Bruttonationaleinkommen pro Kopf, CHF, kaufkraftbereinigt (2016) for various countries including Liechtenstein.]
Prologue: Closer Look on Liechtenstein's Economy

Real GDP Growth Rates

- Switzerland
- Liechtenstein

1973-2017
### Principal Components Analysis

Date: 04/14/19  Time: 19:24  
Sample (adjusted): 1998Q2-2018Q4  
Included observations: 83 after adjustments  
Balanced sample (listwise missing value deletion)  
Computed using: Ordinary correlations  
Extracting 16 of 16 possible components

#### Eigenvalues: (Sum = 16, Average = 1)

<table>
<thead>
<tr>
<th>Number</th>
<th>Value</th>
<th>Difference</th>
<th>Proportion</th>
<th>Cumulative Value</th>
<th>Cumulative Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.833300</td>
<td>2.815393</td>
<td>0.3021</td>
<td>4.833300</td>
<td>0.3021</td>
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<td>2</td>
<td>2.017906</td>
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<td>6.851206</td>
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<td>3</td>
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<td>0.244861</td>
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<td>8.367209</td>
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<td>4</td>
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<td>0.158707</td>
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#### Eigenvectors (loadings):

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