BANKA SLOVENIJE
EVROSISTEM

Estimating business and financial cycles in Slovenia

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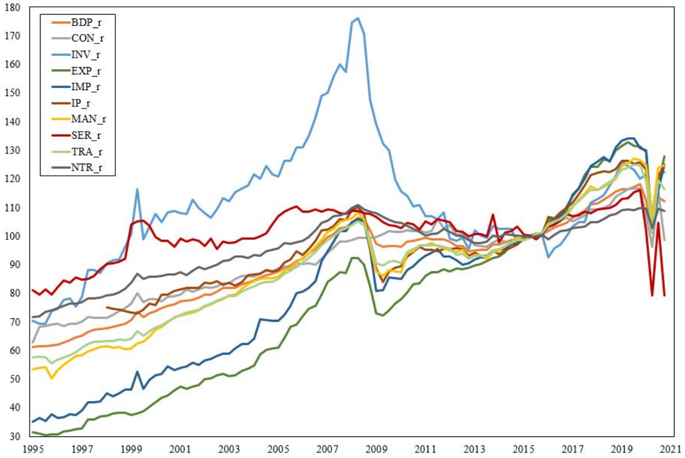
Modelling Objectives I

- The GFC from 2008 has led us to revisit the roles of economic policies.
- Strict pursue of price stability does not ensure the overall macroeconomic stability, as the rapid rise of credit and asset prices can lead to inefficient compositions of output, while the financial market imperfections intensify.
- Consequently due to asymmetric effects, differences between the characteristics of business and financial cycles can occur.

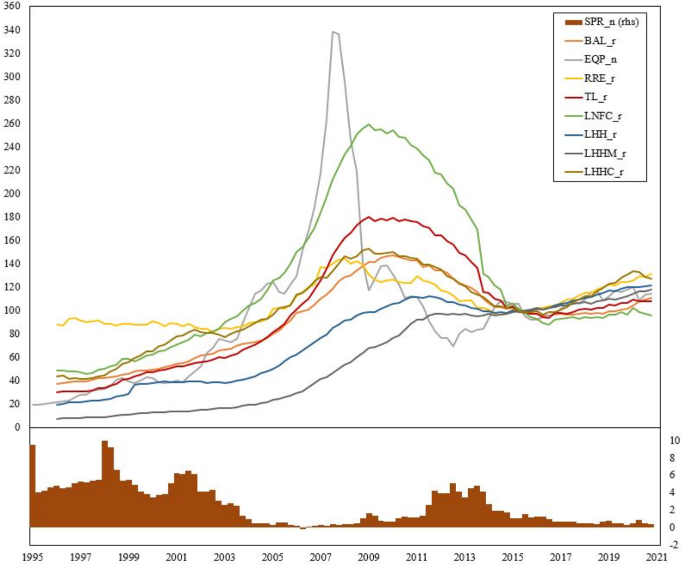
Modelling Objectives II

- Against this backdrop we try to estimate the trend, cyclical and irregular components of the several time series as we utilize a multivariate multivariate structural time series model (STSM).
- We use a set of macroeconomic and financial variables for Slovenia.
- From the policy implications perspective it is important to understand the obtained results as we may in the case of cycle divergence think of optimal and possibly separate policies that have to be in play, in order to achieve the optimal price and/or financial stability.

Modelling Objectives III



Modelling Objectives IV



Literature review

- The model is based on a extended version of the multivariate STSM model introduced by Rünstler and Vlekke (2018) and/or Rünstler et al. (2018).
- Their methodology broadly follows the seminal work of Harvey and Koopman (1997) done on multivariate structural time series model (STSM).
- The multivariate structural time series models are extensively used. We will only name a few: Chen, Kontonikas and Montagnoli (2012), De Bonis and Silvestrini (2013), Galati et al. (2015), de Winter et al. (2017), Melolinna and Tóth (2018) and Bulligan et al. (2019).

The STSM model

- The key feature of the STSM model is the decomposition of a time series into several components, i.e. trend, cyclical and irregular components, so that

$$\mathbf{x}_t = \mu_t + \mathbf{x}_t^C + \epsilon_t \tag{1}$$

- The trend component follows a random walk with a time-varying slope, i.e. ($\mu_t = \mu_{t-1} + \beta_{t-1} + \nu_t$, where $\beta_t = \beta_{t-1} + \zeta_t$).
- For irregular components we assume that they are normally and independently distributed with a mean zero ($\Sigma_\epsilon, \epsilon_t \sim$ n.i.d. $(0, \Sigma_\epsilon)$).
- The cyclical components are specified as a vector $\mathbf{x}_t^{C\prime} = (x_{1,t}^C, ..., x_{n,t}^C)'$ and are linear combinations of n independent stochastic cycles denoted as $\tilde{\mathbf{\Psi}}_{i,t} = (\Psi_{i,t}, \Psi_{i,t}^*)$, where $t = 1, ..., n$, so that

$$(1 - \phi_i L)\left(I_2 - \rho_i \begin{bmatrix} \cos\lambda_i & \sin\lambda_i \\ -\sin\lambda_i & \cos\lambda_i \end{bmatrix} L\right) \begin{bmatrix} \Psi_{i,t} \\ \Psi_{i,t}^* \end{bmatrix} = \begin{bmatrix} \kappa_{i,t} \\ \kappa_{i,t}^* \end{bmatrix} \tag{2}$$

Data

- The macroeconomic variables that represent the business cycle are transformed more or less similarly (only log transformations).
- We also extract the dynamics of the tradable and nontradable sectors from the NACE classification of activities gross value added data based on (Lenarčič and Masten, 2020).
- We extend of the housing price series with the intention of overcoming the short time series problem and covering as much information as possible with respect to business and financial cycles in the data.
- The original raw financial variables are expressed mostly in nominal terms. We then deflate them with an HICP index, and log-transform them.

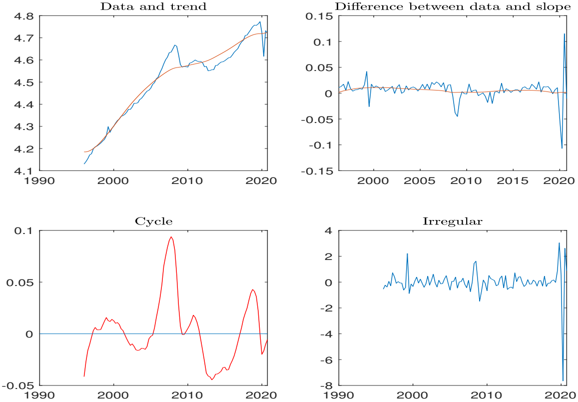
Estimation variable combinations

Variables	$\ln BAL_r$	$\ln TL_r$	$\ln LNFC_r$	$\ln LHH_r$	$\ln LHHM_r$	$\ln LHHC_r$	$\ln EQP_n$	SPR_n
$\ln GDP_r$	X	X	X	X	X	X	X	X
$\ln IP_r$	X	X	X				X	X
$\ln CON_r$	X	X		X	X	X		
$\ln INV_r$	X	X	X				X	X
$\ln MAN_r$	X	X	X				X	X
$\ln SER_r$	X	X	X				X	X
$\ln TRA_r$	X	X	X				X	X
$\ln NTR_r$	X	X	X				X	X
$\ln EXP_r$	X	X	X				X	X
$\ln IMP_r$	X	X	X				X	X
$\ln GDP_r$ with $\ln RRE_r$		X		X	X			

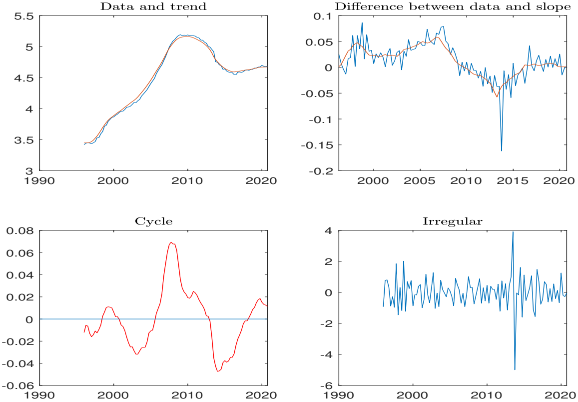
Results of the trivariate STSM model (cycle lengths)

Variable	Cycle length	Std. dev.
$\ln GDP_r$	8.161	3.560
$\ln TL_r$	8.887	5.703
$\ln RRE_r$	8.093	2.534
$\ln GDP_r$	8.313	3.272
$\ln LHH_r$	7.700	3.330
$\ln RRE_r$	8.456	5.321
$\ln GDP_r$	8.920	3.493
$\ln LHHM_r$	7.761	4.539
$\ln RRE_r$	7.682	5.106

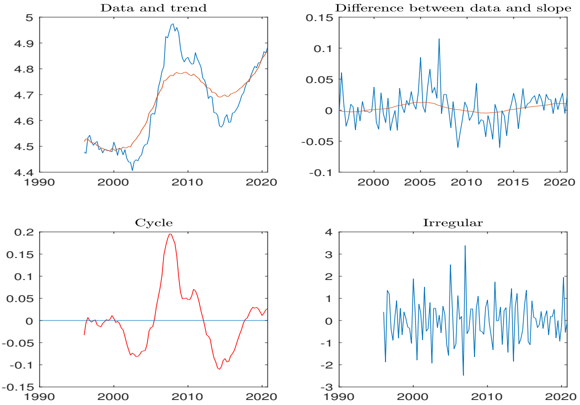
Dissection of GDP in the trivariate STSM model



Dissection of TL in the trivariate STSM model



Dissection of RRE in the trivariate STSM model



Results of the bivariate STSM model (average cycle lengths)

Variable	Average cycle length	Average std. dev.
$\ln GDP_r$	7.78	1.38
$\ln IP_r$	7.77	1.12
$\ln CON_r$	7.67	1.03
$\ln INV_r$	7.72	4.03
$\ln MAN_r$	7.95	1.16
$\ln SER_r$	7.75	1.64
$\ln TRA_r$	7.74	1.18
$\ln NTR_r$	8.02	1.61
$\ln EXP_r$	7.97	0.72
$\ln IMP_r$	7.58	1.36
$\ln BAL_r$	7.83	1.21
$\ln TL_r$	7.88	1.45
$\ln LNFC_r$	7.86	1.59
$\ln LHH_r$	7.62	1.30
$\ln LHHM_r$	8.02	0.90
$\ln LHHC_r$	7.85	1.14
$\ln EQP_n$	7.93	1.21
SPR_n	8.01	0.97

Results of the univariate STSM model (average cycle lengths)

Variable	Cycle length	Std. dev.
$\ln GDP_r$	7.8340	2.16
$\ln IP_r$	8.0117	3.20
$\ln CON_r$	8.1269	1.16
$\ln INV_r$	8.6513	5.54
$\ln MAN_r$	8.0152	4.04
$\ln SER_r$	6.9695	3.00
$\ln TRA_r$	8.5471	3.31
$\ln NTR_r$	7.6531	1.12
$\ln EXP_r$	6.6534	5.16
$\ln IMP_r$	7.2163	4.80
$\ln RRE_r$	10.3397	3.27
$\ln BAL_r$	8.3772	1.18
$\ln TL_r$	8.0504	0.72
$\ln LNFC_r$	8.0485	1.15
$\ln LHH_r$	12.9223	4.67
$\ln LHHM_r$	9.8858	2.94
$\ln LHHC_r$	9.4196	2.93
$\ln EQP_n$	10.2729	20.91
SPR_n	8.0679	123.61

Conclusions

- The main premise was to assess the differences in cyclical components between the business and financial cycles for Slovenia based on a set of both macroeconomic and financial type of variables.

- The results show that financial cycles are in most cases somewhat longer compared to business cycles. Comparing the standard deviations of financial and business cycles give inconclusive results on average, but excluding particular macroeconomic variables that are by definition more volatile, we see that also standard deviations of financial cycles tend to be larger.

- These results might not come as a surprise in the existing literature, but are utterly important for economic policy makers by additionally implementing financial stability goals on the basis of macroprudential policy (on a national level) alongside the monetary policy mandate, as financial cycles seem to be longer and deeper compared to business cycles.

Thank you for your attention

Additional slides

Results of the bivariate STSM model for macro variables (cycle lengths)

Variables	$\ln BAL_r$	$\ln TL_r$	$\ln LNFC_r$	$\ln LHH_r$	$\ln LHHM_r$	$\ln LHHC_r$	$\ln EQP_n$	SPR_n
$\ln GDP_r$	7.7145	7.9135	7.8114	7.8451	7.7823	7.7684	7.4268	7.9981
	(4.20)	(1.39)	(0.54)	(1.63)	(0.68)	(1.03)	(0.94)	(0.65)
$\ln IP_r$	7.7234	7.8759	7.6465	.	.	.	7.8672	7.7491
	(1.09)	(1.19)	(1.43)	.	.	.	(1.33)	(0.54)
$\ln CON_r$	8.0143	7.8025	.	7.5674	7.2089	7.7516	.	.
	(0.76)	(0.86)	.	(1.69)	(0.98)	(0.85)	.	.
$\ln INV_r$	7.8530	7.8729	7.8533	.	.	.	7.7758	7.2317
	(4.63)	(12.67)	(0.77)	.	.	.	(0.98)	(1.09)
$\ln MAN_r$	7.9450	7.8980	8.0367	.	.	.	8.3269	7.5609
	(0.96)	(1.66)	(1.13)	.	.	.	(0.68)	(1.37)
$\ln SER_r$	7.8522	7.5347	8.4091	.	.	.	7.4992	7.4747
	(0.41)	(2.40)	(4.29)	.	.	.	(0.70)	(0.42)
$\ln TRA_r$	7.8069	7.8838	7.8613	.	.	.	7.3717	7.7673
	(3.33)	(0.49)	(1.09)	.	.	.	(0.83)	(0.16)
$\ln NTR_r$	7.7441	8.5141	7.8165	.	.	.	8.0120	8.0099
	(0.64)	(1.96)	(0.89)	.	.	.	(0.64)	(3.94)
$\ln EXP_r$	7.8744	7.8326	7.7333	.	.	.	8.1530	8.2422
	(0.91)	(0.83)	(0.87)	.	.	.	(0.66)	(0.33)
$\ln IMP_r$	7.8563	7.6214	7.9005	.	.	.	7.7060	6.8394
	(0.95)	(1.40)	(0.94)	.	.	.	(0.80)	(2.73)

Results of the bivariate STSM model for financial variables (cycle lengths)

Variables	$\ln GDP_r$	$\ln IP_r$	$\ln CON_r$	$\ln INV_r$	$\ln MAN_r$	$\ln SER_r$	$\ln TRA_r$	$\ln NTR_r$	$\ln EXP_r$	$\ln IMP_r$
$\ln BAL_r$	7.5918	7.9776	7.7891	7.8242	7.8097	7.8607	7.9551	7.9380	7.8232	7.7346
	(1.55)	(0.87)	(0.86)	(1.55)	(0.40)	(1.40)	(1.59)	(0.42)	(1.32)	(2.13)
$\ln TL_r$	7.9550	7.8657	7.8529	7.8606	7.6614	8.0743	7.9135	8.1506	7.8489	7.6501
	(1.45)	(1.26)	(0.73)	(1.24)	(0.72)	(4.00)	(1.24)	(1.01)	(1.30)	(1.50)
$\ln LNFC_r$	7.8489	7.8269	.	7.8538	7.8271	8.2111	7.8483	7.7979	7.6840	7.8834
	(0.37)	(0.51)	.	(0.74)	(4.66)	(4.87)	(0.47)	(1.01)	(0.91)	(0.73)
$\ln LHH_r$	7.8408	.	7.4047	.	.	.	.	.	.	.
	(1.35)	.	(1.25)	.	.	.	.	.	.	.
$\ln LHHM_r$	7.8811	.	8.1572	.	.	.	.	.	.	.
	(0.72)	.	(1.07)	.	.	.	.	.	.	.
$\ln LHHC_r$	7.7808	.	7.9098	.	.	.	.	.	.	.
	(1.14)	.	(1.14)	.	.	.	.	.	.	.
$\ln EQP_n$	7.4987	7.9355	.	8.0106	8.2785	7.6916	7.4941	8.0037	8.2712	8.1665
	(1.64)	(1.23)	.	(1.21)	(1.15)	(1.05)	(2.14)	(0.68)	(0.72)	(1.05)
SPR_n	7.6491	7.9311	.	6.9915	8.1972	7.9542	7.6187	8.1319	8.0303	9.5535
	(0.41)	(1.77)	.	(0.98)	(1.07)	(0.22)	(1.26)	(2.17)	(0.20)	(0.66)