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Use of unit root methods in early warning of financial crises

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Introduction

Unit root tests have been used for detecting asset price bubbles in many studies. We provide cross-country evidence for performance of unit-root based early warning systems in ex-ante prediction of financial crises in 15 EU countries in the past 3 decades. We extend the use of the test procedure from asset prices to other macroeconomic time series and find that aggregate credit variables produce early warning signals that have quite high relative usefulness. To further improve the crisis prediction, the signals from multiple time series can be combined into a composite indicator. It is also possible to use a mix of data with different frequencies, which can be useful for providing more timely warning signals.

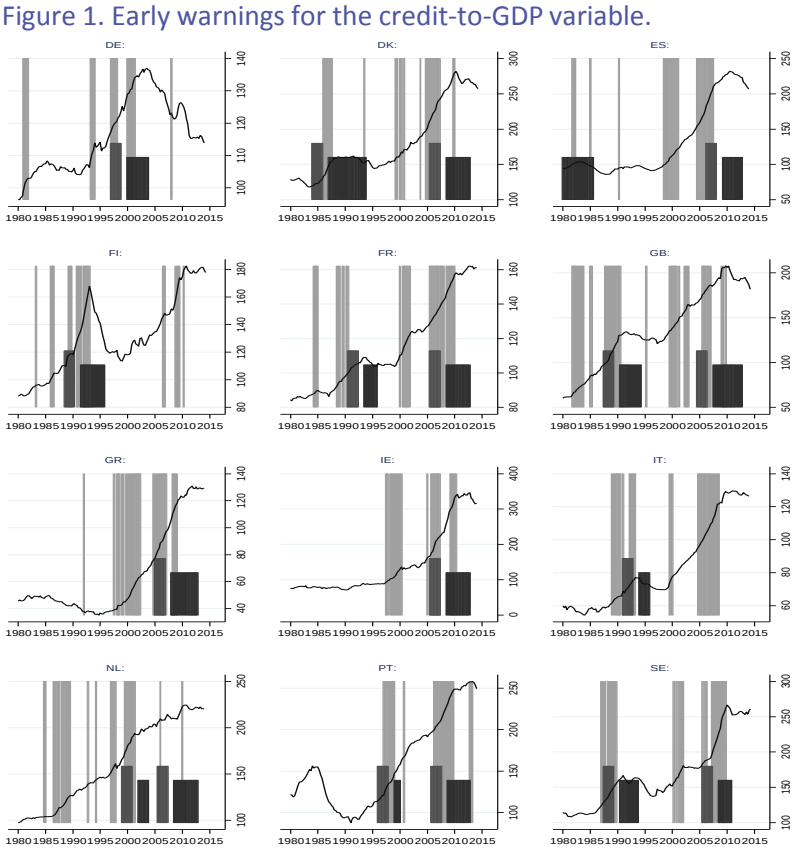
Methods

We have employed the right-tailed ADF test with a rolling window setup, proposed by Taipalus (2012) and the backwards sup ADF test of Phillips, Shi and Yu (2014) to determine regions, where a time series process changes from an I(1) to an explosive process. An early warning signal is issued if the test statistic exceeds the critical value of the test at a certain significance level (95% used as default value).

The rationale behind the tests is that an asset bubble causes the price to exhibit this measurable change in the time series process according to the theory of rational bubbles (see e.g. Campbell and Shiller, 1988). An asset price bubble, in turn, increases the risk of a financial crisis.

To evaluate the usefulness of the signals, we use the crisis classification by the ECB and ESRB (Detken at al. 2015), which is based mainly on expert opinions from the individual central banks. We calculate the usefulness of the warning signals using the policymaker's loss function defined in Alessi and Detken (2011)(*).

Figure 1. Early warnings for the credit-to-GDP variable.



Short bars denote crisis periods and medium-sized bars the pre-crisis periods. Tall grey bars mark the early warning signals.

Early-warning indicator data

Our dataset includes credit aggregates, real estate prices, stock prices, stock prices and other macroeconomic variables for 15 European countries. It is based on a quarterly data series compiled by ECB and shared within the macro-prudential analysis group (MPAG). We have amended the dataset with monthly observations of stock market from Bloomberg and house prices from BIS.

Results of the performance evaluation

We find that the alerting lead varies markedly for different variables. For instance, many real estate variables typically alert four to five years before the crisis. All variables also produce some false warning signals. The debt service ratio variable is the most accurate in this respect.

Table 1. Usefulness values and prediction probabilities for the whole sample (1980 – 2012) with unit-root test confidence level 95 %.

		Usefulness				False ratios (%)			
		θ=0.5		θ=0.6		ADF		PSY	
Variable	F	ADF	PSY	ADF	PSY	FP	FN	FP	FN
Bank credit-to-GDP	Q	0.34	0.54	0.11	0.46	18.0	4.6	26.3	1.7
Bank credit	Q	0.34	0.39	0.17	0.34	29.8	3.4	46.8	0.9
Total credit-to-GDP	Q	0.44	0.53	0.25	0.45	16.3	3.9	28.5	1.5
Total credit	Q	0.40	0.36	0.26	0.33	29.9	2.7	51.8	0.6
Debt service ratio	Q	0.37	0.34	0.10	0.07	9.3	5.4	9.4	5.6
Household debt service ratio	Q	0.41	0.44	0.20	0.25	14.0	6.9	15.3	6.1
Residential RE price-to-rent	Q	0.14	0.22	-0.20	-0.05	16.1	8.5	20.3	6.8
Residential RE price (OECD, real)	Q	0.15	0.30	-0.16	0.10	20.5	7.5	24.6	5.1
Stock price (nominal)	Q	0.11	0.23	-0.27	-0.05	12.7	7.9	19.8	5.8
Stock price	Q	0.10	0.19	-0.30	-0.15	9.5	8.4	11.2	7.2
Residential RE price (nominal)	M	0.22	0.14	0.15	-0.02	52.6	2.5	42.6	6.7
Residential RE price (real)	M	0.12	0.19	-0.07	-0.05	39.0	7.8	26.2	9.7
Stock price (nominal)	M	0.30	0.18	0.12	-0.17	29.6	4.3	12.4	8.3

** The policy manager loss function is defined as*

$$L_{AD}(\theta) = \theta T_2 + (1-\theta)T_1 = \theta \frac{FN}{TP+FN} + (1-\theta)\frac{FP}{TN+FP}$$

We find that the usefulness of a variable is sensitive to the definition of the pre-crisis window and the alerting lead. The selection of the rolling window length and significance level of the test also affect the usefulness, but the results are robust to small changes in these parameters.

We also experiment with combining the early warning signals of different variables to a composite early warning index by calculating a simple weighted average of the warning signals. We find that these composites can reach a relative usefulness between 50 and 60 percent quite easily. Thus, there is room for further research on how to optimally combine the information from the various early warning indicators.

Concluding remarks

We have demonstrated that a unit root test based early warning indicator can be helpful in predicting financial crises. Signals derived from aggregate credit variables have relatively high usefulness. The approach works also with stock prices and real estate prices, assuming that the alerting lead is taken in account. Furthermore, it is possible to improve the usefulness by combining the early warning signals into a composite indicator. The results suggest that this approach has a place in the toolkit of financial stability supervision.

Relevant literature

Alessi, L. and Detken, C. (2011), Quasi real time early warning indicators for costly asset price boom/bust cycles: A role for global liquidity. *European Journal of Political Economy*, 27 (3), 520–533.

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