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Model analysis of the link between interest rates and crashes

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HIGHLIGHTS

- Interest rates are related to financial crashes.
- Increase in interest rates leads to few number of failures, at the expense of early moderate crises.
- Low interest rates for very long periods may lead to large number of failures at short timespans.

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ABSTRACT

We analyse the effect of distinct levels of interest rates on the stability of the financial network under our modelling framework. We demonstrate that banking failures are likely to emerge early on under sustained high interest rates, and at much later stage – with higher probability – under a sustained low interest rate scenario. Moreover, we demonstrate that those bank failures are of a different nature: high interest rates tend to result in significantly more bankruptcies associated to credit losses whereas lack of liquidity tends to be the primary cause of failures under lower rates.

1. Introduction

Little is known about the long term effects in the financial system of different levels of interest rates, since it is not feasible to conduct long term experiments with such a key monetary policy instrument. In addition, financial markets and the economy as a whole are complex systems with a multitude of evolving and interacting agents that do not necessarily respond to changes in rates in a mechanistic manner [1,2]. This makes the development of reliable, yet simple, theoretical modelling environments particularly important as a means to develop an understanding of the key mechanisms that can lead to financial instability.

In this paper we analyse the effect of interest rates on the stability of the financial markets under the modelling framework developed in Ref. [3] in which endogenous systemic crashes are shown to occur due to the evolutionary dynamics arising from copy of business models and benchmarking. Given the evolutionary dynamics inherent to the system, large and concentrated levels of financial failures will occur regardless of the levels of interest rates. However, the likelihood and timing of those events will depend on such levels.

The model is underpinned by five key principles (i) the relationship between risk and returns on the investment of an agent is always rationally maintained so that at the time of an investment, the returns are always higher than the expected losses; (ii) the funding costs of a bank increase as a function of its risk profile; (iii) in order to replicate basic regulatory rules, banks cannot obtain funding above a certain leverage threshold, and cannot operate below a determined capital ratio

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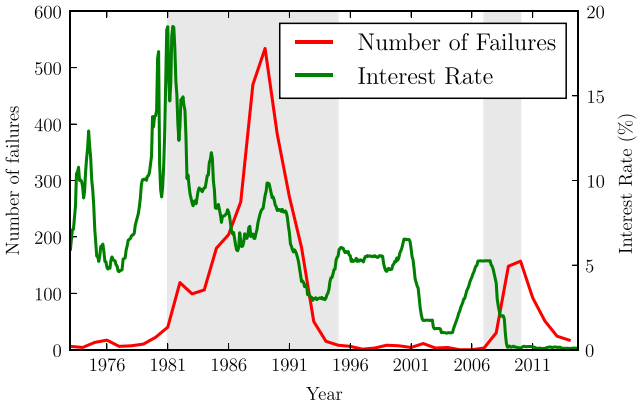

Fig. 1. Total number of banks that have failed in a given year versus base interest rate in US where highlighted are two periods of crisis.

threshold; (iv) investors diversify their portfolios, therefore, concentration limits on a single counter-party are required; and (v) a basic asset and liability management strategy is used so that banks do not have maturity or interest rate mismatches.

Under this framework, we find that sustained low interest rates result in a higher likelihood of crashes after prolonged periods of time. The magnitude of the crashes will be of a maximum magnitude comparable to the failures observed at higher interest rates. However, high rates result in a very quick market saturation and a substantial proportion of failures earlier on, albeit, with a lower probability.

2. Historical outlook

Looking at the historical data of the US Federal Funds Interest Rates ("FED rates") [4] and the number of FDIC regulated institutions [5] (see Fig. 1) one can note that the FED rates reached historically high levels before the "Loans and Savings Crisis" in 80–90s [6] and unusually low ones, nearing zero, since the beginning of the "Subprime Crisis" which originated in 2007 [7].

The peak of the FED rates was reached in 1981 in response to inflationary pressures, whereas, a large number of bank failures only started occurring after 1985, at a time that the FED rates had already returned closer to the long term trend. By 1989, when the crisis reached its summit, the time FED rates had already dropped by a factor of two as compared to the peak reached in 1981. Since the mid-nineties, interest rates tended to drop. At the time the "Subprime Crisis" has started, a period of historically low interest rates was reached. Such observations suggest there is a non-trivial relationship between interest rates and bank failures, which can be better understood using a model environment driven by fundamental market dynamics.

3. Model

Our analysis is underpinned by the agent-based model developed in Ref. [3], and all details can be found in Appendix A. The model successfully reproduces crashes in financial markets by supplementing conventional dynamics with two evolutionary elements: the *Cultural Dissemination* of investor strategies and *Infection* of Bank Business Strategies. Crashes occur without introducing any exogenous shocks.

The basic description of the model can be summarised in Fig. 2 where types of agents and cash flows are indicated.

The model is based on 3 types of agents: investors, banks and borrowers. Banks act as the connecting part between the other two agent types in a tripartite interconnected network. The investors choose which banks they want to invest in based on their risk appetite at a given moment. Banks can then lend that money out in a form of loans. All the unallocated money will go to market placements, which represent the central bank. For simplicity interbank lending is ignored. However, the potential contagion effects on defaults arising from interbank lending and borrowing network are recognised in the model through the interbank market losses mechanism described in Eq. (A.26) whereby losses are shared between all of the banks within the same rating category [8]. This is to recognise that losses are likely to be clustered within a group of banks without the need to generate a model for a full interbank network. Finally, in the model, some of the loans will default, thus triggering losses for banks and investors.

We emphasise that under the conventional dynamics, i.e. without any of the aspects of the evolutionary dynamics, crashes do not emerge, in line with the principles of rational expectations [9,10]. Crashes do however occur when the model supplements the conventional dynamics with the following two modifications: (1) culture dissemination in the investors' community and (2) strategy infection among the banks which supports arguments seminally laid out by Minsky [11] that crashes are inherent to the structure of the system and occur endogenously without any exogenous input.

(1) Investors performing under the benchmark, i.e. their returns are at the 40th percentile between the best and worst performers, can adjust their Investment Return Expectations with a fixed probability towards the benchmark. To do that we