Exploration of phase transitions in an agent-based model of margin calls and fire sales in a scenario of declining growth rates

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For the past decades, long term economic growth rates have been declining in high income countries (Fritz et al., 2019; Jackson, 2019). There are many reasons that might lead to continuation of this trend, such as global pandemics, climate change impacts or side effects of large scale climate change mitigation measures. In the context of environmental policies, Jackson (p.1 2019) argues that '*it is now time for policy to consider seriously the possibility that low growth rates might be 'the new normal''*. As a complex system, our economy as well as the financial system might have become adapted to a certain level of economic growth. In this paper, we focus on financial stability. What challenges do lower growth rates pose for financial stability? What effect do a decline in expected future growth rates have on the probability of financial crashes? To analyse this question, we focus on margin calls and fire sales and implement them in an agent-based model of a stylised stock market. Fire sale dynamics are a well known mechanism to cause self-reinforcing dynamics in financial systems (Shleifer and Vishny, 2011). The mechanism falls into the category of overlapping portfolio contagion (Aymanns et al., 2018), which means that the price impact from forced selling of some market participants leads to asset devaluations in the balance sheets of others who then can also face margin calls.

The effect of an increase in financial instability with declining growth rates can be particularly problematic if a small decrease in growth rates leads to a large shift in financial instability. In complex systems terminology, such a phenomenon is called a phase transition (Solé et al., 1996). The purpose of this paper is to analyse the existence of phase transitions in the probability of crashes, along the dimension of growth rates. For simplification, we assume that a decline in economic growth rates translates into a decline in growth rates of dividend payments and other fundamental value indicators of stock shares. Asset price dynamics are determined by current changes in the demand of traders, who consider fundamental values in their trading decisions but also face constraints due to margin requirements. We then analyse whether a small change in the growth rate of fundamental values leads to a large shift in the probability of crashes. Preliminary results from a model with one risky asset show that such a phase transition from near zero crash probability to a crash probability of nearly one indeed exists. Furthermore, we analyse the effect of heterogeneity among agents on the level and shape of the phase transitions.

While phase transitions have been frequently analysed in the context of financial instability (see e.g. Acemoglu et al., 2015; Caccioli et al., 2014), to our knowledge, an analysis of phase transitions in the context of changes in long term growth expectations is still missing. The present work contributes to this field by providing a connection between long term growth expectations and fire sales dynamics including phase transitions. The results could then be used as starting point for further research on the question what kind of financial regulations are well suited in low growth scenarios.

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