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Price dynamics, financial fragility and aggregate volatility ☆

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ABSTRACT

Within a general equilibrium framework à la (Long and Plosser, 1983), we investigate the dynamics emerging from the interactions of households and firms that are adaptive price setters and financially constrained. Adaptive price-setting behavior induces micro-founded out-of-equilibrium dynamics along which agents become heterogeneous in terms of prices and wealth. The stringency of the financial constraints determines the regime into which the model settles: either an equilibrium one or a disequilibrium one conductive to financial fragility and aggregate volatility. In this setting, we investigate how the structure of the production network affects the emergence of aggregate volatility from micro-level price and financial shocks, hence providing a dynamical counterpart to recent results of Acemoglu et al. (2012).

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1. Introduction

In a recent paper, Acemoglu et al. (2012) investigate the influence of the topology of production networks on the transmission of shocks and the build-up of macroeconomic volatility. They show that in the presence of intersectoral input–output linkages, microeconomic idiosyncratic shocks do not necessarily average out but may lead to aggregate fluctuations. They also provide quantitative estimates which indicate that these fluctuations could be of the same order of magnitude as those of US GDP.

These results potentially represent major advances in our understanding of the origins of macro-economic fluctuations. Yet, the approach used by Acemoglu and co-authors is essentially static and asymptotic: "aggregate volatility" is measured through a comparative static analysis of the level of GDP at equilibrium when the number of sectors tends towards infinity. In this equilibrium perspective, the actual mechanics of crisis and, more generally, the temporal dimension are absent.

The aim of this paper is to fill this gap by introducing a micro-founded dynamic model in which the emergence and the propagation of shocks are endogenous, the unfolding of crisis can actually be observed and where aggregate volatility materializes in a truly dynamic sense. This mainly implies shifting from a framework where adjustment to equilibrium is

☆ The source code for simulations reported in this paper is available online at https://sites.google.com/site/antoinedavidmandel/codes.

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assumed to take place instantaneously to a framework where convergence to or divergence from equilibrium is determined endogenously. The efforts of general equilibrium theory in that direction were based on centralized price adjustment processes and almost entirely stopped by the impossibility results put forward in the Sonnenschein–Mantel–Debreu theorem. We take here a different route and use agent-based modeling to generate out-of-equilibrium dynamics via the simulation of the interactions of boundedly rational and heterogeneous agents (see LeBaron and Tesfatsion, 2008, for an introduction to agent-based modeling).

More precisely, we place ourselves in the general equilibrium framework à la (Long and Plosser, 1983) considered by Acemoglu et al. (2012) and define out-of-equilibrium dynamics through the interactions of agents that are adaptive price setters and whose production is financially constrained. The assumption that agents are adaptive price setters is based on recent work of ours in which we show that evolutionary learning of heterogeneous price setting agents provides a viable alternative to the Walrasian tâtonnement (see Gintis, 2007; Gintis and Mandel, 2012). The assumption that agents are financially constrained is based on the work of Greenwald and Stiglitz (1993) emphasizing the real impacts of asymmetric information on credit markets and is here taken as an endogenous route to disequilibrium: financial constraints on production can impair the local functioning of markets and hence generate endogenously micro-economic shocks from which aggregate volatility can emerge. Moreover, as in previous work on financial fragility by Delli Gatti, Gallegati and co-authors (most recently Delli Gatti et al., 2010; Battiston et al., 2012), the presence of credit networks and the positive feedback between financial fragility and financial constraints foster the propagation of financial shocks. As a whole, our model accounts both for processes of convergence towards equilibrium and for the endogenous creation of shocks, disequilibrium and aggregate volatility. The model is stock-flow consistent and dynamically complete.

The results we obtain in this setting confirm those of Acemoglu et al. (2012) as far as the influence of the topology of the production network on aggregate volatility is concerned. Yet, we also identify a strong connection between disequilibrium and aggregate volatility, which is, by definition, absent in the equilibrium model of Acemoglu and co-authors. In our setting, it is out-of-equilibrium, that is when prices move away from their general equilibrium values and markets do not clear, that crisis and aggregate volatility materialize.

Disequilibrium itself is brought about by financial constraints which impair the competitive functioning of markets and propagate shocks through credit networks. Establishing this link between financial fragility and disequilibrium is another contribution of the paper as it clarifies the relationships between agent-based models and general equilibrium. Hence the paper contributes both to the literature on the origins of aggregate fluctuations and to the theoretical foundations of agent-based modeling.

There is a substantial literature on the origin of aggregate fluctuations that investigate whether independent idiosyncratic shocks can generate aggregate volatility. The pioneering contribution by Bak et al. (1993) looks at self-organized criticality in production networks and shows that independent shocks fail to cancel in the aggregate if interactions are local and technologies non-convex. Gabaix (2011) arrives at a similar conclusion in a model where the distribution of firms' size is fat-tailed. He moreover shows that the idiosyncratic movements of the largest 100 firms in the United States appear to explain about one-third of variations in output growth. Yet, the models by Bak and Gabaix focus on the production sector and therefore lack macro-economic closure and potential feedback mechanisms brought about e.g. by variations in demand.

The “equilibrium” contributions by Acemoglu et al. (2012) and its precursors such as Horvath (1998, 2000) and Dupor (1999) are more complete from this perspective. Yet these authors consider aggregate volatility as an equilibrium response to exogenous productivity shocks in a static framework whereas we emphasize the role of disequilibrium and the endogenous origin of shocks. Hence, with respect to the equilibrium literature, our contribution is to ground existing results on the non-diversification of shocks in a dynamical setting with heterogeneous interacting agents and to allow for the endogenous generation and propagation of shocks via bankruptcies, defaults and network-based financial accelerator mechanisms (see Delli Gatti et al., 2010) thanks to the introduction of out-of-equilibrium dynamics and of an explicit financial structure. In particular, we address some of the research questions put forward in Acemoglu et al. (2012): *“another important area for future research is a systematic analysis of the relationship between the structure of financial networks and the extent of contagion and cascading failures.”*

The relation between disequilibrium and aggregate fluctuations is on another hand central to the agent-based literature (see among others Dosi et al., 2010; Dawid et al., 2011; Mandel et al., 2010; Wolf et al., 2013). For example, in a series or recent contribution (see Napoletano et al., 2012; Dosi et al., 2013), Dosi and co-authors emphasize how income inequality and/or the lack of redistributive fiscal policies destabilize the economy, impair growth and employment, accentuate volatility. Our own contribution is more closely related to the work of Delli Gatti, Gallegati and co-authors (see Delli Gatti et al., 2005, and further references) emphasizing scaling laws and financial fragility as sources of macroeconomic volatility. Yet, these agent-based models generally have one or two aggregate sectors and cannot therefore investigate the influence of intersectoral linkages that is central to Acemoglu et al. (2012) and to our analysis. A notable exception is Battiston et al. (2007) who consider the spreading of shocks in a hierarchical production structure where firms are linked both by technological and trade-credit relationships.

Yet a main shortcoming of Battiston et al. (2007) and more generally of the agent-based literature on financial fragility (Delli Gatti et al., 2005, and further references) is that it abstracts away from the price formation process. Indeed, in these models the dynamics of prices is determined by random processes and lacks behavioral foundations. More broadly, the link between this class of agent-based models and the general equilibrium literature has, up to now, remained obscure.

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