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CONSUMER BEHAVIOR AND FLUCTUATIONS IN ECONOMIC ACTIVITY

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We develop a simple Keynesian type business cycle model in which heterogeneous agents are either optimistic or pessimistic. If the majority of the agents are optimistic, then consumption expenditures are high and the economy booms, otherwise consumption expenditures are low and the economy is in a recession. Within our model, the sentiment of the agents is affected by their social interactions. For instance, people regularly meet each other and thus their mood may change. Overall, our model suggests that swings in consumer confidence may generate irregular fluctuations in economic activity.

Keywords: Econophysics; consumer sentiment; optimism and pessimism; social interactions; opinion formation; business cycles.

1. Introduction

Our goal is to relate two strands of literature. First, a number of empirical studies [1, 9, 10] point out that consumer sentiment has some explanatory power for current changes in household spending and thus on the evolution of business cycles. Most of the time, consumer sentiment moves with current economic conditions and bears a stable relationship to a few economic variables. But sometimes consumer sentiment can move independently from current economic conditions. This is important. Suppose that the majority of the consumers become pessimistic. Then it is likely that the economy will experience a recession, although this may fundamentally not be justified. Understanding the determinants of consumer confidence is apparently quite important.

Second, a number of interesting theoretical models have recently been proposed which are concerned with opinion formation and social interaction (for surveys, see Refs. 4 and 7). Some of these models explicitly seek to explain swings in consumer and business confidence indicators. For instance, Hohnisch *et al.* [3] develop a stochastic model of interactive expectation formation. In their approach, the expectations of a business manager about future business prospects are influenced by the expectations prevalent in his professional peer group. Note that experimental evidence indeed indicates that individuals adopt the opinions of others in certain situations. Prominent examples include group pressure effects or herding behavior. For a related theoretical framework of interactive expectation formation, see Flieth and Foster [2]. Both approaches have the power to reproduce some salient features of the German business climate index (the so-called Ifo-Index), in particular the occurrence of abrupt, large but rare up or down swings

Therefore, we try to develop a simple business cycle model in which the sentiment of the agents is influenced by their social interactions. To be precise, the agents may either be optimistic or pessimistic. The switching between these two emotional states is modeled as suggested by Kirman [5, 6]. Accordingly, changes in sentiment occur as a result of stochastic interactions between individuals. For instance, people regularly talk to each other and thus their sentiment may modify. Besides becoming "infected" due to communication, the emotional state of a person may also change exogenously. If the majority of the agents are optimistic, then consumption expenditures are high and the economy booms, otherwise consumption expenditures are low and a recession sets in. Overall, our model is able to produce irregular business cycles, caused by swings in consumer confidence.

The remainder of this paper is organized as follows. In Sec. 2, we first develop our business cycle model. In Sec. 3, we discuss its dynamics with the help of numerical simulations. Finally, we conclude the paper.

2. The Model

Let us first describe the economy. To make matters as simple as possible, we only focus on the goods market and apply a simple Keynesian type multiplier framework. National income Y at time $t+1$ is given by

$$Y_{t+1} = G_{t+1} + C_{t+1}, \tag{1}$$

where

$$G_{t+1} = \bar{G} \tag{2}$$

comprises all autonomous expenditures (private and governmental). Consumption in period $t+1$ is expressed as

$$C_{t+1} = a_t Y_t. \tag{3}$$

The agents consume a given fraction a_t of their past income in every period. The rest of their income is saved. The so-called marginal propensity to consume is bounded between $0 < a_t < 1$.

In standard economics models, a_t is typically constant. Then, it follows from (1)–(3) that the long-run equilibrium income is proportional to autonomous expenditures

$$\bar{Y} = \frac{\bar{G}}{1-a}. \tag{4}$$

The factor $1/(1-a)$ is the famous "Keynesian multiplier." Should autonomous expenditures increase by one unit (e.g. due to governmental deficit spending), then equilibrium income increases by $1/(1-a)$ units.

In this paper, we seek to endogenize the marginal propensity to consume. Agents are either optimistic or pessimistic. If they are optimistic, then they consume a higher share of their income then when they are pessimistic (put differently, they save less of their income). Therefore, one may write

$$a_t = a^O\left(\frac{K_t}{N}\right) + a^P\left(1 - \frac{K_t}{N}\right), \tag{5}$$

where a^O is the marginal propensity to consume of optimistic agents, a^P is the marginal propensity to consume of pessimistic agents, K_t is the number of optimistic agents, and N is the total number of agents, Hence, $0 < a^P < a^O < 1$.

The evolution of K_t is formalized as in Kirman's opinion model according to which changes in opinion occur as a result of stochastic interactions between individuals. To be precise, there are two prevalent views of the world (in our case optimistic versus pessimistic), and each agents holds one of them. Overall, there are N agents. The state of the system may thus be defined by the number K_t of agents holding view 1, i.e. $K_t \in \{0, 1, \ldots, N\}$. The system evolves as follows: two individuals meet at random. The first is converted to the second's view with probability $(1-\delta)$. Moreover, there is a small probability ε that the first will change his opinion independently (e.g. an existing agent is replaced by a new one who does not share the same view). The dynamic evolution of the process is then given by

$$K_t = K_{t-1} + \begin{cases} 1 & \text{with probability } p^1_{t-1}, \\ -1 & \text{with probability } p^2_{t-1}, \\ 0 & \text{with probability } 1 - p^1_{t-1} - p^2_{t-1}, \end{cases} \tag{6}$$

where

$$p^1_{t-1} = \left(1 - \frac{K_{t-1}}{N}\right)\left(\varepsilon + (1-\delta)\frac{K_{t-1}}{N-1}\right), \tag{7}$$

and

$$p^2_{t-1} = \frac{K_{t-1}}{N}\left(\varepsilon + (1-\delta)\frac{N-K_{t-1}}{N-1}\right). \tag{8}$$

With probability p^1_{t-1}, K_{t-1} increases by $+1$ and with probability p^2_{t-1}, K_{t-1} changes by -1. With probability $1 - p^1_{t-1} - p^2_{t-1}$, K_{t-1} remains constant.

Kirman shows that the equilibrium distribution of the Markov chain (6)–(8), i.e. the proportion of the time the system will spend in each state, depends on the relative values of ε and $(1-\delta)$. Let us briefly consider two interesting examples.

When the probability of self-conversion is relatively high, and the probability of being converted by another agent is relatively low ($\varepsilon = 0.15$, $1-\delta = 0.7$, $N = 100$), the state of the system fluctuates around $K = 50$ so that most of the probability mass is located in the center. But when the probability of self-conversion is relatively low and the probability of being converted by another agent is relatively high ($\varepsilon = 0.005, 1-\delta = 0.99, N = 100$), the system spends most of the time in the extremes. Then, nearly all agents hold the same view for some time, but suddenly the whole crowd may switch to the other view. In neither example does the system converge to any particular state K, i.e. none of the states $K \in \{0, 1, \ldots, N\}$ is, itself, an equilibrium.

3. Simulation Results

For the simulation analysis, we assume the following parameter setting:

$$\bar{G} = 10, \quad a^O = 0.91, \quad a^P = 0.89, \quad N = 100, \quad \varepsilon = 0.15, \quad \delta = 0.3.$$

Let us first study three specific scenarios. Suppose that the groups of optimists and pessimists are permanently equal in size. National income then converges to $\bar{Y} = 10/(1-0.90) = 100$. This situation may be regarded as the "long-run equilibrium outcome." When all agents are permanently optimistic, national income is $\bar{Y} = 10/(1-0.91) \approx 111.1$ and when all agents are permanently pessimistic, national income is $\bar{Y} = 10/(1-0.89) \approx 90.9$. However, consumers regularly meet each other and thus their sentiment is time varying.

Figure 1 displays a typical simulation run. The top panel shows the evolution of national income for 10,000 time steps. National income obviously oscillates around its "long-run equilibrium value" $\bar{Y} = 100$. Visual inspection furthermore suggests that there are about eight business cycles during this time span. The ebb and flow of economic activity is relatively irregular, which is consistent with actual observations [8]. This concerns both the amplitude and the frequency of the business cycles.

Within our model, booms and recessions are caused by consumer sentiment. The bottom panel displays the number of optimistic agents, which hovers around 50. In some periods, the number of optimists goes down to about 25; in other periods, it climbs up to about 75. Note that the average emotional state of the consumers may be interpreted as a consumer confidence index. The evolution of this "index" appears quite erratic. It may be relatively stable for some time (e.g. around period 1,250), but then a larger change may set in. To sum up, fluctuations in economic activity are driven by consumer confidence, which in turn adjusts with respect to social interactions.

Let us further clarify the model's cause-and-effect relation. Suppose that national income temporarily increases due to external factors. Figure 2 presents a simulation run where national income is equal to $Y = 104$ between periods 2,500 and 2,750 (otherwise the simulation design is as in Fig. 1). Visual inspection reveals that after $t = 2{,}750$, national income quickly decreases again. Note that consumer

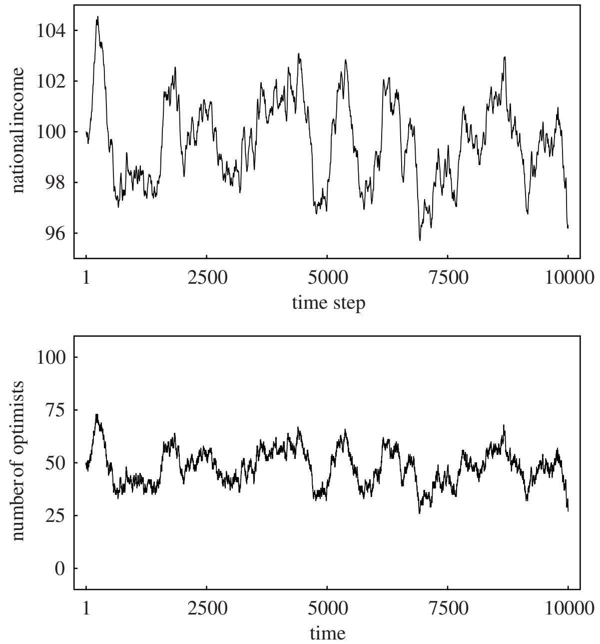

Fig. 1. National income (top) and consumer sentiment (bottom) for 10,000 time steps. Parameter setting as in Sec. 3.

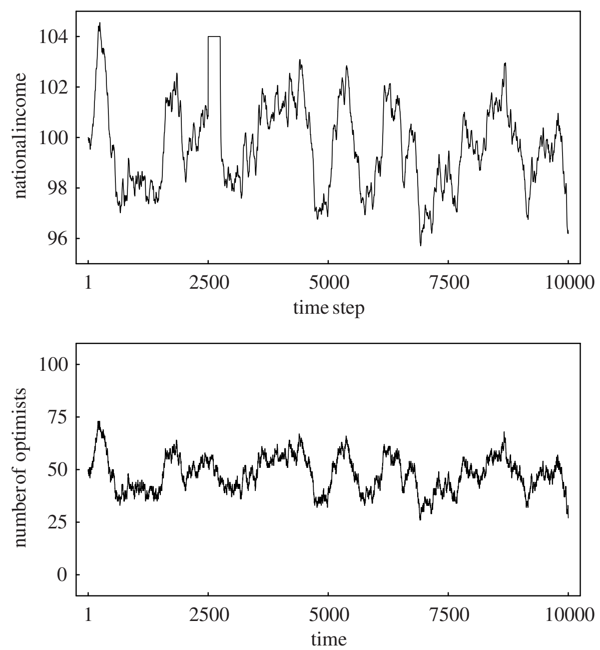

Fig. 2. The same simulation design as in Fig. 1, but now $Y = 104$ between $t = 2{,}500$–$2{,}750$.

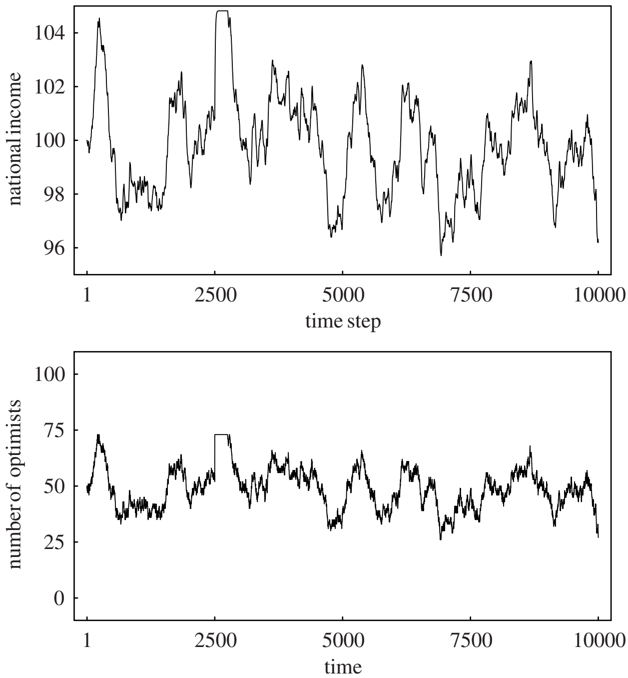

Fig. 3. The same simulation design as in Fig. 1, but now $K = 73$ between $t = 2{,}500$–$2{,}750$.

sentiment remains, however, as in Fig. 1, i.e. consumer confidence is not affected by the positive income shock.

Now we manipulate consumer confidence. In Fig. 3, we fix the number of optimistic agents at $K = 73$ between periods 2,500 and 2,750. The top panel of Fig. 3 shows that national income is affected by consumer confidence. Clearly, national income strongly increases between $t = 2{,}500$–$2{,}750$. After the exogenous intervention vanishes, both national income and the number of optimistic agents approach their former values (with a short transient phase). Hence, neither temporal shocks in national income nor temporal shocks in consumer confidence have a long-term impact on the dynamics of the model.

4. Conclusions

Our goal is to explore the relation between social interactions, consumer sentiment and business cycles. We assume that the mood of a consumer is either optimistic or pessimistic and that an optimistic agent spends a higher fraction of his income than a pessimistic one. The mood of a consumer may either change exogenously or due to his social interactions with other consumers. The average emotional state of all consumers may be interpreted as a consumer confidence index. According to our model, social interactions may lead to swings in consumer confidence which in turn may trigger business cycles. An interesting extension of the current setup would be to allow also for a feedback from the business climate to the sentiment of the agents. We hope that our contribution will stimulate more work in this interesting and important research direction.

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