A Note on Interactions-Driven Business Cycles

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Abstract: Within the standard Keynesian multiplier framework, extended by a micro-model of interactive formation of individual consumption propensities, we demonstrate that socioeconomic interactions can lead to cyclical fluctuations in aggregate economic activity. The underlying micro-model of direct interactions is a version of Alan Kirman's generic opinion formation model, with an additional feedback effect from macroscopic variables on the transition probabilities. Our model engenders cyclical fluctuations of economic variables, despite the fact that neither the Keynesian multiplier model nor Kirman's model does so on its own.

JEL-classification: D11, E12, E32

Keywords: socioeconomic interactions, business cycles, Keynesian multiplier model

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[1]Presented at the *Computational Political Economics* conference in Bielefeld, May 2006, at the *Complexity 2006* meeting in Aix en Provence, May 2006, and at the *Workshop on the Economics of Heterogeneous Interacting Agents* in Bologna, June 2006. We would like to thank the participants for stimulating and encouraging discussions. M.H. gratefully acknowledges financial support from DFG grant TR120/12-1. Address: Frank Westerhoff (corresponding author): Department of Economics, University of Osnabrueck, Rolandstrasse 8, D-49069, Osnabrueck, Germany; email: Frank.Westerhoff@uos.de; Martin Hohnisch: Experimental Economics Laboratory and Research Group Hildenbrand, Department of Economics, University of Bonn, Adenauerallee 24-42, 53113 Bonn, Germany; email: Martin.Hohnisch@uni-bonn.de

1 Introduction

There has been an increasing appreciation among economists of the role of direct socioeconomic interactions in the market process. Blume and Durlauf (2001, p.16) define the (direct) interactions-based approach as one "focusing on direct interdependencies between economic actors rather than those indirect interdependencies that arise through the joint participation of economic agents in a set of markets".

In the present paper we demonstrate within the textbook Keynesian multiplier framework, extended by a micro-model of interactive formation of individual consumption propensities, that direct socioeconomic interactions can lead to cyclical fluctuations in aggregate economic activity (i.e. to business cycles). Our starting point for modelling the micro-level interactions is the interactive opinion-formation process introduced by Kirman (1993), in which we interpret the two individual states as optimism - associated with a higher consumption propensity - and pessimism - associated with a lower consumption propensity.[2] Our model introduces the new feature, that in times of aggregate output and consumption growth it is less likely that a pessimist will be able to "convince" an optimist, while an optimist will be similarly challenged during a decline in output. This feature is an instance of a macro-variable affecting individual decision-making, a principle advocated by Hahn (2003), among others. Since regular cyclical fluctuations are present neither in the basic Kirman model (in which opinion swings are exponentially distributed) nor, as is well-known, in the Keynesian multiplier model, their appearance in our model must result from the specific interplay of these two basic components.

2 The model

The underlying framework of the present paper is the well-known *Keynesian multiplier model* of the real sector, in which national income Y at time $t+1$ is written as

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

[2]The basic approach of Kirman has already proven its strength in modelling social dynamics in financial markets (see Kirman 1991, Lux and Marchesi 1999, Alfarano et al. 2005).

with G_{t+1} comprising all autonomous expenditures (private and government), and C_{t+1} denoting the aggregate consumption. The autonomous expenditures are constant at the level $\bar{G}$. Aggregate consumption depends in the Keynesian multiplier model on the last period's national income via

$$C_{t+1} = A_t Y_t, \tag{2}$$

with $A_t \in (0, 1)$ denoting the *marginal consumption propensity* at time t.

While in the standard Keynesian model the behavioral parameter A_t is exogenous and constant (presumably applying both to individual and aggregate behaviour), in the present model the value of A_t evolves as a population average in a stochastic micro-model with direct imitative interactions between consumers. This interaction process is in the spirit of Kirman (1993), with the additional feature of a feedback from aggregate (macroscopic) variables acting upon the individual transition probabilities of the process.

In our interpretation of the Kirman process, an individual variable s_t^i defines the sentiment of consumer i, for which we allow, for simplicity, only two values: consumers can be either optimistic or pessimistic. Following recent empirical evidence on the impact of consumer sentiment on consumption behavior (see, for instance, Souleles (2004)), we assume that an optimistic consumer will consume more - and thus save less – relative to a pessimistic one. Let us define a_t^i as the consumer i's individual propensity to consume. Accordingly, this individual variable has two possible realizations denoted by a^O and a^P (common to all consumers), with $a^O > a^P$. The latter realization is associated with a pessimistic consumer, the former with an optimistic one.

Assume that in period t, there is a proportion α_t of consumers in the population who are in state a^O and a proportion of $1 - \alpha_t$ in the state a^P. Then the population average of a_t, corresponding to the parameter A_t in the Keynesian multiplier, will be

$$A_t = \alpha_t a^O + (1 - \alpha_t) a^P. \tag{3}$$

Let us now turn to the specifics of the interaction process. The basic structure is as in the Kirman (1993) model. Assume a population of N consumers, each holding at a given point t in time one of the two possible values of individual consumption propensity. Time is discrete. Let $K_t = \alpha_t N$ denote the number of consumers with the higher value of consumption propensity (optimists) at time t. In each time step, two consumers meet at random and the first consumer will adopt with a given probability

$1-\delta(\cdot)$ the state of mind – and along with it the consumption propensity – held by the other. In addition, there is a small probability ϵ of an autonomous change. In our model - unlike the Kirman (1993) model - the probability δ may be asymmetric with respect to whether an optimist influences a pessimist or vice versa, dependent on the aggregate state of the economy. The idea is that it should be harder for an optimist to convince a pessimist to adopt his (the optimist's) state of mind if aggregate output is decreasing than if it is increasing, and vice versa.

Formally, the transition probability of K_t is described by the following expression:

$$K_t = \begin{cases} K_{t-1}+1 & \text{with probability} \quad p_{t-1}^{+} = \frac{N-K_{t-1}}{N}(\epsilon + (1-\delta_{t-1}^{P\to O})\frac{K_{t-1}}{N-1}) \\ K_{t-1}-1 & \text{with probability} \quad p_{t-1}^{-} = \frac{K_{t-1}}{N}(\epsilon + (1-\delta_{t-1}^{O\to P})\frac{N-K_{t-1}}{N-1}) \\ K_{t-1} & \text{with probability} \quad 1-p_{t-1}^{+}-p_{t-1}^{-} \end{cases} \tag{4}$$

with the interaction-driven probability from pessimism to optimism $\delta_{t-1}^{P\to O}$ and from optimism to pessimism $\delta_{t-1}^{O\to P}$ given by

$$\delta_{t-1}^{P\to O} = \begin{cases} \delta+\gamma & for \quad Y_{t-1}-Y_{t-2}<0 \\ \delta-\gamma & otherwise \end{cases} \tag{5}$$

and

$$\delta_{t-1}^{O\to P} = \begin{cases} \delta+\gamma & for \quad Y_{t-1}-Y_{t-2}>0 \\ \delta-\gamma & otherwise \end{cases} \tag{6}$$

respectively.

3 Results

The model presented in the previous section was analyzed using the Monte-Carlo simulation approach. The parameter values were $N=100$, $a^0=0.91$, $a^P=0.89$, $\delta=0.5$, $\gamma=0.45$, $\epsilon=0.05$ and $\bar{G}=10$.

Our main result – illustrated in Figure 1 – is the appearance of cyclical fluctuations of national income resembling those found in empirical data. Figure 2 displays the distribution of cycle-lengths. A cycle length is defined by two consecutive points at which Y_t crosses the long-time average value of Y_t in an upward direction.

It is important to note that neither of the two components of our model can reproduce such fluctuations on its own. Indeed, the Keynesian multiplier displays monotone convergence to its fixed-point value

$$Y(A) = \frac{\bar{G}}{1 - A}, \tag{7}$$

while the Kirman (1993) opinion process does fluctuate, but with an exponential distribution of cycle length.

Let us now briefly explain how the dynamics of the model comes about. We will do so using Figure 3. First, note that there are $N + 1$ equilibria in the multiplier model, corresponding to the average consumption-propensity taking a value in the range $a^P \leq A_t \leq a^O$. The situation where all consumers are optimistic (thus $A = a^O$), corresponds to the line segment denoted by K^{max}. If A were fixed at that level, the unique equilibrium of the Keynesian multiplier would be at $Y^{max} = Y(a^O)$. For all agents being pessimistic, we have the line denoted by K^{min} and the equilibrium $Y^{min} = Y(a^P)$. When A_t follows some dynamics bounded between the extremal values a^O and a^P (represented, for instance, by the line segments K_t^1 and $K_{t+\Delta t}^2$), Y_t will undergo the standard discrete-time multiplier dynamics (indicated in the figure for a few iterations), but with the line K_t changing its slope A_t.

If the change of A_t is slow relative to the multiplier dynamics - as is indeed the case in our model - the associated dynamics of Y_t is a quasi-equilibrium dynamics, because for each t, the output Y_t is close to the equilibrium value $Y(A_t)$. However, the dynamics of Y_t in our model is not driven solely by the stochastic process of A_t. Indeed, if we used the generic specification of the interactive process as specified by Kirman (1993), the cycle length would be exponentially distributed (since opinion swings follow a Poisson process in the Kirmann model). Since in our model cycle length is not exponentially distributed, there is also a fundamental feedback from the real-sector dynamics to the process itself.

This influence is most clearly visible if we focus on the change in the direction of movement of A_t. If A_t has increased in the previous periods, so has Y_t, and the increase of the latter, in turn, makes A_t more likely to continue to increase (because the probabilities of convincing are asymmetrical). But once A_t comes close to its maximal value, and the increase of Y_t slows down or comes to a halt, the transition probabilities are more likely to switch from $\delta^{P\to O} = \delta - \gamma$ to $\delta^{P\to O} = \delta + \gamma$ and from $\delta_{t-1}^{O\to P} = \delta + \gamma$ to $\delta^{O\to P} = \delta - \gamma$. Then, if a moderate decrease in A_t occurs, the self-reinforcing effect between Y_t and A_t takes place in the opposite direction.

4 Discussion

In our model, there is a bi-directional dependence between the real sector and the socio-economic "level" of interpersonal interactions. The latter determine the average value of consumption propensity and thus national income. In turn, the dynamics of the real sector impacts on the interpersonal process at the socio-economic level, determining its path-space distribution. We believe it is worthwhile emphasizing the implications of this bi-directional feedback structure for policy in this type of model. Whereas in those standard Keynesian models which display fluctuations in national income the government can affect the real sector by countercyclical spending, in our type of models there is an additional influence channel acting through consumer sentiment. Government action can affect the real sector directly, but it may also have an indirect effect through changes in consumer sentiment (for some preliminary results see Westerhoff and Hohnisch (2006)).

Finally, we would like to stress that it appears worthwhile to validate our simple business cycle model in a more serious fashion. This may be done either by calibrating the model such that it matches some prominent stylized facts of business cycle dynamics or – even better – by directly estimating its parameters. For literature on these issues, see Huellermeier et al. (1995) and Glaeser and Scheinkman (2001). Note that in the case of financial markets, some progress in estimating agent-based models has recently been achieved. The techniques applied in Westerhoff and Reitz (2003), Alfarano et al. (2005), Boswijk et al. (2006) and Manzan and Westerhoff (2006) may also be of interest.

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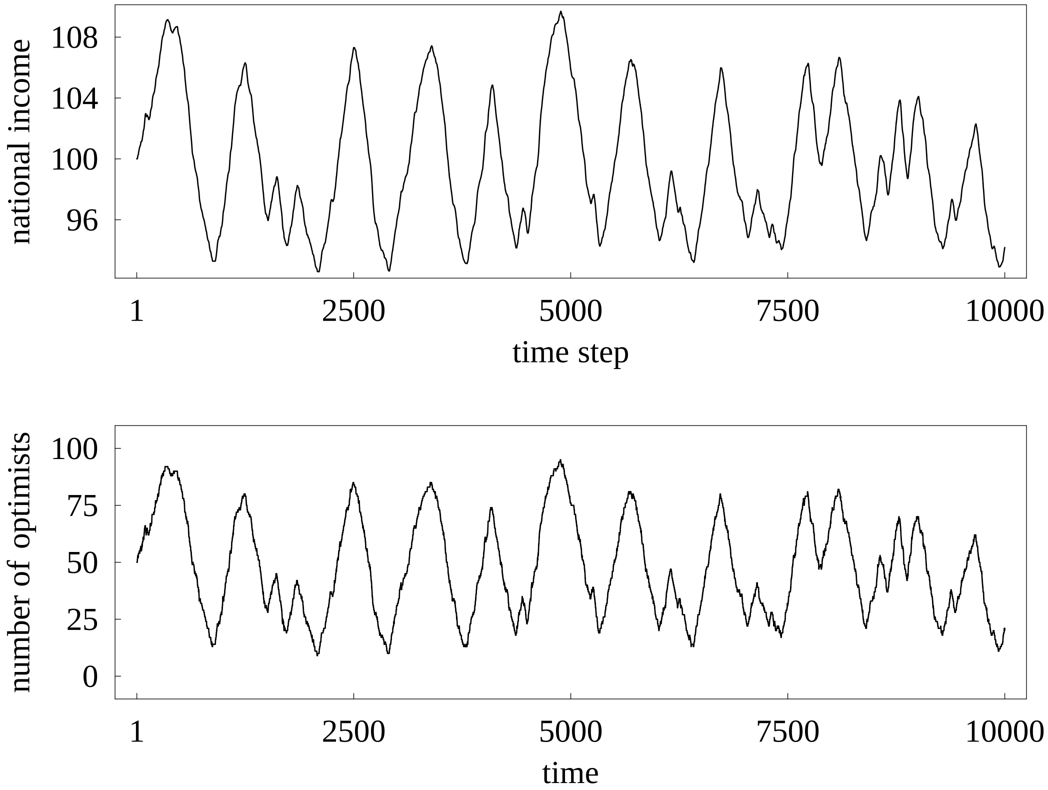

Figure 1: National income (top) und number of optimist (bottom) over time

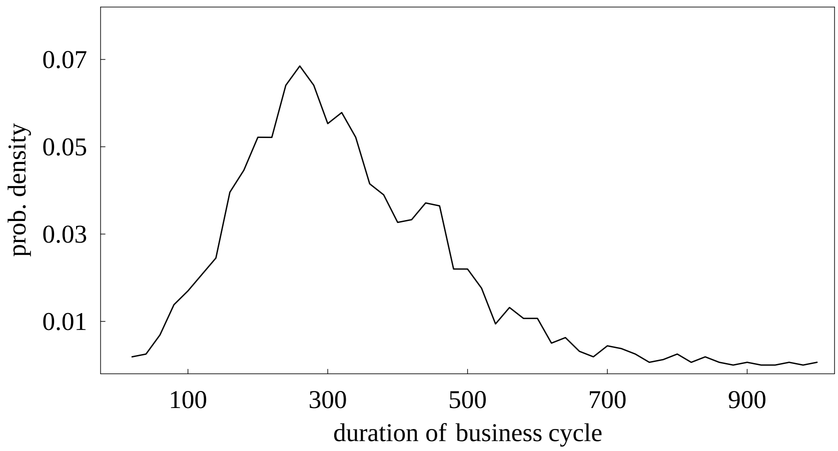

Figure 2: Distribution of cycle length for the time series shown in the top panel of Fig.1

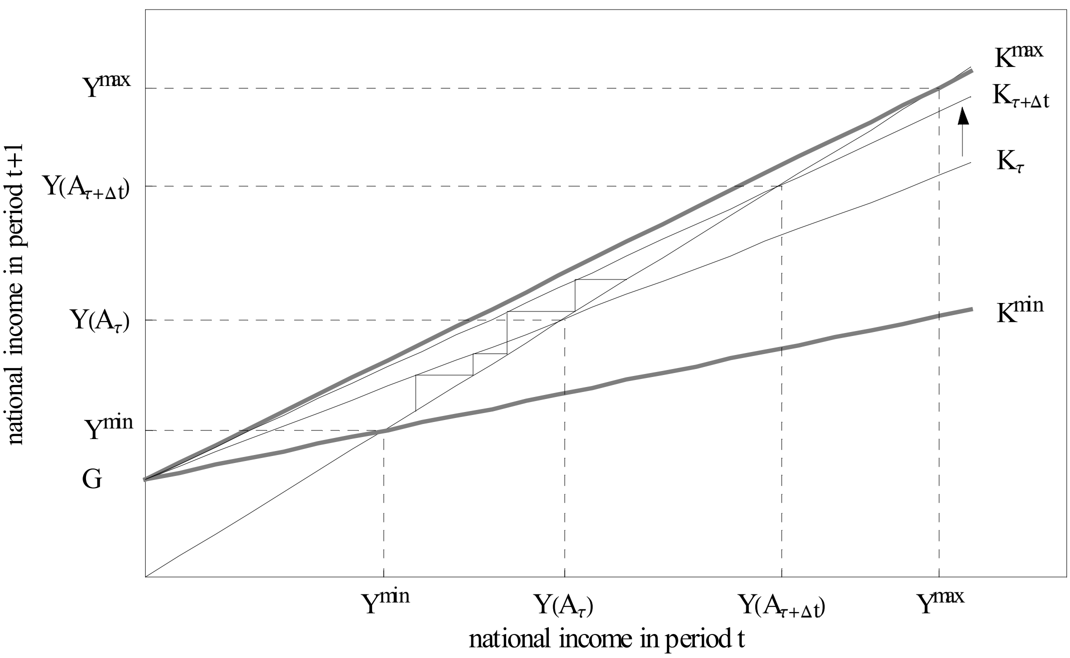

Figure 3: The Keynesian multiplier process with variable consumption-propensity (see Section 3 for explanations)