E C O N O M I C S  B U L L E T I N

# A Comment On Gintis's "The Dynamics of General Equilibrium"

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## *Abstract*

Gintis (2007, 'The Dynamics of General Equilibrium', Economic Journal 117 (523) , 1280–1309) provides an agent-based model of a Walrasian economy where the tâtonnement is replaced by imitation. His simulations show that the economy converges to the Walrasian equilibrium. Gintis concludes that 1) his stability results provide some justification for the importance placed upon the Walrasian model, and 2) models allowing agents to imitate successful others lead to an economy with a reasonable level of stability and efficiency. Since these conclusions appear to be intended as general, we caution that Gintis's findings can only be accepted for Walrasian models without capital goods; in models with capital goods imitation-based adjustments alter the equilibrium's data (which makes the demonstration of stability impossible) and raise other important problems (absent from Gintis's simulations) still awaiting exploration.

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## 1. Introduction

Professor Gintis must be congratulated for his study about the stability and efficiency role of imitative behavior in general equilibrium models. By means of agent-based simulations, Gintis (2007) shows that imitation can be a powerful mechanism fostering stability and efficiency in stochastic ergodic systems of traders, consumers and firms. In particular, Gintis provides evidence that, at least in some cases where (in spite of equilibrium uniqueness) the tâtonnement is unable to ensure convergence to equilibrium (Scarf, 1960), imitation produces convergence. The importance of this finding is reinforced by the fact that the adjustments based on imitation and error correction posited by Gintis provide a much more realistic description of adjustment processes than the tâtonnement fairy tale.

However, we find that the two general conclusions, drawn by Gintis on the basis of his study of the production model of sections 4 and ff., are too strong. Let us briefly review them. The reported simulations show that, under a wide range of initial parameter values, there is convergence to a nearly-full-employment steady state which closely approximates the quantities and relative prices of the Walrasian equilibrium of that economy. Gintis concludes that:

(i) [this result] 'provides some justification for the importance placed upon the Walrasian model in contemporary economic theory' (p. 1303),

(ii) 'models allowing traders, consumers, workers and firms to imitate successful others lead to an economy with a reasonable level of stability and efficiency' (p. 1304).

If valid in the general terms in which Gintis formulates them, these conclusions would be of extreme importance. But we claim that the scope of these conclusions is limited to the class of Walrasian models where production is carried out without capital goods. This is so, we will argue, in spite of the fact that in the production economy model there is a factor that Gintis calls capital, because this 'capital' is in fact land; therefore it is not proved that the convergence-to-equilibrium results apply also to Walrasian models where production includes the utilization and production of heterogeneous capital goods. In fact, we further argue, both conclusions become questionable, albeit not to the same degree, the moment the implications of admitting production with capital goods are considered; and for reasons of great relevance. Briefly, our arguments are as follows.

We argue in Section 2 that the extension of conclusion (i) to Walrasian models with heterogeneous capital goods encounters a logical difficulty. The Walrasian equilibrium[1] of an economy with utilization and production of heterogeneous capital goods, be it intertemporal or temporary, includes given endowments of the several capital goods among the data (endowments, preferences and technical possibilities) that determine it. But imitation requires time-consuming disequilibrium adjustments; then the stocks of the several capital goods in the economy will change during disequilibrium and, because of this, the adjustment process cannot logically prove the asymptotic convergence to the Walrasian equilibrium corresponding to the initial data,

[1] We will argue as if, given the data, the Walrasian equilibrium were unique. As professor Gintis freely admits, his assumptions on consumer preferences and on technology make it very likely that the model has a unique Walrasian equilibrium; this means that his result of convergence to a unique 'steady state' would need reassessment for models of economies without capital goods but with a substantial probability of multiple equilibria. But we do not further discuss this issue because we consider our objections based on the problems raised by capital goods to be more important.

depriving conclusion (i) of its foundation. Actually, as we explain at the end of Section 2, the implications of this observation point in a direction opposite to conclusion (i).

As to (ii), differently from (i) we emphasize in Section 3 that there are no logical reasons preventing conclusion (ii) from being valid for economies with capital goods. Actually, we think that the exploration of the validity of (ii) for economies with capital goods would be an interesting investigation to carry out. However, in such an investigation the presence of capital goods utilized and produced, coupled with the need to admit time-consuming (or, as we prefer to say, *non-virtual*) adjustments as required by imitation, would oblige one to tackle problems (e.g. what determines investment decisions) that do not arise in Gintis's model, and for which the potential implications of the realistic imitation-based adjustments considered by Gintis will depend on theoretical choices on which there is an ongoing debate, so that the validity of (ii) becomes a totally open question. Gintis's apparent interpretation of (ii) as also valid for economies with capital goods is therefore unsupported. We conclude our comment on Gintis's article with a brief illustration of two of these problems and of some of their potential implications.

**2. On Gintis' First Conclusion**

Gintis writes that the goods in the model of his Section 4 are produced by labour and capital, but the model includes no production nor depreciation of capital goods, and thus also no investment decisions and no need to reach an equilibrium between savings and investment; thus it cannot be capital he is talking about[2], it must be some indestructible, non-produced factor such as a type of land. In other words, Gintis's model is one of production with labour and land, not capital.

An extremely important aspect of models of production without capital goods among the factors is that the data that determine the Walrasian equilibrium can be assumed, with some plausibility, to be unaffected by the implementation of disequilibrium productions and exchanges. These data are tastes, technical knowledge and the factor endowments of consumers. As a first approximation, one can assume that tastes and technical knowledge are unaffected by disequilibrium productions and exchanges. Since factor endowments do not include produced goods, one can assume that the total endowment of each factor is unaffected by disequilibrium productions. If one further assumes that lands and other natural resources can be rented but not alienated[3], it is then legitimate to compare the Walrasian equilibrium with the outcome of any realistic adjustment process requiring the implementation of disequilibrium productions and exchanges. If the adjustment process results in the economy gravitating towards a state which is reasonably close to the Walrasian equilibrium, then one can argue that the assumed adjustment process, not the auctioneer fairy tale, provides some justification for considering the Walrasian equilibrium a good indication of the

[2]An Addendum to the present Comment, that critically discusses a possible defence of the treatment of capital as analytically identical to homogeneous land, is available at the web page of either author: www.econ-pol.unisi.it/bilancini, www.econ-pol.unisi.it/petri.

[3]In the history of neoclassical theory the effects on equilibrium of redistributions of land ownership due solely to disequilibrium transactions appear to have been universally considered negligible, and with good reason, it would seem; redistributions of land property are mostly very slow and gradual, and when not, they are not due to disequilibrium but rather to political or other cataclysmic changes, to which the method of comparative statics should be applied.

tendential result of market forces. This is what Gintis does and, we are arguing, legitimately so for production economies without capital.

However, the situation is radically different when we turn our attention to economies with capital goods. In fact, introducing capital goods as factors of production in a Walrasian framework forces the equilibrium's data to include endowments of the several capital goods[4]. This inclusion renders necessarily negative the answer to the question, can the Walrasian equilibrium corresponding to those data be seen as the asymptote of realistic adjustment processes allowing for the implementation of disequilibrium productions and exchanges? Any such adjustment process would inevitably alter the quantities of the several capital goods in the economy and, hence, that group of data[5], rendering therefore nonsensical the question of stability of equilibrium with respect to that type of dynamics. It makes sense to talk of convergence to, and stability of, an equilibrium only if the givens determining the equilibrium are not influenced by the dynamical law governing the system.

Now, Gintis's adjustment process is definitely one of those that would alter the data of the Walrasian equilibrium of an economy with capital goods. Imitation requires that disequilibrium actions be implemented and their consequences be observed (as indeed they are in Gintis's analysis), and this takes time[6], during which time the endowments of capital goods can change significantly[7].

These observations have implications for an opinion expressed by Gintis in the opening lines of his article, where he argues (p. 1280) that the auctioneer assumption survives "because no one has succeeded in producing a plausible decentralized dynamic model" for Walrasian equilibrium models. It seems to us that an even more important cause has been some perception of the logical difficulty we have pointed out. The very origin of the 'auctioneer', the introduction by Walras – in the 4th edition of his *Eléments*

[4]The given vector of endowments of capital goods is precisely what these models have in common with Walras' original model with capital goods (which, however, was neither an intertemporal nor a temporary equilibrium model, cf. Petri, 2004: ch. 5) and is the reason why here we accept to call them Walrasian in spite of their differences from Walras.

[5]One encounters, in fact, the problem highlighted by Franklin M. Fisher when writing: "In a real economy, however, trading, as well as production and consumption, goes on out of equilibrium. It follows that, in the course of convergence to equilibrium (assuming that occurs), endowments change. In turn this changes the set of equilibria. Put more succinctly, the set of equilibria is path dependent ... [This path dependence] makes the calculation of equilibria corresponding to the initial state of the system essentially irrelevant." (Fisher, 1983, p. 14).

[6]Indeed, considerable time, since in Gintis's simulations goods are produced each period and it must take some time to produce them (in fn. 5, p. 1297, Gintis interprets his period as representing a month), and adjustments take hundreds of periods. Thus Gintis calls 'long-run market clearing prices' (p. 1282) the prices his adjustments converge to. But in economies with heterogeneous capital the determination of long-period, or long-run, relative product prices goes necessarily together with an endogenous determination of the composition of capital, which is the reason why traditional marginalist analyses (e.g. Wicksell) did not take as given the endowments of the several capital goods and had then to take as given the total endowment of 'capital' conceived as a single factor of variable 'form', an amount of exchange value - the conception of capital nowadays universally recognized as indefensible.

[7]Nor can the relevance of this problem be decreased by suggesting that the change in the capital endowments might be small, because even if small it might still cause drastic alterations of prices (Garegnani 1990, pp. 57-58), and furthermore it is easy to conceive cases (e.g. circulating capital goods specific to a production method which is abandoned during disequilibrium) where the change might be very rapid.

– of the provisional 'tickets' in a tâtonnement originally conceived as taking time and involving actual disequilibrium productions, was due to that difficulty: Walras explicitly indicates that the advantage of the 'bons' is to avoid changes in the endowments of capital goods during the groping toward equilibrium (Walras 1954, p. 282, §251; 1988, p. 377). And, although sometimes only implicitly, the difficulty has been admitted by numerous authors.[8] On this basis, we suggest, one can better understand why there has been so little attempt even *to try* to do without the auctioneer for economies with capital goods.[9] Indeed, the moment one drops the tâtonnement and admits that adjustments inevitably take time, it is unclear what 'stability' of an intertemporal or temporary equilibrium can mean.

We can now assess the implications of the above considerations for Gintis's conclusion (i). The 'importance placed upon the Walrasian model in contemporary economic theory' would not be there if the Walrasian equilibrium approach were not considered applicable also to economies with capital goods. The Walrasian models of pure exchange and of production without capital are only simpler introductions to a theory whose usefulness would be quite small if its generalization to include capital goods were not possible. Therefore results not generalizable to the Walrasian models of economies with capital goods cannot justify the importance nowadays attributed to the whole class of Walrasian models. Unfortunately, as pointed out above Gintis's convergence result suffers precisely from such non-generalizability. Indeed and somewhat paradoxically, Gintis's insistence on the need to drop the auctioneer and to admit non-virtual adjustments goes in a direction opposite to that suggested by his conclusion (i). By arguing in favour of adjustment processes that take time and require the implementation of disequilibrium production decisions, Gintis implicitly argues against the capacity of Walrasian models to indicate the state toward which market forces cause economies with capital goods to tend: realistically conceived disequilibria necessarily alter the equilibrium's data, and in directions that Walrasian equilibrium theory cannot indicate because it is silent on what happens in disequilibrium, then the theory is unable to indicate the tendencies of economies not continuously in equilibrium. It seems to us that this amounts to a serious questioning, rather than 'some justification', of 'the importance placed upon the Walrasian model in contemporary

[8] F. M. Fisher (cf. footnote 5) admits changes in endowments due to disequilibrium productions. With reference to temporary equilibrium, Bliss writes: 'there might not be enough time within the space of a [Hicksian] "week" for prices to adjust to an equilibrium' (Bliss, 1975, p. 28), a cause for worry only if from one 'week' to the next the data of equilibrium are going to change significantly, which, as pointed out in the text, will not be the case for economies without capital goods. Arrow and Hahn find it difficult to abandon the tâtonnement because, they note, at disequilibrium prices not even planned *intentions* can be all carried out, which makes the results of non-virtual disequilibrium particulary difficult to determine, 'and it is a special feature of what we shall call a tâtonnement that it sidesteps this difficulty' (Arrow-Hahn 1971, p. 264): this admitted indeterminability of the results of non-virtual disequilibrium implies that the economy (including the capital endowments) would go off the equilibrium path, and in unpredictable directions.

[9] We are aware of a single neoclassical author attempting such a task, F. M. Fisher (whose researches on the topic, motivated by the observation quoted in fn. 5 above and culminating in Fisher (1983), end up essentially in defeat: cf. the negative assessment by Fisher himself in Fisher 2003, p. 91; also Petri 2004, pp. 48-49, 67-71). This is all the more striking since there has been, on the contrary, a number of adjustment models that do without the auctioneer for pure exchange economies (a very recent one is Axtell 2005); the absence of attempts to extend them to economies with capital goods would appear to confirm the impossibility of the task within a Walrasian framework.

economic theory'.

### 3. On Gintis' Second Conclusion

We have already said that we find Gintis's conclusion (ii) acceptable, as long as it is restricted to models without capital goods. Moreover, and differently from conclusion (i), we see no logical reason preventing (ii) from possibly holding also for economies with capital goods, and no doubt an investigation of such a question would be very important. But it seems clear to us that on this question very little can be inferred from Gintis's present simulations. In order to motivate this view, we proceed to point out some very important open problems, absent from the framework of Gintis's simulations, that unavoidably prop up in a study of economies with capital goods where adjustments are non-virtual.

We see no reason to doubt that also in a model with capital goods firms' adjustments as formalized by Gintis will lead to the same adaptation of productions to demands for the several produced goods, at prices covering normal costs on average, that he obtains for his model. Indeed we see Gintis's formalization of firms' decisions as in line with textbook Marshallian analysis of long-period industry adjustments. Note that, importantly, this process will *endogenously* determine the quantities produced and the inventories of the several capital goods existing in the economy; these will result from an adaptation to the firms' demands for capital goods. However, the implied capacity of the composition of production to adapt to the composition of demand is not the same thing as 'an economy with a reasonable level of stability and efficiency'. Stability requires absence of strong fluctuations of aggregate demand, and efficiency requires a tendency toward the full employment of resources, in particular of labour. Here problems prop up in the economy with capital goods that are absent in the labour-land economy, and on which Gintis's exercise does not help us.

We may start from labour employment. In Gintis's model wage flexibility ensures a tendency toward the full employment of labour because firms increase the proportion of labour to 'capital' when the real wage decreases, and the total endowment of 'capital' is given (and fully employed by assumption). Relative to this, one striking difference made by the presence of heterogeneous capital goods in amounts determined endogenously by demand is that, when looking for the effects of changes in wages, one no longer has the right to take as given the endowments of the factors other than labour. The implications are of great importance, not only for Gintis-type simulations but, it would seem, for economic theory in general. The system of general equilibrium equations becomes indeterminate; hence an equilibrium real wage can no longer be determined; and given the real wage, labour employment is still not determined[10], and with Gintis-type industries it will certainly depend on aggregate demand to some extent, since those industries tend to adjust production to demand. Then also the effect of wage flexibility on labour employment will depend on its effect on aggregate demand[11].

Thus, it would seem, the results of Gintis-type simulations applied to an

[10]The determination of labour employment on the basis of a parametrically given real wage in a fully disaggregated general equilibrium system is the basis of the traditional labour demand curve; it consists, essentially, of determining the equilibrium real wage associated with a parametrically given labour supply, and then interpreting the latter as the demand for labour and hence the labour employment that would result from that real wage. Such a determination becomes impossible if the endowments of some factors are not given.

economy with capital goods will relevantly depend on what determines aggregate demand. Now, it seems clear that in such an economy Gintis-type adjustments imply the (dynamic) Keynesian multiplier. This is because the constraint on the purchasing power of consumers deriving from their *actual* income (i.e. from whether they have found purchasers for the factor services they offer) implies the existence of some form of Keynesian consumption function. Then much will depend on what determines the autonomous components of aggregate demand − investment, first of all. Now, notoriously the theory of aggregate investment is a field characterized by considerable uncertainty and disagreement. Therefore there seems to be no generally agreed way to introduce investment decisions into Gintis-type simulations; and yet, much will depend on what is assumed in this respect. For example an accelerator theory of investment, coupled with imitative behaviour, might well cause ruinous multiplier-accelerator interactions.

The above considerations make clear that the consequences of abandoning the auctioneer and introducing time-consuming imitation-based adjustments in models of economies with capital goods can only be assessed after taking sides on some relevant open problems of current economic theory. For the moment, one can only say: we don't know. In conclusion, Gintis's claim about the capacity of imitation to induce stability and efficiency must be interpreted as supported by his analysis only for economies without capital goods.

This is what we intended to prove in this Section, but we consider it even more important to have shown, in the process, some of the striking implications of the admission of non-virtual adjustments in economies with capital goods. These implications reinforce the conclusion of Section 2: Gintis's commendable insistence on the need to abandon the auctioneer and to admit time-consuming adjustments has implications that, far from supporting the Walrasian approach, reveal a need to depart from it and, in particular, to admit that quantities of capital goods are endogenously determined, with all the consequences of such an admission.

[11]The assumption itself of wage flexibility may need reconsideration if it is unable to bring the economy to (near-)full employment in reasonable time and without too drastic a fall in real wages. The empirical evidence, for example Bewley (1999, 2005), certainly does not support the assumption of indefinite wage flexibility; nor does imitative behaviour necessarily entail it.

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