

ECONOMIC GROWTH IN A MICRO-MACRODYNAMIC SIMULATION MODEL

Mario Possas*, Esther Dweck**

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Abstract

The purpose of this paper is to present some recent simulation results of the micro-macrodynamic model developed by the authors, focusing on the economic growth trend properties and their determinants, including microeconomic factors that can be explored within the model. This simulation model tries to integrate in the same setup effective demand-based macrodynamics with structural and sectoral features that may generate emergent properties. Each sector is modeled on the basis of neo-Schumpeterian evolutionary microfoundations, with additional micro behavioral assumptions, and are put together with exogenous foreign and government sectors into a multisectoral model. The simulation results focused in the paper give an idea of the trend path generated by the model, namely a somewhat irregular long run growth trend essentially determined by the autonomous components of the aggregate demand –investment and consumption, public expenditures and net exports –, as in the tradition of growth models based on dynamic properties of effective demand, and not by some kind of supply shock as in mainstream models.

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* Institute of Economics (IE), Federal University of Rio de Janeiro (UFRJ), Brazil.

** Dep. of Economics, Fluminense Federal University (UFF), Niterói, RJ, Brazil; fellow researcher at IE/UFRJ.

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1. Introduction

The purpose of this paper is to present some recent simulation results of the micro-macrodynamic model developed by the authors¹, focusing on the economic growth trend properties and their determinants, including microeconomic factors that can be explored within the model.

The theoretical assumptions² and the structure of the model have been extensively discussed in Possas; Dweck (2004), Possas; Dweck (2006) and Dweck (2006). To put it briefly, it is a micro-macro multisectoral evolutionary simulation model in which microeconomic features are explicitly introduced at the sectoral level – *e.g.* technical coefficients, input-output relations, import coefficients, technological opportunities – as well as at firm level – *e.g.* price and production strategies, productivity, profitability, long and short run expectations, investment and financial constraints, process and product innovation strategies.

The main features of the model are: (1) simulated sectoral trajectories of a stylized economy derive from endogenous competitive dynamics as well as direct (input-output) and indirect (income, consumption) interactions; (2) sectors are distinguished according to their role in the productive structure and demand categories – consumption, intermediate and capital goods; (3) no equilibrium is assumed: dynamic interactions among firms' decisions (based on adaptive expectations) and their effects generate open-ended trajectories.

As a result, macro and sectoral dynamic properties are drawn, such as sector output and demand paths with both cycle and trend components, and the aggregate behavior of income distribution. These results widely confirm, although with several provisos, the general predictions of the neo-Keynesians and Kaleckian business cycles models, built on much simpler aggregate framework. The micro-macro structure of our model allows for more detailed results and especially to test the macro effects of some specific micro elements, such as processes and decisions at the firm or sector level.

¹ Evolutionary Economic Dynamics Research Group - IE/UFRJ, Brazil. The first version of the model was published in Possas, Dweck (2004), and a second one, with further macrodynamic simulations, in Possas, Dweck (2006). The current version was discussed in Dweck (2006, PhD thesis), including the simulations shown in this text. The sectoral model was first presented in Possas, Koblitz *et al.* (2001) and its macrodynamic part in Possas, Dweck e Reif (2004) and Reif (2006), which is based on the original multisectoral dynamic analytical model by Possas (1983, 1984).

² Main references are Nelson e Winter (1982), Simon (1979), Silverberg (1987), Silverberg *et alii* (1988) at the micro level and Keynes (1936), Kalecki (1954), Minsky (1975) at both the micro and the macro ones.

In what follows, section 2 briefly discusses some methodological features of the simulation model and the aim of the selected simulation runs. In section 3, more extensive, we discuss, first, the basic macrodynamic properties replicated by the model, especially those concerning long-run growth trends; then, some microdynamic properties of the benchmark simulation run; and finally, the influence of some micro assumptions on the general growth trend. A brief conclusion follows.

2. The micro-macrodynamic simulation model

a. Methodological assumptions

The combination of evolutionary assumptions, in which agents adopt creative and adaptive behavior, with structural endogenous change, which generates out-of-equilibrium and open trajectories (non-ergodicity) allows to consider capitalist economy as a complex evolutionary system (Allen, 1998). Given this assumption, non-linearities become relevant and stable equilibria an exception, so the use of computer simulations (numerical calculus) may be more appropriate than analytical solutions from a methodological standpoint.³

Simulations are capable of generating trajectories which depend on initial conditions and specific parameter values, so as to test them in a more or less systematic way. But such features, often appreciated by non-orthodox economists who deal with modeling, have very small appeal to orthodox economists. The obvious *trade-off* between simplicity and realism – or, from a different angle, between tractability and relevance – has no optimal solution irrespective of theory or assumptions adopted for the subject of analysis. Therefore, among model builders, the usual preference of *mainstream* economists for analytical solutions is strongly correlated with their exclusive focus on equilibrium solutions, while the preference of evolutionarily oriented non-orthodox economists (especially neo-Schumpeterians) for simulations is associated to a low confidence on equilibrium positions as representative states of open dynamic processes.

From our standpoint, simulations are instruments, potentially powerful, to elaborate theories on complex systems, such as the capitalist economy. The main purpose of a simulation is to test theories on complex processes, more specifically investigating the dynamics emerging from the hypotheses and parameters introduced in the model, instead of replicating real phenomena⁴. This involves not only to restate some expected results – and to verify the conditions under which they take place –, but also to find out new properties. The

³ Dweck (2006), III.1 to III.3 (p. 129-138). A deeper analysis may be found in Valente (1999).

⁴ In this sense it keeps away from so-called “*history-friendly*” models.

relevance of simulations for the latter objective results from such (“emergent”) properties not only being unintuitive, from the sheer complexity of the processes involved, but also from often not being able to obtain from mathematical solutions without introducing too strong simplifications as to become potentially harmful for the reliability of the results or their interpretation.

Since our model includes both determinist and (fewer) stochastic variables, the simulations shown ahead will exhibit three main factors generating variety: changes in initial conditions and in parameters, as usual, but also in the random seeds employed. Instead of an extensive and systematic analysis such as the Montecarlo one, we chose to perform a much simpler one: to replicate the same configuration for a limited number of runs, in order to detect the stochastic variability. Although the number of replications was not statistically high, the stochastic component of the model is practically reduced to technological success of firms, so that changes in initial conditions and in parameters remain the chief ones.

Finally, since the basic aim of such simulations is atheoretical one - to assess the plausibility of hypotheses and to identify dynamic attributes of trajectories and of their regularities, the model is not intended for prediction or to anticipate results that could be tested empirically.

b. Indirect calibration method

Initial conditions in this model represent an economic heritage from the past. If they affect the path, then the model is called *history-dependent* (Dosi, Orsenigo, 1994, p. 98). Before going into the analysis of results, therefore, it is important to acknowledge how initial conditions were set.

The method adopted here may be defined as an exercise of indirect calibration - an adaptation of the method proposed by some models of the “*agent based*” kind. It consists mainly in four steps: (1) definition of which stylized facts are expected to be reproduced or explained within the model; (2) utilization of all available information on parameters of direct economic meaning and on initial conditions so as to reduce the parameter space to be effectively tested; (3) if the model is non-ergodic (as in this case), the parameter space is again reduced to values consistent with proposed stylized facts; and, most importantly, (4) to enlarge the knowledge of causal mechanisms which generate the stylized facts and to explore possible unforeseen emergent properties. Point (2) suggests more descriptive models (the more descriptive, the greater the number of parameters with direct economic meaning, for which a limited interval of possible values may be known in advance. In other words, more

descriptive models, despite seeming to possess more degrees of freedom, may have a narrower parameter space.

This calibration method is far aside from the one proposed by Real Business Cycles economists (Kydland e Prescott, 1982). Although both employ empirical data to determine the value of parameters, the basic procedures are very different. RBC calibration involves the quantitative replication of some empirical results, estimating parameters not within the model itself but from an independent source or chosen as to ensure that the model may replicate some features of the data. The validation of the model depends on the comparison of predicted variance and covariance of several series generated by the model with those of real data. The focus is then put on quantitative replication and prediction, *i.e.* in the opposite direction of the one adopted in our model.

Parameters and initial conditions in this model may be divided into three groups⁵: (i) parameters and variables for which an educated guess may be given, based on empirical data or in economic consistency criteria which limit possible value ranges⁶; (ii) parameters for which no source for estimation exists or whose possible range is too wide and therefore had their figures tested according to step (3), above, of indirect calibration; and (iii) values endogenously determined so as to avoid creating an initial trend in the model⁷.

Variables and parameters of the *first* group are: domestic and imported input coefficients; incremental capital/productive capacity; proportion of consumption and investment on GDP, as well as GDP; wage productivity; direct and indirect tax rates; desired proportion of inventories; import and export coefficients; marginal propensity to consume by income class; degree of initial indebtedness of firms; government expenditure; primary budget surplus target; depreciation rate; income distribution parameters to convert functional into personal income distribution.

Variables and parameters of the *second* group are: number of firms in each sector; expectations parameter; distribution parameters of pass over from inflation and productivity gains to wages; desired degree of capacity utilization; desired liquidity parameter; maximum accepted debt ratio; technological parameters; distributed profits rate; exports growth rate; money wages growth rate; *payback* period; interest rates; foreign prices rate of increase.

Those belonging to the *third* group are: demand towards intermediate goods sectors; amount of income of each income class; net surplus of sectors; initial *mark up*; initial

⁵ A complete list may be found in Appendix I of Dweck (2006).

⁶ Data for Brazil, particularly from Brazilian Institute of Geography and Statistics (IBGE), were widely used.

⁷ For this purpose a separate archive for the initial conditions was created.

productive capacity; total taxes; initial *market shares*; debt and financial assets of income classes and firms; initial autonomous consumption⁸ and investment⁹; initial capital stock acquisition dates (“vintages”).

Lastly, the main stages of this model were: (1) implementation of programming code; (2) analysis of a single run; (3) statistical analysis of multiple runs; (4) exploration of parameters; (5) control of the model’s specification; (6) display of results. No doubt, there is a large interaction among points 1 to 4. Variables were extensively presented in Dweck (2006), cap. II; technical details were not presented but may be checked in electronic files¹⁰.

3. Simulation results: the growth trend components

The interactions generated by the model include both trend and cycle elements, and their effects are not easier to distinguish than it would be in any empirical analysis. In general, it is not possible to isolate the effects of trend and cycle and to analyze the theoretical (causal) distinctions among them. Therefore, in what follows trend and cycle will have the usual statistical and empirical, not theoretical, meaning. In order to decompose the series we applied a bandpass filter¹¹ and separated the series in three components: trend, cycle and noise (irregular fluctuations).

In the analysis we made elsewhere of the cyclical component (Possas; Dweck, 2006), two general theoretical points called attention: firstly, as in neo-Keynesian and Kaleckian models, the regularity of the main observed fluctuations is explained, in very broad lines, by the lagged dual effect of investment, stimulating demand in the short term through multiplier effects and adding productive capacity in a longer term, whose eventual utilization may exceed or lag the desired level, propagating the original impulse. Secondly, a comparative analysis of simulations under different assumptions showed that the relative stability of the fluctuations, unlike traditional aggregate neo-Keynesian models, was due to a much more complex investment function, where the usually explosive accelerator effect is balanced by the influence of the degree of capacity utilization and by a very effective financial constraint.

⁸ Defined so as to keep a given initial average propensity to consume.

⁹ A positive initial level was set to avoid a growth trend from the beginning. After about 50 periods this value is replaced by the endogenous investment levels. For this reason, in many runs the first 50 periods is omitted.

¹⁰ <http://www.ie.ufrj.br/gedee/artigos.htm>. Stylized facts are detailed in Dweck (2006), section III.5, from p. 140 on.

¹¹ Baxter, King (1995). The parameters of the filter were the usual ones (6, 32, 12). Other values were tested with similar results.

In the simulations that follow, we will try to analyze the link between macroeconomic paths and technological progress. The main point of this paper is to explain the causal mechanisms implicit in the model that account for the long run growth. In a few words, to explain how technological change influence the growth trend, focusing the role of demand, the determinants of investment and the role of financial constraints.

Under neo-Keynesian and Kaleckian traditions, the main possible determinants of long run trend¹² are associated with autonomous expenditures. The chief ones are aggregate demand effects of structural changes, expressed as autonomous changes in: (i) gross investment, particularly related to process and product innovations; (iv) consumption, related (but not only) to product innovations; (ii) exports, given the growth of foreign income and the evolution of competitiveness; and (iii) government expenditures. In the next sections, each of these components will be discussed separately.

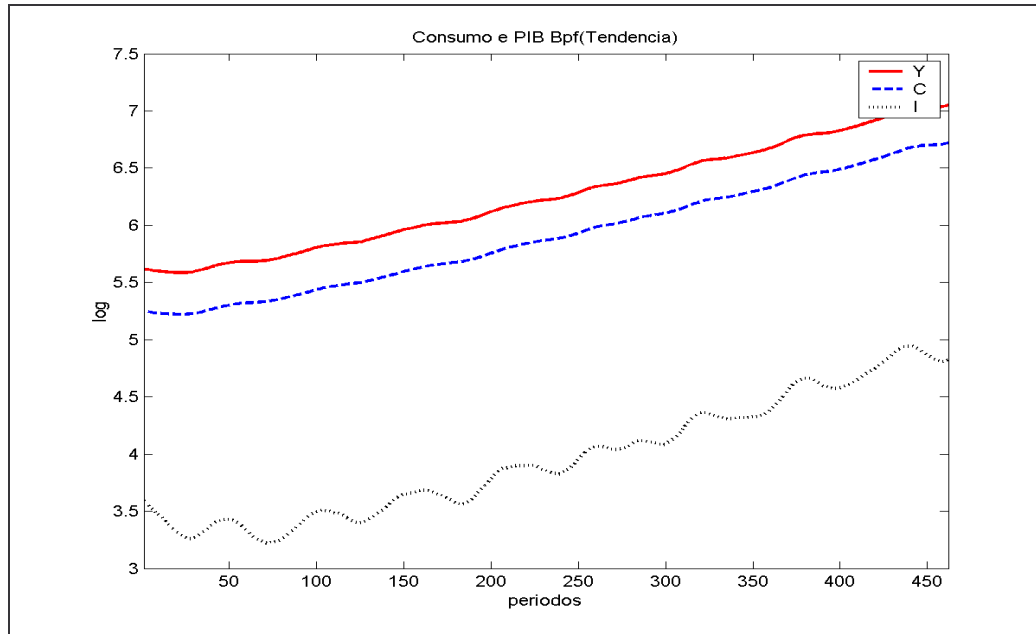
a. Benchmark simulation

The following specifications may be changed according to different simulation hypotheses. In the benchmark setup for this model, there are four sectors and four income classes. The sectors are: consumption (one), intermediate (two) and capital (one), with different number of firms - 10 for the last three sectors and 20 for the consumption goods sector. All firms are identical in each sector, including their technological and price strategies. All firms invest in R&D in order to obtain product and process innovations or to be able to copy the best practice or the best product. Consequently, the emergent differences among the firms result from the stochastic and cumulative forces present in the model. Every four periods, the wage level for each sector is corrected by the sector's average productivity gain and the inflation rate. The total amount of government expenses is determined, given the primary surplus target¹³, by the difference between the expected taxes (corrected by the expected growth rate) and the target surplus, subject to a minimum level determined by the amount of public sector real wages, set initially at some fixed proportion of the government expenses. Each simulation step is equivalent to a production period for all sectors, except the capital good sector, since the investment period is composed of six production periods.

¹² For a more robust analysis a low pass filter should have been applied to isolate the trend component. However, even a rough visual description is sufficient to point out some results that will be briefly commented.

¹³ A rule for changing endogenously this target may be subject to simulations.

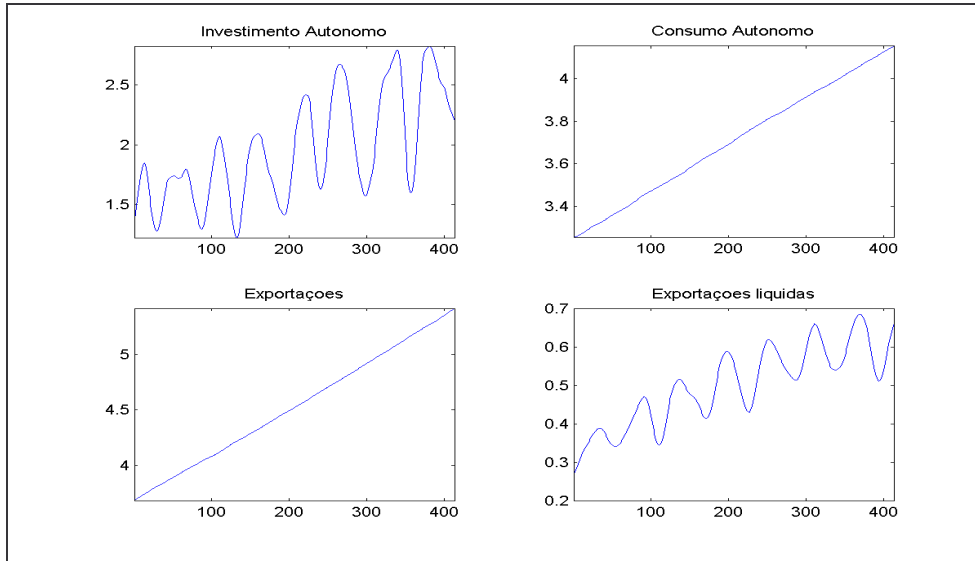
Figure 1 – Trend components of GDP, consumption and investment



As can be seen in Figures 1 and 2, all trend components described above, as expected, have grown. Given the foreign multiplier parameters, such as the propensities to consume and to import associated to each sector, the GDP growth rate will be a weighted average of the growth rate of the autonomous components described above. Government expenses were not plotted in Figure 2, because in the benchmark setup they are basically endogenous.

Although all components present an increasing trend, their volatility is very different. Both autonomous consumption and exports present a stable trend, given the way they were incorporated in the model. Exports are determined by a fixed coefficient, over the “rest of the world” income and the corresponding income elasticity. This simple form captures both the general international situation, expressed by the world income, and the sector-specific conditions expressed by the export coefficient and elasticities. Autonomous consumption is determined endogenously according to the product innovation success which is stochastic; however, the growth of the “average quality” of consumption goods is relatively stable. The autonomous investment is the most volatile since it depends not only on the technological success but also on the pay back period rule and it is subject to a tighter financial constraint.

Figure 2 – Trend component of autonomous expenditures



Obs.: Trend components in figures above are plotted in natural logs.

In current neo-Schumpeterian models, which focus mainly on the *supply* side, the chief element of the long run trend is technological innovations, but in a different sense than in Kalecki's and Keynesian models, as well as in the present model, where the *demand* side is the main dynamic drive of the economy. In the presence of innovations, demand could seem not to play a role of its own neither in the trend nor in the cycle (as in RBC models). But in order to generate long run growth, from a Keynesian macro perspective, innovations must necessarily influence one of the demand components.

In the following sections we approach separately each one of the components: process and product innovations, the government expenditures and exports. In order to isolate the effect of each one of them, the parameters and initial conditions of each block will be varied. The objective is to point out the causal relations and to present some tests allowed by the model.

b. Technological innovation

As discussed above, most endogenous growth models, neoclassical or evolutionary, emphasize technical progress, but leave out a central aspect: the demand components that actually explain how technical progress can influence the growth performance of the economy, as pointed out by Kalecki (1962). However, as mentioned above, technical innovation has an important impact on autonomous expenditures; therefore, it may influence the economic growth according to their relative weight, which varies among different economies and during time.

To capture the dynamic effects of process and product innovations, a micro-macro approach is needed, since they depend on complex interactions between investment decisions,

technological outcomes and financial constraints at the microeconomic level. Financial constraints influence the autonomous investment (related to innovations) in a way not much different from its influence on induced investments. The main difference is that, while both induced investments and financial constraints are a function of the level of activity, autonomous investment is a trend component, so that it co-determines the long run level of activity. However, in order to play this role, it cannot be fully limited by financial constraints. In what follows, product and process innovations will be discussed separately.

i. Process innovation

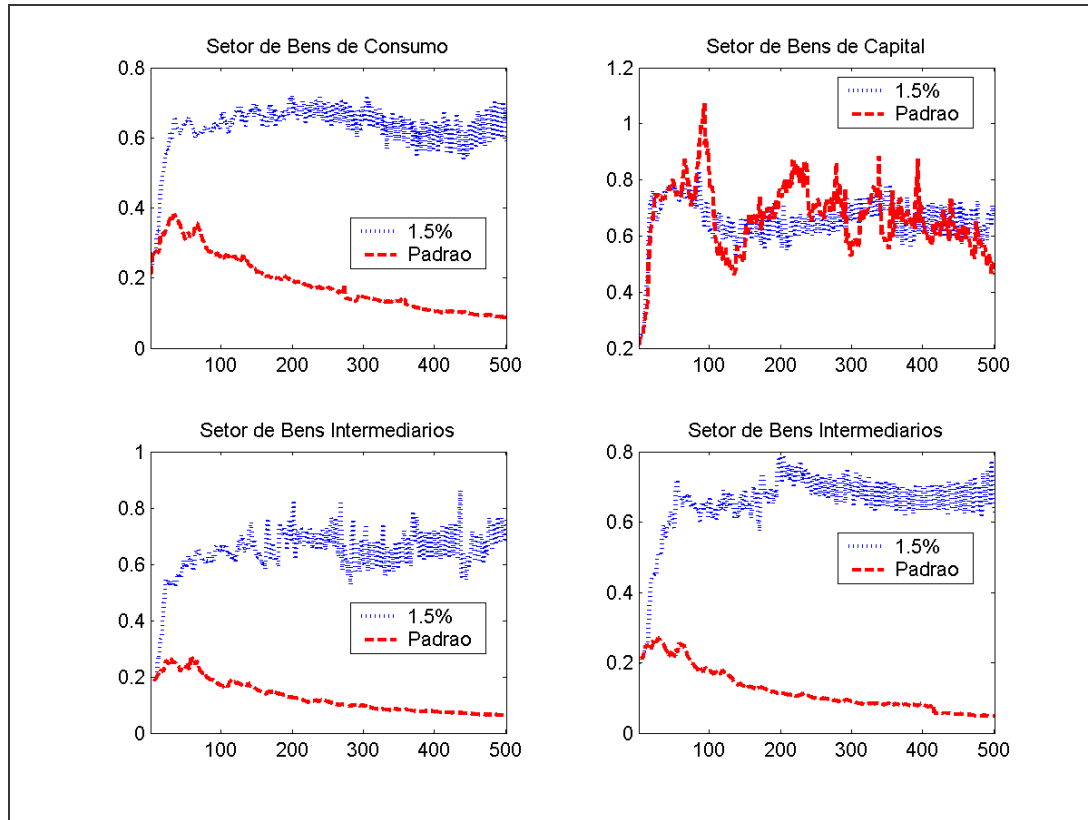
Process innovation stimulates gross investments by accelerating technical obsolescence of capital goods. Its net effect on investment depends on the balance between the positive effects of innovation diffusion among competitors and the negative effect due to market share losses. In order to assess this net effect, all other trend components are removed: external income growth; product innovation and its impact on autonomous consumption; and the exogenous growth rate of public wage expenses¹⁴. When their effects on trend are removed, they still contribute only to set a floor to fluctuations.

In the first simulation, all trend components except investment were kept constant, and technological parameters (growth rate of latent productivity and R&D expenditures) were set as in the benchmark simulation¹⁵. The main results were: the absence of any trend; and an increase in the average debt ratio (debt to total capital) for all sectors. The next test was to accelerate technological obsolescence by increasing the growth rate of latent productivity: (i) 0.7% p.p. for all sectors; (ii) 1.5% p.p. for all sectors; and (iii) 0.7% p.p. for consumption good sector and 1.5% p.p. for the rest. As a result, there was an increase in the average GDP level, but there was still no growth trend. This could be explained by the financial constraint binding in all sectors. As can be seen in Figure 3, under the parameters (ii) above, the debt ratio of all sectors fluctuates around 60%, with a peak at 80%. Notice that firms only consider acceptable a ratio up to 60% and that firms which keep 100% during 6 periods exit the market and are “taken over” by an entrant.

¹⁴ A fixed proportion of government spending in wages, investment and consumption was assumed. The total government expenditure is determined, as in the benchmark conditions, by a fixed budget surplus target, which follows the level of GDP.

¹⁵ 0.2% p.p. (per period) for consumption goods, 0.35% p.p. for capital goods; 0.25% p.p. for intermediate goods.

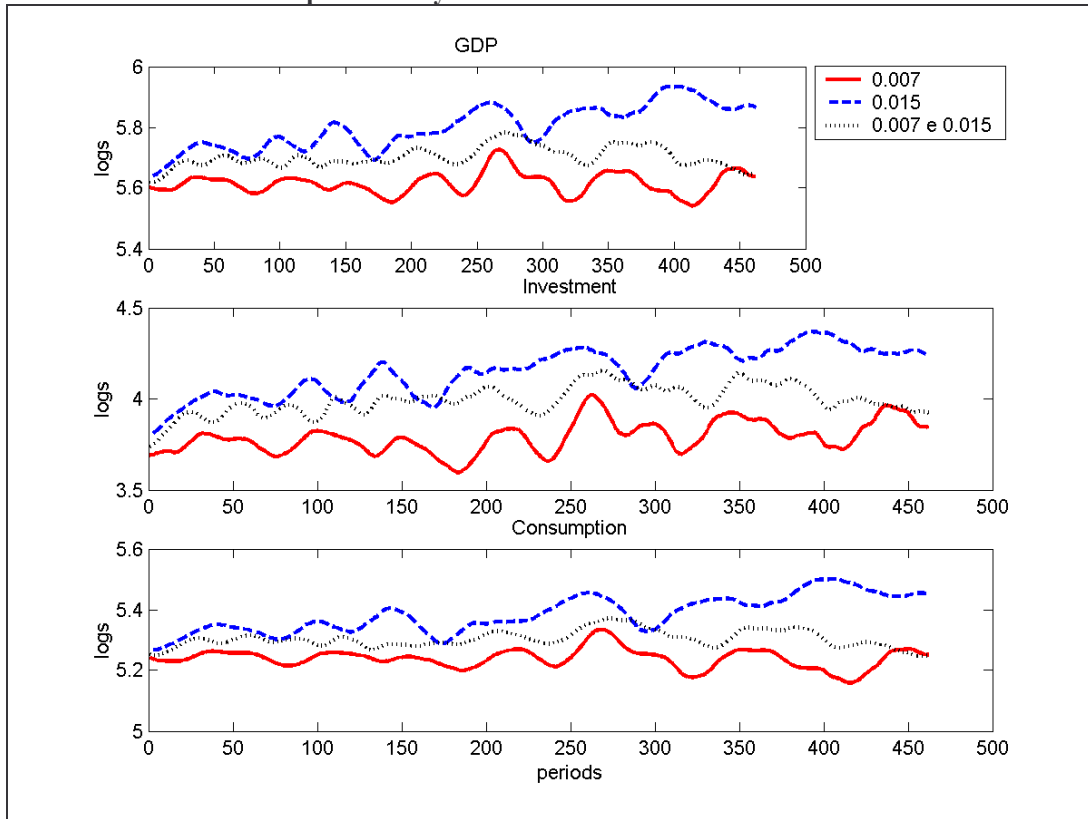
Figure 3 - Average debt ratio by sector



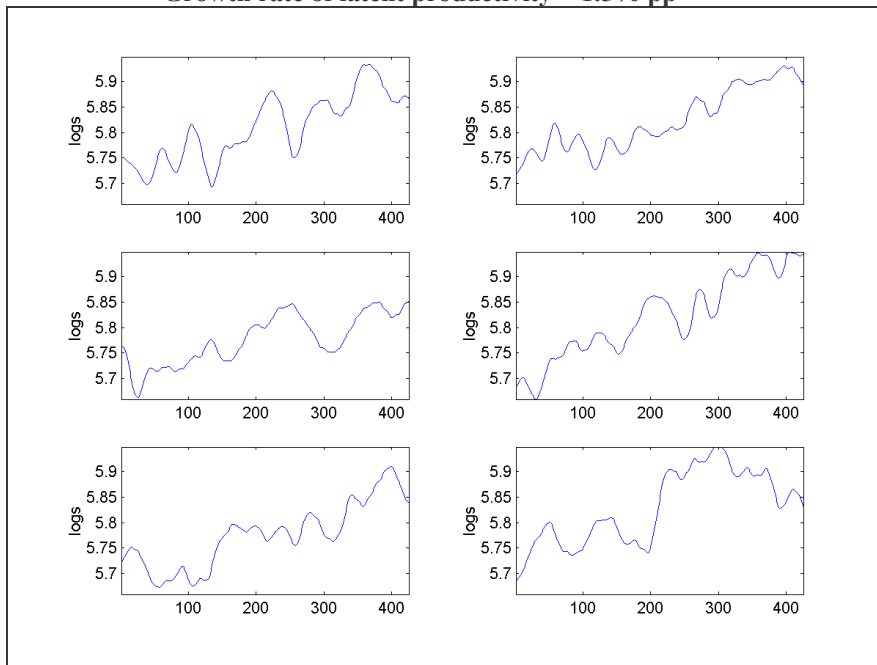
This result is for a single run. In Dweck (2006), Appendix II, Fig. V-21, four different runs are shown where the debt ratio remains basically the same.

A third test was designed to remove the financial constraint on investment. Even so, the trend was relevant only for a very high growth rate of latent productivity, as can be seen in Figure 4. This happens for different random seeds, as shown in Figure 5. Autonomous investment becomes endogenously determined but does not grow at a relatively stable rate. In this configuration, then, it is difficult to keep a steady growth, since GDP growth rate is a weighted average of a number of fixed large components added to a small component that grows at a very unstable rate. Besides, the GDP growth rate is not high enough to compensate for the labor productivity increase, which results in technological unemployment. A final expected result is the positive correlation (also found in Nelson & Winter, 1982) between the increase in the growth rate of latent productivity and market concentration.

Figure 4 – Trend components – different growth rates of latent productivity without financial constraint



**Figure 5 – GDP trend component for different random seeds
Growth rate of latent productivity = 1.5% pp**



At a theoretical level, any linear finite difference equation on investment or income (*e.g.* (neo-Keynesian or Kaleckian) generates, under given parameters, a growth path driven by

autonomous investment¹⁶. However, given the nature of such expenses, it is most likely in this case that growth will also involve fluctuations, not only due to the timing of technological progress, but also because the financial constraint will be binding under such an intense pace of investment in innovations. Therefore, in periods of recession or stagnation other autonomous expenses - such as government expenditures, as suggested by Keynes – will be needed to reinforce private autonomous investments in order to get a growing trend. In addition, the micro-macro interactions also provide ambiguous effects, since the aggregate net effect of individual investment decisions depends on the balance of positive and negative¹⁷ effects. In an aggregate model, v.g. based on a “representative firm”, any change in the autonomous investment will have an aggregate impact *by definition*, which is highly misleading and adds to the relevance of an approach, like ours, based on micro-macro multisector interactions.

Hence, even though it is possible to obtain mathematically an increasing trend pulled by autonomous investments, it can be economically insignificant or less likely. This is an important limitation of a excessively formalized analytical tools that omit essential elements of the economic system, such as: financial restriction to investment, a plausible rhythm of technological innovations and the interaction of heterogeneous agents taking conflicting decisions. Only a more disaggregated, descriptive and economic realistic model, such as the one proposed here, makes it possible to overcome this limitation.

ii. Product innovation

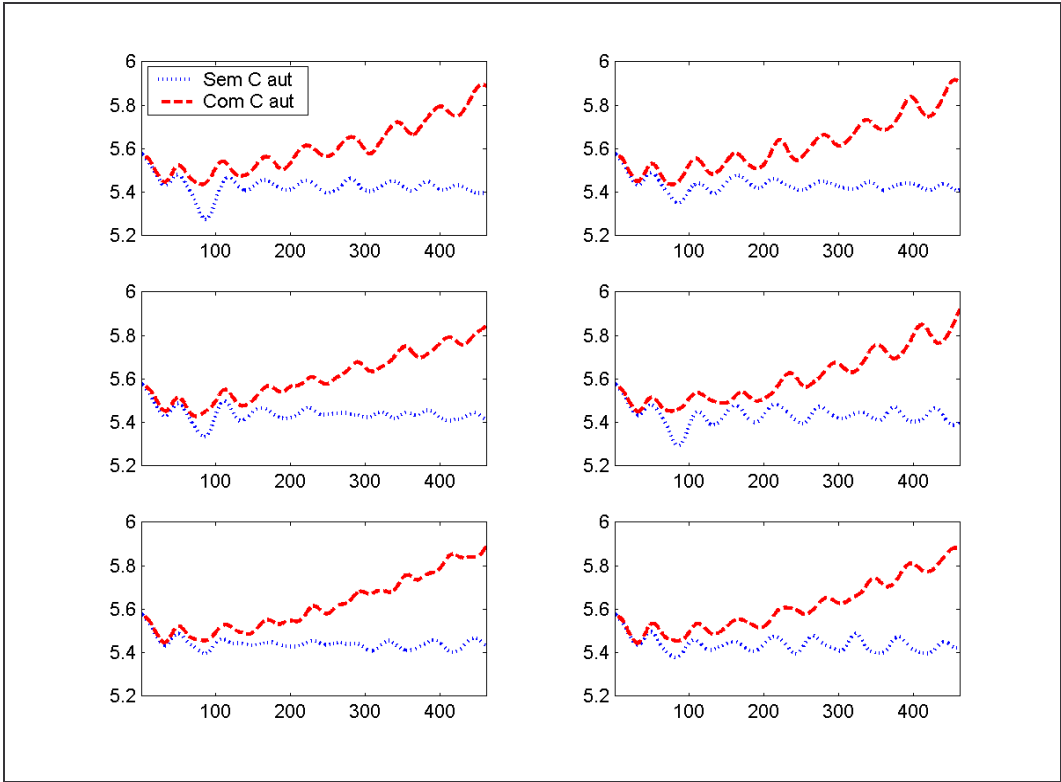
In the previous section all autonomous demand components except investment - in process innovation - were kept constant, which resulted in no trend being produced for benchmark technological parameters. Product innovation is now introduced to the benchmark scenario with the focus on its effect on autonomous consumption. As expected, the main result is an increasing trend, as shown in Figure 6. The way autonomous consumption is determined in the model – as a positive function of the sector’s product innovation index – turns it directly related to the exogenous increase of what we named “latent quality” (to phrase it in analogy to “latent productivity” of process innovations).

¹⁶ Possas (1987, p. 156) observes that in Kalecki’s 1954 model there will be a positive growth trend of net investment (*i.e.* capital accumulation) “if and only if the independent term of the net investment equation is positive, which requires that the independent term of the gross investment in fixed capital is larger than a small fraction of fixed capital depreciation”.

¹⁷ As commented before, there are positive effects, associated to innovation diffusion, as well as negative ones, related to market losses or failure of competitors.

A second interesting result is the effect of product innovation on income distribution. As pointed out by Kalecki (1954), there are two structural factors that determine the functional distribution of income – the mark up and the ratio between the cost of raw materials and wages; the higher these parameters, the higher the profits share of income. When competition is not focused on price, but on product differentiation, once a firm hits a product innovation success it may increase its mark up without compromising competitiveness, thus reducing the wage share in income. The second factor tends to move in the opposite direction, since while prices in the intermediate sectors rise slower than inflation, money wages will increase (by assumption in the model) at least by the inflation rate. But this is not enough to compensate for the mark up rise and therefore the wage share of income will decrease.

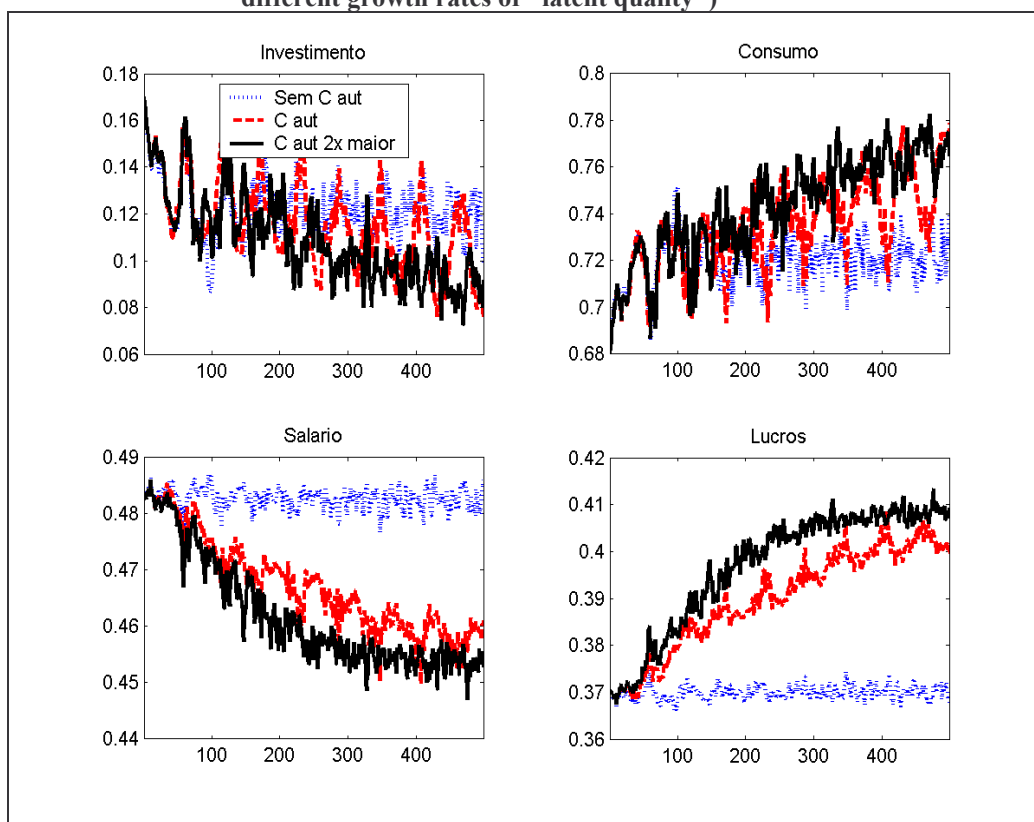
Figure 6 – GDP trend due to autonomous consumption growth for different random seeds



This distributive effect might lead to a decrease in the average marginal propensity to consume, since it tends to increase the income share of higher classes. As pointed out by Cesaratto *et alii* (2006, p. 15), however, the continuous introduction of new or differentiated products may have some effect on autonomous consumption so as to increase the average propensity to consume. In Figure 7, it is shown that the combination of the distributive effect with the increase in autonomous consumption results in a decrease in the wage share, along with an increase in the share of consumption. As a

consequence, the GDP increase tends to balance part of the technological unemployment present in the first simulations related to process innovation.

Figure 7 – Share in GDP of consumption, investment, wages and profits (for different growth rates of "latent quality")



c. Government expenditures

The relevance of these expenditures is due both to its relative weight in GDP and its specific policy features. The level of government expenses is the only economic policy decision, amongst those possible in this model, to have been tested in the simulations discussed here. It cannot be explained without taking in consideration historical and political factors specific to each economy; but it is possible to argue that, in general, the determination of both its amount and composition affect cycle and trend. In the simulations, they were determined by a fixed surplus target and therefore government expenses were a procyclical and lagging variable. The fiscal policy assumed here ruled out any countercyclical role of government spending.

Government expenses are assumed to comprise wages, consumption and investment. Initial shares were set at 80%, 10% and 10% respectively. Since public wages are assumed to increase exogenously, its share depends on both the GDP increase and the budget surplus target, while public consumption and investment are residual. In order to assess the effect of government expenditures on the trend two tests were conducted: (i) to

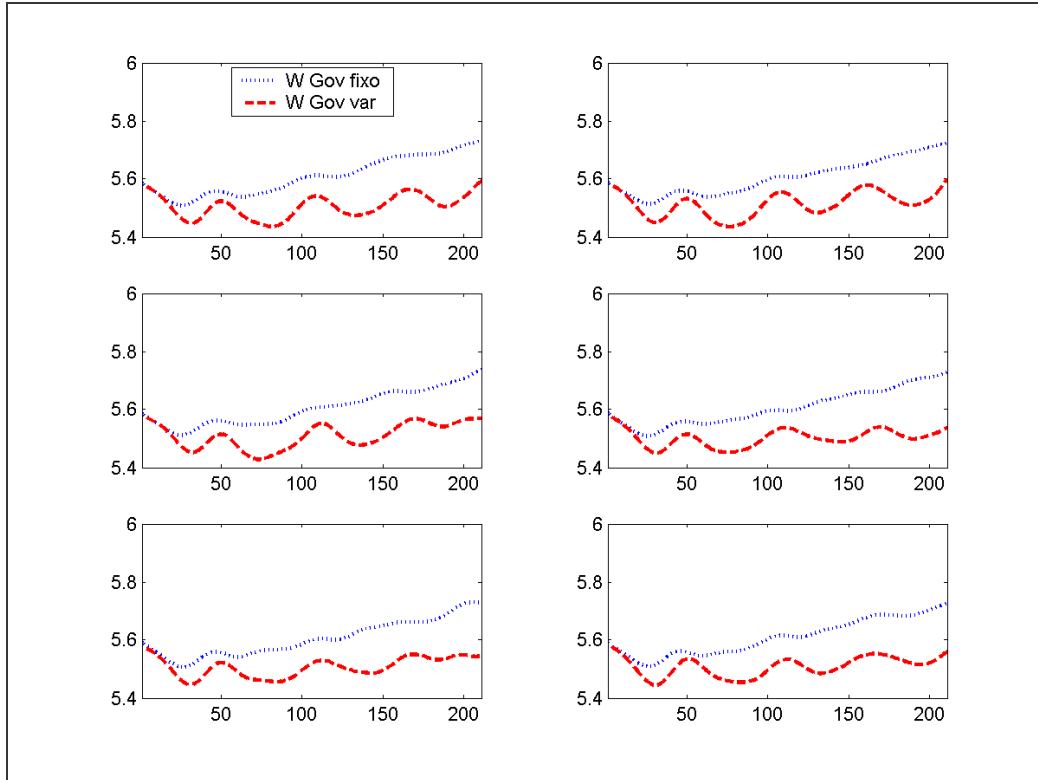
set wages payment as a floor to government expenses; and (ii) to allow for changes in the surplus target.

In the first test, as shown in Figure 8, the growth rate of GDP is higher than the one with product innovation¹⁸, due to the increase of public wages. In this simulation, for all random seeds, the two chief trend components are autonomous consumption and public wages. Given this floor to public expenditures, surplus target no longer remains a priority, so government expenses starts to play an important role in growth trend.

In the second test, the budget surplus target is redefined every four periods according to a double goal: to keep the public debt to GDP ratio below some threshold level and to allow for a counter-cyclical action by the government, especially during recessions. However, this second goal is only assumed possible when the debt/GDP ratio is below 50%. When it is under 30% the target is reduced by a specific amount. The same happens when the ratio falls between 30 and 50% and the debt growth rate is smaller than that of GDP, otherwise the target is kept constant. On the other hand, when the debt is above the threshold the target is increased. In the results below, one sees that if the surplus target changes in a pro-cyclical way but is kept always positive, it is not enough to level off the cyclical movement. Only when public deficit is allowed for, at given periods, it is possible to observe some positive effect on the trend.

¹⁸ The comparison is with the results previously presented, in which the only trend components are the autonomous investment and consumption related to the benchmark parameters. The red line in figure 8 is equivalent to the red line in figure 6, although in figure 8 the results shown are only up to period 220.

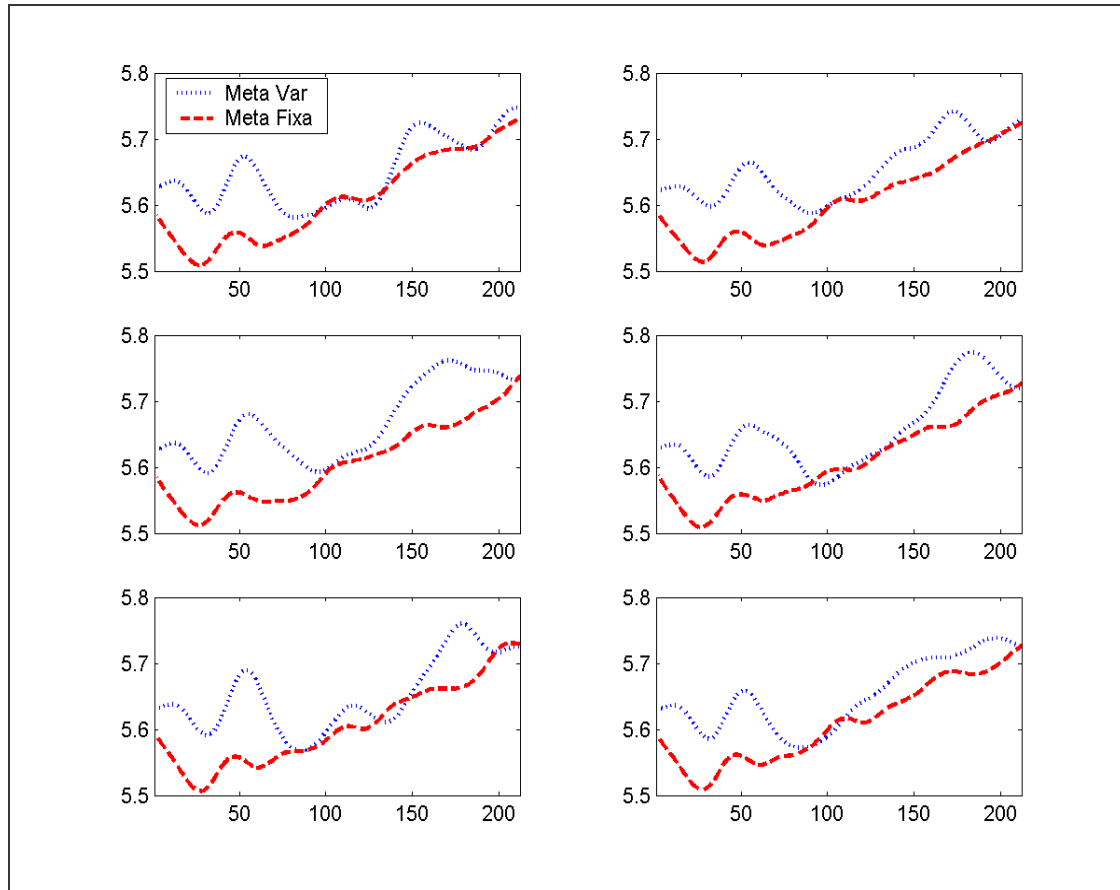
Figure 8 –GDP trend for different compositions of government expenses



Obs.: “W gov fixo” – refers to an exogenous fixed growth rate of public wages; “W gov var” – wages are determined as a fixed proportion of the government expenditures; therefore are pro-cyclical.

As can be seen in Figure 9 (for several random seeds), when the lower limit is set at a primary deficit of 2%, this target variation influences growth trend, but is still unable to foster a higher rate for GDP. Given the initial conditions, the other trend components cannot assure a GDP growth rate high enough to prevent an increase of debt/GDP ratio in periods when there is a public deficit. Therefore, in order for the government expenses to play a more active role in the trend, its determination cannot be fully attached to cyclical components, such as the expected tax revenues.

Figure 9 – GDP Trend with fixed and variable budget surplus targets



d. Foreign sector

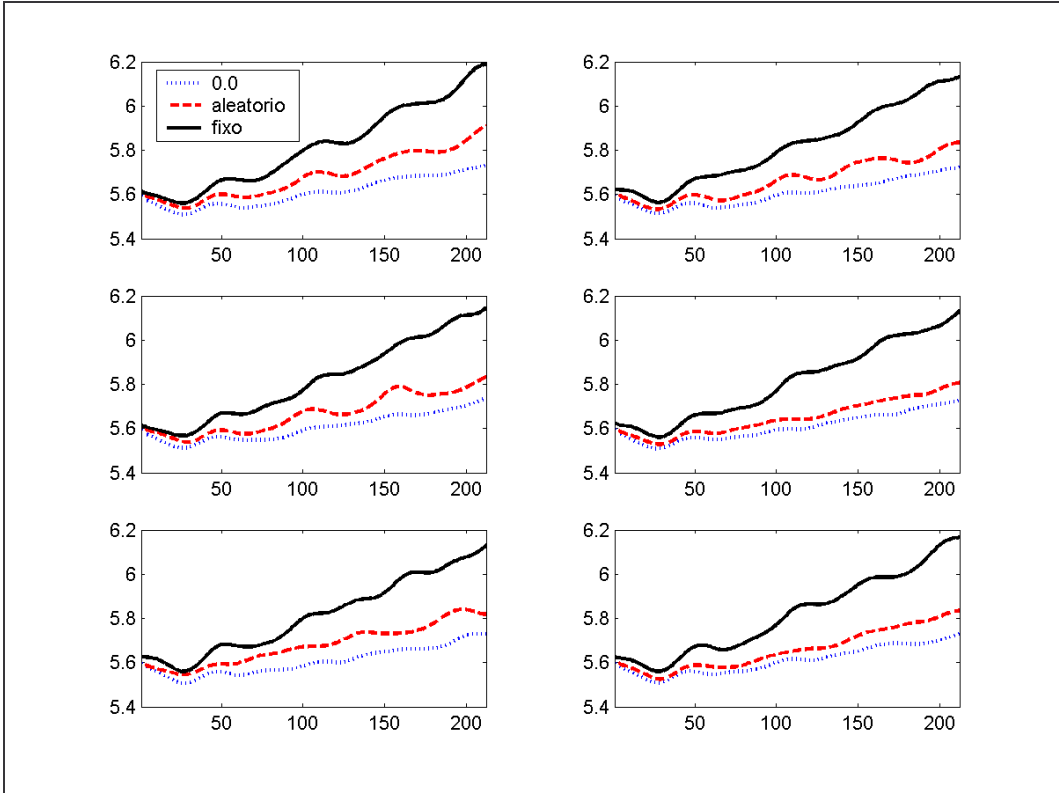
The way exports were introduced makes them non-cyclical. The main dynamic impact of exports is on the trend component. In the simulations discussed so far, exports were fixed at the initial amount, which only assured a bare minimum to demand, but without any role as a trend component. In order to assess its influence two hypotheses were tested: (i) a fixed growth rate of 0.5% p.p.; and (ii) a random growth rate, defined by a uniform distribution between the interval (-0.25%; 0,75%). The results for different random seeds are presented in Figure 10. As expected, when all trend components grow at positive rates, the growth rate of GDP is the highest of all simulations presented here.

One of the consequences of assuming a random growth rate for foreign income is a possible impact on the cyclical component. In one of the simulations, the cyclical component of exports is slightly pro-cyclical, which is closer to the stylized fact. Since such result is not observed in all simulations, this suggests that the growth rate of foreign income is likely to be more cyclical than assumed here.

An important point to be analyzed in the future is the influence of factors related to the international competitiveness of firms and sectors, such as the income-elasticity of the exports

and imports, changes in the import coefficient of capital and intermediate goods, changes of the domestic and foreign relative prices and the impact of variations of the exchange rate.

Figure 10 – GDP Trend for different foreign income growth rates and several random seeds



4. Conclusions

The general macrodynamic properties derived by the simulations as regards growth trends follow those of the theories and models centered in the principle of effective demand, namely: (i) although the fluctuations are very irregular, they are relatively stable; (ii) the existence of a long run growth trend, also irregular, related to the autonomous components of the aggregate demand – investment and consumption, public expenditures and net exports – and not to any supply impulse or shock as in mainstream models.

The effect of autonomous investment over the long run trend, in particular associated to innovation, is significant only when a high technological dynamism is assumed and the financial constraint is taken out. The autonomous consumption associated with product innovation, on the other hand, plays a more important role, increasing with the innovation pace. As price competition becomes less important as compared to product differentiation there is a significant increase in prices, mark ups, and therefore in profit share on income.

Public expenditures were modeled in two different ways: firstly, a fixed primary budget surplus target was assumed, which prevents it from having any effect over the long run growth trend. Secondly, a more active role for budget deficit was allowed for. Net exports, as expected, have a direct impact when they are supposed to grow at a positive rate. When this rate is random, it also tends to have some pro-cyclical influence.

As for the microdynamic effects of the benchmark simulations, some important results were the effects of product differentiation strategy in terms of market concentration, increasing mark ups, and their effects on income distribution. Finally, the influence of micro parameters on macrodynamics are exemplified by the expectation parameter and the extension of the investment period. Both were tested and shown to have an important influence over the amplitude of the fluctuations.

Lastly, these results are discussed in comparison to other models, in order to clearly indicate the differences that emerge from an approach to economic growth where the basic causality is centered on the demand side, as in the Keynesian-Kaleckian tradition, and not on the supply-side, as suggested by mainstream “common sense”.

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