# Keynes, Lucas, Aoki, Chen and Yoshikawa: reappraising macroeconomics

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**Abstract** In this review article we discuss three recent contributions to the debate about the microfoundations of macroeconomics: (i) an article by Ping Chen (2002) (ii) a recent book by Masanao Aoki and Hiroshi Yoshikawa (2007a) (iii) a follow-up article by the same authors (2007b). This debate centers on the acceptability of the conception set forward by Robert Lucas in the 1970s. As this conception was largely seen as an anti-Keynesian stand the discussion also turns out to be a controversy over Keynesian economics. In the concluding part, in line with the econophysical perspective that we propose, we argue that ultimately it is only through large-scale, carefully conducted empirical tests that this kind of discussion can be settled.

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This article takes its inspiration from a recent book and article by Professors Masanao Aoki and Hiroshi Yoshiskawa (2007 a,b) and from a paper by Professor Ping Chen (2002). It addresses the problem of the relationship between micro- and macroeconomic behavior. It must be emphasized from the outset that the author of the present paper is not a macroeconomist but an econophysicist who has an interest in macroeconomics and in more generally way in the question of of how economic models can be tested.

# 1 Introduction

Before discussing the content of the Aoki-Yoshikawa book, it may be worthwhile to present its authors. As UCLA professor Aoki observes in the preface, the book published in 2007 is a new step in an ongoing research project aimed at reformulating the microfoundations of macroeconomics. His two previous books on this topic were published in 1996 and 2002 respectively and were seen as landmark achievements as attested by the fact that the second one won the Japanese Economic Research Prize in 2003. Aoki signals in the preface that whereas the two previous books were mostly devoted to the construction of conceptual models which had but few connections with real data, the present book offers more substantive macroeconomic examples. Besides being a professor at the University of Tokyo, Yoshikawa had also been a member of the Council of Economic Policy which advises the Japanese government on its economic policy in the same way as the Council of Economic Advisers advises the US administration. Together the two co-authors combine an expertise which ranges from the mathematics of analytically solvable stochastic processes to the assessment of monetary and fiscal policies. Like the books of 1996 and 2002, this one aims at finding an alternative to the mainstream view about micro-macro connections which mainly rests on the conceptions of Robert Lucas (see the next section). It is of interest to note that an attempt in the same direction has been made quite independently by professor Ping Chen in several papers (e.g. 1993, 2002). In what follows we will mainly discuss his paper of 2002.

There is no doubt that both the Aoki-Yoshikawa book and the paper by Chen should be very appealing to econophysicists and in a broader way to economists who are not completely happy with the formal<sup>1</sup> and self-centered style<sup>2</sup> of most econometric studies. The models which are presented in the works under discussion contain only few parameters, their mathematical formulation is clear and elegant and most often they are solved analytically. Any researchers who likes nice models will take great

<sup>&</sup>lt;sup>1</sup>This term refers in particular to the uncritical and casual way with which data are handled.

<sup>&</sup>lt;sup>2</sup>This expression is used in a sense which will be explained in the last section; it will be seen that even the present studies are, in the author's opinion, too much focused on the discussion of conceptions at the expense of actual tests.

pleasure in this reading. Whether based on closed form formulas or on simulations, the models' results are presented through graphs which, in our opinion, give a much better overview than the tables with significance tests that are to be found in standard econometric papers. In fact, the models are not used in the narrow perspective of whether their parameters estimates are significant or not, but help us to get a better insight into the economic mechanisms which are at work.

### 2 Lucas and rational expectations

What is the main thesis of the authors? To this date the mainstream ideas about the microfoundations of macroeconomics are those put forward by Robert E. Lucas in the 1970s. Aoki-Yoshikawa as well as Chen call this framework into question on several counts.

One of the main pillars of Lucas' conception is the rational expectation hypothesis. It posits that the best<sup>3</sup> forecast made by economic agents do not differ systematically from market equilibrium results. There are several problems with this hypothesis.

• When confronted with empirical evidence (that is to say with actual forecasts made by economic agents) it appears that even in situations of quasi-equilibrium the accuracy of the forecasts is not better than 15% and every time that there is an unexpected shock (e.g. the beginning of the Korean War in June 1950) the difference can become higher than  $30\%^4$ .

• Secondly, the rational expectations hypothesis implicitly supposes that there is only *one* equilibrium state. What happens when there is more than one equilibrium? This question of multiple equilibria is addressed in great detail by Aoki-Yoshikawa in several parts of the book (p. 12-13, 71, 101).

• Thirdly there is the crucial question of friction and time lag. Like the related (but stronger) efficient market hypothesis, the rational expectations hypothesis supposes that agents can adjust fairly quickly (and in an optimum way) to new situations. This may be true, at least to some extent, in financial markets but is certainly not correct in most other sectors. Peng (2002, paragraph 4.3) suggests a *gedanken* experiment which helps to see the matter more clearly. Suppose, he says, that a large number of households take their vacation in the summer quarter. The large resulting demand will drive up the prices of leisure goods like airfares or hotel accommodation. This creates an incentive for shifting their vacation to another quarter. However, observation shows that this incentive is usually not strong enough to overcome other constraints and preferences. In order to save the rational expectations hypothesis one

<sup>&</sup>lt;sup>3</sup>"best" in the sense that it uses all available information; in this respect, it can be noted that the notion of "all available information" has no clear operational definition. "Available information" is a fuzzy, unbounded set.

<sup>&</sup>lt;sup>4</sup>More details can be found about such tests in Roehner (1995, p. 52-53).

would have to translate these constraints and preferences in terms of market value. However, as they have no well defined market value<sup>5</sup> these elements can be translated into monetary terms only in a fairly arbitrary way which actually voids the rational expectations assumptions of any real operational content.

• Last but not least, there is the problem of heterogeneity. Peng notes that in this respect the model proposed by Lucas (1972) is only a marginal improvement over the representative agent model. In the later, all agents are supposed to act like an hypothetical "average agent". Peng observes that although Lucas' model of an island economy (the so-called LMI model) considers N agents and two different markets, in fact he assumes that there are two classes of agents within which all agents are supposed to act in perfectly correlated ways. At first sight this might appear as too easy a criticism. Is it not customary even in physics to begin with a simple case, say the hydrogen atom, before trying to describe more complex cases, say an atom of gold? The main point is that whereas a model of the hydrogen atom can be confronted with experimental evidence, an economic model with only two classes cannot be tested in any meaningful way because no such simple case can be found in the real world. In other words, if one wants to construct a model which can be tested, one *must* provide a theoretical framework which can take into account *multiple* classes. This is precisely what Aoki-Yoshikawa do; as a matter of fact this is a central theme not only in this book but also in earlier as well as later papers by these authors. The question is solved with great elegance in chapter 2 of Aoki-Yoshikawa (2007a) and in 2007b. Designing a stochastic model which can describe an economy with an arbitrary number of sectors  $K_1, K_2, \ldots, K_N$  where N may change in the course of time and where each  $K_i$  is itself an aggregate of  $n_i$  agents (or companies or products or innovations) is not a trivial mathematical problem. The formalization relies on a number of interesting mathematical tools: partitions vectors, the Ewens sampling formula, K-dimensional Pólya distributions and the Poisson-Dirichtlet distribution. These basic concepts and results will be an essential part in any theoretical description of a real economy.

The next section provides more detailed insight on some select topics.

### **3** Glimpses

Rather than trying to summarize the content of the 10 chapters in a few sentences we prefer to give an overview of the content by focusing on a number of points.

<sup>&</sup>lt;sup>5</sup>In some cases preferences may of course have a market value. For instance, most persons prefer to work during the day rather than during the night; consequently employers pay a premium for night work; the premium represents the market value of this preference. However, in the case under consideration there are many different constraints and preferences; identifying them clearly would require an elaborate comparative analysis; moreover, many of them would probably be found to have no clearly defined market value.

• In chapter 4 there is a long and insightful discussion of the Japanese economy in the 1990s. It turns out that after the bankruptcy of a number of big financial institutions around 1997 (p. 111) the Japanese economy experienced a credit crunch which had some resemblance with the banking crisis which started in 2007. At that time as in 2007 there was a sharp decline in bank lending but not because interest rates were high (quite on the contrary they were close to zero) but rather for some structural reason. The main reason was that back in 1997 banks were compelled to meet the stricter capital requirement standards set by the Bank of International Settlements. Thus, in order to raise the capital/loan ratio they had to cut lendings. In 2007 we are again in the same paradoxical situation of a credit crunch in a context of dwindling interest rates. Whatever the main factor in the current crisis, it seems clear that useful lessons can be learned from how Japan was able to cope with the credit crunch that it faced at that time.

• Proposed in 1962 by US economist Arthur Okun, Okun's law is an empirical relationship between changes in Gross Domestic Product (Y) and the unemployment rate (u); it reads:

$$\Delta Y/Y = k - \alpha \Delta u$$

 $\Delta Y$  is the change in real (that is to say adjusted for inflation) GDP,  $\Delta u$  is the change in unemployment expressed in percent, k is the GDP growth rate for constant employment that is to say the growth rate due purely to increased productivity<sup>6</sup>.

 $\alpha$  is equal to about 3 in the case of the United States and to 13 in the case of Japan (p. 214). How should such a huge difference be interpreted? At this point it would clearly be enlightening to know the value of  $\alpha$  for other countries. The fact that this is not done is an indication that in a general way economists have little appetite for comparative analysis.

• The last chapter of the book makes an interesting point about power-law versus exponential distributions. It can in substance be summarized as follows (p. 301). "People feel that real and financial markets are different. It rarely happens that our salaries are doubled within one year but in contrast we know that the price of a stock can double in a year. The difference is reflected in the fact that the changes in variables such as consumption or income follow an exponential distribution whereas changes in stock prices follow a power-law." To account for this observation, the authors offer an elegant model which leads to an exponential distribution when the number of micro-changes is small and to a power-law when this number becomes large. In that line of thought it would be of interest to test this explanation further by considering different cases. Depending on which stock one considers there are huge differences in the frequency of micro-changes. For some stocks there are as few as

<sup>&</sup>lt;sup>6</sup>Incidentally, with respect to the measurement of productivity the authors emphasize a useful and not often made distinction between *physical labor productivity* and *value productivity* (p. 85).

2-3 transactions per week while for others there are as many as several thousands per day. Does this translate into a difference in their distribution of price changes as predicted by the model?

In the next section we offer some tentative suggestions for a future research agenda.

# **4** Critical importance of observational tests

In his preface professor Aoki wrote. "I have been contemplating changing my specialization to economics" and was invited to attend a workshop in economics. "I remember vividly my shock when I first encountered representative agent models. I was very puzzled and kept asking myself: what about interactions between agents?" Similarly, as an econophysicist, I am greatly puzzled when I read a book or an article written by economists and I keep asking myself: how well do these models perform? Rightly or wrongly, I am convinced that it is because this question is not treated seriously that many economic debates find no clear-cut conclusions.

Both the Aoki-Yoshikawa book and the article by Peng question the conception of the micro-macro connection proposed by Lucas. As one knows, in physics statistical mechanics provides the microfoundation of thermodynamics and is considered a more satisfactory theory than the later. But why exactly is it considered as a better theory? Is it because intellectually it is more satisfactory to start from individual elements at micro level? Is it because its mathematical framework is more sophisticated? It is for none of these reasons. The real reason<sup>7</sup> is that statistical physics is able to explain physical observations that thermodynamics cannot explain such as for instance the distribution of the velocities of molecules in a gas or changes of the specific heat of a solid as a function of temperature. This naturally leads us to ask:

Can Lucas' theory account for observations for which there was no satisfactory explanation before?

If the answer is "yes", then there is little point in disputing the assumptions of the theory for any model rests on assumptions which in some way are unrealistic (simply because models are a simplification and idealization of the real world).

If the answer is "no", then Lucas theory can just be ignored.

If the answer is "yes-no", there a two possibilities. One is that the theory has not yet been tested seriously, that is to say its predictions have not been compared to observations in a sufficiently large number of well selected cases. Another more likely

<sup>&</sup>lt;sup>7</sup>I suppose most physicists would agree on this point.

possibility is that Lucas theory can account for any observation, but not because it is a very good theory but because it is not really a theory. Let us explain this point through a parallel with a physical theory. The so-called standard model of cosmology (SMC) rests on the assumption of a big explosion, the big-bang, that occurred at the beginning of the universe. But this assumption is of course not sufficient to explain the many features and idiosyncrasies of the actual universe such as the abundance of the elements, the distribution of the galaxies and so on. In order to explain these features many other mechanisms must be invoked which are quite independent of the big-bang hypothesis. In short, so many different mechanisms can be introduced into the SMC framework that it is always possible to make it capable of "explaining" new observations<sup>8</sup>. Eventually the only serious tests of the SMC would be its capability of correctly predicting the results of observations that have *not yet* been made<sup>9</sup>.

We mentioned the SMC because, as in economics, it is not possible to make experiments; one must rely on observations. However, the situation is much more favorable in economics than in cosmology. Indeed, whereas there is only one universe, there are almost two hundred countries<sup>10</sup>. Some economies are small, others are large, some are industrialized while others are still mainly agricultural; for some (e.g. Singapore) foreign trade is important whereas others (e.g. Bhutan) are fairly isolated economies. This broad spectrum of economies should give the possibility of testing any model in a meaningful way. For instance if a model contains a parameter  $\alpha$  it will be easy to get the model's prediction when  $\alpha$  goes to zero (or alternatively when  $\alpha$  becomes very large). In order to test this prediction, all one needs is to find an economy for which  $\alpha$  is small (respectively large).

The methodology that we advocate is fairly different from the way the standard econometric approach treats data. Instead of treating all data indiscriminately, what we propose is to set up a huge set of cases and then to pick up those situations for which the signal to noise ratio is highest. Let us briefly illustrate this approach by two examples.

• The first one considers the influence of interest rates on exchange rates. The natural idea is that if the interest rate in country A is higher than elsewhere, this

<sup>&</sup>lt;sup>8</sup>Similarly Ptolemy's model of the solar system was able, up to a point, to explain all observations and even to make fairly accurate predictions but at the cost of ever increasing complexity. The observation which really marked the failure of Ptolemy's model was the fact that over a period of six month the apparent positions of the stars change in a measurable way for this shows that the earth is moving with respect to the stars. However such changes are so small that their observation only become possible in the mid-19th century; the first observation of that kind was carried out by the astronomer and mathematician Friedrich Bessel in 1838.

<sup>&</sup>lt;sup>9</sup>Even that test will not be clear-cut because there are several versions of the SMC each one leading to a different prediction. Thus, one of them may turn out to be correct almost by chance and the others will be quickly forgotten. In short, the SMC can hardly be shown to be false. In this sense it is not really a theory but rather a description.

<sup>&</sup>lt;sup>10</sup>Furthermore, macroeconomic variables are also available at the level of regions (for instance for the 50 American states) which means that the number of cases that can be used in tests is in fact of the order of several thousands.

will attract funds which in turn should result in an appreciation of the currency of A. This argument is certainly correct, but there are so many other effects which can interfere that it is very difficult to detect that relationship in actual data. For instance, during the time period 2003-2007, instead of being positive the correlation between the exchange rate of the dollar and the Federal Fund rate was in fact negative<sup>11</sup>. In other words, in this situation the noise (under this term we understand all other factors than the interest rate) is more powerful than the signal. In order to overcome the influence of background noise one should rather consider situations in which the interest rates took *extremely high values*. Thus, between December 1980 and December 1981 the discount rate (which is closely related to the Federal Fund rate) remained comprised between 13% and 14%; this indeed resulted in a huge appreciation of the dollar with respect to other currencies<sup>12</sup>. Naturally, there have been many other historical episodes characterized by very high interest rates and exchange rates on a firm basis.

• As a second example we consider the relationship between changes in price level on one hand and changes in note issues on the other hand. According to the quantitative theory of money, one would expect the two variables to be closely correlated. However, because there are several other mechanisms at work at the same time, this relationship is not easy to observe in "normal" situations. Once again, the picture becomes clearer if we consider *extreme situations* where the price increase is very fast. It turns out that during hyperinflation episodes the ratio of price increases to note issue increases is indeed very close to one (see Chou 1963, p. 265). History also provides a broad range of intermediate situations between moderate inflation and hyperinflations. Such a spectrum of cases should constitute an ideal "laboratory" for studying the mechanisms of inflation.

### 5 Keynesian economics: theory versus policy making

In his preface professor Yoshikawa emphasizes that the new approach which is proposed"revives the old Keynesian economics". As a matter of fact "Keynesian theory" is a central theme in this book. In the index the entry corresponding to this expression refers to 42 pages. As a matter of comparison, the expressions "business cycle", "equilibrium" and "Japanese economy" refer to 29, 23 and 44 pages respectively. Nowadays, due to the complete dominance of the neoliberal creed the ideas

<sup>&</sup>lt;sup>11</sup>If the exchange rate considered is an average of the dollar-euro and dollar-yen exchange rates, one gets a correlation of -0.29 with a confidence interval (-0.64, 0.16), probability level = 0.95.

<sup>&</sup>lt;sup>12</sup>For instance, the exchange rate between the dollar and the French franc jumped from about 4.5 F for one dollar to about 11 F.

of Keynes have dropped out of favor<sup>13</sup>.

Discussing the ideas cannot lead to any clear-cut conclusion. It is possible to choose between the systems of Ptolemy and Copernicus only by confronting them with detailed data from astronomical observation. Similarly, instead of discussing the conceptions, let us rather look at the policies which have been implemented in the past 30 years. We will see that they are Keynesian in all but name. Let us first agree that one of the main discoveries of Keynes is the fact that is it possible to stir up and fuel economic growth by increasing the demand at macro level. This can be done by the state but it can also be done by other economic agents. The history of economic growth in the United States during the past 30 years reveals several methods for spurring the demand.

• Between 1985 and 2000 the multiplication by 20 of the stock prices of information technology companies on the NASDAQ market was tantamount to increasing the money supply. It became possible to remunerate executives and personnel partly by stock options, a money supply originating from the treasury stocks of the companies, (see Roehner 2005 for more detail); inflated stock prices made it easy for companies to get additional capital either by issuing new stock or through bank loans with stock market capitalization as collateral; at the same time skyrocketing stock prices also inflated earnings, thus attracting new investors.

• Between 1998 and 2007 inflated housing prices played a similar role<sup>14</sup>.

• On top of that, the war in Iraq which began in 2003 and was largely funded by budget deficit, provided an exogenous stimulation of demand. This was a clear illustration of what is sometimes called military Keynesianism, i.e. large military spending aimed at increasing economic growth. Former illustrations include the Korean War, the Vietnam War or the huge increase in military spending (also funded by budget deficit) during the Reagan administration.

• Moreover the economic growth of China over the past 20 years provides a vivid illustration of the Keynesian mechanism of stimulating an economy by government investments in infrastructure.

In short, there is a real paradox about Keynes. He is shunned and spurned by mainstream economists but policy makers rely on Keynesian guidance and recipes every time they wish to stimulate economic growth . In more recent times, western governments resorted to similar policies to prop up real estate markets <sup>15</sup> or to bail out

<sup>&</sup>lt;sup>13</sup>Actually, this situation can be seen as the result of a long series of public relation campaigns which decried and stigmatized state intervention and Keynesianism almost since the beginning of the New Deal. In other words, it would be a misconception to think that the supremacy of the neoliberal model is purely the result of an intellectual debate among distinguished economists. More details on this point can be found in Roehner (2007, p. 115-134). Incidentally, the authors mention the "New Keynesian Economics" school (p. 87) but point out that it is only Keynesian in name.

<sup>&</sup>lt;sup>14</sup>For instance in a period of falling interest rates house buyers were able to replace their former mortgage loans by cheaper loans plus complementary loans aimed at financing housing upgradings or other consumption-oriented expenses. <sup>15</sup>The Economist of 28 May 20056 explains how Gordon Brown's plan subsidized housing loans and provided a gov-

bankrupted financial institutions; see in this respect the examples of the American hedge fund "Long Term Capital Management" in 1998 and of the British mortgage lender "Northern Rock" in 2007<sup>16</sup>. In response to the recent credit squeeze the reaction of Central banks was to "pump more money into the financial system", a typically Keynesian recipe, e.g. on 8 December 2007 an Associated Press dispatch mentioned the injection of \$ 40 billion by the Federal Reserve, a move which followed a long string of similar actions in the the past six months.

### 6 Conclusion

To a number of economists our perspective will probably appear naive or unsophisticated and many of our statements self-assertive, especially in so far as they are made by an outsider. However, the achievements of macroeconomics have also been questioned by renowned economists such as Wassily Leontief (1983), Anna Schwartz (1995) or Lawrence Summers (1991). The books and articles that we reviewed in this paper propose an alternative to mainstream conceptions. In the two last sections we suggested that the best way to decide between different models is to judge them on actual performance in accounting for observed facts. Intellectual consistency is only one aspect. Ultimately, theories must show that they are up to the task for which they have been built. Moreover, such empirical tests should rely on a broad series of observations in many different countries: we argued that because macroeconomic data are widely available, macroeconomic models can (and should) be tested on hundreds of cases<sup>17</sup>.

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ernment guarantee to private lenders.

<sup>&</sup>lt;sup>16</sup>The media reported the decision of the Bank of England by saying that is was the first time since 1973 that a High Street lender was bailed out; but one should keep in mind that in 2001 the British government had to renationalize "Rail-track" after a series of train crashes shattered public confidence. At the time of writing the nationalization of "Northern Rock" is also seen as the most likely outcome by British newspapers: in the terms of The Independent of 21 December 2005, "the N word loomed larger for Northern Rock this week".

<sup>&</sup>lt;sup>17</sup>This "experimental" approach is developed and illustrated through an number of case-studies in Roehner (1997).

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