QUADERNI

Università degli Studi di Siena
DIPARTIMENTO DI ECONOMIA   POLITICA

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The evolution of IS-LM models: empirical
evidence and theoretical presuppositions

n. 246 - Febbraio 1999

1. Introduction

IS-LM models have played a crucial role in the evolution of macroeconomics in the last sixty years. Notwithstanding growing criticism in the profession, particularly after the mid 1970s, they still play a crucial role in macroeconomics. They remain the core of many introductory and intermediate-level textbooks (e.g., Dornbusch and Fischer, 1978; Gordon, 1987; Hall and Taylor, 1988; Blanchard and Fischer, 1989; Mankiw, 1992; Blanchard, 1996). In addition they are still the backbone of disaggregated macroeconometric models utilised by public authorities and firms for policy evaluation and economic forecasting (e.g. in the USA the MPS and the DRI models). The survival of IS-LM models in a prominent position in macroeconomics is quite surprising since in the last sixty years the real world has apparently changed considerably and so have done the economic theories and methods. This longevity has been made possible by the great adaptability shown by IS-LM models to the changing perceptions of the economic environment within which they have been applied (which I will call for short Environment throughout the paper) that depend on the evolution of the relevant stylised facts and of the salient policy problems as well as on the evolution of the prevailing theoretical assumptions and methodological approaches. How can we explain the adaptability of IS-LM models to a changing Environment and their resilience after many, apparently crippling, criticisms?

In order to answer these questions we have to distinguish from the very outset different roles performed by IS-LM models during their honoured career:

- *Propaedeutic role* for didactic or heuristic purposes. No doubt the success of IS-LM models has relied very much on a comparatively high benefit \ cost ratio attributable to their use since they have often shown a significant heuristic and analytic power obtained through very simple means. In fact IS-LM models are able to represent the demand side of a whole economy by using just two equations and two endogenous variables (income and the rate of interest). Since one equation (IS) represents the real sector and the other (LM) the monetary sector, the IS-LM model is likely to be the simplest conceivable model which allows an analysis of the interaction between the real and the monetary sectors of the economy (at least as far as the demand side is concerned). Finally the extreme simplicity of the model and the possibility of representing it by a two-dimensional graph allows an intuitive control of its implications for economic analysis and policy and

permits easy communication between macroeconomists and a broader public (journalists, politicians, and any audience sufficiently conversant with basic macroeconomics).

- *Hermeneutic role* in order to clarify the interpretation of a certain macroeconomic theory in comparison with other theories. Since its appearance (Hicks, 1937), IS-LM models have played a crucial role as a common ground for theoretical and policy debates involving macroeconomists and policy-makers with different theoretical and policy perspectives: Keynes vs. the classics until the late 1960s, Keynesians vs. monetarists in the late 1960s and early 1970s, new Keynesians vs. new classical economists more recently.

- *Descriptive role* for representing, explaining or forecasting the performance of a certain economy. As such IS-LM models have played a crucial role as the backbone of econometric representations of the behaviour and performance of a certain economy. This explains in part their early success since their pregnant simplicity allowed easy econometric applications in the early days of econometrics (the early work by Klein is a prominent example). Subsequently IS-LM models have inspired the construction of more sophisticated multi-equations disaggregated econometric models.

- *Prescriptive role* for choosing the best policy measures or rules. Generic theoretical versions have been used for discussing which are the best policy rules under different hypotheses. Econometric versions of the IS-LM models have been utilised for choosing the best policy measures for a certain economy in a certain period. The policy implications of IS-LM models have proved to be very sensitive to competing assumptions on the slope of the two curves.

Of these four roles only the first one is relatively uncontroversial. Even a radical critic of IS-LM models wittily remarked a few years ago that 'IS-LM is the best mouse-trap built so far in macroeconomics' (Leijonhufvud, 1983, p.64). The clever simplicity of IS-LM models is sufficient to justify their use as didactic or propaedeutic devices, provided that it is kept well in mind, and made altogether clear to the audience, that the conclusions drawn from them may be wrong or misleading and require a further analysis with more sophisticated arguments and instruments.

In the light of the severe limitations of the IS-LM models we could wonder how can we explain the resilience of IS-LM models whose range of application has gone well beyond what may be considered justified for more than sixty years. Clues for an answer to this question may be found by reflecting upon the surprising adaptability shown by IS-LM models to a changing Environment. In this paper we intend to document this adaptability and to

clarify its reasons and implications. In order to do so we have to examine first, in section 2, the prototype of IS-LM models suggested by Hicks just after the publication of the GT. We have then to examine in section 3 the evolution through time of the IS-LM models based on the Hicksian foundations and, in section 4, the different foundations and implications of an emerging new generation of IS-LM models which aim to be consistent with new classical tenets. We are then in a position to hazard in section 5 a few remarks on the evolution of IS-LM models trying to sort out the influence of empirical evidence on one side, and of theoretical and methodological presuppositions on the other side. In the concluding section the resilience of IS-LM models is related to their intrinsic ambiguity rather than to their good performance in macroeconomic analysis.

2. The prototype of the first-generation IS-LM models: Hicks (1937).

As is well known, the first prototype of IS-LM model was introduced by Hicks (1937) as an hermeneutic device for clarifying the relationship between Keynes's *General Theory* (from now on GT) and *General Equilibrium* (from now on GE) classical theory in a language that could be understood also by the emerging group of econometrists[1] and mathematical economists (Hicks, 1982, p.100). At that time Hicks was busy in writing *Value and Capital* (1939) meant to clarify the foundations of Walrasian GE theory in order to build on them more manageable models for economic analysis and policy. Therefore it came natural to him to represent the bulk of GT in a small-scale semi-aggregate GE model and compare it with an analogous GE model of Walrasian inspiration in order to isolate and discuss the differences between them.

The GT model in the Hicksian suggested interpretation considers explicitly only three aggregate markets (money, capital and goods) and postulates that in the short period the market for labour as well as price changes do not play a significant 'active' role in the determination of macroeconomic equilibrium, so obtaining the following simple model:

$$(1) \quad L = G (i), \quad I = F (i), \quad I = S (Y)$$

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[1] Not by chance Mr Keynes and the Classics was written to be given at a meeting of the Econometric Society, held in Oxford in September 1936, and was published in Econometrica. The author himself underlines the role played by this target (Hicks, 1982, p.100).

where the symbols (that not always correspond to those, now obsolete, utilised by Hicks[2]) have the usual current meaning: L is the aggregate demand for money (which is in equilibrium equal to the aggregate supply of money M), i is the nominal rate of interest, I is the aggregate investment (in plants and machinery), and Y the aggregate income. The variables are measured in nominal terms but, owing to the assumption of fixed prices, their changes also represent changes in real terms.

The classical (Walrasian) GE model assumed as a benchmark by Hicks is formally very similar although its foundations are quite different:

$$(2) \quad L = kY, \quad I = F (i), \quad I = S (i, Y)$$

where the first equation represents the simplest version of the 'Cambridge Quantity Equation', while the other two represent as before the investment and the saving equations.

The only formal differences between (1) and (2) may be detected in the first equation which in the classical case relates the aggregate demand for money to aggregate income (according to the 'Cambridge Quantity Equation') rather than to the interest rate (as maintained by the Keynesian theory of liquidity preference), and in the third equation since aggregate saving crucially depends in the classical case also on the interest rate. This second amendment is considered by Hicks a mere simplification (1937, p.107) while it is the first one which leads to the 'startling conclusion, that an increase in the inducement to invest, or in the propensity to consume, will not tend to raise the rate of interest, but only to increase employment' (*ibidem*). Hicks calls the system of equations (1) 'Mr Keynes's *special theory*'. However, 'in spite of the fact that quite a large part of the argument runs in terms of this system'(*ibidem*), Keynes's *general theory* recognises that the aggregate demand for money depends also on aggregate income which plays a crucial influence in the transaction and precautionary motives of demand for money. Therefore the final model suggested by Hicks as representation of the GT is the following :

$$(3) \quad L = G (i, Y), \quad I = F (i), \quad I = S (Y).$$

This model re-introduces the interdependence between the market for money (transaction, precautionary, and speculative motives) and the markets of goods (investment and

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[2] By the way, the name given by Hicks to what is now called IS-LM was originally IS-LL and became SI-LL in his subsequent writings probably to emphasise, with a touch of typical Hicksian self-irony, the idea that this apparatus has to be taken just as a preliminary step towards more serious analysis.

consumption goods) which is crucial in Walrasian GE models and was absent in the special theory of Keynes. The two models become substantially equivalent because the implicit form of the equations obscures the different implications deriving from different foundations. It is at this stage of the argument that Hicks has a real stroke of genius: it is still possible to push further the discussion of the differences between Keynes and the classics without loosing touch with economic intuition through a graphic method based on a further simplification of the model. By analogy with the first equation of the system (3) which expresses a relationship between income and the rate of interest under the assumption of equilibrium in the market for money, the reduced form which may be obtained from the second and the third equations by equating in equilibrium investment and savings also implies a relationship, generally different from the first one, between the same variables. This permits a simple representation in a two-dimensional Cartesian diagram of the macroeconomic equilibrium as the intersection of two curves: the LM that takes account of the equilibrium constraints arising in the market for money and the IS that takes account of the equilibrium constraints arising in the market for goods. The differences between Keynes and the classics is now reflected by the different assumptions on the slope of the two curves. The peculiar Keynesian results depend, according to Hicks, on the so-called *liquidity trap* which implies a horizontal section of the LM curve when the economy is far from full employment equilibrium. Keynes's *special theory* which neglects the feedback of income on the rate of interest may be now better understood not as based on the denial in principle of the interdependence between the monetary and real sectors but as the result of offsetting forces which may work adversely under given circumstances. Hicks seems inclined to believe that these circumstances are reasonable only in a depression (*ibidem*, p.111). Analogously, if the axes measure the nominal rate of interest and the real aggregate income as in many IS-LM models, the classical dichotomy should imply a vertical LM and a horizontal IS (Hicks, 1937, and 1967b); however many classical economists recognised some degree of interdependence between the monetary sector and the real sector in the short period (Hume, Thornton, Marshall, Lavington, etc.).

The final verdict by Hicks on the difference between GT and GE is altogether clear: the only deep difference is in the assumption of flexible prices which assures in the classical models the stability of full employment equilibrium and the long-run dichotomy between the real sector and the monetary sector. However, in his opinion, in the short period the passive role of the supply side of the economy (and possibly even the stickiness of prices) may be justified as an approximation, and could be accepted as such also by classical economists. In any case the extent to which these assumptions are justified depends on contingent

circumstances (phase of the cycle, industrial sector, country, and historical period) rather than on theoretical or methodological fundamentals. Therefore, according to Hicks, the residual differences between Keynes and the classics should be discussed mainly in empirical or econometric terms.

This interpretation based on the IS-LM apparatus has been found appealing because it has managed to set a common ground for discussion and comparison of different theoretical approaches to the determination of short-term macroeconomic equilibrium, downplaying fundamental or irreducible contrast between them and setting at the same time common rules of the game for debating the issues and adjudicating the argument case by case. Therefore the IS-LM apparatus offered a very honourable compromise to both competing camps (Keynesians and classics) in the form of an alleged synthesis between two basically correct, but partial, points of view, setting at the same time the outlines for future productive research perfectly attuned with the new emerging tendencies of econometrics and mathematical economics. Therefore the tremendous, and relatively rapid, success of IS-LM models is perfectly understandable in historical terms, but has involved costs by no means negligible. The profound theoretical and methodological questions raised by Keynes in the GT were completely ignored or trivialised in IS-LM style macroeconomics. In order to understand that we have to go deeper into the relationship between the IS-LM apparatus and Keynes's theory.

As is well known, the main argument of GT is developed in two stages: in the first stage, which occupies the first part of the book and is summarised in the eighteenth chapter, a fixprice heuristic model is developed which is meant to expose and justify Keynes own peculiar approach to short-period economic problems; in the chapters 19th-21st Keynes applies this approach to the explanation of unemployment equilibrium and to sorting out the most efficient policy remedies to it. In the second stage Keynes drops the assumption of fixed prices and grounds his conclusions on the structural instability[3] of the relationship connecting the endogenous variables (which implies a marked structural instability for both IS and LM curves). This structural instability depends mainly on, possibly abrupt, changes in the long-term expectations of investors and speculators in the financial and productive capital markets, triggered by shocks which may be produced by policy interventions (for further details on this reconstruction of the GT argument see Vercelli, 1991). In this view the IS-LM apparatus is a

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[3] Structural instability indicates the propensity of a certain (macroeconomic) system to change the qualitative features of its dynamic behaviour (number and type of equilibria, their stability or instability, out-of-equilibrium behaviour, etc.) in consequence of a small shock. This property should not be confused with the usual concept of instability, that may be called dynamic instability, routinely utilised in economic analysis, which indicates progressive divergence of a system from equilibrium whenever a shock pushes it out of equilibrium. (For a more detailed discussion of instability concepts along these lines see Vercelli, 1991).

fairly faithful reconstruction of the first-stage fixprice heuristic model of Keynes, although restricted to the demand side of the economy. However, in the second stage, Keynes explicitly rejects the applicability of the first-stage fixprice heuristic models to situations characterised by structural instability, as those which had led to the persistence of 'unemployment equilibrium' in the 1930s. He clarifies in the GT and elsewhere that this is not the exception but the rule in a sophisticated monetary economy (see in particular his review of Tinbergen, Keynes, 1939). Therefore, the crucial and more general second stage of the Keynesian argument contains implicitly a clear confutation of the descriptive and prescriptive roles of the IS-LM apparatus. Of course this does not exclude its propaedeutic use which is implicitly fully exploited by Keynes himself in the first stage of the argument, but its applicability as a reliable apparatus for drawing conclusions for the real world is explicitly denied. In order to cope with the structural instability exhibited by a sophisticated monetary economy, Keynes suggests a very innovative methodological approach based on strong uncertainty, probabilistic causality, attention for the time-sequence of changes, and a crucial role for long-term expectations (see Vercelli, 1991). These innovative ideas, hardly consistent with Walras methodology, completely disappear from IS-LM models. Their hermeneutic, descriptive and prescriptive implications are therefore in general completely different from Keynes's own. In particular, the specific Keynesian results on the severe limitations of monetary policy for recovering unemployment equilibrium and the weakness of the feedback of income on the rate of interest do not depend neither on special assumptions on the slope of the relevant functions nor on the assumption of fixed prices; on the contrary the stickiness of prices and their inability to adjust the relevant variables to optimal values and the so-called 'liquidity trap' were both explained as a consequence of the structural instability of a sophisticated monetary economy[4]. We may conclude this section by observing that the IS-LM models ignore and cloud the most interesting methodological and theoretical insights put forward by Keynes in the GT.

3. The evolution of IS-LM models

The first prototype of IS-LM models suggested by Hicks was mainly motivated by the exigence of clarifying the theoretical and methodological issues raised by the GT. The first reason of its success was its (alleged) ability to reconciling the GT Keynesian representation

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[4] Keynes stresses also institutional reasons for the stickiness of wages and prices, but this should not obscure the fact that in the second stage of his analysis he aims at a general theory which should apply also under the assumption of flexible prices, since ' a theory cannot claim to be a general theory, unless it is applicable to the case where (or the range within which) money-wages are fixed, just as much as to any other case' (Keynes, 1936, p.276).

of the economy as a whole with that of classical GE theory under the assumptions of short period and fixed prices. This gradually produced a substantial consensus on the basic framework of macroeconomics (the so-called 'neoclassical synthesis'). Perhaps it is also possible to claim that the appearance of the IS-LM apparatus contributed to coagulate a wide consensus on the need of policy interventions to get out of the great depression first, and then to finance the war and finally to convert the war industries and reconstruct the economies damaged by the war (Marshall Plan). But these were exceptional circumstances under which it was relatively easy to agree. IS-LM models were worked out and discussed in the late 1930s and in the 1940s mainly in order to clarify the relationship between Keynes and the classics while only in the 1950s they became the cornerstone of econometric models aiming to describe the performance of the economy and to *fine tune* it in ordinary times. However, in a sense, even the 1950s were not ordinary times. The success of IS-LM models in that period in the above role is strictly related to the (with hindsight) peculiar economic Environment of the 1950s characterised by:

- substantial monetary stability and relatively peaceful industrial relations which justified the assumption of fixed prices and wages (in the short period),
- slow and steady shifts of the supply curve which could be fairly approximated in the short period by a given supply curve,
- substantial structural stability of the two curves which was sufficient to allow the use of IS-LM models for descriptive and policy purposes.

The descriptive use of IS-LM models which catches on in the 1950s and consolidates in the 1960s could not emerge in the troubled times of the late 1930s and 1940s for reasons already clearly expressed by Keynes which we have recalled in the second section (structural instability of the two curves fed by strong systemic uncertainty).

In the 1960s the Environment began to change as the industrialised countries experienced the first relevant supply shocks of the post-war period (mainly wage pushes) which in the late 1960s deepened and generalised. In this period it became progressively clear that the IS-LM models could not represent the whole economy, not even as a first approximation, because the supply side and the process of formation of prices and wages could not be ignored any longer, even in the short run[5]. In that period it became altogether evident that the traditional IS-LM models could only be at best a simplified representation of the demand side of the economy. However IS-LM models were promptly rescued by appending a third equation –the Phillips curve just introduced in the literature by Phillips

(1958) and Lipsey (1960)- which could somehow represent the supply side and the process of price and wage change in a certain economy.

The new augmented IS-LM models however had still to assume the structural stability of their equations, while since the late 1960s a series of connected shocks (generalised wage push in the late 1960s and early 1970s, the breakdown of the Bretton Woods system, and the two oil shocks) introduced a climate characterised by strong uncertainty and pronounced structural instability of the three curves. Attempts of rescue focused on more complex formulations of the Phillips curve or alternative formulations of the supply side as well as more sophisticated versions of the IS and LM curves. However, notwithstanding all these efforts, in the late 1970s a period of decline started for IS-LM models. This was due not only to the structural instability of the late 1960s and 1970s which could not be accomodated by IS-LM models, but also by the growing success of new classical economics and its basic challenges to the fundamental theoretical and methodological tenets of IS-LM Keynesian economics.

The growing success of IS-LM models in the post-war period had not come unchallenged, but until the mid 1970s the main opposition had been brought by currents of thought that had not managed to exert a particularly deep influence on mainstream macroeconomics (e.g. orthodox Keynesians such as Kaldor, Joan Robinson and Pasinetti, or monetarists such as Friedman[6] and Brunner and Meltzer[7]). Since the mid 1970s a more radical opposition came from the main leaders of the emerging school 'new classical economics' (Lucas, Sargent, Barro, etc.). IS-LM models were severely criticised for their lack of sound microfoundations (consistent with new classical standards), the complete neglect of endogenous and forward-looking expectations, an obsolete concept of equilibrium, the static approach (which restricts their use to comparative statics), the systematic violation of the classical dichotomy between the monetary and the real sectors of the economy. The most crippling and influential criticism was the so-called *Lucas critique* (Lucas,1976) which argued that functions such as the IS and LM curves are in principle not invariant to changes in economic policy rules and therefore cannot be used for policy evaluation. More in general the

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[5] This was clearly anticipated by Hicks himself in his review of Patinkin (1956) published in 1957 (reprint with editorial changes in Hicks, 1967a), and accurately examined in a few pioneering works (such as Bailey, 1962).
[6] Friedman who in the 1950s and 1960s raised the most influential criticisms to mainstream 'neoclassical synthesis' never liked the IS-LM apparatus but did not reject it altogether, at least as a possible vehicle of communication with Keynesian economists (see e.g., Friedman, 1976, 310-317).
[7] Brunner and Meltzer who must be reckoned among the early critics of the Keynesian use of IS-LM models did not exclude the use of a more sophisticated version of IS-LM models extending the range of substitution between assets (for a recent restatement of their approach see Brunner and Meltzer, 1993).

so-called 'Lucas critique' in its *pars destruens* correctly underlines that the main trouble with IS-LM models lies in their irremediable structural instability triggered by policy shocks[8].

In consequence of the new classical revolution (or, better, counter-revolution) of the 1970s the use of IS-LM models for hermeneutic, descriptive, and prescriptive purposes sharply declined. This did not affect their prominent role in textbooks of Keynesian inspiration (e.g., Dornbusch and Fischer, 1978; Gordon, 1987; Hall and Taylor, 1988; Mankiw, 1992; Blanchard, 1996, etc.)), while in the textbooks of new classical inspiration they were mentioned, and to some extent discussed, exclusively as expression of an approach considered out-of-date[9] (see, e.g., Sargent, 1979; Barro, 1993). The harsh confrontation between new classical economists and new Keynesian economists implies in particular a divergent view on the legitimate roles of IS-LM models since the new classical economists are prepared to recognise some residual value for IS-LM models as propaedeutic device, but strongly refute their descriptive and prescriptive roles,[10] while these are still vindicated by many new Keynesian economists (see, e.g., Gali, 1992; Taylor, 1993; Ball, and Mankiw, 1994).

The influence of facts on the genesis and evolution of IS-LM models is recognised by both camps in a symmetric way. New classical economists consider the Keynesian revolution which has led to the birth of IS-LM models as an over-reaction to the Great Depression of the 1930s, while the new Keynesians consider the new classical counter-revolution which has led to the alleged demise of IS-LM models as an over-reaction to the supply-side turbulences of the 1970s. It is altogether clear that both episodes, as well as more ordinary factual developments, are seen in a completely different perspective because of different theoretical and methodological frameworks. The evolution of IS-LM models depends, no doubt, on the Environment within which they are formulated, but the Environment depends not only from the stock of accumulated empirical evidence and from the flow of new additions to it, but also

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[8] It is ironic that the most crippling and influential critique to Keynesian, IS-LM style, models has been (independently) based on concepts already clearly expressed by Keynes, in particular in his critique to Tinbergen (Keynes, 1939). However the argument is inserted by Lucas in a different theoretical and methodological perspective. The structural instability is according to Keynes an ontological property of socio-economic systems and is particularly pronounced in a sophisticated monetary economy so that economic models cannot escape from it while their correct use must adapt to it. On the contrary, structural instability is according to Lucas either an illusory appearance of economic phenomena or, in any case, a property outside the reach of sound scientific methodology, so that models must be built and utilised in such a way to avoid it.

[9] A partial exception is the textbook of McCallum (1989). See on that the next section.

[10] This point of view has been recently reasserted by Lucas (1994, p.153):' Sometimes, as in the U.S. Great Depression, reductions in money growth seem to have large effects on production and employment. Other times, as in the ends of the post-World War I European hyperinflations, large reductions in money growth seem to have been neutral, or nearly so. Observations like these seem to imply that a theoretical framework such as the Keynes-Hicks-Modigliani IS\LM model, in which a single multiplier is applied to all money movements regardless of their source or their predictability is inadequate for practical purposes'. For other recent critical assessments of IS-LM models on similar lines see, e.g., Sims, 1992; King, 1993; Leeper and Sims, 1994.

by their interpretation which is grounded on the theoretical assumptions and methodological approaches adopted.

4. A second-generation of IS-LM models?

As we have seen, in the new Environment of the 1970s a period of decline started for IS-LM models, at least as far as its descriptive and prescriptive roles are concerned. However a more stable economic Environment in the 1980s and 1990s contributed, since the mid 1980s, to a revival of IS-LM models also in their descriptive and prescriptive roles.

The revival of IS-LM models since the late 1980s is characterised on the one hand by more refined foundations provided by new Keynesian economists, particularly to the assumption that prices are sticky in the real world (see Mankiw and Romer, 1991); on the other hand by the emergence of a family of IS-LM models which try to cope with the new classical theoretical and methodological tenets. The authors of this family of models derive IS-LM models from explicit maximising analysis of rational economic agents, being convinced that the lack of proper microfoundations is the main shortcoming of traditional IS-LM models. As a matter of fact the single models on which traditional IS-LM models are based have received through time accurate microfoundations: examples are the theory of consumption by Modigliani, liquidity preference by Baumol and Tobin. However these microfoundations are not fully consistent with those deemed sound by new classical economists, in particular because they ignore expectations or consider them exogenous or because they do not grant the classical dichotomy at least in the long term. Therefore the representatives of this new family of IS-LM models aim first of all to provide explicit microfoundations consistent with the theoretical and methodological tenets of new classical economics. Among the most interesting examples of IS-LM models of this kind we may reckon Fane (1985), McCallum (1989), Koenig (1989, 1993), Auerbach and Kotlikoff (1995), McCallum and Nelson (1997 and 1998). Although this family of models is not yet very numerous nor very homogeneous, it could start a new generation of IS-LM models which might rehabilitate them with new classical economists and give new impulse to their use. In any case these models confirm the great adaptability of IS-LM models to a wide range of theoretical and methodological environments by beginning to conquer even the school of thought which has been so far more sceptical on their virtues. I am going to give to the models belonging to this new family the common label of 'new generation' of IS-LM models in order to emphasise that, notwithstanding unquestionable formal analogies of the equations

with those of first-generation IS-LM models, the different foundations involve a quite different range of applicability of the models, as well as different results from their use.

In order to clarify these assertions we are going to examine in some detail one emblematic representative of this new generation of IS-LM models which is particularly interesting and coherent: the model recently suggested by McCallum and Nelson (1997) which restates the model first worked out in McCallum (1989). While Fane (1985) and Koenig (1989 and 1993) confine their analysis to comparative statics and Auerbach and Kotlikoff (1995) derive the IS-LM apparatus from an overlapping generation framework only under the restrictive assumption of rigid prices, McCallum and Nelson (1997) provide a fully-fledged dynamic analysis, in the new classical sense, applicable also under the assumptions of sticky prices.

McCallum (1989, pp.102-107) and McCallum and Nelson (1997, p.3) maintain that useful insights into monetary policy and business cycle behaviour may be provided by the following semi-reduced macroeconomic structure:

$$(\text{IS}) \quad log \ y_t = b_o + b_1 \ [\ i_t - E_t \ (\ log \ P_{t+1} - log \ P_t \ ) \ ] + E_t \ log \ y_{t+1} + v_t$$

$$(4) \quad\quad\quad (\text{LM}) \quad log \ L_t - log \ P_t = c_0 + c_1 \ log \ y_t + c_2 \ i_t + \eta_t$$

$$(\text{AS}) \quad log \ y_t = a_0 + a_1 \ (\ log \ P_t - E_{t-1} \ log \ P_t \ ) + a_2 \ log \ y_{t-1} + u_t$$

plus a policy rule for M_t (or i_t), where y_t is real income at time t, P_t the price level at time t, L_t nominal money balances equal to nominal money supply M_t, i_t is the nominal interest rate, and $E_t (\ . \ ) = E (./ \ \Omega_t \ )$, with Ω_t representing the set of information available in period t.

The first thing to notice is that the IS-LM equations are correctly considered as a semi-reduced representation exclusively of the aggregate demand side of the economy so that they must be used in conjunction with a representation of the aggregate supply (AS curve). This role is played not by a version of the Phillips curve as in traditional models but by a simple version of the new classical supply curve. This reveals a deep conceptual shift because it reinstates the long-run classical dichotomy between the monetary and the real sectors of the economy while short-run deviations are due to stochastic shocks on prices. The same new classical approach consistently underlies also the foundations provided for the IS and LM curves. These seem at first inspection the usual IS and LM curves but the appearance is highly misleading as they are based on alternative foundations aimed to make them fully consistent

with the basic tenets of new classical economics. To this end McCallum and Nelson show that they can be derived from the optimising behaviour of fully rational agents under standard simplifying assumptions. Consistency with optimising behaviour just requires one simple but crucial modification to the usual specification of the IS curve: the expected value of next period's output has to be added as a crucial determinant of the output demanded in the current period. McCallum and Nelson (1997, p.19) stress that this extra term gives a forward-looking aspect to the IS-LM curve that is not present in typical IS-LM models, and which is likely to have a major effect on the dynamic properties of the representation of a macroeconomic system .

Despite the strong formal analogy between McCallum's and Nelson's IS and LM curves and the usual ones, the conceptual and methodological differences are quite deep and must be fully understood in order to avoid potential confusions. In particular:

- The underlying model assumes flexible prices although the derived relations are meant to 'be used sensibly in a setting with slow price adjustment' (*ibidem*, p.15);

- The derivation of IS and LM curves from maximising behaviour is developed first in a deterministic setting and is then carried on in a stochastic setting by employing commonly- made approximations. Uncertainty is introduced in the usual way of new classical macroeconomics by assuming a stationary distribution of stochastic shocks impinging upon one or more endogenous variables and by assuming that economic agents entertain rational expectations over the future. The stochastic micro-foundations are particularly interesting because they promise to amend a crucial weakness of IS-LM analysis by introducing uncertainty explicitly and because they assure a deeper consistency with new classical tenets.

- Differently from the first-generation IS-LM models, McCallum's and Nelson's model does not restrict IS-LM analysis to the short-period (vs. long-period) issues but to business-cycle (vs. growth) issues. This is a crucial conceptual difference between first-generation IS-LM models and the McCallum's and Nelson's model since the dichotomy short/long period does not overlap at all with the business-cycle/growth one. In the Marshallian tradition underlying both Keynes's and Hicks's models, as well as first-generation models, the assumption of short period implies a given and invariant quantity and quality of capital stock and, in the absence of stochastic shocks, also a given and invariant supply curve. This simplifying assumption permits comparative-static exercises meant to choose the best policy interventions in a given situation but is not apt for a satisfactory analysis of both business-cycle and growth issues. The model of McCallum

and Nelson is fully dynamical (in the new classical sense) even in its supply curve which therefore plays a crucial role in the determination of income and, indirectly, of the other endogenous variables. The model supports comparative dynamics exercises which however are restricted to business-cycle issues because it is assumed that the time path of capital is exogenous. McCallum and Nelson assume in the theoretical analysis that the stock of capital grows at a given steady rate while in empirical applications they approximate the behaviour of the stock of capital through a random walk with drift so that investment is assumed to have a constant expected growth rate (*ibidem*, p.7). This simple treatment of the dynamics of the capital stock does not prevent a satisfactory analysis of business-cycle issues because 'there is very little connection at cyclical frequencies between capital stock movements and aggregate output' (*ibidem*, p.8); however, of course, this assumption prevents any meaningful analysis of growth issues. This difference is crucial for defining the range of applicability of the model. The assumption of short period, typical of first generation IS-LM models implies, that the model cannot be applied to a too long series of data (exceeding, say, one year) while the assumption of a steadily growing capital stock is 'designed for quarterly time series data over sample periods of many years' duration (e.g. 10 to 50 years.) (*ibidem*, p.7). Unfortunately this longer time horizon is obtained only at the cost of a stringent assumption of stationarity for the relevant time series which is not necessarily assumed in the traditional IS-LM analysis and was definitely not assumed in the second-stage heuristic model of Keynes.

- Strictly related to the last point is another important feature of McCallum's and Nelson's model. While traditional IS-LM models may be used for choosing the optimal policy interventions in a given short-period situation but could not be safely used to choose the best policy rule under given assumptions, Mc Callum's and Nelson's model is fit for this second goal rather than for the first one. Notice that the model assumes a given policy rule for the nominal supply of money M_t (or for the nominal interest rate i_t) and not a given value as in traditional IS-LM models. The results which may be derived from the model are therefore conditional to the assumptions made on the monetary policy rules.

We may now attempt a preliminary assessment of the second generation of IS-LM models in the light of the analysis of McCallum's and Nelson's model. The main targets of these models seem to be the following:

- to provide a common ground for macroeconomists and policymakers with different perspectives, in particular new Keynesians and new classical economists (Koenig, 1993);

- to choose the optimal policy rules (McCallum and Nelson, 1997 and 1998) under given circumstances.

These targets are both ungranted. First-generation and second-generation models really address different issues. The first generation user (at least according to the original point of view of Keynes himself) may be likened to the captain of the Titanic which sees the iceberg and wants to know how to avoid the impact, while the user of a second-generation model aims to choose the best route for the Titanic taking account of all the possible shocks (including floating icebergs) but the solution to the second problem doesn't help solving the first one and *viceversa*.

We are not going to discuss here whether the second generation models may really help to choose the optimal policy rules. Of course the validity of the results obtained from them are subject to all the limitations typical of the new classical school which have been many time discussed in the literature (see e.g., Vercelli, 1991; Vercelli and Dimitri, 1992). In any case we do not intend to deny a role for second-generation IS-LM models which is similar and complementary to that of the first-generation models: a simple propaedeutic presentation and discussion of the behaviour of a macroeoeconomic system and of its reaction to different kinds of external shocks or changes in policy interventions or rules. In particular its didactic value is quite evident; after having presented the characteristics of a typical first-generation IS-LM model, a teacher may substitute the new classical supply curve for the Phillips curve, may introduce uncertainty and rational expectations and show why the model has different implications for theory and policy applications.

5. The role of empirical evidence vs.theoretical and methodological presuppositions

We are now in a position to advance a few tentative remarks on the evolution of IS-LM models. According to the cursory reconstruction of the evolution of IS-LM models here outlined we have to distinguish two generations of IS-LM models which have completely different foundations. While it is not yet clear whether the second generation, which temporally overlaps with the recent specimens of the first one, will catch on in the future, it has to be sharply distinguished from the first generation since it has completely different foundations, as well as different implications for macroeconomic analysis and policy. The first generation is based on the deterministic version of GE suggested by Hicks and Samuelson (see in particular Hicks, 1939, and Samuelson, 1947), while the second generation is based on the Arrow-Debreu stochastic version of GE in agreement with the microfoundations suggested by Lucas and Sargent (see in particular the introduction to Lucas

and Sargent, 1981; comments may be found in Vercelli, 1991). According to the foundations of GE models suggested by Hicks and Samuelson, disequilibrium is a meaningful concept and expectations do not need to be rational, while in the second case disequilibrium is meaningless and expectations must be rational. These different foundations imply a different conceptualisation and a different range of applicability of the two generations (short period in the first case and business cycles in the second case, despite strong formal analogies of the two models). Generally speaking, it is possible to say that a new generation of IS-LM models appears after a major structural change in the Environment: the first generation as a response to the Great Depression of the 1930s and the second generation as a response to the supply-side crisis of the 1970s and early 1980s.

Each generation of IS-LM models is characterised by many specimens which may differ considerably (e.g. because they add further parameters and even, sometimes, further endogenous variables) and may be classified according to the standard routine of application to empirical evidence (e.g. with or without an aggregate supply curve). A change of operational routine is sensitive to structural changes less radical than those which have originated a new generation of models: the positive and normative use of IS-LM models as a complete representation of the economy established itself in the 1950s and 1960s in a period of stability of prices and steady shifts of the supply curve, while the addition of a third relationship in order to represent the supply side of the economy established itself in the late 1960s in consequence of the growing importance of the supply-side shocks.

All the evolutionary changes which we have detected typically lag behind the originating structural changes in the Environment with a delay of about 5-10 years. The Hicksian prototype of IS-LM models emerges in order to model the fixprice heuristic model of Keynes aimed to representing the causes of, and to designing the remedies for, the Great Depression triggered a few years before by the collapse of Wall Street. Its systematic use for fine tuning starts at the end of the 1950s after almost one decade of steady growth in industrialised countries. The integration of a third equation to represent aggregate supply constraints is almost contemporaneous to the growing influence of supply shocks in the 1960s, while the eclipse of IS-LM models starts only in the late 1970s, almost 10 years after the breakdown of the stability of the Phillips curve. The revival of the IS-LM models since the late 1980s reflects almost a decade of recovered structural stability in the growth process and in prices after the troubled 1970s.

As for the specific role of cumulated empirical evidence on this process of evolution, it may be observed that successive specimens in a certain generation belonging to a certain

routine may be very sensitive to new empirical evidence made available by official sources and econometric models, while a new routine typically emerges only when different pieces of evidence systematically violate over time the tenets of the preceding routines (e.g. the irrelevance of the supply side in the short period); a new generation of models requires in addition a radical re-conceptualisation of empirical evidence which is based on completely new theoretical and methodological assumptions.

6. Concluding remarks

The cursory overview of the evolution of IS-LM models reported in this paper has documented a remarkable resilience of IS-LM models which have been able to adapt to frequent and radical changes in the Environment. A first possible explanation could be the good performance of IS-LM models for the purposes for which they have been designed and utilised. This may be part of the truth: the clever simplicity of these models could be sufficient to explain their unfailing success in textbooks, with media, and in research reports for propaedeutic, didactic or heuristic purposes. What about the other roles of IS-LM models? Let's consider them separately following the classification suggested in the first section of this paper:

1. Since its first introduction by Hicks, IS-LM models have been often praised for setting a common ground for competing theories and for helping their interpretation and assessment. Unfortunately the conclusions drawn by this hermeneutic use of IS-LM models have been often misleading as testified, e. g., by the three following crucial episodes:

   -in the 'Keynes vs. the Classics' controversy the synthesis suggested relied on the false conclusion that the main difference between Keynes's GT and Walrasian GE classical theory was rooted in the Keynesian assumptions of sticky prices and the special slope of (part of) the LM curve (because of the so-called 'liquidity trap'). The ensuing compromise (i.e. 'neoclassical synthesis') was sufficient to justify 'Keynesian' policy measures (deficit spending) and practices (fine tuning) but trivialised the message of Keynes and ignored the deep methodological differences between GT and Walrasian GE theory which had led Keynes to reach his policy conclusions under very general assumptions (as argued in section 2).

   -in the 'Keynesians vs. Monetarists' controversy, the crucial difference between the two camps was reduced again to a question of slope of the LM curve assumed to be horizontal by Keynesians and vertical by monetarists. This dichotomy characterises only one aspect

of the conflict between fixprice Keynesism and that variety of extreme monetarism that assumes the irrelevance of the rate of interest in the quantity theory of money; however it completely clouds the deep methodological differences involved in the debate: the Friedman's Marshallian method, the Walrasian GE method of the 'neoclassical synthesis', and Keynes's own method.

-in the recent 'new Keynesians vs. new classicals' controversy the use of IS-LM models risks again to muddle the main issues by obscuring the deep methodological and conceptual differences underlying the different foundations of IS-LM models. The main differences between the two approaches, apart from those underlying different supply functions, seems still to reside in the Keynesian assumption of stickiness of prices. This gives the wrong impression that a compromise between the two schools of thought is possible provided that the stickiness is explained in rational terms as systemic consequence of the optimising behaviour of economic agents. However, as we have recalled (see retro section 4) the two approaches address different problems and what is common is seen in a different light.

2. The use of IS-LM models for descriptive purposes is restricted to cases in which the structural instability of the economy is fairly irrelevant. In industrialised countries this may have been approximately true for long spells of time in the 1950s and 1960s and part of the 1980s but it is certainly not true in general. This problem is particularly severe for predictive uses because it is almost impossible to hazard forecasts on the future developments of structural instability. This crucial limitation in the application of IS-LM models has been lucidly anticipated by Keynes and rediscovered by Lucas in a different perspective.

3. The use of IS-LM models for policy purposes is barred again by the necessary requirement of structural instability. The choice of the optimal policy interventions in a given situation, or of the best policy rule under standard assumptions, both involve forecasts as they involve a comparative assessment of the consequences of alternative policy measures or rules. In addition, as has been lucidly perceived by both Keynes and Lucas, the introduction of a new policy rule, or of a new policy measure, may produce discontinuous changes in the behavioural rules of the agents and therefore discontinuous shifts in the IS and LM curves, increasing the degree of structural instability of the economic system.

We have to conclude that the performance of IS-LM models applied to hermeneutic, descriptive and prescriptive issues has been very poor and often misleading. The reason of the

resilience of IS-LM models has to be related more to their adaptability to different theoretical and economic milieus than to their good performance, with the only exception of their propaedeutic function for each of their possible uses. Therefore we are led to conclude that the main reason of their enduring popularity is to be found in their flexibility which is ultimately rooted in their ambiguity. What is common to all the IS-LM models is after all not very demanding:

- The useful but quite obvious idea that the equilibrium aggregate demand of a certain economy implies equilibrium in both the market of goods and the market for money. In other words the IS-LM models perform a sort of minimal disaggregation of the determinants of equilibrium aggregate demand which is, no doubt, particularly convenient for studying the interrelations between the monetary and the real sectors of the economy. This very basic idea underlying IS-LM models is consistent with (almost) any theory prepared to accept the relevance for macroeconomic analysis of the equilibrium concept and of the distinction between a monetary and a real sector. For the same reason IS-LM models, short of precise a priori restrictions on the slope and position of the two curves, are consistent with almost any sort of empirical evidence and are therefore virtually non-falsifiable.

- Each curve represents the locus of all the possible couples of equilibrium values for the same endogenous variables by taking account separately of the constraints originating in the real and monetary sectors. The choice of aggregate income and the rate of interest as the endogenous variables of the model, i.e. as the crucial bridges between the two sectors, is hardly controversial.

Summing up we may conclude that IS-LM models are consistent with most economic theories because a certain IS-LM model can be interpreted as the semi-reduced form of different structural models which may have different theoretical foundations, and it may have different theoretical or policy implications according to the operational routine chosen. This suggests that the adaptability of IS-LM models to different Environments is basically due to their ambiguity. Unexpected empirical evidence has always been accomodated in a way or another, by changing the specification of the curves, or the operational routines, or the theoretical foundations. This ambiguity of the IS-LM models may well explain why they have been often utilised for suggesting compromises between different theories (e.g. the so-called 'neoclassical synthesis'). Unfortunately, the dialogue between different theories based on IS-LM models has always proved rather sterile, never succeeding to provide a genuine and sound syntheses between competing theories, nor to clarify very much the issues at stake.

The former criticisms are not meant to deny that IS-LM models may have a useful propaedeutic role, for didactic or heuristic purposes, as a first stage of inquiry which precedes a deeper analysis of macro problems and theories. Therefore there is no reason to anathematise IS-LM models for the restrict uses for which they are fit, provided that the usual warning is taken very seriously: 'handle with care'.

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