DRAFT VERSION

Integrating search in macroeconomics: the defining years[*]

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I. INTRODUCTION

While unemployment has been a central feature of capitalist economies for more than a century, surprisingly enough, economists have had a hard time integrating it in their theoretical discourse. Among the first economists having tried to address unemployment, the names of Hicks (1932) and Pigou (1933) must be mentioned. While they pinpointed that the existence of frictions and monopoly power were the main causes of the phenomenon, they were unable to theorize this insight. Batyra and De Vroey (2011) argue that this is due to these economists failing to realize that, by construction, Marshallian supply and demand analysis precluded the possibility of a rationing outcome. Keynes's *General Theory* (1936) was the next milestone. In view of the peaks to which unemployment had risen in the wake of the Great Depression, Keynes decided to split unemployment into frictional and involuntary unemployment, the former considered normal, the second abnormal. Taking (wrongly) for granted that the first type was well understood, he zeroed in on elucidating the latter. To this end, he took the bold standpoint of arguing that the causes of unemployment needed to be looked for elsewhere than in the labor market; in other words, unemployment needed to be understood as a problem of interdependency across markets or, to use a more modern terminology, as a case of coordination failure. Keynes's insight has, until this day, a definite ring of veracity. Unfortunately, translating it into a consistent theoretical argument was a task for which the adequate tools were lacking. As a result, Keynesian economists, more or less grudgingly, ended up falling back on the more trivial assumption of wage sluggishness. In the late 1960s and early 1970s Keynesian macroeconomics came under heavy attack first by Milton Friedman, later by Robert Lucas, the outcome of which was the dethroning of the Keynesian by the Lucasian paradigm or, to borrow from Christiano, Eichanbaum and Evans (1999), the ascent of the 'Lucasian program'.[†] This went along with a redefinition of the object of macroeconomics, from the study of unemployment to that of business fluctuations. In the first years of existence of this program, at least, the attention was focused on the level of activity, i.e. the number of hours worked, their distribution between employed and unemployed people being left aside. Thus, unemployment *per se* was left out of the picture.

This is the context in which the search paradigm saw the light of day. Its aim was to restart the study of unemployment from square one, i.e. abandoning Keynes's split between frictional and involuntary unemployment and deciding to reason exclusively in terms of the first category. Another departure from Keynes was to return to a labor market explanation of unemployment. Finally, the analysis, it was argued, needed to consider unemployment as an equilibrium phenomenon. All this indicates that in the beginning the search theory of unemployment evolved in total disconnection from macroeconomics. Our paper is concerned with what happened later, namely attempts at reconnecting the two.

We will concentrate our attention on what are to us the two main initial attempts at an integration of search in macroeconomics. The first one is associated with the name of Peter Diamond (1982a, 1984 (a) and (b)) the second one with those of David Andolfatto (1996) and Monika Merz (1995), two papers written independently yet very close in content. These works differ in several respects. The first is the context. Diamond conceived of his model, which combines a search and a coordination failure perspective at a time where the Lucasian program was not yet holding sway. The two other papers were written when this program was well established, in its RBC variant. A second difference relates to profile and motivation. Diamond had played a pioneering role in the launching of the search program in its 'pure' (i.e.

[†] To date, the latter has evolved over three stages: firstly, new classical modeling, secondly, RBC modeling and, thirdly, DSGE modeling.

isolated form) but then deciding to enter the macroeconomic field.[‡] The objective he pursued was ambitious as it consisted in no less than offering an alternative to the Lucasian program. He did this in a paper that abided with Lucas's standards for sound macroeconomics yet aimed at supporting a Keynesian policy conclusion. For their part, Andolfatto's and Merz's aim was to improve the RBC paradigm rather than to question it. The three models have in common that technically, i.e. in terms of consistency, and abiding by basic methodological principles, they were all a success. However, their fate differed. Diamond's model, while widely hailed, remained a one-shot achievement and few people followed the line he had opened. In contrast, Andolfatto's and Merz's work got the status of a well-established (though modest) contribution to RBC modeling.

In Section Two, we focus attention on the search paradigm. We take a look at how the idea of searched evolved to answer a number of challenges that could not be met in a classical framework. We then describe why there was a need to move to two-sided search, and how one particular branch, random search and bargaining (RSB), evolved to maturity. In Section Three and Four, we put the spotlight on the two attempts mentioned above. We assess these in the last section.

II. THE ASCENT OF THE RANDOM SEARCH AND BARGAINING (RSB) PROGRAM

In this section we undertake two tasks. First, we briefly narrate the birth of the search program. Second, we zero in on the development and stabilization of one particular branch of this program, the random search and bargaining sub-program. The latter is important for our purpose because it contains the ingredients allowing it to be crossed over with the RBC variant of the Lucasian program, thus making possible the integration of search in macroeconomics à la Andolfatto/Merz.

The building of a research program can be compared to the construction of a tower, and the one we are interested in is the 'RSB tower'. First, the ground on which the tower is build must be prepared. Next, its foundations (the skeleton structure) must be erected. Finally, the building may be finished, store after store. [§]

Preparing the grounds

The literature grew out of the realization by a number of economist, Stigler (1961, 1962) most notably, that many observable situations could not be explained using the neoclassical, frictionless view of the market. The inability of the perfect competition model to address in an internally consistent way rationing, i.e. heterogeneity of treatment of similar individuals, has struck economists for a long time. Another problem with the classical representation concerns the question of adjustment to equilibrium. How does one converge to the equilibrium? Are adjustments instantaneous, or is there a transition process that eventually yields the outcome? Information problems and search frictions stood out as a realistic feature of many markets that could explain these facts. Leaving a static framework, as laid out by Stigler, to a dynamic one, the search literature was moved forward by papers by McCall (1970), Mortensen (1970), and Gronau (1970).

At first, one sided, sometime referred to partial-partial, models of search were proposed. In those papers, emphasis is put on one side of the market, very much as outlined by Stigler in

[‡] Okun (1981) was an earlier attempt at introducing search in macroeconomics (of a traditional Keynesian kind).
[§] The difference between the construction of a research program and the one of the tower is that in the case of a tower the majority of the details of the construction must be know ex-ante, which is clearly not the case for a research program.

a static framework. One side of the market is taken to be represented by an exogenous distribution. Typically the employer side is represented by a wage distribution. Workers randomly face wage offers and must decide whether to accept these offers, or reject in the hope of subsequently getting a better offer. This partial-partial approach proved fruitful both theoretically and empirically, but suffers from a double drawback.

First, in an important paper, Diamond (1971) showed that, in a goods market setting, under a set of assumptions, and considering the Nash equilibrium, producers would set the price at exactly the buyers' reservation price. This, of course, is contrary to the typical assumption in the one-sided search model. Given these results, the question of efficiency of the search equilibrium clearly had to take center stage, and Diamond was certainly not the only who thought so. Second, there is no reason to believe that only one side would exert effort to search in a market with frictions. This is, of course, clearly not the case for the labor market. Moreover, one would like to have a model where rationing is observed on both sides of the market, a task on which several bright minds started to work. Thereby, the ground was set for the foundations to be built. Building a representation of a decentralized market, in which agents need to find partners, requires making two important modeling assumptions, one one the meeting process and one on the way prices are set. There were two possibilities for each decision. Meeting could be assumed as random or not, and the power to set prices could be given fully to one side, or left for negotiations. Each of these possible choices leads to a different setting: there was place for more than one tower. The RSB model is one of them.

From the point of view of the meeting process, search can be taken to be either random or directed. The wage determination process, meanwhile, can either stress the monopsony power of the firm, and assume wage posting, or allow for negotiations between the firms and the workers, and take the form of bargaining. While once could conceive of 4 possible combinations of these models, in fact the great majority of the literature fits in one of three categories. Directed search with wage posting (Butters 1977, Burdett and Judd 1983, Mortensen 1990, Burdett and Mortensen 1998), random search with wage posting (MacMinn 1980, Albrecht and Axell 1984), and random search with bargaining (Mortensen 1982, Diamond and Maskin 1979, Pissarides 1979, 1990). Construction of the later, in which search is random and prices are set by bargaining, is at the center of much of the rest of this section. We will describe the building process that lead to the establishment of the canonical model. Before moving on, we briefly describe the other two towers, towers that are still being actively worked on.

In random search with wage posting, it is assumed that workers are heterogeneous with respect to some element unrelated to productivity. Firms with monopsony power may then be indifferent, in equilibrium, between setting high or low wages. It can be shown that, in general, the distribution of wages will coincide with some subset of worker reservation wages. Firms' heterogeneity may be required for robustness. Workers do not search on the job.

In directed search with wage posting, ex ante homogeneous workers search for a job by sampling wages decided by firms. Firms compete to attract workers. Setting a higher wage offer allows the firm to attract workers form other firms. For wage dispersion to arise, one requires on the job search and search frictions.

Building the foundations to the RSB tower

Three foundation elements are needed. First, there is a need to render operational the concept of random meeting. Obviously, in such a setting, a pair yields a surplus that it to be shared. The second element of the foundation is, then, to describe how the surplus is endogenously shared. Describing in more details how jobs are created is the third and final step.

Foundations: stage 1

Given searchers on both sides of the market, and the number of each type, what would define the probabilities of an encounter? This founding stone was laid at the same time in contributions by Pissarides (1979) and Diamond and Maskin (1979) but in very different contexts. While attracted to search models because of their realistic definition of unemployment, Pissarides was dissatisfied by the feature that, in those models, the long-term unemployed were deemed to be in such a situation because of a failure to locate high enough wage offers. His hunch was that characterizing job offers as mere wage offers was misleading; much more was involved, namely the problem of matching jobs with workers, each with different attributes. To model that, he introduced a meeting mechanism, which he dubbed the matching function. The situation he conceived of was one in which wage distribution was absent, but unemployed and vacancies co-existed. Noticeworthy, the matching function started as an assumption meant to represent a specific institution in the labor market, namely the British Employment agency. Unemployed workers can apply to the agency, and firms with vacancy can post said vacancies in the agency repository. But workers and firms can also side step the agency, with firms posting privately advertising for jobs, and workers randomly encountering advertised jobs. It quickly turned out, however, that the notion of matching function could serve a bigger purpose as it constituted a template of one of the central concepts of economic theory, the production function. As a result, all what economists at long learned about the production function could be extended to the matching function. Small wonder then that, in spite of its black box character, it became a cornerstone of the search program .

For their part, Diamond and Maskin proposed a model of bilateral contracting. The focus of their paper is on contracting and breaches of contracts, and as such their terminology is somewhat alternative to Pissarides'. The objective, in Diamond and Maskin's terms, was to analyze "steady state equilibria in models where individuals meet pairwise in a costly stochastic search process and negotiate contracts to produce output" (ref.) In their framework, matches can be good or bad, and agents may want to breach contracts. They investigate the impact of different damage rules on equilibrium search and breach behavior. They consider two types of meeting technology: quadratic and linear. In the quadratic case, the aggregate number of matches increases in a quadratic fashion with the number of searchers. Additional searchers create a positive externality by raising meeting probabilities for all. In the linear case, the meeting probability is independent of the number of searchers, but the chance of meeting a free partner is affected. In this case, there is a negative externality imposed by searchers who are in a match. Given the search externalities, in general decisions to search and decisions to breach are inefficient, and there may be multiple equilibria. Thus, needing to conceptualize a meeting technology, Diamond and Maskin somehow stumbled in the same idea as Pissarides, the matching function.

Foundations: stage two

The second stage consists of two elements. First, when agents meet in a decentralized market, a surplus from the match is created. This raises the question of how the surplus is divided between firms and workers. In this stage of the establishment of the foundations of the RSB model, that question is tackled. In addition, given that search by individual agents on one side and on the other of the market imposes externalities on other agents, there is no reason to think that the solution to this problem will be efficient. It becomes, then, important to characterize under which conditions the solution is efficient (if any) and under which conditions it is not. This is the second element. Contributions on these topics are essentially due to Mortensen (1982a,b) and Diamond (1982b), building on Mortensen (1978) and Diamond and Maskin (1979).

When working on these foundational issues, Diamond had unemployment and the labor market as central concern. He used the matching function as introduced in Diamond and Maskin (1979) together with a full fledged two-sided setting. He also introduced Nash bargaining as a more sophisticated assumption on negotiation: bargaining is used as a proxy for contracting and negotiation issues. This implies, he underlined that depending on bargaining power, the equilibrium wage in general will be inefficient. Diamond also focused his attention on situations with a different number of unemployed workers and vacancies

For his part, and roughly at the same time, Mortensen added a matching function and a division of the surplus via Nash bargaining to a two-sided search model in order to analyze existence and efficiency of Nash equilibria in this context. Increased recruiting effort reduces the probability of finding a worker for other firms but is beneficial to workers searching. Similarly, more search effort by workers is beneficial to firms posting vacancies but detrimental to workers searching. As in Diamond (1982b), in Mortensen's models decision makers do not internalize these costs and benefits. Thus, there is no reason to expect the equilibrium to be efficient. However, pursuing his inquiry, Mortensen ended up eliciting a case where efficient is present. To this end, he considered two possible matching functions, a linear and a quadratic one, which he generated using ball and urn models. His next step was to to prove the existence (and uniqueness in the case of a linear matching function) of a Nash equilibrium for all possible sharing rules. Finally, for the linear case, he was able to elicit the existence of one particular sharing rule that induces efficient search incentives. This result was further extended by Hosios (1990) in what was to become the Hosios condition.

Foundation: stage three

Given the matching function, bargaining as wage setting, and the possibility of unequal numbers of unemployed and vacant jobs, the last element needed for having strong foundations consisted in figuring out how the relative number of job openings to searching workers is set. The key contribution, here, was laid out in two papers by Pissarides (1984, 1985). The underlying idea is to consider a vacant job as an asset to the firm. It is then easy to imagine that the financial arbitrage arising in financial markets will have its counterpart in this setting: given free entry, if opening a vacancy yields a positive value, new vacancies will be posted. In equilibrium, therefore, the value of a vacancy must be zero.

Combing bargaining and the job creation component and the focus on the relative number of vacancies to unemployment allows for a simple, intuitive (though less than Supply and Demand,) graphical representation. The framework can easily lead to wage distribution, but it is also ready for a single-wage world. There is unemployment in equilibrium. The efficiency of the equilibrium is far from obvious; thus, it is central to analyze it.

Solidifying the foundations

In a time where, in economics, monographs have lost their earlier power to impact, it is nonetheless through the first edition of *Equilibrium Unemployment Theory* (1990) that Pissarides anchored the theory. In this book, he spelled out all the elements that have been appearing the papers mentioned above in a piecewise way, using a single thread and unifying notation. Perhaps more importantly, the book revealed Pissarides to Mortensen. Pissarides was clearly aware of Diamond's and Mortensen's contributions to the last stage of the foundations, but his earlier work was not cited in Diamond's or Mortensen's stage 1 and 2 contributions. After publication of Pissarides's book, things changed radically:

> Although I was aware of and followed his work with interest in these years, only after the publication of the first edition of his book *Equilibrium Unemployment* in 1990, which fully articulated the first generation of the DMP model, did we collaborate in a string of coauthored papers, initiated by "Job Creation and Job Destruction in the Theory of Unemployment," published in 1994. This paper extended the model in the first edition of his book to include endogenous job separation as well as creation. Subsequently, the extended model was incorporated in the second edition of the book, published in 2000 (Mortensen 2011).

Mortensen and Pissarides started collaborating on a number of extensions to the model, chief of which was endogenizing job destruction. Those Mortensen-Pissarides extensions were incorporated in the second edition of the Pissarides book (2000), further establishing the framework which we describe briefly next. Until then, and in part because of timing, Diamond and Mortensen were the two leading figures in the field. This changed with Pissarides taking over Diamond's role. The latter, stimulated by the changes that were occurring in the field of macroeconomics with the arising of what at the time was called the "rational expectations revolution", decided to engage in a new research line. It consisted in constructed a macroeconomic model embodying search and aiming at offering a research line alternative to the Lucasian one.[**]

The basic RSB model

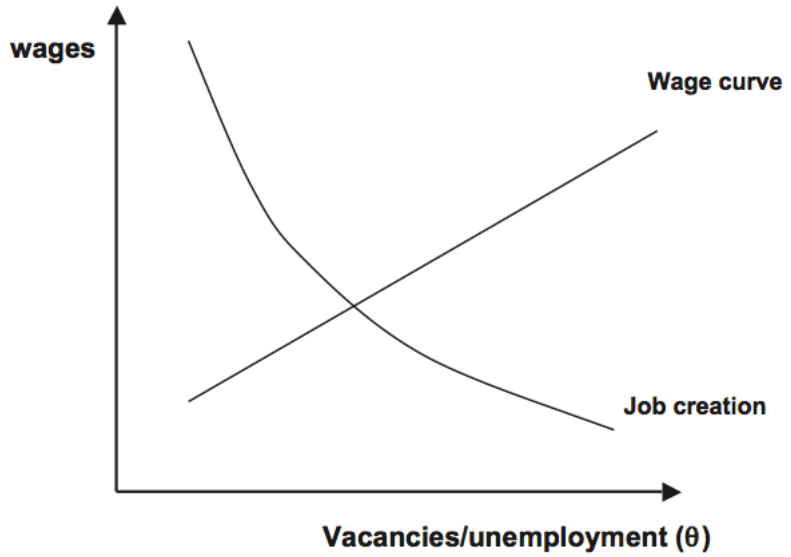
After presenting the genesis of the tower, it is time for a brief tour of the mature construction. The economy is inhabited by many workers and many firms; these are of a small size, consisting of just one job. The labor market of this economy is decentralized and uncoordinated. Hence both workers and firms have to engage in a costly search before being able to trade. Workers can be in one of two states, employed or unemployed. Firms can (a) be in a production relationship, (b) have an open vacancy, or (c) be in an ethereal state. Agents take their decisions rationally. Searching for a partner takes time, and firms may, in addition, incur a cost when posting a vacancy. Pairs in production exogenously separate with a certain probability. Given the decentralized nature of the market, two modeling decisions must crucially be made: how workers and firms meet, and how prices are set.

The matching function gives the number of jobs formed at any point in time as a function of the number of workers and firms searching for a partner. It is a reduced-form modeling device that summarizes all the choices available to workers and to firms. It captures the idea that that the time needed will vary across workers and firms (there is a luck component), while in parallel the total number of vacancies and total number of unemployed affect the average amount of time needed to find a good match.

[**] In 2010, all three men received the Nobel prize for their contributions to what has since then been dubbed as the 'Diamond-Mortensen-Pissarides model' (ref.). From further examination, and while recognizing that Diamond contributed greatly to two of the three foundation elements of the model, it is easy to see why, earlier on, the model was known as the Mortensen-Pissarides model.

Once a pair is formed, the need for the price setting assumption kicks in. Here, using advances in the modeling of bargaining, it is assumed workers and firms split the pair surplus following a Nash bargaining process. Add to this an assumption of free entry of firms, and it become possible to determine an equilibrium ratio of vacancies to unemployment. This ratio of vacancies to unemployed is referred to as *market tightness*. From the pairwise interaction of firms and workers through the Nash bargaining process one can derive a wage equation. It tells that, as the ratio of vacancy to unemployment increases, workers are able to bargain their way to higher wages or hold out for better offers. It follows from the free entry assumption that vacancies with a negative net value shut down. It also indicates that, if the net value of vacancies is positive, new vacancies get posted. As a result, the net value of a vacancy must be zero in equilibrium. There is thus an inverse relation between the ratio of vacancies to unemployment and the wage rate: the expected value of a vacancy increases as the wage rate decreases, and thus the number of vacancy to unemployed increases. On the one hand, a positive relationship between the wage rate and market tightness has to hold due to the wage setting mechanism. On the other hand, a negative relationship between these variables has also to hold given the free entry assumption. It is then easily seen that a wage rate and a level of market tightness for which equilibrium is achieved can be derived. Figure 1 illustrates.

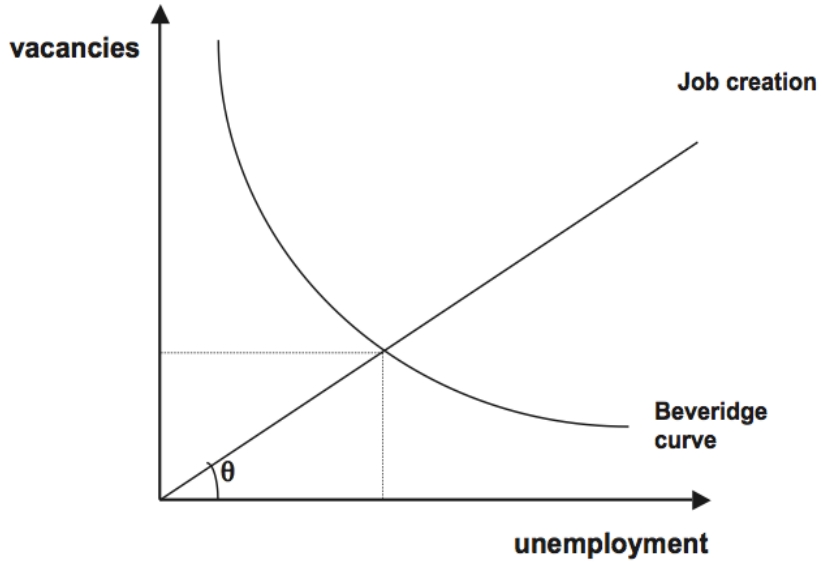
Figure 1: Determination of wage and market tightness



To isolate the equilibrium unemployment level from the equilibrium ratio of vacancies to unemployment, one restricts attention to a situation in which there is a steady state level of unemployment: in a steady-state equilibrium, the number of workers entering the state of unemployment (i.e. loosing their job) is exactly equal to the number of unemployed workers finding a job so that equilibrium unemployment remains constant. This assumption, together with the characteristics of the meeting technology, allows deriving a negative relation between unemployment and vacancies, relation which captures the concept of the Beveridge curve. It is then a trivial matter to pinpoint the relative levels of unemployment and vacancies that satisfy both the Beveridge curve and the equilibrium conditions stated before. Graphically, letting $\theta=v/u$, where v denotes vacancies and u unemployed, be market tightness, one can depict in the (w, θ) plane the wage relation and the job creation, the intersection of which gives us the equilibrium level labor market tightness. The Beveridge curve can then be

depicted in the (v,u) plane. Finally, one can observe that the set of equilibrium θ can be represented as an upward line in the (v,u) plane. The intersection of this line with the Beveridge curve gives the unique pair (v^*,u^*) on the Beveridge curve that can be an equilibrium (see Figure 2).

Figure 2: Steady state unemployment and vacancies



Crucially for our purpose, in this basic setting, identical individuals are treated equivalently and are able to negotiate the same wage. In addition, although in general the equilibrium is inefficient, simple conditions can be given that ensure efficiency. Unwittingly, all had been set so that, some years later this construction would prove to be fit for an integration in the RBC model. The underlying reason is easy to understand: while the other branches of two-sided search have wage/price dispersion as their center of attention, the random search and bargaining model focuses on endogenizing the acceptance rate and modeling equilibrium unemployment. The fact that the homogeneous agent version of the model has no wage dispersion makes it a prime candidate to use in a representative agent model, which, at the time, was the workhorse model in RBC macroeconomics.

III. INTEGRATING SEARCH IN MACROECONOMICS, FIRST ROUND: DIAMOND

The nascent search theory and Keynesian macroeconomics shared the same aim of explaining unemployment and of drawing policy conclusions from their analysis. However, in spite of this communality of object, these two research streams and scientific communities were disconnected. The aim of search economists was to construct a theory of labor rationing based on the premise that labor market frictions impeded the attainment of the equilibrium allocation to be found in standard supply and demand analysis. Their explanation of unemployment focused on the working of the labor market. For their part, Keynesian macroeconomists strived to explain unemployment otherwise than by invoking frictions. They also tended to seek its cause in other parts of the economy than the labor market, e.g. the liquidity trap. Then, in the early 1980s, things changed with Lucasian macroeconomics dethroning Keynesian macroeconomics. One aspect of this transformation was that unemployment almost disappeared from the agenda of macroeconomics, business fluctuations

replacing as the proclaimed object of analysis of the discipline. This was the time when Diamond decided to enter the fray. [††]

He was not a macroeconomist by education. As can be drawn from his interview by Moscarini and Wright (2007) and his Nobel Prize lecture (2011), his education as an economist was strongly influenced by neo-Walrasian theory (he took a course with Debreu soon after the latter had written his *Theory of Value*), a trait that singularizes him with respect to Keynesian macroeconomists. His attitude towards neo-Walrasian general equilibrium theory was that of a reformer striving at bringing it closer to reality. Two points about which he felt an urgent need of departing from it were time and trade technology. Having interacted at MIT with Franklin Fisher, the author of *Disequilibrium Foundations of Equilibrium Economics* (Fisher 1983), he was acutely aware that neo-Walrasian theory, though a success as far the determination of the logical existence of equilibrium was concerned, failed on the matter of the attainment of equilibrium. To him, the line of trying to build non-tâtonnement models, adopted in the 1960s by economists such as Fisher, Hahn and Negishi, was a dead end. Another route needed to be taken:

> Rather than asking whether a process could be found that would converge to a standard competitive equilibrium, I chose to work on the question of finding the allocation to which a plausible process would converge (Diamond 2011: 1047).

As to time, it may be presumed that his investment in search theory was motivated by his desire to bring it into the picture; in effect, search is by essence a time-taking activity. However, while his co-founders of the search approach engaged exclusively in the task of building the new approach, Diamond witnessed to more versatility. The years during which he was working on search were also those during which Lucas's work was making its way in macroeconomics. This led Diamond to cross the frontier between search and macroeconomics. The result was his "Aggregate Demand Management in Search Equilibrium" article (Diamond 1982a) in which he introduced the 'coconuts' model, an elementary macroeconomic model evolving at the same level of abstraction as Lucas's 1972 canonical Expectations and neutrality of money article. In his Nobel Prize lecture, Diamond commented his theoretical move in the following way:

> While I started working on search theory out of dissatisfaction with general equilibrium theory, I gravitated to seeing search also as a way to address my dissatisfactions with macro theory. My dissatisfaction did not relate to basic Keynesian concepts, but to the nature of modeling. I wanted to see a microfoundation that would enhance the ability to do normative analysis and to develop policy insights (Diamond 2011: 1056).]

Diamond's paper has been widely praised — quite understandably: it stands out as an example of what neoclassical theory can do at its best, conveying a major insight with a simple yet elegant model. [‡‡]

The coconuts model

In this paper, Diamond followed the Phelps/ Lucas tradition of referring to the island metaphor. However, while the former used this parable to bring out communication problems between many islands, his was a single tropical island model economy. It comprises a continuum of risk-neutral self-employed identical agents living in an isolated island and having coconuts as their exclusive mean of existence. To be able to eat coconuts, they must find a tree and climb it, and the climbing has a cost c. Every coconut tree bears the same number of coconuts yet trees vary in terms of the effort needed to reach and pick them. The

[††] Okun (1980) is an interesting attempt at breaking this disconnection.

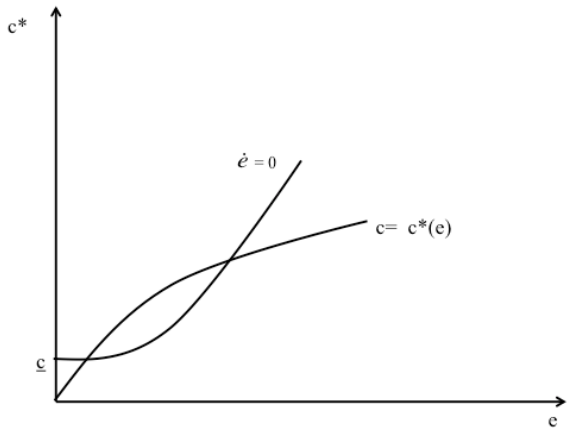
[‡‡] It was further expanded in a 1984 book, *A Search-Equilibrium Approach to the Micro Foundations of Macroeconomics*, the publication of his 1982 Wicksell lectures (Diamond 1984).

decision rule of this one-sided search takes the shape of a reservation cost c^*. Agents will get the coconuts from all trees for which the cost is below c^*, and wait for the next opportunity otherwise. Diamond gives the 'unemployed' label to those who fail to find a fitting tree and hence hold no inventory and the 'employed' those who found one and hence hold inventory.[§§] them the unemployed. A further trait of the model is that, because of some taboo, agents are forbidden to consume the coconuts they have picked. Thus, those agents with coconuts must find a trading partner, a second search operation, this time a two-sided search. Trading opportunities arise according to a Poisson process. At this juncture comes the assumption that drives the model: the rate of arrival of trading partners, denoted b, is strictly increasing in the level of activity. That is, b is a function of e, $b(e)$, with $b' > 0$. Thus, trade technology exhibits increasing returns to scale. "If more people are attempting to trade, it becomes easier to carry out trades" (Diamond 1984: 4).

Diamond's next step is to look for steady state equilibria where the level of activity (e) does not change over time, i.e. $\dot{e} \equiv \frac{de}{dt}$ is equal to zero. In every period, there are agents who have found a tree that is worth climbing, i.e. for which $c<c^*$, and other agents who, having found a partner, hold no longer any inventory. In a steady state, these two measures are identical. Clearly, given a homogeneous distribution of trees, the probability of finding a tree with $c<c^*$ increases with c^*. Thus in the (c^*,e) quadrant, $\dot{e} = 0$ is an increasing function. On the other hand, the higher the number of potential partners with coconuts, the more worthwhile it is to have coconuts to exchange. Put differently, the cutoff cost c^* is an increasing function of e. A steady state equilibrium is a situation a situation in which the pair c* e satisfies both the locus of points for which $\dot{e} = 0$ and the function c*(e). Graphically, $\dot{e} = 0$, which depends on c*, must intersect c*(e). But both are increasing. For an equilibrium with positive employment to exist, it is enough that one of these curves be concave and the other convex. Diamond is able to prove that it is sufficient for the arrival rate $b(e)$ to be increasing and concave to ensure concavity of $c^*(e)$. As for the $\dot{e} = 0$ curve, as long as there is a c* at which the probability of meeting a tree with c≤c* is one and it is reached asymptotically, it is convex. Finally, to keep $\dot{e} = 0$ as a very specific case, Diamond assumes there is a lower bound to c. This gives him a figure like the one reproduced in Figure 3.

[§§] This terminology is misleading since the model comprises no labor market ; the labels' attribution is also arbitrary. However, it reveals what Diamond must have had in the back of his mind.

Figure 3 Different levels of activity in Diamond's search model



A shown in Figure 3, Diamond's model features multiple Pareto-rankable equilibria (in the figure they amount to three, the two intersections plus the origin). Put differently, the economy exhibits several levels of 'natural employment' and it can get stuck in sub-optimal one, a situation that can be remedied upon by exogenous demand activation.

> One of the goals for macro policy should be to direct the economy toward the best natural rate (not necessarily the lowest) after any sufficiently large macro shock (Diamond [1982a] 1991: 32).

This quotation indicates that Diamond is interested in macroeconomics *à la* Lucas, i.e. having business fluctuations as its object of analysis, rather than *à la* Keynesian. Of course, unemployment hovers at the back of his mind, but what counts first is to be able to picture business fluctuations. In his model, he writes, "there is also no hired labor. I am therefore claiming that it is possible for a barter economy of self-employed individuals to have business cycles" (Diamond 1984: 7). And also:

> The model I will present is a steady state equilibrium model. It has that form primarily for its simplicity. But I am interested in the model as a description of phenomena that are important in the context of a business cycle and must therefore evaluate the appropriateness of the assumptions to an economy that is subject to cycles (Diamond 1984: 4).

Like in Lucas's model, it is unnecessary to introduce unemployment in the picture when devising a model of the business cycle. No explanation of what, in Diamond's eyes, explains fluctuations — waves of optimism and pessimism with self-fulfilling effects — is offered in the 1982a article, but is adumbrated in the 1984 book where he refers to a forthcoming joint paper with Fudenberg for a more formal analysis.[***]

The underlying idea is that the economy can bounce back and forth along different levels of activity, the result of changes in expectations about the future economic environment. Assume that agents are all optimistic, i.e. they expect easier trading. As a result, they will accept more production opportunities. The economy will then reach a higher equilibrium level of activity, thus warranting agents' initial optimism. The same is true for pessimism. Change in expectations will shift the *c*(e)* curve upwards when agents move towards more optimism and downwards in the opposite case. These changes in the economy's equilibrium points resemble the business cycle.

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[***] In the bibliography, the article is announced as forthcoming in the *Journal of Political Economy* but, somewhat oddly, its was published only in 1989.

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Diamond's model saw the light of day in a context of high theoretical turbulence. It is thus useful to compare it with contemporary related research lines. Two observations can be made in this respect. The first is that Diamond's coconuts model is fairly different from both the RSB research line and most other so-called new Keynesian models. The second is that the model to which the coconuts model comes closest is Lucas's Neutrality of money model, the very model that Diamond wanted to challenge. The next three sections develop these observations.

Comparing Diamond's coconut model with the RSB model

The joint attribution of Nobel Prize in 2012 has led to talking about the 'Diamond-Mortensen-Pissarides' model while before one usually referred to the Mortensen-Pissarides model (check with JSTOR).[†††] Such a merger is apposite when considering Diamond's early models but once his coconut model is considered, it ceases to make sense.[‡‡‡] This model belongs to (dynamic) macroeconomics, the 'Diamond-Mortensen-Pissarides to pure search theory. Table 1 summarizes the involved differences.

[†††] Two examples are Nobel Prize citation article and Albrecht's 2011's survey.

[‡‡‡] The joint attribution of the Nobel Prize to Diamond, Mortensen and Pissarides covered a disparate state of affairs: Diamond had long since abandoned to work on search while the other are still very active in the field.

Table 1 Comparing Diamond's coconut model with the stabilize search model

	Diamond's coconut model	**The RSB model**
Aim	Demonstrating the possibility of sub-optimal levels of activity as determined by cyclical factors	Explaining unemployment
Object of study	A self-employed workers barter economy with Walrasian prices	A decentralized labor market
Equilibrium	Steady-state equilibrium; multiple equilibria; agents maximize their lifelong utility function; rational expectations	Steady state equilibrium; single equilibrium; agents maximize their lifelong utility function; rational expectations
The model's basic features	– On-sided search for production opportunities with cost dispersion; two-sided search for trade contacts – The level of activity is an increasing function of the market thickness	– Two-side search for a match + Nash bargaining wage formation – The level of activity is determined by a constant returns matching function
Efficiency and policy conclusion	Any equilibrium other than the maximum one is inefficient; demand activation is the solution.	The market outcome is inefficient; employment subsidies and unemployment compensation are the policy instruments to be used.

Only the fourth line requires a comment. Vacancies are absent from Diamond's model. Nor has it room for the Beveridge curve. Nonetheless, Diamond's model falls back on Pissarides' reasoning. When constant returns are assumed, the function $M(V, U)$ can be transformed in the function $m(\theta)$, where θ stands for market tightness. This is the function that is instrumental in the matching reasoning. Assuming that 'thickness' and 'tightness' are the same (what is not obvious), we see that the $m(\theta)$ function is part of Diamonds model, with the difference that it now receives the increasing returns specification.

Diamond and new Keynesian macroeconomists

Diamond's 1982a paper was included in the Mankiw and Romer volume of seminal new Keynesian papers (Mankiw and Romer 1991). Its inclusion can be justified on the grounds that it shared the common trait of new Keynesian models, i.e. to react to the Lucasian macroeconomics. However, Diamond's paper differs significantly from most of the other papers in the volume. It differs in method — they were partial equilibrium models, his was general equilibrium analysis — but, above all, the way in which it reacts to Lucas. The majority of new Keynesian papers were geared to rehabilitate Keynes's or Keynesian insights —that wages are sticky and money non-neutral — while accepting the equilibrium discipline imposed by Lucas. Several of the most known ones, by Shapiro and Stiglitz, Akerlof or Mankiw, took especially at heart the defense of the involuntary unemployment notion against Lucas's fierce dismissal of it. Pursuing these aims was a defensive strategy. For all their cleverness, these models hardly evolved at the same level of generality and abstraction as Lucas's. Therefore, they hardly challenged Lucas's positive contribution of having produced an equilibrium model of the business cycle. On the contrary, providing another equilibrium model of business fluctuations was the aim pursued by Diamond. For his part, he hardly bothered to rescue Keynes or Keynesian theory.

Diamond and Lucas

We have just seen that Diamond differs on several score from those economists with whom one is tempted to affiliate him. Is there somebody else to whom he could be considered closer methodologically? We think so, and the person we have in mind is Lucas. Both Diamond and Lucas place themselves under the aegis of the Arrow-Debreu model, what is not the case for most labor market search theorists. They share the same preoccupation of making Walrasian theory amenable for macroeconomic purposes by simplifying it and modifying some of its assumptions. This makes them having a keener interest for policy matters than traditional Walrasians. Although they both insist on empirical relevance, their two more important models (Lucas 1972 and Diamond 1982a) are theory without measurement. Finally, they both viewed their seminal models, each of which was not directly concerned with business fluctuations, as a fine steppingstone for broaching this topic. This commonality between Diamond and Lucas is summarized in Table 2.

Table 2. Comparing the Lucas and the Diamond approaches

	Lucas	**Diamond**
Aim of the model	1972: demonstrating that money non-neutrality does not warrant Keynesian policy conclusions 1976: extending the model to the study of business fluctuations	1982a: demonstrating the possibility of sub-optimal levels of activity related to business fluctuations 1984: extending the model to the study of business fluctuations
Aegis	Neo-Walrasian theory	Neo-Walrasian theory
Equilibrium	General equilibrium analysis; single equilibrium; equilibrium discipline; rational expectations	General equilibrium analysis; multiple equilibria; equilibrium discipline; rational expectations
Labor market and type of economy	Absent (self-employed workers inhabiting separate islands)	Absent (self-employed workers inhabiting a single island economy)
Price/wages	Flexible	Flexible
Money	Present	Absent
Departure from the baseline Walrasian model	Misperception of price signals	Increasing returns to scale + self-fulfilling prophecies
Policy conclusion	Non-interventionism	Demand activation

The main difference between Lucas 1972 and Diamond 1982a lies in the direction taken in departing from the baseline mode and in the motivation underpinning it. When conceived his 1982a model, Diamond's had the firm intention to react to Lucas, whose model he dubbed the 'classical model', as well as to Prescott by constructing a model incorporating a departure that would produce an inefficiency result.[§§§] Thus, he had no qualms admitting that he

[§§§] "*Macro Dynamics*: Why did you take that direction—as opposed to, say, Lucas and Prescott's island model? *Peter Diamond*: The island model, I believe, as Lucas and Prescott set it up, fits the Welfare Theorem of Arrow-Debreu. They've got efficiency properties, and I believe the route into seeing that would be to think about it from an Arrow-Debreu perspective where the role of the island is a constraint on your consumption possibility set. There you have the property that I was trying to get away from—there is some central mechanism, something similar to the Walrasian auctioneer, which is controlling the flows between islands in a way that is a central mechanism" (Moscarini and Wright 2007: 554).

pursued a policy motivation. Like Keynes, he believed that the market system is susceptible to fall prey to malfunctioning, in particular under the form of coordination failures. Demand activation is then deemed to be the action to be taken when these arise. Diamond's problem was to translate this insight, and the ensuing policy conclusion, into an emendation of a simplified Arrow-Debreu model. Ideally, the new factor introduced needed to have the status of a compelling 'fact of life'. As already stated, Diamond was sensitive to the time dimension involved in the attainment of equilibrium, but he ended up introducing it only laterally, through the thickness idea: the thicker the market, the bigger the number of potential traders, the shorter the time spent in finding them will be. To Diamond, this idea was beyond dispute in terms of real-world relevance, and its neglect hardly benign since by taking it into account the policy conclusion of the non-amended model are reversed.

> The importance of this basically different way of viewing the world is that it shifts the presumption from limitations on policy to the potential for good policy (Diamond 1984: 63).

Diamond's standpoint could be viewed as a normative bias. We do not see it this way. By construction, macroeconomics models lead to policy conclusion. The fact that the model builder has or not a policy motivation does not matter. Whether Lucas planned it or not, his model of the business cycle reaches a non-interventionist policy conclusion. The latter, as Lucas admitted (see De Vroey 2011), is embedded in its premises. Thus, Diamond and Lucas must be put on the same footing.

On top of our claim that Diamond was methodologically close to Lucas, we also want to make the further claim that he considered Lucas as his main interlocutor. Reading the second of his Wicksell Lectures makes clear that he regarded his model might serve as an alternative to Lucas's. He was entitled to hold such an opinion. Few contemporary models could be deemed to belong to the same league as Lucas's Neutrality of money paper in terms of originality, cleverness, parsimony, and elegance, but Diamond's one was certainly among these.[****] If Diamond's paper was published in 1982, this means that he must have been working on it in the last years of the 1970s. In their entry on "Rational expectations Business Cycle Models" in the New *Palgrave Dictionary* (1987), Dotsey and King consider that four approaches in macroeconomics could be put on the same footing of being promising research lines. Diamond's model was not among these, but Dotsey and King's remark shows that in the late 1970s, early 1980s the future of macroeconomics was still quite open. Hence it should come as no surprise that Diamond might have nurtured such an ambition.

In the Wicksell Lectures, Diamond also raised the question, "How can one decide whether competitive markets or search represents a better starting point for theoretical macro analysis"? (1984: 46). There was, of course, no mystery about his answer. On the one had, he argued that his model had a better fit. On the other, he brought out the limits of the rational expectations assumption. With hindsight, none of these arguments were really biting. To limit ourselves to his criticism of rational expectations, Diamond walked on a tightrope since, after all, his model was also based on this assumption. This led him to make Salomon-like judgments, writing for instance that rational expectations are "still the right assumption to use for most, but not for all, analyses" (1984: 54). In his view, its main defect was that, as soon as multiple equilibria are present, agents are unable to pick up the equilibrium state that is highest in welfare ranking, despite their being equipped with rational expectations. Moreover, making the rational expectations assumption forbids coming to grips with factors such as optimism or pessimism, mimetic behavior and self-fulfilling prophecies. Both remarks are well taken if one accepts to take the multiple equilibria route, but irrelevant for those who decide to take another one. In other words, as often the case, Diamond's criticism rests on the

[****] Grandmont's 1986 Endogenous competitive business cycles paper was another one.

premise that his viewpoint is better than his adversary's. Anyhow, such discussions scarcely come to and end: there is little way, if any, of sorting out two models evolving at such a high level of abstraction.

IV. INTEGRATING SEARCH IN MACROECONOMICS, SECOND ROUND: ANDOLFATTO AND MERZ

At the end of the 1980s, the RBC model had jumped to center stage. Macroeconomics had gone from a qualitative to quantitative approach. The baseline RBC model performed well, matching many US business cycle facts. But it did not score high in all dimensions. The quest, then, was to tweak the baseline model in ways that would improve the fit. It is in this context that Andolfatto (1996), Merz (1995), (and, to some extent Mortensen (1992)) come in.

The explicit purpose is to remedy a number of empirical misses of the standard RBC model. While a clear success in many aspects, the original RBC model has a hard time replicating labor market facts. For one, the agent decision is made on hours worked, and variations in the labor market can only entail changes in hours worked. Unemployment, and vacancies, are left out of the picture. There is no way the model can replicate the negative correlation of unemployment and vacancies, nor can it replicate the high persistence of unemployment. Disregarding unemployment can be justified by arguing that understanding the manner in which hours worked were distributed in an economy is not a crucial objective of the model. If the model can say something about the cyclical properties of hours worked, the discussion about the part of those movements attributable to the intensive or to the extensive margin is then left for labor economists to discuss. Even when accepting this justification, the RBC model still misses on a series of other labor market cyclical facts. For instance, the fact that labor market productivity is more volatile than real wages, and is a leading indicator of employment, is hard to come by. In addition, there are some indications that the labor share of total income is countercyclical (although relatively stable). Finally, as is the case with unemployment, employment is very persistent, much more in the data than can be achieved in the standard RBC framework, and more volatile than real wages. The importance of matching labor market facts was clear in the mind of a number of RBC economists. Hansen (1985) and Rogerson (1988) introduced non convexities in hours, together with the extensive labor margin, in an attempt to get the RBC model to fit better labor market facts. In their framework, agents entering the labor market face an employment lottery. The winners work, the losers stay home.[††††] This change improved the model's performance with respect to the relative volatility of employment to real wages, and introduced the concept of unemployment in the framework. But unemployment, employment, and output were still not persistent enough.

At that point, many advances had been done in the search literature. The first edition of *Equilibrium Unemployment Theory* was out, Mortensen and Pissarides had joined efforts to finalize the mature model. Qualitative evidence coming out of search models, for instance Wright (1986), pointed to the very possibility that search frictions could improve the fit of the RBC model. Given the advances made by researchers in the search literature, it was just a matter of time until attempts to crossover RBC and models in the search tradition were made.

As it turned out, the perfect bride existed, a model that had elements to allow for an almost perfect match with the RBC framework. At the center of the RBC model is the representative agent. This agent receives a real wage for as payment for his work effort, which he decides optimally. All individuals in the economy are paid at the same level. Equilibrium is

[††††] One could well say that in this model, the true winners are those who lose at the employment lottery.

Pareto efficient, allowing for a attractive computational trick: one can solve the planner's problem to find the efficient allocations, then find the competitive prices that support this allocation as a competitive equilibrium. Most search model were used, at least in part or in hope, to explain how it is possible for identical workers to be paid differently, and deliver situations in which equilibrium is, in general, inefficient. All but one: the RBS model, in its bare bone version, allows for homogeneous agents to be paid the same wage. In addition, thanks to work by Mortensen, Pissarides, later generalized by Hosios, the precise conditions under which the equilibrium is efficient are known.

One element could still pause a problem: although, in the Mortensen Pissarides framework, agents are ex ante homogeneous, they are ex-post heterogeneous: some are employed, other are not. This one piece didn't fit directly. Or didn't it? One trick was required to make all pieces of the puzzle fall into place. Assuming large households, or perfect insurance, one could make sure that all agents, unemployed or working, look identical in all other aspects, and, in particular, in terms of utility. The RSB model was ready to be used within the RBC framework, and this is what Andolfatto, Merz (and Mortensen) did. It is instructive to examine, in some more details, the specificities of this merger.

In the Andolfatto-Merz economy, there are many workers inhabiting the unit interval. They have standard preferences over consumption and leisure, and face a consumption-saving decision problem coming straight out of the RBC framework. However, exchanges of labor occur in a search environment. Individuals are either working or unemployed and searching. When searching, they get job opportunities at random. Meeting probabilities are determined via an aggregate matching function and thus depend on the numbers of unemployed and vacancies. The labor market, then, is laid out as a RSB environment. There are also many firms mastering a constant returns to scale technology, so that one can consider each firm to consist in exactly one job. Matched pairs face separation with exogenous probability, and workers need to provide searching effort when searching. One can rework the discrete time version of the expressions that lead to the Beveridge curve in the RSB model to get dynamic equation guiding employment. It is then possible to solve a social welfare maximization problem in which vacancies are added as a choice variable, and with adding to the economy wide constraint a constraint stemming from the labor accumulation equation. From this well-behaved problem, one backs out four optimality conditions that must hold in equilibrium (in addition to the resource constraint and the labor accumulation constraint). Two of these conditions are completely standard and govern the intra and inter-temporal allocations of consumption and labor/leisure and the consumption and saving/capital. A third condition insures that the cost of, and the expected return to, recruiting are equalized at the margin. A final condition assures us that the household is indifferent when facing marginal changes in employment.

While the planner's solution is perfectly interpretable, it is not obvious that this can be decentralized (as is typically done in the case of a perfectly competitive RBC model.) The search economy embodies, after all, a completely decentralized market economy, or, at the very least, a decentralized market in an economy. Typically, one has to show that there exists a price vector that yields the Pareto optimal allocation. Given that the main difference is the presence of the labor accumulation constraint, the key problems to be solved are then, first, to find a wage equation such that there is appropriate vacancy posting, and, second, to find a way to deal with the agent heterogeneity that stems naturally from a model of the labor market with frictions. To solve the first problem, using the standard bargaining assumption, one can turn to the Hosios condition: the share rule to which workers and firms agree must be such that the share of the match surplus accruing to the firm corresponds to the elasticity of the matching technology with respect to recruiting effort (i.e. the parameter weighting the

surplus share in the generalized Nash bargaining solution must be equal to power parameter on vacancies in the matching function.) To solve the second problem, it is sufficient to assume perfect insurance. This is equivalent, in fact, to using the extended-household device introduced by Hansen (and Rogerson). Under these assumptions, it is then possible to find the decentralized search equilibrium by solving the respective problems of firms and workers and finding the wage equation associated to it, and show that the search equilibrium allocation satisfies the conditions and constraints that were key to the planner's solution.

And the job is done: a macroeconomic model is built in which the labor market is prone to frictions, and in which unemployment is natural. The model improves the fit of the baseline RBC model in some dimensions while,furthermore leaving the door open for further improvements.

V. ASSESSMENT

In this last section we bring together the threads developed in the earlier ones. We start from the premise that, technically, Diamond, Andolfatto and Merz have all three achieved their aim of constructing a consistent model integrating search in macroeconomics. The issue we are interested in is different, i.e. whether these models made their way in the theoretical corpus. The answer differs according to the authors concerned. Diamond's aim was ambitious as he hoped that his model might constitute a substitute to Lucas model; this hope did not come through. In contrast, Andolfatto and Merz were pursing the more modest aim of bringing in a result from one branch of the search universe into the standard RBC model. Still today, this introduction is considered an established improvement . In a first subsection, we attempt at explaining why the line opened by Diamond lost out to the Lucasian line. In the second, we ponder upon Andolfatto's and Merz's success.

The demise of Diamond's program

At present, we know that the Lucasian program came out as the winner (not forgetting that in a field such as economics any victory, if one wants to use this terminology, is always temporary). However, at the time, this outcome was less obvious.[‡‡‡‡]

It must be reckoned that, from the start, the Lucasian program held the edge. First, it was ten years older and this time span had been usefully used in strengthening it. Second, the Lucas model belonged to a well-established stream of literature pertaining to the real effects of monetary change. The model was innovative, but the subject was well trodden. In contrast, Diamond traveled an unknown territory; there had been some talk about coordination failure but little theoretical work. Third, multiple equilibria may well be an appealing idea but, for sure, managing single equilibrium models is easier, not counting the conundrum of how testing a multiple equilibria model empirically. Fourth, Diamond admitted that his model differed from Lucas's, on only point, the increasing return assumption.[§§§§] To him, this point was crucial and justified. Nonetheless, in such circumstances, an easy way of discarding the challenging model consists of declaring it to be a special case of the classical model, hence a mere extension rather than a radical alternative. Fifth, while Lucas's 1972 model and

[‡‡‡‡] In a lecture given in 1986 at the Canadian Economics Association Meetings, Peter Howitt, one of strongest supporters of Diamond's program, declared that he saw macroeconomics at an important crossroads, one route being RBC modeling, the other transaction externalities modeling. "Which of these two paths will be the main attractor of graduate students in the years to come is impossible to predict" (Howitt [1986] 1990, p. 79).

[§§§§] "The model I presented in the first lecture looks a great deal like the classical market model if one removes the assumption of trade externalities. That is, if the relative availability of trading partners does not affect the length of time to find a trade, then the search model must behave like a classical market model"(1984: 49).

Diamond's 1982a model might have the same persuasiveness ability, the same is not true for their respective extensions. Lucas's equilibrium model of the business cycle flew from his 1972 model in a straightforward way. This cannot be said of the Diamond-Fudenberg extension of Diamond (1982a). Finally, Lucas' non-interventionist policy conclusion has the advantage of neatness. In contrast, Diamond's policy conclusion, that demand activation should be undertaken for bringing the economy to a higher equilibrium suffers from the fact that this conclusion falls out of the blue; any agent susceptible of implementing it is absent from the model.

All these factors certainly played a role. Nonetheless, we think that the clue for understanding the fate of these rival programs resides elsewhere. To us, the decisive factor lies in whether a new model, which always starts as a one-shot achievement, can be transformed into a progressive, workable research program — 'progressive' meaning that it gives rise to a succession of cumulative developments, 'workable' that the needed tools and recruits for such developments show up at the right time. Against this criterion, the Lucasian *program* fared better than Diamond's. The crucial turn occurred more or less concomitantly to the publication of Diamond's model when Kydland and Prescott took over from Lucas, inaugurating the RBC variant of the Lucasian program. But then, the 'victory' that took place was less that of the Lucas's *model* than the result of the ascent of RBC modeling. As aptly underlined by Woodford, Kydland and Prescott transformed Lucasian qualitative modeling into quantitative modeling.[*****] Adding the 'replication discipline' to the 'equilibrium discipline', they were able to impose the idea, which had been put in practice by Keynesian macroeconomists but had somewhat been put under parenthesis when a Walrasian perspective came to the forefront, that there is no salvation in macroeconomics outside of applied work. In addition, to econometricians' outcry, Kydland and Prescott were also able to force the widespread acceptance of a very specific empirical assessment procedure, the calibration technique. The latter implied that the search for a baseline model of business fluctuations was over as the stochastic extension of the Solow model was deemed 'established theory'. What remained to be done was applying it to different contexts and solving the puzzles that its application might bring out. RBC modeling was thus a game changer. It stabilized the Lucasian revolution into a narrow research program providing the research bread and the butter for regiments of economists for more than a decade. This marked the spell of modeling *à la* Diamond. With such a change the rule of the game, Diamond's model was bound to be out of the game. Diamond did not recognize it explicitly, but he voted with his feet, abandoning the search topic to devote his attention to matters of social security and pensions.[†††††]

The Andolfatto/Merz integration: a decent success

[*****] "The real business cycle literature offered a new methodology, both for theoretical analysis and for empirical testing. … It showed how such models [of the Lucas type] could be made *quantitative*, emphasizing the assignment of realistic numerical parameters values and the computation of numerical solutions to the equations of the model, rather than being content with merely qualitative conclusions derived from more general assumptions" (Woodford 1999: 25-26).

[†††††] "*Macro Dynamics*: Your continued working on search for quite a while, with Olivier Blanchard, for example, and that work influenced a cohort of students at MIT in the 1990s. But then at that point you stopped working on search. You moved on exactly when this was blossoming. Did you think that this was all done, and hence we're wasting our time? You have a record of choosing different topics and moving on to the next one. *Peter Diamond:* I do enjoy the "how do you set up a model to address a question or problem." To me, asking, "I got this model and now I have to work hard to make it more realistic and put in more features," I do not enjoy it as much as the thinking hard about how to get started. Some of that has to do with the laziness of doing hard math, that many people go through as they age. And of course you have to keep in mind that Social Security became a very hot topic" (Moscarini and Wright 2007: 557).

The general opinion is that Andolfatto and Merz made a substantive contribution. The fact that the search idea had been integrated in the RBC model was considered good news. Their two models also improved the fit of the baseline model, the decisive assessment criterion in the RBC community. Thus, it was considered a step forward, not a ground-breaking one, just a decent progress. After all, it was a rather modest enterprise, integrating two relatively mature frameworks. The rivalry dimension that characterized Diamond's enterprise was here absent.

In a sense, search economists could not but be flattered to have one of their central notion, the matching function, along with their vision of the concept of unemployment, being adopted by RBC macroeconomists (and later by DSGE ones). Moreover, the evolution was Pareto-optimal. Macroeconomists' gain has been described. For their part, until then, RSB theory, had suffered from to drawback of being purely abstract, with little empirical counterpart. Closer contacts between the two communities led RSB economists to realize that they could fill the gap by importing quantitative techniques from RBC modeling.

However, in another, perhaps more important, sense, search economists have some good reason for being frustrated with the evolution that took place. First, the integration concerns only the RBS research stream. That opened by the Burdett-Mortensen paper and which is based on job search, heterogeneity and wage dispersion, is very active; to many labor economists, it has significant advantages over the RBS line. In present circumstances, its integration in macroeconomics remains ought of sight. Second, the integration was possible because of Mortensen's efficiency result mentioned above. It is true that a case exists were the Nash bargain is efficient, but to many students of the problems, it was considered an occurrence of minor importance. But without adopting this special assumption, the integration of the matching function in RBC modeling would not have been possible. The third and probably more important reason for frustration is that the basic objective of search theorists was to understand real-world unemployment. In this respect, the idea of replacing the single agent with a family the members of which are able to insure themselves against any loss in utility incurred as the result of being unemployed, cannot but be considered as a trick betraying the deep nature of the inquiry's *explanandum*. Deleting the view that the unemployed effectively suffer in utility because of their status runs counter a basic tenet of the search program. Of course, the lack of consideration for this feature has a technical reason, the difficulty of introducing heterogeneity in macoeconomic modeling. Still, our guess is that many search economists have a hard time in swallowing this bitter pill. All this set the stage for a second wave of integration between the RBC world and search, stage where the quantitative methodology central to the RBC strategy was integrated into search models of all types, not only of the RSB branch.

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