Adjusting to Technological Change

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Adjusting to technological change

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I. INTRODUCTION

The subject of my address is adjusting to technological change, something that a lot of people are doing nowadays. The revolution in information and communication technologies and the transition to a knowledge-based economy are inducing people in every sector to change how they work and do business. What I want to emphasize is that these changes constitute a social process that involves more than the sum of our individual struggles with inanimate nature. People are adjusting not only to changes in technology but to changes that others are making to technology. Adjustments in one sector induce unexpected adjustments and innovations in other sectors in a complex process that none of the participants can possibly comprehend. The process is governed by social institutions, particularly by the business enterprises that organize almost all economic transactions in a modern economy, and at the same time it is transforming those institutions.

A graphic account of how peoples' lives are being tossed about by the winds of change might be too depressing for this occasion. So to keep it light I am simply going to talk about macroeconomic theory. If there is one profession that has not yet seen much of the darker side of technological change, it is macroeconomic theory. In fact, the recent resurgence of interest in growth and technological change seems to have had a calming effect on the profession by diverting attention from the issues of unemployment, inflation, and aggregate-demand management that have been the subjects of the furious controversies since the Keynesian revolution. Peaceful coexistence has emerged between previously opposing schools, now united by the

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new techniques of endogeneous growth theory, which have provided the means for pursuing a common research agenda that hasn't involved the divisive issues of the past, at least not yet.

Paul David (1988) has argued that the course by which technological change affects an economy is inherently unpredictable. Even those on the frontiers can see only a few steps ahead. New ideas commonly end up with applications and implications that astonish their inventors. I think the same sort of phenomenon is at work in macroeconomic theory, that the way technological change affects macroeconomics will be very different in the next decade than it was in the past. In particular, I think the current lull in controversy is unlikely to last much longer. What I am going to argue is that technological change raises almost the same coordination and adjustment issues that used to separate Keynesians and New Classicals, issues that were never resolved, merely temporarily forgotten. Many of these issues are now being brought to light by endogenous growth theory, and more revelations are on the way. Furthermore, if we are ever going to make progress in dealing with these issues, we shall need a radically different approach from the one that now unites so many theorists. For although the techniques of endogenous growth theory have helped to uncover many coordination and adjustment problems, the theory is ultimately rooted in a conventional equilibrium analysis that assumes most of them away.

II. ADJUSTMENT IN THE LONG AND SHORT RUNS

The specific issues involved in the great macroeconomic debates used to change kaleidoscopically, but beneath the surface there was always the same fundamental adjustment question: is a free-market economic system a naturally self-adjusting mechanism, or does it need guidance and occasional stimulus from collective action to avoid massive coordination failures. Keynes saw this question as having long-run significance. He argued in the *General Theory* that destabilizing expectations, distributional effects, and debt-deflation would prevent the automatic process of wage and price adjustment from bringing about full employment, even in the longest of runs, that in the absence of intervention a situation of subnormal activity might persist indefinitely, and that attempts to reinforce the automatic process by making wages and prices more flexible could well worsen the instability problem. The modern literature on Keynesian coordination failures has also posed the question in long-run terms, as an issue of whether an economy might get trapped in a Pareto-inferior long-run equilibrium with low activity and high unemployment.

Most macroeconomists, however, have come to regard adjustment as strictly a short-run question. The latest generation of Keynesian economists has accepted rational expectations, the long-run neutrality and even superneutrality of money, and the long-run stability of a unique natural rate of unemployment, immutable to demand management policies. Although there is still disagreement over how much guidance can be found in short-run Keynesian economics, it has become

quite uncontroversial to use conventional neowalrasian equilibrium analysis, with its neglect of all aspects of the transactions process, when it comes to dealing with long-run questions of growth, accumulation, and technological change. The point of view now reflected in most introductory textbooks is the classical one, which goes back at least to David Hume. Macroeconomic coordination and adjustment problems arise in the short run because of wage and price stickiness, but the long run is a completely different story.

I think the classical dichotomous view, which sees trend and cycle as distinct, unrelated phenomena, is misleading. Technological change raises the same sort of coordination problems as do changes in aggregate demand, and adjustment to technological change is not a question of making a self-limiting transition to a new steady state, but is a permanent condition of economic life in a progressive society. I think the more unified Schumpeterian view is closer to the truth. Schumpeter saw economic growth as being driven by the process of innovation, broadly conceived as 'putting productive resources to uses *hitherto untried in practice*, and withdrawing them from the uses they have served so far.' (1928, 378), and he saw depressions as arising from unevenness in that same innovation process and from the absence of any mechanism for making it unfold in a smoothly coordinated fashion. I quote from (1934, 12–13):

> The emergence of mass production of cheap cotton goods from the last decades of the eighteenth century onward spelled elimination of many an old shop. The construction of railroads changed the competitive position of localities and opened up undreamt of sources of supply of all kinds of commodities, necessarily supplanting some old ones. Now we have had combines and dry farming, more efficient methods of producing electricity, rayon and motors and radios, and a thousand similar things. This is really at the bottom of the recurrent troubles of capitalist society. They are but temporary. They are the means to reconstruct each time the economic system on a more efficient plan. But they inflict losses while they last, drive firms into the bankruptcy court, throw people out of employment, before the ground is clear and the way paved for new achievement of the kind which has created modern civilization ...

According to this unified Schumpeterian view, when we turn our attention to long-run questions we aren't turning away from coordination and adjustment problems, we are simply looking at them from a different perspective.

The unified view of trend and cycle has been supported by a number of recent developments in growth theory. George Stadler (1990) has pointed out that the endogeneity of technological knowledge implies that random changes in the level of economic activity over the course of the cycle, no matter what their origin, are likely to shift the economy's long-run growth path permanently in the same direction, by temporarily affecting the pace of on-the-job training and of learning-by-doing. Furthermore, as Schmookler (1966) once argued, even short-run downturns have a depressing effect on the research and development that generate innovations and hence drive long-run growth. Stiglitz (1993) has described a credit-market channel through which a recession can permanently reduce output; that is, many of the new firms with innovative ideas essential for future growth will not yet have reached

the point where their cash flow enables them to weather the credit restrictions associated with large downturns; their ideas are likely to die with them.

Several authors, including Caballero and Hammour (1994), Aghion and Saint-Paul (1991), and Cooper and Haltiwanger (1993), have spelled out other channels through which a cyclical downturn can enhance long-run growth rather than retard it. They observe that periods of high unemployment are also periods of rebuilding, when old methods of production are discontinued, old product lines abandoned, old plant and equipment scrapped, and old job matches dissolved, to be replaced by the new methods, products, capital goods, and job matches appropriate to higher level of technological development. They interpret this phenomenon as reflecting the intertemporal substitution of adjustment. That is, the more unemployment and excess capacity there is, the lower is the opportunity cost of making changes. According to this view, the long-run effect of a countercyclical policy that avoided recessions would be not to raise productivity, but on the contrary to delay the painful restructuring needed in order for society to benefit from technological progress.

I think a similar effect is inherent in the Schumpeterian view of the competitive process, which has been championed recently by writers like Michael Porter (1990). According to this view, competition takes place not through prices, as it does in the textbooks, but through innovation. The firms that survive the competitive struggle of creative destruction are not those that respond to adversity by reallocating resources within known technological parameters, but those that respond by innovating, by producing the goods, processes, and markets that will induce people to trade with them on profitable terms even in hard times. This view suggests that necessity, that is, the necessity of surviving the trough of the cycle, is the mother of invention, and that therefore a successful countercyclical policy that dampened the business cycle would also eliminate much of the spur that drives long-run growth.

Various other authors have pointed out that even if technology were to grow smoothly and steadily, the economy's equilibrium growth path might well be cyclical. Adrei Shleifer (1986), for example, has produced a model of implementation cycles, according to which even though innovations are made at a smooth pace, their implementation will be bunched over time, because the reward to implementing an innovation is highest when there is a boom caused by various other innovations being implemented at the same time. Others have pointed out that the external economies of scale present in almost all endogenous growth models typically give rise to many equilibria with chaotic or at least periodic behaviour, even under stationary conditions. Jess Benhabib and Roberto Perli (1994) have shown recently that even Bob Lucas's (1988) celebrated model of endogenous growth possesses stable but cyclical growth paths for a large class of parameter values.

These theoretical interconnections between growth and cycles are reinforced by taking into account the unevenness of innovation and diffusion and the tendency for them to cluster in Schumpeterian waves. These ideas underly the recent revival of interest in the long waves that Schumpeter thought accounted for the most serious cyclical changes. Writers like Christopher Freeman (1984) argue that much of the

high unemployment of recent years is attributable to the fact that we are now in the throes of the fifth Kondratiev cycle.

Personally, I am reluctant to attach much significance to something of which there have been so few reported instances as Kondratiev cycles; however, empirical investigations of job creation and destruction in the manufacturing sectors in both Canada and the United States suggest to me that the pace of technological change is correlated with the higher-frequency business cycle as conventionally measured by either NBER techniques or various de-trended macroeconomic aggregates. A recent paper by Baldwin, Dunne, and Haltiwanger (1994) looks at comparable data in both countries at the establishment level and concludes that the results reported by Davis and Haltiwanger (1992) for the United States also hold for Canada (Canadian data were analysed earlier by Baldwin and Gorecki 1990). That is, there has always been considerable creation and destruction of jobs, the rate of job destruction is more cyclically volatile than job creation, and the overall rate of job turnover tends to be higher during recession than during expansion. It seems me this countercyclical pattern in turnover reflects a countercyclical pattern in Schumpeter's process of creative destruction.

III. GROWTH AND COORDINATION

Aside from fact that economic growth and cycles are best seen as a unified process, endogenous growth theory points to some serious coordination problems which can occur even in steady state equilibrium. They arise because of the fundamental role that imperfect competition and externalities play in endogenous technological change. As Schumpeter argued, it is the prospect of monopoly profits that provides much of the incentive for innovation. And countless writers have observed that the difficulty of appropriating the return from new knowledge makes it inevitable that innovations will generate external economies. On the other hand, as Philippe Aghion and I (1992) have argued, creative destruction also gives rise to a negative rent-seeking externality in the form of what is known in the patent-race literature as the 'business-stealing' effect; that is, a successful innovation will reward the innovator not only with the social rents it generates but with the rents appropriated from the earlier innovations that it renders obsolete.

The presence of imperfect competition and external economies of scale makes the formal structure of endogenous growth models remarkably similar to that of the Keynesian coordination failure models that were developed in the 1980s (see Cooper and John 1988), where the external economies of scale came not from technology spillovers but from what I call thin market externalities – the external economy that buyers confer on sellers when they enter the transaction process and put more resources into the activity of making transactions. So it is not surprising to see that many endogenous growth models produce the characteristic result of coordination failure models: multiple suboptimal equilibria. Low-level growth traps are as easy to generate in endogenous growth models as high unemployment traps were in coordination failure models, and for the same basic reasons.

There is even a new literature suggesting that faster economic growth can create a permanent coordination problem in the form of higher unemployment. Of course, the possibility of technological unemployment has been a popular concern in capitalist societies ever since the first large-scale introduction of machinery in manufacturing. For the most part, these concerns have received little support from the mainstream of our discipline, although there have been prominent exceptions. Ricardo (1821) initiated an ongoing controversy on the subject when he introduced the notorious chapter 31, 'On Machinery,' in the third edition of his *Principles*, in which he endorsed the views of John Barton and argued that under some circumstances the invention of new machinery will cause 'a diminution in the demand for labour, population will become reductant, and the situation of the labouring classes will be that of distress and poverty ... some of their number will be thrown out of employment ...' (266).

As Paul Samuelson (1988, 1989) has observed, a long list of distinguished mainstream economists over the years have tried to point out fallacies in Richardo's analysis. Even Ricardo seemed to think that his analysis was applicable only to the short run – or at least that's how I interpret him. The mainstream view, as expressed, for example, by Wicksell (1934, 733-44; Jonung 1981), has been that although a new labour-saving invention might temporarily displace some workers, the problem is purely transitory. In the absence of artificial impediments to the working of the price system, those whose jobs are destroyed should eventually find re-employment, at which time they too will benefit from the reduced price of goods produced by the new technology.

This mainstream view is of course another instance of the classical dichotomous view of the short and long runs (which, Rashid 1987 shows, predates Hume). The main problem is that it focuses upon the effects of a single technological innovation. If we want to account for the effect of growth on unemployment, or even if we want to see what happens in the face of a long wave of innovations, we have to look instead at the effects of an increase in *the rate at which* new technologies are being introduced. Even if it is true that those displaced by a single innovation will eventually become re-employed and better off, nevertheless the faster the pace of job-destroying innovations the greater will be the flow into unemployment in any given situation, and therefore the greater will be the steady-state rate of unemployment.

In a paper that Philippe Aghion and I (1994) have recently written on the subject, technical change renders old capital equipment obsolete by raising the price of the other factors that must be combined with capital and labour to produce output. When those factor prices have risen to the point where a machine or plant is no longer economically viable, a worker still employed with it will become unemployed. The faster the rate of growth, the sooner this point will be reached in all job matches in the economy; hence the shorter will be the average duration of a match, which is to say the greater will be the economy-wide rate of job destruction. Through this channel, faster growth will tend to create a higher steady rate of unemployment.

Of course the overall effect on unemployment will depend also upon what is happening to the rate of job creation, which will determine how long an unemployed worker has to search before finding an employer willing to put him to work with a machine or plant of more recent vintage. This in turn will depend on how much incentive entrepreneurs have to pay the set-up cost of creating the new capital, creating the vacancy, finding a worker capable of operating the capital, and initiating an employment relationship with that worker. This incentive could be affected in either direction by the prospect of more rapid growth. On the one hand, a shorter match duration will lower the discounted stream of profits from a successful match, but on the other hand, if paying these set-up costs buys the entrepreneur an inside track to exploiting future technological opportunities, faster growth will raise the capitalized prospective pay-off. Overall, our analysis predicts an inverted U-shaped long-run relationship between growth and unemployment, with more growth creating more unemployment when growth is slow to begin with, but less unemployment when growth is sufficiently rapid[1] .

IV. THE GENERALIZED HARROD-DOMAR PROBLEM

The coordination problems that I have been describing so far can arise even in steady-state equilibrium. But there is a deeper coordination problem that has not yet been addressed in the endogenous growth literature, one that lies at the heart of the growth process. It is what I call a disequilibrium coordination problem, because it concerns how a state of equilibrium might be reached. It is almost the same as the one at the root of Keynesian economics, and a particular form of it is what motivated Harrod (1939, 1948) and Domar (1946, 1947) to make the contributions that originally gave rise to the modern literature on economic growth.

The Harrod-Domar problem was to ensure enough effective demand that the increased productive potential created by economic growth would be fully utilized, rather than becoming excess capacity and causing unemployment. It was a question of coordinating the expectations of investors with the yet unarticulated future demands of savers. As long as the marginal propensity to consume was less than unity, business firms would somehow have to see that it was in their interests to increase their investment outlays each year, and by just the right amount. Harrod rightly perceived that this brought into question the stability of equilibrium. Under his assumptions, any time entrepreneurs underestimated the growth of final sales, they would scale back their collective investment outlays, and the subsequent multiplier effects of this cutback would cause actual sales to fall even more than anticipated. A vicious circle would be created, whereby shortfalls in investment demand would feed on themselves in cumulative fashion.

What most people know as the Harrod-Domar *model* has a knife-edge property

1 Higher growth is also likely to raise unemployment if it raises the dispersion of the wage distribution, because (a) higher dispersion will induce longer search spells among unemployed workers and (b) minimum wages and unemployment insurance benefits that are geared to the average wage are likely to induce more unemployment the higher the dispersion rate.

as a result of an extreme and unrealistic assumption of fixed factor proportions.[2] But the Harrod-Domar *problem* arises even in conventional models with smooth substitution possibilities.[3] In a textbook IS-LM model, for example, it is easy to come up with examples in which a positive shock to the aggregate production function will result in a short-run excess supply of labour, causing either wages or employment to fall, even though the neoclassical growth model of Solow and Swan would predict a higher level of money wages at the same level of employment. Of course there are also cases in which investment demand will be stimulated so much by the positive technology shock that the demand for labour will rise even on impact. But to count on this always happening would be to ignore Keynes's shrewd observations concerning the volatility of investment demand and the pervasive influence of uncertainty; it would also be to assume the Harrod-Domar problem away.

The standard resolution to this problem is to say that if entrepreneurial expectations don't respond appropriately, then sooner or later wages will have to fall, and the problem will go away. But this response begs the further questions of whether recovery will really be promoted by a debt deflation that will drive many firms out of existence, possibly bringing down with them some of the financial intermediaries whose services will be needed to finance adjustment, whether it will be possible for central banks preoccupied with exchange rates, and controlling a shrinking fraction of the means of payment, to avoid a monetary contraction once prices start falling, and what will counteract the destabilizing expectational and distributional effects upon which Keynes rested his instability case in the *General Theory*.

The Harrod-Domar problem is just the tip of an iceberg, because adjustment to technological change requires far more than the right level of overall investment demand. We know that Engel curves are not straight lines through the origin. As incomes grow, marginal expenditures are devoted to new and different goods. Full adjustment in a multi-good economy requires entrepreneurs to create the sort of productive capacity and the sort of jobs – in many cases to create entirely new goods and markets – that will enable them ultimately to satisfy the yet unknown wants that people will have when their incomes are higher. Until people have that increased income, or at least enough of a prospect of increased income that they are induced to run down their liquid assets even faster, how are they to make their demands effective, especially if technological change has made them unemployed?

Not only do entrepreneurs have to anticipate demands that have not yet been articulated, they have to anticipate the decisions that other entrepreneurs are making, because paying the set-up cost of hiring people and capital and developing a market to produce and sell any particular range of goods will pay off only if that range is compatible with the standards, techniques, and strategies that others are developing. And of course these decisions have to be coordinated somehow with those of the unemployed and young workers trying to choose occupations, find sectors, and acquire skills to anticipate the jobs opportunities of the future.

2 Harrod, however, always maintained that the fixed-proportions model was a caricature of his theory. See, for example, Harrod (1959).

3 A point which Eisner (1958) emphasized in his critique of neoclassical growth models.

More generally, in order to accomplish the social objective of exploiting an increased productive potential each year, new trading relationships have to be established that involve literally millions of people. How are these arrangements going to be made when none of the transactors can possibly have a detailed understanding of what is going on, none of them is in direct communication with all the others, and all of them are guided by purely private interests? What signals are going to induce business firms collectively to provide the kind of capital equipment, job opportunities, products, processes, and markets that will profitably absorb the potential increases in purchasing power wrought by technological change? How much time, bankruptcy, mismatch, and unemployment will it take? Or will adjustment ever be complete without some form of collective guidance, and if so what kind?

V. TECHNICAL PROGRESS WITHIN ECONOMICS?

Of course these coordination problems are a variation on a theme as old as economics. Hayek described almost the same variant in his famous 1945 article on 'The use of knowledge in society,' where he described society's economic problem as that of utilizing knowledge that was not given to anyone in its totality, in a world where local knowledge was constantly changing and affecting people in other sectors. Hayek argued that this problem would be taken care of by the price system; that prices contain all you needed to know about what others are doing. This is also the message of modern general equilibrium theory: as long as wages and prices are free to adjust, equilibrium will be attained, at least in the long run.

The problem with this message, however, is that it begs Keynes's adjustment question: Would the automatic mechanism of price adjustment actually converge to an equilibrium, even in the long run? Of course there is a literature on the stability of general equilibrium, which flourished in the 1950s and 1960s. But nothing in that literature in any way establishes a presumption of stability. All that can be shown is that there are hypothetical sufficient conditions for stability, such as universal gross substitutability. When theorists discovered what a messy subject they had on their hands they just dropped it, although they had hardly begun to deal with expectations. In fact, most of the literature analyses only non-monetary economies in which no one has to trade until the auctioneer has succeeded in arriving at an equilibrium, that is, economies in which effective demand, unemployment, bankruptcy, debt-deflation, endogenous money supply, and so forth have no meaning.

This brings me to the issue of technical progress within economics. I think there is no doubt that the main reason for the rise of endogenous growth theory has been the advances its leaders have made in modelling increasing returns, which arise almost inevitably once one endogenizes technology. The new techniques of endogenous growth theory, which are mostly borrowed from industrial organization theory and international trade theory, have yielded tractable dynamic general equilibrium models with imperfect competition and external economies of scale, both of which arise naturally in the context of technological growth, and both of which permit the existence of equilibrium even in the presence of increasing re-

turns. The basic substantive ideas of endogeneous growth have long been known to economic historians and specialists in the economics of technology,[4] but it was not until the modelling innovations of endogenous growth theory that these ideas could be incorporated into the mainstream of economic theory.

Putting endogenous technology into a conventional equilibrium framework has certainly facilitated discussion. It has also helped in laying bare many of the previously unappreciated adjustment and coordination problems inherent in the growth process. But endogenous growth theory as it now exists is not well suited for dealing with the deepest adjustment and coordination problems raised by technological change, because the general equilibrium framework in which it has been cast assumes away all problems of disequilibrium coordination. Not all endogenous growth models are Walrasian competitive equilibrium models, but they are all rational expectations equilibrium models, and the assumption of rational expectations equilibrium implies either that people have no need to adjust to each other, as in many representative agent models, or that they have already been provided, by some unspecified mechanism, with a pre-coordinated set of beliefs on which to base their actions.[5]

There is now a substantial literature on the convergence (or otherwise) of various adaptive learning schemes to rational expectations. Like the older literature on stability of competitive equilibrium, it offers no general presumption of long-run convergence, and it is also rather messy. But even long-run convergence would make rational expectations applicable only in a stationary context, not in a situation where unprecedented events keep changing the relationships people are trying to learn about. So, in particular, existing endogenous growth models offer no help in understanding whether entrepreneurs will generate the level and direction of investments needed to employ the people displaced by technological change, when no one knows how people would spend their incomes if they did find jobs.

VI. LOOKING AHEAD

I think it is possible for macroeconomic theory to tackle this disequilibrium adjustment problem, and that the most promising approach is one that builds on a central element of endogeneous growth theory. We need to do more, however, than tack some disequilibrium dynamics onto existing models. We need to build a new conceptual foundation. To think clearly about how transactions are coordinated in real

4 Indeed many of them were clearly spelled out generations ago by John Rae (1834), after whom the Canadian Economics Association's special prize for outstanding research has been named.

5 For example, Jovanovic and Nyarko (1994) show how technological stagnation can follow from an individual's rational comparison of the costs and benefits of switching to new technologies, but since there is only one individual in their model, there is no coordination problem. Likewise, Atkeson and Kehoe (1993) show how the prospect of more rapid growth might generate a prolonged economic downturn through accelerated scrapping of old capital and the short-term costs of experimentation with new technologies, but they assume away the problem of adjusting to others' adjustments, by analysing only the allocation that maximizes the representative household's lifetime expected utility.

economies we need a clear conceptual account of what Jevons called the mechanism of exchange, one base not upon any methodological principles of equilibrium or disequilibrium, but upon careful modelling of the way in which business firms organize transactions in real life.

The reason why each of us can count on the implicit cooperation of millions of others in carrying out the economic transactions of everyday life is not just that the butcher and baker are pursuing self-interest, but that they and thousands of other business enterprises have been led by this interest to undertake the costly and uncertain activity of creating and operating trade facilities. If it were not for costly facilities like shops, personnel departments, offices, warehouses, auction houses, brokerage houses, banks, etc., and for the activities of clerks, brokers, agents, managers, accountants, and all the other inputs needed to operate these facilities, economic life as we know it would be impossible. The prospect of having to find and secure the cooperation of a set of co-workers, to find the right capital equipment and material inputs, to market the fruits of joint efforts, and to locate someone with available stocks of reliable-quality consumption goods, all without the help of a network of firms that have undertaken the costs involved, would send everyone back to autarky. These costs amount to about 50 per cent of total output in the U.S. economy, according to the estimates of Wallis and North (1986), and there is no reason to think they are any less substantial in Canada.

I am convinced that making the business firms that actually create and maintain markets the central actors of economic theory and modelling their behaviour according to the rules and procedures they actually follow, rather than according to maximization principles that make sense only in rational expectations equilibrium, is the way to understand how complex economies adjust to technological change, or to any kind of change. For these are the agents that post and change the prices whose adjustment is critical to any kind of adjustment, that hold buffer stocks to allow others to trade even when their purchase and sale plans have not been pre-coordinated, that must provide a steady market for someone's specialized labour services if that person is to escape unemployment, and that must undertake the risk of creating markets for new goods if society is to progress. This is why I am now working with Bob Clower on a new conceptual foundation for monetary theory that focuses on the way business firms create and operate markets.

It is too late in the day, and far too early in our own efforts, for me to present you with any detailed results. I would just like to leave you with the observation that the firms that create and operate the mechanism of exchange in real economies are Schumpeterian entrepreneurs, and the creation of a market is the quintessential Schumpeterian innovation – the ultimate creative act that allows a new match between resources and uses to be consummated. Axel Leijonhufvud (1968, 397) once remarked that the economics of Keynes was Walrasian economics without the auctioneer. But just removing the auctioneer would be destruction without creation. It takes an innovation to beat one. If I am right, the sort of innovation that will finally allow us to deal coherently with Keynes's fundamental adjustment question, which I believe is central to the question of adjusting to technological

change, will involve replacing the Walrasian auctioneer with the Schumpeterian entrepreneur.[6]

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6 Actually, there is no auctioneer in Walras (1926). Later mathematical economists invented him to personify the forces operating in Walras's 'tâtonnement.' Moreover there *is* an entrepreneur in Walras, but not one that bears the risk of doing something unprecedented in the hope of being able to share some prospective gains from trade.

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