TECHNOLOGICAL INNOVATION AND THE CAUSES AND CURES FOR UNEMPLOYMENT

Rick Szostak

In explaining economic fluctuations, economists place too little emphasis on the bunching of technological innovations and on the differing macroeconomic effects of product and process innovations. The period 1925-34, for instance, saw the introduction of only one major new product, the electric refrigerator, but of several very important process innovations that reduced the demand for labour. Public policy should encourage the research, especially basic research, that leads to diverse innovations. It should also support public investment projects that can employ labour when for a time the bunching of innovations does lead to unemployment.

Les économistes, quand ils nous expliquent les fluctuations économiques, ne soulignent suffisamment ni la prolifération des innovations, ni les effets divergents que l'arrivée de nouveaux produits et de nouvelles techniques entraîne dans le domaine macroéconomique. Durant la période 1925-1934, par exemple, on n'a vu apparaître qu'un seul nouveau produit important : le réfrigérateur. Mais, durant la même période, sont nées plusieurs innovations techniques majeures, qui ont considérablement réduit la demande de main-d'œuvre. Les politiques publiques devraient encourager la recherche, et en particulier la recherche fondamentale, source d'innovation dans les domaines les plus divers. Elles devraient également soutenir les projets d'investissement susceptibles de créer des emplois lorsque, pour un certain temps, le foisonnement d'innovations ralentit ou paralyse la croissance économique.

Readers of the business pages are regularly confronted by analyses of economic prospects which hinge entirely on prognostications about the future course of technological change. Are we on the verge of a biotechnology revolution, or is this still a few years off? To what degree will the Internet affect the way business is done? Are we beginning to see huge productivity gains from the application of information technology?

Yet the macroeconomic models which economists use to analyse business cycles contain virtually no mention of technology. The one exception to this rule is (was?) "real business cycle theory," which suggested that variations in unemployment could be understood in terms of workers choosing between work or leisure, depending on how technology affected productivity (and thus wages) at any given time. Empirical support for this theory, which was in vogue in the 1980s, has proven as weak as its theoretical basis.

Economists admittedly can point to the fact that technology does have a prominent place in the latest generation of economic growth models, which argue, for example, that innovators respond to a variety of economic incentives. Yet technological innovation is a risky and uncertain process, influenced by a variety of social and cultural factors. Moreover, at any time it depends crucially on the body of technical and scientific understanding on which innovators can build. Given these non-economic influences, and the long time research and development generally take, trying to "explain" innovation by reference only to the previous period's economic conditions inevitably leaves us with a seriously deficient understanding of economic growth.

Formal growth theory is generally taught to economics students as one topic in senior macroeconomics courses. In effect, we treat growth as if it were a side-effect of fluctuations. It would be more accurate to view fluctuations as a consequence of growth: If our economy did not change over time, why would it fluctuate so much?

I draw two main conclusions from these observations: that we will never fully understand fluctuations unless we incorporate technology into our analysis, and that we should look beyond mathematical models in order to enhance our understanding of the role technology plays in both growth and fluctuations. I will illustrate these two arguments with reference to the Great Depression, a tactic that reflects both my ongoing research interest in the

Depression, and the fact that the effects of technology are more readily appreciated in a period that standard macroeconomic models have so signally failed to explain.

Start with two important technological characteristics of the interwar period. First, the period 1925-1934 was—by far—the worst in the last century for new product innovation. The only "major" development was the electric refrigerator. Second, the decade of the 1920s is *the* period of most rapid adoption of three major process developments: the assembly line, continuous processing (for homogenous products like oil), and electrification. These innovations had an important impact on productivity. Estimates of a 50 per cent increase in industrial productivity for the decade in both Canada and the US may actually be low, as they fail to account for improvements in product quality. Productivity advance continued in the 1930s, in part from improvements in management of the new processes, which required very little new investment, and in part from such developments as tungsten carbide cutting tools. They tripled the cutting speeds of machine tools while reducing waste: The new blades could be fitted to existing machines. In general, there was very little scope for investment to take advantage of new process technology. The exception was new rolling mills for steel, of which several were built in the early 1930s.

I believe these "stylized facts" for the 1920s can be understood as part of the continuing evolution of the three main components of the Second Industrial Revolution of the 1880s: internal combustion, chemicals, and electrical products. Each yielded major product innovations both in the early 1920s (namely, affordable automobiles, rayon, and radio), and in the late 1930s (commercial aircraft, nylon, and television). And each spawned process innovations that had their major impact in the 1920s. Because the products of the late 1930s were much more complex than those of the early 1920s, it is not surprising that there was a gap between these two clusters of innovation, one that helps explain the economic slowdown of the late 1920s. It should also be noted that in the early decades of this century the emerging industrial research laboratories tended to focus on process innovation.

It is straightforward to develop models in which product innovation causes a medium-term increase in employment, and process innovation the reverse. Employees are needed in order to build new products. New processes allow more output to be produced with fewer employees. There are exceptions to this rule, of course: A substantial drop in the cost of a product may so increase demand as to increase employment. Yet the general result holds. It's true that in a completely frictionless economy, wages and prices might instantly adjust across all markets in order to maintain full employment. But in the real world, fluctuations will occur. Unfortunately, given the difficulty of quantifying innovation (since each innovation is unique), such models have rarely been applied empirically.

Much of the effort of business cycle theorists is devoted to understanding why investment and consumption fluctuate as they do. In studying investment within macroeconomic models, we tend to focus on variables such as aggregate expectations, the money supply, and interest rates. Yet investors, especially in industry, generally invest with a particular product and process in mind. I would argue that we miss much that is important by failing to analyze such micro-level determinants of investment.

In the early 1930s, there were no new products to stimulate investment. As mentioned, the exception was electric refrigerators: New plant was built and output grew despite the Depression. The process innovations of the 1920s had been incorporated in fairly new plants, and those of the 1930s required little further investment.

The introduction of a new product (and sometimes process) often stimulates excess investment as firms fight for market share. In the early 1920s, this syndrome created overcapacity in many sectors. Even if demand for cars had not tailed off, automakers had the capacity in 1929 to produce twice as many cars as they had sold in their best year ever. This overcapacity placed a further brake on investment

In trying to explain the declining investment of the 1930s or of other sluggish periods, we rarely ask the question, "What do we think people should have invested in?" We should. The same is true for consumption: Our propensity to consume depends in part on the range of goods available. We experience "shocks" as new products are introduced. An increase in income unaccompanied by new products will likely cause a medium-term drop in our propensity to consume. The result is increased saving—just as a lack of new products lowers investment demand.

We know that people purchase consumer durables unevenly over time. When a new durable is introduced, we may see a clumping of

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purchases across individuals. If a period in which a number of durables (especially expensive durables) are introduced and achieve substantial market penetration is followed by a period of little durable product innovation, we should expect a drop in consumer expenditure. The 1920s were the decade in which the automobile, radio, and a handful of electric appliances became articles of mass production and consumption. While we may never see such a bunching of major durable innovations again, this should not blind us to the effect which an uneven introduction of new durables can have on the aggregate economy.

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If the Depression was in large part a result of an unusually large amount of process innovation and an unusually small amount of product innovation, did the relative economic stability of the postwar period reflect a better balance between product and process innovation? While economists generally credit economic stability to the equilibrating tendencies of markets (and then struggle to comprehend large perturbations from equilibrium such as the 1930s or 1970s), the Depression experience suggests that such mechanisms are too sluggish to protect us from a severe technological imbalance. A return to full employment depends on entrepreneurs who see opportunities for profitable investment, and this requires more than just low interest rates and high expectations. It requires technological opportunities.

This does not mean that another Depression is coming. The innovative process is much more diffuse today than it was in the interwar period; if a wide variety of research programs is being pursued, we are unlikely to see a severe imbalance. Modern industrial research laboratories tend to be more evenhanded in their approach, and pursue many possible initiatives at once, and there are more of them than there used to be. Still, it is likely that we will from time to time observe innovation imbalances capable of generating double-digit unemployment over a period of years.

Modern economic history is characterized by periods of a decade or more of rapid growth and low unemployment, followed by periods of a decade or more of slower growth (or worse) and higher unemployment. Macroeconomic models, with their focus on cycles of three to five years, necessarily tell us little about these longer periods. Analysing the time path of product and process innovation can tell us much more.

The distinction between product and process innovation clearly is one we ignore at our peril. Yet even among those who recognize the economic impact of technology the distinction is often not made. Will the information and biotechnology revolutions generate mostly new products or new processes? If the former, to what extent will the new products replace existing products? If the latter, will decreases in costs stimulate a dramatic increase in sales? And will product and process innovations occur evenly or will they be bunched temporally?

What, if anything, can we do to foster a benign technological trajectory? My argument that a multiplicity of research endeavours is our best insurance against another Depression provides yet another rationale (there are many more) for government encouragement of research, and especially of the basic research from which diverse ideas can flow. For those, like myself, who fear inflationary pressures much less than deflationary pressures, governments might be advised to emphasize research likely to generate new products—though it can be difficult to predict the precise results of a research enterprise.

Though I believe we have not been aggressive enough in using fiscal and especially monetary policy to fight unemployment over the last decade or so, my analysis of technology does suggest that traditional fiscal policy measures may well be least effective when they appear to be needed most. Tax breaks in the 1930s, when the people who would have received them saw only limited opportunities for investment or consumption, would have had a correspondingly limited stimulative effect. On the other hand, governments in most countries were able to significantly reduce unemployment by simply hiring the unemployed to perform public works. By falsely attributing economic fluctuations exclusively to movements in expectations or interest rates, modern economists worry that the beneficial impact of such government expenditures on employment will be largely or even entirely counteracted by the negative impact of the taxes or borrowing needed to finance them. Recognizing that much of the problem is technological leads us to be considerably less concerned about these side effects. If during good economic times we could both save money and compile lists of desirable public works initiatives, we would be much better able to weather the bad times that inevitably hit modern economies.

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