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Economic models

Big questions and big numbers

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We cannot live without big and ambitious economic models. But neither can we entirely trust them

AMONG the many gadgets, instruments and artefacts in its care, London's Science Museum holds a peculiar contraption that most resembles the work of a deranged plumber. Yellow tubes connect together a number of tanks and cisterns, around which coloured water can be pumped. Sluices and valves govern the flow of liquid and makeshift meters record the water-levels.

The “plumber” responsible for this device was William Phillips. Educated as an engineer, he later converted to economics. His machine, first built in 1949, is meant to demonstrate the circular flow of income in an economy. It shows how income is siphoned off by taxes, savings and imports, and how demand is re-injected via exports, public spending and investment. At seven feet (2.1 metres) high, it is perhaps the most ingenious and best-loved of economists' big models.

Economists today use computers and software not perspex and piping, but they share Phillips's itch to build models that faithfully mirror the real economy. For each of the big economic questions facing the world (What do we stand to gain from a global trade deal? By how much has expensive oil retarded growth? What might be the economic costs of an avian flu pandemic?) there is a model that will provide a big numerical answer ($520 billion, 1.5% of world GDP, and $4.4 trillion, respectively). Such figures are trotted out far and wide. But can we entirely trust them?

Economic models fall into two broad genres. Macroeconomic models, the distant descendants of

Phillips's machine, belong mostly in central banks. They capture the economy's ups and downs, providing a compass for the folks with their hands on the monetary tiller. The second species, known as computable general equilibrium (CGE) models, largely ignore the vagaries of the business cycle. They concentrate instead on the underlying structure of production, shedding light on the long-term repercussions of such things as the Doha trade round, a big tax reform or climate change.

Both kinds of model share a debt to Leon Walras, a 19th-century French economist. Walras was adamant that one could not explain anything in an economy until one had explained everything. Each market—for goods, labour and capital—was connected to every other, however remotely. This interdependence is apparent whenever faster car sales in Texas result in an increase in grocery shopping in Detroit, the home of America's “big three” carmakers. Or when steep prices for oil lead, curiously enough, to lower American interest rates, because the money the Saudis and the Russians make from crude is spent on American Treasury bonds. This fundamental insight moved one economist to quote the poetry of Francis Thompson: “Thou canst not stir a flower/Without troubling of a star.”

Flowers and zombies

Such thinking now comes naturally to economists. But it still escapes many politicians, who blindly uproot flowers, ignorant of the celestial commotion that may ensue. They slap tariffs on steel imports, for example, to save jobs in Pittsburgh, only to find this costs more jobs in the domestic industries that use the metal. Or they help to keep zombie companies alive—rolling over their loans, and preserving their employees on the payroll—only to discover they have starved new firms of manpower and credit. Big models, which span all the markets in an economy, can make policymakers think twice about the knock-on effects of their decisions.

Wassily Leontief was one of the first to do more than just theorise about this tangled web of interdependence. In 1941 he published his book “The Structure of American Economy”, which he updated a decade later. Tucked in the back was a 55cm x 65cm table—too big to be printed in the book itself—showing the flow of commodities and services back and forth among America's households, trading partners and 41 national industries. Of the $5.58 billion-worth of yarn and cloth that passed out of America's factory gates in 1919, for example, $318m was exported, $41m was used up in agricultural production, $31m in making furniture, $6m in the shoe industry, and so on. In Leontief's blueprint, each industry is represented by an equation. The inputs to the industry are entered on one side of the equation, the industry's output appears on the other. Since the output of one industry (steel, for example) serves as an input for another (construction), one cannot solve any equation without solving them all simultaneously.

In the palm of their hands

Short of good data, and stretched to their computational limits, the early modellers nonetheless had high ambitions. They aimed not merely to understand the economy, but to run it. Leontief's book was translated into Russian; his techniques studied by Soviet planners. Leif Johansen, a Norwegian economist often credited with building the first CGE model, put his handiwork to use at Norway's planning ministry. During the second world war, the stewards of America's war effort turned to the Cowles Commission, an economics brain-trust, to help them ration America's resources. “We imagined that we held the well-being of the economy right in the palms of our hands,” one of the Cowles economists told a journalist, David Warsh. One measure of the modellers' prestige is the disquiet they inspired among free-market types. Leontief noted the “unconcealed alarm” among businessmen, who feared that “too close and too detailed an understanding of the structure of the economic machine and its operation might encourage undesirable attempts to regulate its course.”

Such ambitions now seem quaint. In countries not cursed by socialism or war, the market is left to decide what to produce and in what proportions. But the state remains responsible for keeping the overall macroeconomy ticking over. Policymakers are largely indifferent to what is in demand, so long as the tank of demand remains full.

For three decades after the war they carried out this duty with remarkable success, aided and abetted by macroeconomic models in the spirit of Phillips's machine. Empirical economists put a lot of effort into teasing out the historical relationships between macroeconomic variables, such as inflation and unemployment. These measurements were fed into their models, which in turn guided their policy advice.

In 1958, for example, Phillips showed that for long stretches of British history, high unemployment coincided with low wage inflation, and vice versa. Many macroeconomic models therefore featured a trade-off between the two: doves could choose low unemployment at the expense of high inflation; hawks the opposite.

But in the 1970s these trusted relationships broke down. And in 1976 Robert Lucas, of the University of Chicago, explained why. Such trade-offs, he argued, existed only if no one expected policymakers to exploit them. Unanticipated inflation would erode the real value of wages, making workers cheaper to hire. But if central bankers tried to engineer such a result, by systematically loosening monetary policy, then forward-looking workers would pre-empt them, raising their wage claims in anticipation of higher inflation to come. Cheap money would result in higher prices, leaving unemployment unchanged.

In short, one could not judge how the macroeconomy would respond to a new policy based on its behaviour under the old regime. The "Lucas critique", as it was called, brought its author fame and a Nobel prize. But it dealt a big blow to the confidence of model-makers. As Christopher Sims of Princeton University has put it, "Use of quantitative models as a guide to real-time policy advice was cast into such deep disrepute that academic research on the topic nearly completely ceased."

It did not start again until academic economists found new foundations for their models, foundations that would not shift under their feet when policies changed. They located this bedrock in the "microfoundations" of macroeconomic behaviour. Mr Lucas and his disciples, echoing Margaret Thatcher, believe there is no such thing as society. Everything that happens at the level of the economy as a whole is simply the sum of the actions of individual households or firms. If you know how the "representative" firm or household makes its choices, the argument goes, you can forecast how the economy might respond to a policy, even if that policy has never been tried before.

In the past decade, a number of central banks—and even the International Monetary Fund (IMF)—have reared a new generation of practical macroeconomic models, all of them sporting microfoundations. First-born was Canada's Quarterly Projection Model in the mid-1990s; its close siblings include the Bank of England Quarterly Model (BEQM) introduced in 2004; the SIGMA model groomed by the Federal Reserve's International Finance Department; and the IMF's new Global Economic Model (GEM). Old hands doubt whether the new microfoundations are quite as secure as they seem—the macroeconomy is surely rather more than the sum of its parts—but no self-respecting theorist can now be seen in public without them.

Stabilising the macroeconomy is only one of the responsibilities of governments in a market economy. They must also raise taxes and most feel the need to impose tariffs, both of which put rocks in the stream of economic life. When they contemplate big changes to these policies, most governments cannot resist turning to CGE models to forewarn them of the consequences.

These models were, for example, a weapon of choice in the battles over the 1994 North American Free-Trade Agreement (NAFTA). The pact's opponents had the best lines in the debate—Ross Perot, a presidential candidate in 1992, told Americans to listen out for the "giant sucking sound" as their jobs disappeared over the border. But the deal's supporters had the best numbers. More often than not, those with numbers prevail over those without. As Jean-Philippe Cotis, chief economist of the OECD, has put it, "orders of magnitude are useful tools of persuasion."

Pick a number, any number

But how plausible were the numbers? Twelve years on, economists have shown little inclination to go back and check. One exception is Timothy Kehoe, an economist at the University of Minnesota. In a paper published last year, he argued that the models "drastically underestimated" NAFTA's impact on trade flows (if not on jobs). The modellers assumed the trade pact would allow people to buy more of the goods for which they had already shown some appetite. In fact, the agreement set off an explosion in the exports of many products Mexico had scarcely traded before. Cars, for example, amounted to less than 1% of Mexico's exports to Canada before the agreement. By 1999, however, they accounted for more than 15%. The only comfort economists can draw from their efforts, Mr Kehoe writes, is that their predictions fared better than Mr Perot's. A low bar indeed.

Dubious computations also helped to usher the Uruguay round of global trade talks to a belated conclusion in 1994. Peter Sutherland, head of the General Agreement on Tariffs and Trade, the ancestor of the World Trade Organisation (WTO), urged negotiators to close the deal lest they miss out on gains as great as $500 billion a year for the world economy. This figure came, of course, from a big model.

Even staunch free-traders, such as Arvind Panagariya, an economist now at Columbia University, thought these claims “extravagant” and “overblown”. They escaped scrutiny, he argued in 1999, because they emanated from “gigantic” models, which were opaque even to other economists. Why then did these models thrive? Supply and demand. “Given the appetite of the press and politicians for numerical estimates and the publicity they readily offer researchers, these models are here to stay,” Mr Panagariya concluded.

That appetite was undiminished at the onset of the next round of trade negotiations, launched in Doha, the capital city of Qatar, in 2001. Two years into the round, as trade ministers gathered for a summit in Mexico, the World Bank was pushing another extravagant simulation. It argued that an ambitious Doha agreement could raise global incomes by $290 billion-520 billion and lift 144m people out of poverty by 2015. Those figures found a ready place in almost every news report about the Doha round that autumn.

Such extravagance did not last. The World Bank has since cut these figures drastically, in part because the ambitions of the Doha negotiators have fallen short of the bank's expectations. One estimate made last year had cut the increase in global incomes to $95 billion and projected 6.2m people might instead move out of poverty. But even as they curb their enthusiasm for Doha, proponents of freer trade argue that CGE models do not show their cause to its best advantage.

Trade's virtuous effects are of two distinct kinds. First, trade helps countries make the most of what they already have. It frees countries to allocate their resources—whether they be cheap labour, fertile land or educated minds—as efficiently as possible. But, secondly, trade can also allow countries to accumulate resources more quickly. Indeed, the biggest prizes lie in faster growth, not heightened efficiency; in accumulation and innovation, not allocation.

By their nature, CGE models are better suited to capturing the first effect than the second. They provide “before and after” snapshots of the economy at two points in time. They are therefore good at capturing the one-off gains that might arrive from a redeployment of the economy's resources. They are much less good at capturing the continuing gains that result from a faster accumulation of capital, or a quickened pace of productivity growth. Most trade models, indeed, hold productivity fixed.

In a recent article, Dominique van der Mensbrugghe, of the World Bank, illustrates the much bigger numbers the modellers could produce given a free hand. He assumes that the very act of exporting raises the productivity of firms, because selling on world markets forces companies to raise their game while exposing them to new ideas and techniques. This alternative assumption raises the gains from free trade in goods by $174 billion (or thereabouts).

These rival assumptions are not right or wrong, but they illustrate how far the results of CGE models flow from the presuppositions of their authors. Most empirical exercises confront theory with numbers—they test theories against the data; sometimes they even reject them. CGE models, by contrast, put numbers to theory. If the modeller believes that trade raises productivity and growth, for example, then the model's results will mechanically confirm this. They cannot do otherwise. In another context, Robert Solow, a Nobel prize-winner, has noted the tendency of economists to congratulate themselves for retrieving juicy plums that they themselves planted in the pudding.

In a recent article, Roberta Piermartini and Robert Teh, two economists at the WTO, urge modellers to "demystify" their creations, making it clear to their audience what makes their models tick. A failure to do this, they argue, "risks bringing a useful analytical tool into disrepute and may even induce unwarranted cynicism about the economic case for open trade."

To be fair, most modellers are quite open about the theoretical principles that underlie their simulations. But to compute an economic model, this theory has to be given concrete form, spelt out in definite algebraic terms. Alfred Marshall, one of the fathers of neo-classical economics, distrusted mathematics for this very reason. To be expressed in mathematical form, he complained, many important economic considerations had to be "clipped and pruned till they resembled the conventional birds and animals of decorative art." Economic theory gives only the roughest guide to this pruning. It points out, for example, that supply rises when prices increase. But does it rise in a straight line or curve upwards? Perhaps, as prices rise, supply traces out an inverted U-shape or an S-shape?

Such choices of form matter more than most modellers recognise, argues Ross McKitrick, of the University of Guelph in Canada. In a 1998 paper, he ran two simulations of the Canadian economy's response to a tax rise. The two projections shared the same Walrasian philosophy, used identical data and examined the same 10% tax on the purchase of services; they differed only in the way they clipped and pruned households and companies, giving different mathematical expression to the laws of demand and supply. But these subtleties of expression had profound effects. In the first of his simulations, the tax rise allowed government spending to increase by more than 60%; in the second, spending could rise by just 14%. The first simulation makes the tax sorely tempting to any big-spending Canadian politician; the second much less so. But the policymakers who swallow these simulations have little way of knowing what is driving the results: is it deep theory, solid data, or arbitrary pruning? Sometimes the model-maker himself does not know.

The lost art of plumbing

Phillips's pump-action model was, he wrote, meant for "exposition rather than accurate calculation." But all models should ultimately be seen as pedagogical devices, their calculations a means to the end of helping policymakers think through their decisions. Unfortunately, Phillips's model was rather better at this than many of its more sophisticated successors. It was transparent: you could see through its casing, trace the flow of expenditures through its pipes and watch wealth accumulating in its tanks. Get things wrong and prosperity drained away in front of your eyes. The model was also easy to tinker with: valves could be loosened, sluices opened and taps tightened. It was clear what was governing its results.

Shantayanan Devarajan, of the World Bank, and Sherman Robinson, of the International Food Policy Research Institute, point out that policymakers need not grasp exactly how a model works, any more than "a pilot needs to understand the insides of a flight simulator." This may be true. But too many policymakers never even "fly" their models. They just want to know where they will land. If they were instead prepared to work through the simulations they might find inconsistencies in their thought, unforeseen implications of their policies, or new reasons for their actions. The big number that sums up a model's story—$520 billion, 1.5% of world GDP, $4.4 trillion—is often the least interesting thing about it.