DOI: 10.24425/academiaPAS.2023.147634

On Modelling

and Dedication

CEZARY PIWOWARSKI

We discuss econometric modeling with **Prof. Aleksander Welfe** from the University of Łódź and Warsaw School of Economics (SGH), Vice-President of the Polish Academy of Sciences.

What is an econometric model?

First, let's consider what a *model* is. It's a fundamental concept used not only in economics or econometrics, but also in most disciplines that are not exclusively theoretical. Broadly speaking, a model is a prototype of some system, showing how it works. Some models are physical, existing in material form, like a scale model of an airplane tested in a wind tunnel. This example also illustrates why models are created – in order to observe, in a simplified way, how a given system works. The main feature of models is *simplification*. In order to explain how a system works, they have to focus only on certain features of that system, ignoring the rest.

So, the purpose of creating a model is to explain certain observations, not to forecast what will happen?

Nicolaus Copernicus, a colossus in the history of science, constructed his model of the Solar System not to forecast but to explain how it functioned and to answer specific questions. Why do we have night and day? Why are there seasons? Why is it colder in the north than in the south? Why are there lunar and solar eclipses? None of the pre-Copernican concepts could explain all these phenomena simultaneously. Only Copernicus' model provided answers, although it was of course a simplification of the real system. It was years later that his descriptions of the paths of the planets were found to be not entirely accurate.

Models of social or economic systems are often criticized on the grounds that they describe systems that are in constant change. However, many scientific

disciplines have to build models for changing systems. Naturally, one useful way models can be applied is in forecasting, predicting how a system will behave in the future. If a model deals with a changing system, such a forecast will be prone to a certain error, but every effort is made to make it as accurate as possible. And this is by no means impossible.

Such a forecast, for instance, is a mandatory part of every business plan presented to a bank when applying for a loan: it has to make some assumptions about the rate of inflation, the projected demand for products the company wants to sell, etc. It is best for such forecasts to be based on formal models. The models used in economics are not physical models, but systems of mathematical equations with specific parameters, which are estimated based on a sample.

Now that we are clear on what a model is, can you explain how an econometric model differs from an economic one?

A simple economic model can be expressed in words. But nowadays models generally take the form of systems of mathematical equations. We can then examine the stability of such a system, whether it tends to return to some kind of equilibrium path or not, whether it is dynamically stable. This is the kind of thing that mathematical economists study. All equations have certain parameters. In economic theory, we can define ranges for their values. For example, the *marginal propensity to consume* (MPC), a parameter that reflects how much of every unit of increased income will be spent on consumption, is defined as falling in the range 0–1. But that range contains infinitely many real numbers. And the difference between a MPC value of 0.93 and 0.96, for instance, can be fundamental. The way the entire economy will react to higher household incomes may be completely different in these two cases, e.g. either triggering a Keynesian multiplier or not. We don't know what the actual MPC value is for a given economy; that value has to be estimated. In econometric models, parameters like these are the subject of estimation, based on a sample of data. Such a sample is simply a snapshot of how this system has behaved in the past.

Prof. Aleksander Welfe

is an econometrician and macroeconomist, Full Member and Vice-President of the Polish Academy of Sciences for the 2023–2026 term, Professor of Economics at the University of Łódź and the Warsaw School of Economics, former advisor to the President of the National Bank of Poland. He specializes in time-series analysis and macro-modeling.
aleksander.welfe@pan.pl

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ALEKSANDER WELFE

Can an analogy be drawn between the relationship of econometrics to economics and, for instance, the relationship between theoretical and empirical physics?

Such analogies could be drawn to any scientific discipline that has a related applied field. Econometrics arose from the combination of mathematics (or more precisely: mathematical statistics) and economics. The name *econometrics* is a combination of two words: *economics* and *measurement*. The term was first used in 1910 by the Polish mathematician Paweł Ciompa in his work, *Zarys ekonometryi i teorya buchalterii* [An outline of econometrics and the theory of bookkeeping], published in Lwów in 1910, but it is Ragnar Frisch and Jan Tinbergen (winners of the first Nobel Prize in Economics in 1969) who are considered the fathers of econometrics, developing the field in the 1930s. From the historical perspective, compared to mathematics, medicine, or even physics and chemistry, econometrics is a very young discipline, barely a century old.

How can we define econometrics as a science?

Econometrics has two main pillars: methods and applications. The methods are an extension of mathematical statistics. Applied econometrics is an empirical science that verifies (economic) hypotheses based on statistical data. Empirical models are created, which can be tested, used in forecasting, and more broadly – in decision-making processes. Data can be in the form of time series, cross-sectional, or longitudinal (panel) data.

Does econometrics ensure the authenticity of economic data?

That's not something econometrics deals with, because econometricians do not collect data. We most often make use of existing databases. These databases are created by the statistical offices operating in various countries, by various organizations, including international ones, or collected for completely different purposes (e.g. by surveyors), and then used in econometrics. Some of this data is made public, some is kept confidential. Some researchers apply for access to certain not fully disclosed data and usually obtain it. This data can be macroeconomic, concerning the whole economy, or microeconomic, concerning individual entities. An example of the latter could be information collected by tax bureaus. It should be emphasized, of course, that such data gets anonymized before being passed on for research purposes.

Can econometric models help us to predict what will happen, for example, in Poland in the next 5–10 years?

Of course, but I haven't prepared such a forecast for this interview. And to do that responsibly, I would have to set up a whole econometric model. But such forecasts do indeed get prepared. In my opinion, this is an area of research that should be more strongly developed. I believe that in Poland, most central and government offices (such as the National Bank of Poland, the Ministry of Finance, the Ministry of the Economy, the Ministry of Family, Labor and Social Policy) should base their analyses not only on econometric models but also on other formalized constructs. Armed with results obtained using such tools, expert teams would make completely different decisions. Worldwide practice in this regard demonstrates that a wide range of models, depending on their type and data sources, are used for forecasting, with time horizons spanning from mere minutes up to 10–15 years or even longer. For example, decisions about buying or selling financial instruments are often guided by models that rely on intradaily data, whereas decisions regarding the construction of a car factory must take into account demand projections spanning the next 10 years or even longer.

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Do technological advancements, including the evolution of artificial intelligence, contribute to the development of these econometric models or the methodologies used to construct them?

Some of the earliest empirical econometric models, developed by the Dutch economist Jan Tinbergen, were commissioned by the League of Nations prior to World War II. These models required the collaborative efforts of entire teams of accountants. People would sit in rooms and perform a series of calculations using mechanical calculators, which were then compiled to obtain the final result. In my own experience, I began working with mainframe computers that were as large as wardrobes – the disk stack alone was the size of a washing machine. Nowadays, if I want to I tackle a probabilistic problem, I can run a program on a personal computer that generates 10 million samples from a specific distribution, ensuring reliable statistical inference. If I let the PC run for two nights, I'll have the calculations completed. This represents a tremendous advancement. As for tools like ChatGPT, I expect they will streamline certain processes, but they will not replace the conceptual work.

Does the position of Vice-President of the Academy give you a different point of view on the science-funding situation in Poland?

I've certainly been receiving a lot more information lately about the funding situation of the Polish Academy of Sciences, and that has significantly altered my perspective. In my view, the funding allocated to the PAS institutes is undeniably inadequate, and these institutes serve as the core hubs for scientific advancement within the Polish context. Without a substantial increase in resources for these institutions, they are at risk of collapse. There will be a shortage of young and talented staff members. It's crucial to attract the best young minds to join research teams. Consider a young individual who completes their undergraduate studies at the age of 24–25, pursues a doctoral degree over the next few years, and shows promise as a scientist, but during this time they also start a family, which comes with various financial responsibilities. If such an individual finds it challenging to make ends meet while working at a Polish Academy of Sciences institute, they will probably seek employment elsewhere, more likely in the private sector rather than at a state university. Therefore, unless there is a radical shift in the funding of PAS institutes, the outlook appears quite challenging. This situation extends to the entire realm of science in Poland.

Can the new Act on the Polish Academy of Sciences improve the financial situation of the institutes?

If the proposed draft that has been submitted by the PAS-affiliated community gains the favor of the new parliamentary deputies, senators, and ultimately the President, then perhaps new opportunities for obtaining financial resources will open up. The separate PAS institutes have legal personality and can win grants, whereas although the Academy itself (the central body) is a state institution and has legal personality, it does not have the capacity to obtain grants or conduct business activities. If something like our proposed law is implemented after the entire legislative process, there is a chance that the situation will improve.

Could you see yourself working in a different profession?

I've always been drawn to scientific work, so if I weren't an econometrician, I imagine I would be involved in some other field. This kind of work has always been a great fit for me. While it leads to a more modest lifestyle compared to those in the business world, it offers something unique and invaluable – a genuine sense of freedom throughout one's professional journey. This freedom arises from the ability to explore topics of your own invention. There's no external force or troublesome boss capable of halting you effectively. If you have a promising idea and a grant, you have the funding to secure access to the necessary equipment and data. In many disciplines, including mine, the primary tool is computers. I have the flexibility to focus on any particular research problem I formulate. Show me another profession anywhere in the world that offers this level of freedom, where I can pursue my interests and still get paid for doing it!

It's somewhat akin to the work of an artist.

This is the bright side of this profession. However, there's also a downside to it, which involves the fact that you're never really "off the clock," and there's always something vying for your attention. Real vacations are hard to come by, because your mind is constantly preoccupied with thoughts about your research work or what else you could be doing. There's a perpetual need to validate yourself as a scientist, which means consistently publishing, submitting, and facing the disappointment that can come with article rejections. Despite having a substantial body of work and a reputable position, one must continually face the discomfort of potential rejection and disqualification. However, there are many other professions where a similar process occurs. Accomplished actors, even those with Oscars to their name, still attend auditions, and after each one, they either receive a callback or they don't. So, while the situation of scientists is not entirely unique, it can be quite frustrating. These are the challenges of this profession, but they don't overshadow the positives.

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Would it be accurate to say that scientific work is something more than a profession for you?

I'd describe it as more of a passion than merely a profession. Perhaps the term "dedication" fits well in this context. However, deep dedication to one's professional activities isn't limited to science alone. For instance, one can be an incredibly dedicated teacher. Personally, I find teaching work extremely fulfilling. Each year, when I step into the classroom for the first lecture with new students, I feel a slight sense of stressful excitement. I want the lecture to be exceptional because these are new individuals who want to get to know me, and vice versa. Our whole collaboration hinges on this initial impression. Despite having 40 years of experience, I prepare myself for each and every lecture, and on the day before, I always take at least a moment to envision what I'll discuss the next day. It might sound commonplace, but being deeply dedicated to one's professional work applies not only to scientists or artists, but to any profession. Every occupation has the potential to become someone's passion.

Interview by
Jolanta Iwańczuk, Daniel J. Sax