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Empirical determination of aggregate demand and supply curves: The example of the RWI Business Cycle Model ☆

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ABSTRACT

Macroeconometric models are often criticised for being too complex and difficult to read in theoretical terms. To overcome these difficulties, Hickman suggested the calculation of a model's implicit aggregate demand/supply (AD/AS) structure. The method helps to understand models and their main properties in theoretical terms and facilitates detailed model comparisons. This paper uses the AD/AS–IS/LM apparatus to analyse the simulation properties of the RWI (*Rheinisch-Westfälisches Institut für Wirtschaftsforschung*) Business Cycle Model, a medium-sized short-term macroeconometric model for Germany. The results confirm theoretical expectations for AD and AS elasticities and reveal particular reactions linked to peculiar model specifications such as an endogenous government sector. The results are also much in line with a previous study in a multi-country model context.

1. Introduction

Over the last 40 years, macroeconometric models have made an impact as major instruments of economic analysis and, most important, of policy analysis, as the management of the world recession 2008/09 has demonstrated. The acceptance of model results, however, suffers from the fact that modern models often have to be large and detailed to meet the needs of model builders as well as users. To outsiders these models appear as overly complex—as "black boxes." In response to this concern, a number of methods have been used to improve model understanding such as flow charts of the main model relationships, logical analysis of model structure, and above all, multiplier analysis. As helpful as all of these methods are, some users still miss a link to standard macroeconomic theory and terms as expressed by aggregate demand and supply functions.

Some 25 years ago, Bert Hickman took up this criticism and suggested estimating the aggregate demand (AD) and supply curves (AS) implied by the models (Hickman 1987). The curves would not only shed light on a model's structure and simulation properties but also facilitate its evaluation in well-known terms. The majority of macroeconometric models can be reduced to an implicit IS/LM–AD/AS core model, whose theoretical implications represent a reference system against which the central features of a model can be analysed. Generally, these implicit curves can be determined in two ways: First, directly by deducing their reduced forms from the corresponding model equations, in essence, their analytic representations (Visco 1991). Given the scope and the non-linearity of most macroeconometric models, this is a rather difficult approach. A simpler alternative is the simulation method, which in an indirect way provides quantitative and qualitative information regarding model elasticities. The results can be readily compared with those of other models. Despite these advantages and the fact that the approach can be employed for a wide range of quantitative models, this approach has rarely been employed.[1]

This paper uses Hickman's approach to reveal the implicit AD and AS functions of a quarterly macroeconometric model for Germany that is regularly used for short-term forecasting and policy analysis. The prime focus of the paper is to extract the model's AD and AS functions and to examine whether they meet theoretical expectations. In addition, with a set of diagnostic simulations, we explore the potential of the method to improve model understanding by identifying the role of important features of the model. In the context of

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[1] See the references in Hickman (2004) and Whitley (1992).

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structural econometric models, the results allow a rather simple appraisal of a model's major short-term reactions in theoretical terms and reveal structural characteristics determining them. The results also offer a simple method of model comparisons, although to the best of our knowledge no similar study of a German model in a single country context exists.

The remainder of this paper is organised as follows. In the following section, we will give a short review of the relevant literature. Section 3 presents the Hickman approach. Section 4 describes the model to be used, the RWI Business Cycle Model, the questions to be examined and the simulations to be made. Section 5 has the results, that is the elasticities of the model curves and the simulation results that support their evaluation. The estimated AD and AS curves are compared with the results of similar models for the U.S. and for Europe. Section 6 contains a brief summary and conclusions and we make some suggestions for future research.

2. Review of the literature

The growing complexity of macroeconometric models has been a steady trend since the pioneering work of Tinbergen and Klein (Uebe 1997). The reasons for this complexity are quite simple: model builders and consumers of model results seem to have an insatiable appetite to learn about the effects of more and more assumptions and policy levers in more and more sectors and spheres. Better theory, methods, data and computers allow model builders to respond to these demands (Wallis 1998). The size and sophistication of models, their complexity, were steadily growing and the reproach of models as "black boxes" was mounting. In reaction to this concern as well as the above mentioned development, since the 1980s, a new generation of small models has emerged.[2]

However, from the beginning, model builders made some efforts to make their models comprehensible, first, by using graphical representations, usually flow charts. But with models of 1000+ equations considerable condensation was still necessary. Furthermore, flow charts usually say nothing about the nature of the model relationships (definitions, stochastic equations), their strengths or their potential role for growth, employment, and inflation. Second, techniques like incidence matrices, causal ordering, or logical analysis (Simon 1953, Gilli 1984) give a complete overview of the model structure, its interactions, and even the hierarchy of its equations from a model solution perspective. However, these techniques still offer no quantitative information about the strengths and role of relationships. Third, quantitative information is available only through techniques such as multiplier analyses (Wallis 1988), structural sensitivity analyses (Kuh et al., 1985) or stochastic simulations, which became the preferred ways to present the "behavioural" characteristics of models.[3]

The following method overcomes some of the shortcomings mentioned. While the method is still a reductionist concept similar to the multiplier or the NAIRU, it states a model's behaviour in terms like AD and AS, terms more common outside the model community. It is true that the IS–LM model – of which the AD–AS model is an extension (Klein 2001, Rao 2007) – came under attack with the advent of neoclassical macroeconomics in the early 1970s. But despite the criticism of macroeconomic theorists, it still serves pedagogical purposes and "finds wide application in areas of applied macroeconomics away from the lines of macroeconomic theory, and lies at the conceptual core of most government and commercial macroeconometric models" (De Vroey and Hoover 2004, p. 1; similar: Lucas 2004, Colander 2004).

In his 1987 paper, Hickman suggested to use the simulation results of various policy scenarios to estimate the elasticities of the implicit IS, LM, AD and AS curves of 14 macroeconometric models for the U. S.[4] These model curves were used to assess both the quantitative as well as the qualitative properties of the models, specifically as they relate to the framework of macroeconomic theory. For a comparative analysis of the effects of unilateral policy shocks in 12 multi-country models, Hickman (1988) broadened the methodology so that it could be used for open-economy models. A further extension of this approach was made by Green et al. (1991) who estimated the IS, LM, AD and AS curves of three models for both the short-term and the long-term by full-model simulations as well as by diagnostic simulation techniques, that is by isolating the effects of various model parts. As a result of the extended simulation period, the AD elasticities increased and the AS elasticities decreased. It was also found that price changes play a central role in the shifts of the long-term model curves.[5]

Whitley (1992) used Hickman's (1988) framework to decompose the price–output relationships on the aggregate supply sides of five European multi-country models. The primary focus of Whitley's paper was to conduct a comparative analysis of the main European economies' (France, Germany, Italy, UK) reactions on several policy shocks and to determine why reactions differed. He found that the wage response is the dominant influence on the AS curve and that the Hickman decomposition helps to "highlight particular differences between the models which appear to be related to differences in their structure" (Whitley 1992, p. 435).

3. Estimating AD/AS curves of a macroeconometric model

Macroeconomic effects of exogenous disturbances are usually discussed within an IS/LM–AD/AS framework.[6] The characteristic elements of these structures can also be found in the majority of macroeconometric models. On the demand side, they are found in the form of its disaggregated explanation and in a more or less aggregated explanation of monetary quantities and interest rates. On the supply side, they are found as a modified Phillips approach determining wages and as a mark-up approach explaining prices. As a consequence, a model's reactions on standard economic policy impulses may be used to compute its implicit AD, AS, IS and LM curves. In this paper, we restrict the analysis to three particular policy impulses and their consequences.

3.1. Demand-side impulses

Fig. 1 illustrates the stylised reactions of a fiscal policy impulse in an IS/LM–AD/AS model core. Assuming log-linear relations, the slopes of the curves express their elasticities. Following an expansionary impulse (for example, increasing government spending), the IS and AD curves are shifted toward the right. If the LM curve remains unaffected, its slope can be calculated from a comparison of the old (A) and new (B) equilibrium values for real income and the nominal interest rate.

The price level increases along the AS curve, so that the LM curve shifts upwards (LM1), as the real money stock falls. Increasing prices also influence IS1, though the effects are uncertain. Employment may not immediately increase to the same extent as output (labour dishoarding), thus labour productivity increases, and unit labour costs decrease. This restricts the pressure on prices, at least in the short-

[2] It may be added that as a kind of reduced model, their interactions are not necessarily easy to understand and for policy analysis, they have to make a host of simplifying assumptions.

[3] The literature on formal and informal methods to present, compare and evaluate macroeconometric models is huge as a number of conference volumes demonstrates: Chow and Corsi (1982), Malgrange and Muet (1984), Hall et al. (2004), and, as an example for Germany, Heilemann and Wolters (1998).

[4] Klein et al. (1985) use a similar approach but emphasise the pedagogical merits of extracting a macroeconometric model's IS–LM nucleus. The differences between their approach and the present approach are that (i) they do not develop an explicit theoretical framework for their analysis and that (ii) they do not restrict their analysis to policy simulations.

[5] A summary of the literature in this paragraph, the methods used, and some updated results for the Hickman/Coen Annual Growth Model can be found in Hickman (2004).

[6] The following discussion abstracts from expectations and foreign trade relationships. For more discussion on this issue, see e.g., Hickman (1988).