



Magic hypercube and index of welfare and sustainability[☆]

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Abstract

This paper systematically surveys the use of different approaches for the magic square (MS) as an indicator of welfare, a formal system of necessary relations to deal with conflicts of socioeconomic objectives. The starting point is the article of Kaldor (1971) followed by contributions by the OECD from the 1970's resulting in a diagram which allowed a visual diagnosis of macroeconomic performance. Such representations were re-examined by Medrano-B and Teixeira (2013), who introduced a required normalization of the variables. Here, we show that this approach was marred by an oversight, namely the issue of the ordering of variables along the axes. In order to avoid this problem, we propose the use of a new mathematical approach involving a Hypercube Graph, which we call magic hypercube, which produces the same index, regardless the ordering of the variables. An application of the new concept is offered using economic data from Brazil and Chile.

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Resumo

Este artigo pesquisa de maneira sistemática a utilização de diferentes abordagens para o Quadrado Mágico, um indicador de bem-estar que cria um sistema formal de relações necessárias para lidar com conflitos de objetivos socioeconômicos. O ponto de partida é o artigo de Kaldor (1971), seguido das contribuições da OCDE a partir da década de 1970, resultando num diagrama que permitiu um diagnóstico visual do desempenho macroeconômico. Tais representações foram reexaminadas por Medrano-B e Teixeira (2013), que introduziram uma normalização necessária das variáveis. Mostramos que essa abordagem foi prejudicada por um descuido, ou seja, a questão da ordenação de variáveis ao longo dos eixos. Para contornar este problema, propomos o uso de uma nova abordagem matemática envolvendo um Gráfico de Hiper cubo, que denominamos Hiper cubo Mágico, que produz o mesmo índice, independentemente da ordenação das variáveis. Uma aplicação do novo conceito é dada usando dados econômicos do Brasil e do Chile.

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Palavras-chave: Quadrado mágico; índice; hiper cubo

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1. Introduction

By the mid-1960s, Kaldor became increasingly interested in domestic and international economic policy, partly as a result of being a Special Adviser of the British Chancellor of Exchequer from 1964, and also as a resident of Great Britain, a country with the slowest postwar growth rate among major industrialized countries in Europe. He focused in particular on the search for empirical regularities related to inter-country and inter-regional growth rate comparisons. In this vein, he produced a number of articles (see, for example, [Kaldor, 1970, 1971, 1976](#)) primarily concerned with fundamental policy issues linked to socioeconomic management such as finance, monetary and fiscal requirements for sustainable growth, distribution and stability.

One of his most stimulating, albeit not too well known, essays on macroeconomic policy is “Conflicts in National Economic Objectives”, originally delivered as Presidential Address to Section F of the British Association for the Advancement of Science (Durham, Scotland, September 1970) and printed by the *Economic Journal* in 1971. There, he deals with a comprehensive analysis of the performance of the British economy after the World War II. The main purpose of his article was to present a logical and empirical reconsideration of a basic macroeconomic framework of necessary relations to achieve some desirable targets, or economic policy objectives. It is our view that Kaldor’s essay goes well beyond the scope of his country. Actually, he produced an explicit and successful attempt to extend the General Theory of [Keynes \(1936\)](#) to an open economy in which the government’s economic policy constitutes a fairly unambiguous component of the power dynamics (decision making) within a mixed economy.

Following, to some extent, the policy announcements of successive governments in Britain, Kaldor’s seminal paper considers four macroeconomic variables (GDP growth, employment, trade balance and inflation), all of them expressed as percentages. His formulation of the economic policy did not contain equations, tables or graphical illustrations. He assumed that a successful management of an open economy comprises at least the simultaneous attainment of explicit targets for the mentioned variables. The reader may wonder why these four variables are the relevant ones to be considered. Why are variables that measure fiscal policy or institutional performance, for example, not included? It is true that the two latter variables might be correlated with some of those that comprise the scope of his approach. Kaldor does not pay much attention to this problem following instead, with minor changes, the announcements of successive post-World War II Chancellors.

As mentioned, Kaldor’s pioneering analysis did not benefit from quantitative nor graphical instruments. This absence was remedied by the introduction of the so-called “Magic Square” (MS), a graphical representation of Kaldor’s approach. According to [Dickhaus \(2004, p. 354\)](#) and others, the credit for this corresponds to Karl Schiller, a German politician and leader of the Social Democratic Party (from 1966 to 1972) who was also Economics Minister of the Federal Republic of Germany. Since the 1970s, economists at OECD began using this instrument, with minor modifications, to deal with the performance of a single country or the comparative performance among a set of nations or regions.

[Fig. 1](#) presents a diagram of the MS as it was conventionally used in the 1980s ([Bernard et al., 1988](#)). The annual variables considered in this Cartesian plane were: rate of GDP growth (%), trade balance (as percentage of GDP), rate of unemployment (%), and rate of inflation (%). Notice that, as measured from the origin, growth rate is supposed to take values from 0 to 10, trade balance values from -2 to 4, inflation from 10 to 0, and unemployment from 12 to 0 (the latter two variables on an inverted scale, given that higher values are less desirable than lower values). Alas, in such simple representation the authors did not bother with the different scales of the variables and they simply joined the four variables according to the axes. The ranges assigned to the macroeconomic variables are somewhat arbitrary but, for a magic square to be built, clearly some ranges had to be chosen. In addition, the correlation existing between some variables is recognized (e.g. Okun’s Law – unemployment versus real GDP; Phillips Curve – inflation versus unemployment).

[Medrano-B and Teixeira \(2013\)](#) realized that such formulation contained a basic mistake since the original area of such figure has no useful meaning due to the non-uniform scales of the axes. To construct an adequate MS all four scales must be redefined to be uniform by normalizing the figure to a unit area. They also pointed out that the performance of any country, given by an area inside the unit square, is drawn not as a square but a diamond shape figure. Such geometric construction allows to quantify the inside figure as a proportion of the unitary MS. As a result, this work introduced a formal indicator, called Index of Economic Welfare. As an application the authors compared

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