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Aid and Income: Another Time-series Perspective

MATTHIJS LOF
Aalto University, Finland

TSEDAY JEMANEH MEKASHA
Aalto University, Helsinki, Finland

and

FINN TARP [*]
University of Copenhagen, Helsinki, Finland

Summary. — This study provides a replication of the empirical results reported by Nowak-Lehmann, Dreher, Herzer, Klasen, and Martínez-Zarzoso (2012) (henceforth NDHKM). We uncover that NDHKM relied on a regression model which included a log transformation of variables that are not strictly positive. This led to nonrandom omission of a large proportion of observations. Furthermore, we show that NDHKM's use of co-integrated regressions is not a suitable empirical strategy for estimating the causal effect of aid on income. Evidence from a Panel VAR model estimated on the dataset of NDHKM, suggests a positive and statistically significant long-run effect of aid on income.
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1. INTRODUCTION

Researchers interested in foreign aid have, for several decades, done their best to empirically estimate the impact of aid on economic growth. This has not been easy, and both methodologies and results have varied over time. The aid effectiveness literature has passed through at least four different generations with each generation having its own distinguishing analytical features (see Arndt, Jones, & Tarp, 2010; Hansen & Tarp, 2000). A positive aid-growth association has been reported as characteristic across the first three generations of aid-growth empirical work surveyed by Hansen and Tarp (2000); but the fourth generation work discussed in Arndt *et al.* (2010) has suggested that aid may be impotent in spurring growth. [1] The balance of evidence in the last 3–4 years, however, does appear to be shifting again toward noting a positive and significant impact of aid on growth at the macro level. [2]

In terms of methodological focus, the early empirical literature on aid and growth for the most part used simple cross-sectional analysis with limited attention to addressing the problem of endogeneity of aid in the growth regression. [3] However, in the 1990s, with better data available, attention shifted to panel data techniques. This made it possible to account for unobserved country-specific factors and exploit variations both across countries and over time. Subsequently, advances in instrumental variable and more advanced panel data techniques like dynamic panel Generalized Methods of Moments (GMM) shifted the methodological emphasis to yet another level, and the endogeneity problem in aid-growth empirical analysis attracted further attention.

Until very recently, the use of time-series techniques like co-integration analysis and vector autoregressive (VAR) models was quite limited in aid-growth empirical research. Yet, studies are now starting to emerge. One recent contribution is Juselius, Framroze-Møller, and Tarp (2013), who carry out a comprehensive study of the long-run effect of aid on a set of key macroeconomic variables including economic growth for a group of 36 sub-Saharan African (SSA) countries. Their findings provide clear support for a positive long-run impact of aid on the macroeconomy of recipient countries. Another recent time-series contribution is the paper by Nowak-Lehmann, Dreher, Herzer, Klasen, and Martínez-Zarzoso (2012), henceforth NDHKM, who conclude that aid has an "insignificant or minute negative impact on per capita income" of recipient countries.

Overall, as noted in Juselius *et al.* (2013), the divergent evidence on aid effectiveness is perplexing in light of the fact that the data on aid and other macro variables used in most papers come from the same publicly available databases. In explaining this, Juselius *et al.* (2013) argue that the choices researchers make regarding data transformations, econometric models, estimation methods, and assumptions related to endogeneity or exogeneity are the main underlying reasons behind the observed discrepancies.

The primary objective of the present study is to illustrate the above points with reference to the aid-growth literature.

Particularly, we show how misguided data transformations and inappropriate use of time-series techniques can easily lead to misrepresenting key elements about how aid is allocated and to incorrect conclusions about aid effectiveness. We illustrate these points focusing on the recent contribution by NDHKM. Although we welcome their effort as a step toward increasing the application of time-series techniques in empirical aid effectiveness research, the NDHKM paper suffers from serious limitations as demonstrated in detail below. We present alternative empirical evidence on the effects of aid on income, by applying VAR models instead of the single-equation model considered by NDHKM, while using the same dataset. We argue that this methodology accurately addresses the endogeneity problem at hand in the aid-growth relationship, and is a better time-series approach to estimating the dynamic long-term effects of aid on income.

To achieve the objectives of this study, we begin by replicating the regression results reported by NDHKM. For this exercise, we make use of the replication files provided by NDHKM in the data archive of the *Canadian Journal of Economics*. The regressions are for the most part based on a panel of 50 countries, which is claimed to be "virtually balanced" with only 3% of the observations missing (NDHKM, p. 298). Our replication reveals that this is not the case. In most of the regressions only 30–40% of the available observations are actually used for estimation. The main reason for this omission is that NDHKM estimate a regression model that includes logarithmic transformations of variables that are not strictly positive.

Although the unbalancedness of the panel affects the asymptotic and finite-sample properties of the employed estimators, [4] this is not our main point. We acknowledge that imperfect datasets are part of the reality in which empirical economists live. Macroeconomic panels are often unbalanced due to the fact that the starting period from which economic variables are available typically varies across countries. Researchers thus face a choice between optimizing the amount of observations, which then constitute an unbalanced panel, or to balance the panel, by cutting early observations from countries with long time-series data.

The problem we address here goes much deeper and has serious implications for the results and conclusions reached. To begin, the observations in NDHKM are not simply *missing*; they are actually *omitted* by the authors. NDHKM compile an impressive dataset including relatively long time-series on aid, income, and other macroeconomic variables for a large group of countries. However, by trying to take logarithms of variables with negative values, a substantial fraction of this dataset is simply disregarded. While typically an unbalanced panel consists of time-series of different length, in this case the logarithmic transformation creates huge gaps within the time-series. This makes analyzing the dynamic properties of the data very difficult, if not impossible. The regression model, which is a log-linearization of a multiplicative Solow-type growth model, cannot be correctly specified since not all the variables in the model are strictly positive.

Apart from these issues with data and model specification, the estimation results in NDHKM should not be interpreted as a causal effect of aid on income. Although the applied methodology enables the analyst to consistently estimate the co-integrating coefficient, even when the regressor (aid) is endogenous, interpreting this estimate as a causal relationship between aid and income requires strict exogeneity of aid. [5] In view of this, the negative and significant coefficient reported by NDHKM cannot have causal interpretation regarding the impact of aid on growth. Besides, although tempting, interpreting the statistically insignificant co-integrating coefficient

as lack of a causal relationship between aid and growth is inappropriate. The insignificant coefficient can at best suggest absence of evidence in the current sample, rather than evidence of absence (see Temple, 2010, chap. 67). In spite of this, NDHKM interpret their statistically insignificant estimate of the co-integrating coefficient as evidence of lack of a causal relationship between aid and income. A serious attempt to isolate potential causal (negative or positive) effects of aid on income is missing. Thus, without a clear identification strategy, finding a negative and significant/insignificant parameter for aid does not necessarily reveal anything about the impact of aid on growth.

Arguably, a system approach such as the VAR model applied in this study provides illuminating insights when estimating the intertemporal effects of aid on income, as will be discussed further in Section 3. Since the seminal work by Sims (1980), VAR models have become the benchmark in empirical macroeconomics. In contrast, in the aid literature VAR models have not yet gained the same popularity, although there have been some recent applications of VAR models, such as Osei, Morrissey, and Lloyd (2005), Hansen and Headey (2010), Gillanders (2011), Juselius *et al.* (2013) and Kang, Prati, and Rebucci (2012). In the present study we apply a Panel VAR model to the dataset of NDHKM to investigate the effect of aid on income. By allowing explicitly for an effect of aid on income as well as an effect of income on aid, we find that the former effect is both positive and significant.

The study is structured as follows. In Section 2, after presenting the replication results, we discuss the data-handling concerns uncovered by the replication exercise. In Section 3, we review the problems with the empirical strategy of NDHKM, and introduce our own strategy. Section 4 presents the results from estimating VAR models on the NDHKM dataset. Section 5 concludes that when a Panel VAR model is applied to the same dataset as in NDHKM, a positive and statistically significant long-run effect of aid on growth emerges.

2. REPLICATION RESULTS

We begin the replication exercise by noting that we are able to exactly replicate virtually all the empirical results reported by NDHKM. Tables 1–7 show the replications of the corresponding Tables 1–7 in NDHKM. Except for the sixth column

Table 1. *Impact of Aid on Income*

Dependent variable	LY	LY	LY	LY
LPOPGPLUS	–	–	–	0.00
LSDOMY	–	0.08	0.07	0.07
LSEXTNY	–	–	0.04	0.05
LSNATY	−0.02	−0.01	−0.01	−0.02
ρ	0.97	0.97	0.98	0.99
N	57	56	50	50
T	41	41	41	41
K	2120	1693	794	755
$K/(N*T)$	0.91	0.74	0.39	0.37

Notes: Estimates of Eqn. (1). *t*-Values are identical to NDHKM and therefore not reported. N refers to the cross-sectional dimension (amount of countries), T to periods, and K to amount of observations used for estimation. Variable descriptions are as follows: LY (log of real per capita income growth), *LSDOMY* (log of domestic savings to Gross Domestic Product (GDP) ratio), *LSEXTNY* (log of net external savings to GDP ratio), and *LSNATY* (log of net aid transfer to GDP ratio).
Source: See text.