KIEL
WORKING PAPER

Is the Supermultiplier Nil? A Replication Study of Deleidi and Mazzucato (2021)

No. 2250 May 2023

Jens Boysen-Hogrefe

Kiel Institute for the World Economy
ISSN 1862–1155

KIEL **WORKING PAPER** NO. 2250 | MAY 2023

ABSTRACT

IS THE SUPERMULTIPLIER NIL? A REPLICATION STUDY OF DELEIDI AND MAZZUCATO (2021)

Jens Boysen-Hogrefe

Analyzing US macro data via a structural vector-autoregressive model, Deleidi and Mazzucato (2021) find strong positive spillover of mission-oriented government spending on private research and development activity and on overall economic dynamism ("crowding in"). However, the result hinges on specific transformation of the data. Deleidi and Mazzucato deflate all variables in their model via the GDP deflator. Applying originally price adjusted data a spillover on GDP cannot be found. Estimating the model with data starting in 1984, the results point at "crowding out" of private research and development activity.

Keywords: Replcation study; Mission oriented innovation policies; Fiscal multiplier; Sraffian supermultiplier

JEL classification: C32, E22. E62, O25, O30

Jens Boysen-Hogrefe
Kiel Institute for the World Economy
Kiellinie 66
D-24105 Kiel, Germany
Email: jens.hogrefe@ifw-kiel.de

1. Introduction

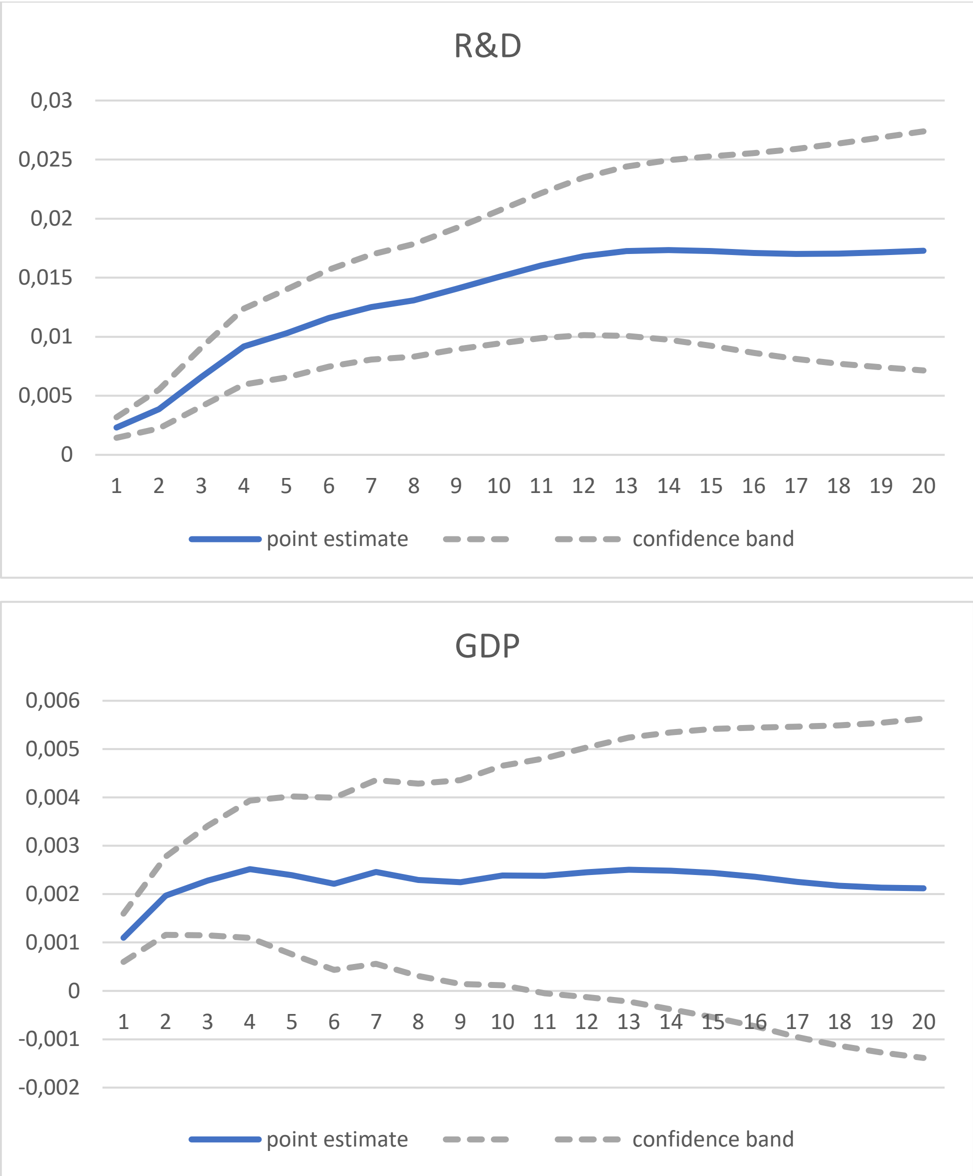
In their article Deleidi and Mazzucato (2021) seek to empirically test the proposition that mission-oriented government spending can be of great benefit to the economy as a whole using an econometric model for data from the United States. The results of the article show strong positive spillovers of mission-oriented government spending for private research and development activity and for overall economic dynamism ("crowding in"). The authors therefore refer to this as a "supermultiplier." A look at the paper, however, raises the question whether the specification of the model is suitable to test the proposition. At this point, therefore, I will replicate the work of Deleidi and Mazzucato, modifying critical specifications of the initial article. In doing so, it can be shown that the results of Deleidi and Mazzucato are not robust to these modifications. Based on data from 1984 onward, the modified model results even point to the "crowding out" of private innovation activity.

2. The empirical model

Deleidi and Mazzucato use a structural vector autoregressive model (SVAR). The model is applied to four time series. Gross Domestic Product (1: GDP), Private Expenditures on Research and Development (2: R&D), Government Expenditures on Military Research and Development (3: G_MO), and Other Government Expenditures on Consumption and Investment (4: G_R). To identify the shocks, the Cholesky decomposition is applied. It decomposes the symmetric variance-covariance matrix of the error terms into the product of a lower triangular matrix. The shape of this matrix, or the associated zero restrictions, means that a direction of the effect of the error terms is specified, thus the covariance is given a causal interpretation. In the arrangement that Deleidi and Mazzucato choose, the errors in government spending on military R&D affect all others, while they are unaffected by the other error terms. Second in the series, Deleidi and Mazzucato place the other government expenditures, then private research and development expenditures, and finally gross domestic product, whose error terms can thus be affected contemporarily by all, but contemporarily have no effect on the other terms.

Deleidi and Mazzucato use nominal data, all divided by the GDP deflator. In the true sense of the term, only the development of GDP is price-adjusted. The other variables are adjusted by a deflator other than their own. Finally, the logarithmized data enter the model as first differences.

Figure 1: Impulse response sequence of the output variant according to Deleidi and Mazzucato.



Response to a shock of the G_MO in the range of one standard deviation of the corresponding error magnitude. Confidence bands correspond to a confidence level of 68% (one standard deviation). Data sample: 1947Q1 through 2018Q4.

Source: Fred Economic Data St. Louis FED, own calculations.

3. Estimation results for the original specification

Deleidi and Mazzucato's results suggest a large increase in private R&D spending due to a boost from government R&D spending (G_MO), see Figure 1. There is also a positive effect on overall economic performance (GDP). While the statistical significance of this result is not high, the point estimate is economically very high. It is important to keep in mind that one standard deviation in government research and development spending is very small relative to economic output. In their paper, Deleidi and Mazzucato therefore report the impulse-response consequences in billions of U.S. dollars, probably based on the ratios at the current edge.

Accordingly, expenditures for government research and development would trigger a multiple of private R&D expenditures and especially of gross domestic product, which is why Deleidi and Mazzucato call it a "supermultiplier."

4. Criticisms

The assumptions that Deleidi and Mazzucato make with the Cholesky decomposition are quite strict. An extensive literature on alternative identification methods has developed over the past decades, see Kilian and Lütkepohl (2017). There is no discussion of the identification strategy. A particularly critical point here is that contemporarily correlated influences on both government and private R&D spending are all attributed to the government. Thus, by model assumption, the state is attributed an importance that it may not have. This identification is particularly noteworthy given the preparation of the data. Instead of using price-adjusted variables, the nominal variables are each deflated by the GDP deflator. This means that price developments occurring in R&D that deviate from aggregate price developments are causally attributed to government action and, moreover, are considered "price-adjusted" or real in Deleidi and Mazzucato's approach. Since original price-adjusted data are available for all variables in Deleidi and Mazzucato's empirical model, these data are used for estimation in the following. However, the calculation of government spending on consumption and investment adjusted for research and development spending needs to be adjusted to account for the chain indices. Details can be found in Annex 1.

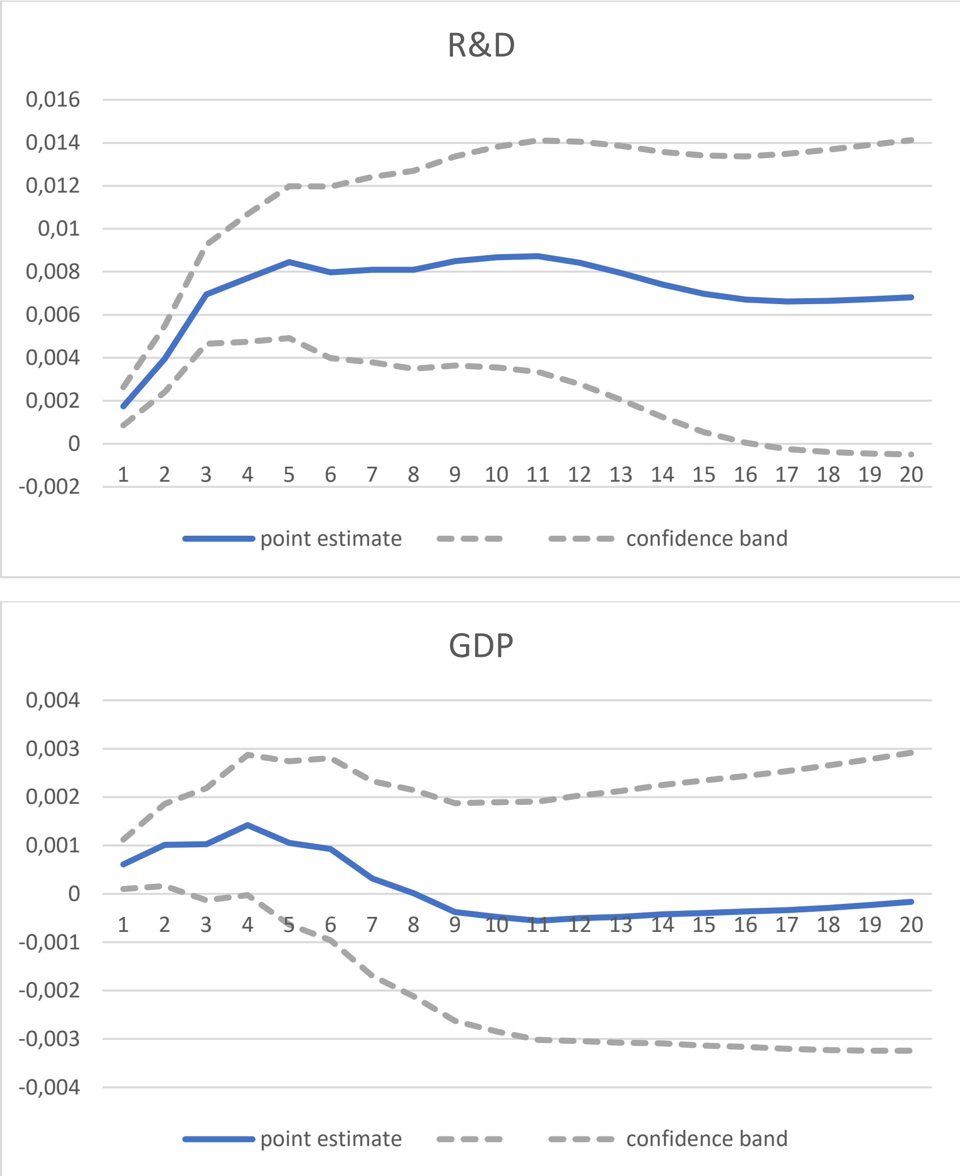
Another criticism of the modeling is the use of first differences. This implicitly assumes that there are no cointegration relationships between the data. This can be easily remedied by estimating the SVAR in the level data, which is also done below, see, e.g., Sims et al. (1990).

Finally, the estimation period covers quite heterogeneous time periods. In the 1950s, the government spent more money on military research than the private sector as a whole spent on R&D. Private spending on R&D as a share of GDP has trended upward over the years, see Annex 2. In addition, there is literature that points to a structural break in U.S. macro data in 1984. The related debate took place under the heading of "Great Moderation," see, e.g., Stock and Watson (2002). To account for the impact of any structural breaks, the model is estimated first for the entire period and second only for data starting in 1984.

5. Estimation Results for modified specifications

When the SVAR is estimated with price-adjusted level data, the response of private research and development spending is found to be significantly lower than in the original formulation of the model. For the GDP response, the point estimate is clearly lower than those in the initial results. After 9 quarters, the response drops below the zero line (Figure 2). The difference from the baseline results is likely to be driven primarily by the fact that specific price developments for R&D spending no longer appear as an impulse. The exclusion of specific price developments therefore seems plausible because the theoretical basis is concerned with real innovations that provide impetus for the economy as a whole and not with the prices of these innovations. The particular form of deflating the data in Deleidi and Mazzucato may thus have produced a statistical artifact that presumably does not capture the real innovation process.

Figure 2: Impulse-response sequence for price-adjusted data



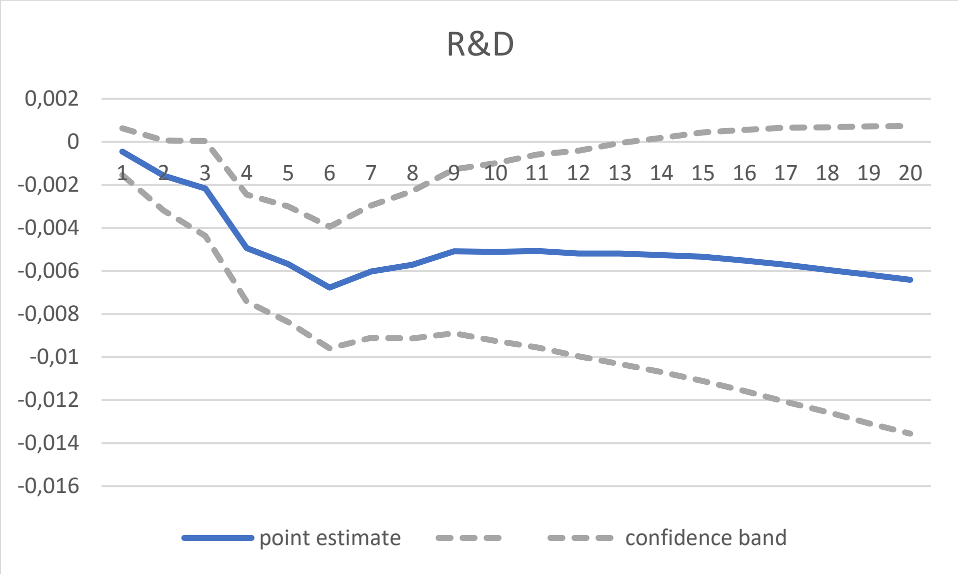
Response to a shock of the G_MO in the range of one standard deviation of the corresponding error size. Confidence bands correspond to a confidence level of 68% (one standard deviation). Data sample: 1947Q1 through 2018Q4.

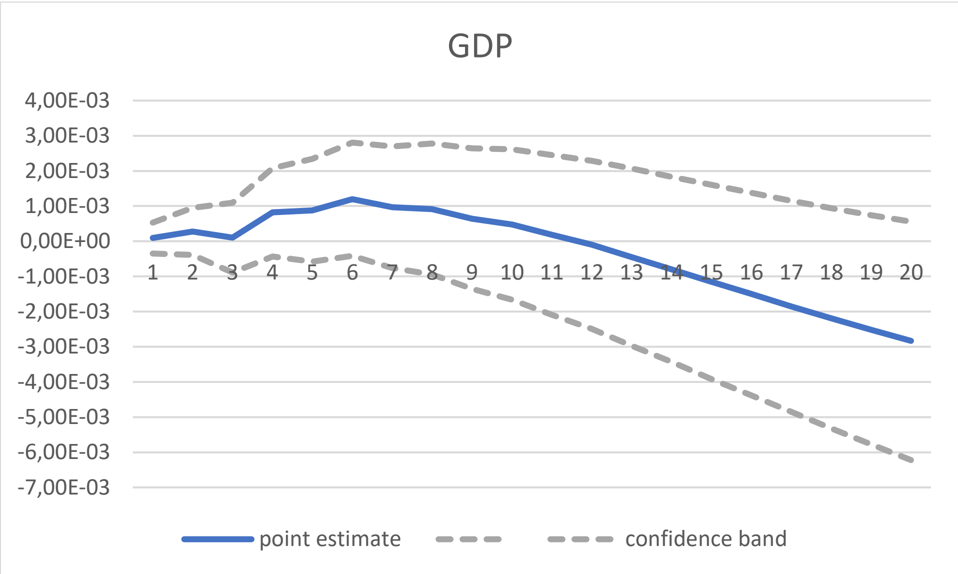
Source: Fred Economic Data St. Louis FED, own calculations.

Moreover, if the data are restricted to use only values after 1984 ("Great Moderation"), we find at least a temporary "crowding out" of private research and development spending. The response of GDP again falls below the zero line over time, which is, however, included by the confidence bands.

The "crowding out" in private R&D spending measured here compared to the results for the entire sample may reflect that the private sector now plays a much larger role. R&D capacity (e.g., in the form of graduate students) is presumably no longer being directed separately toward government tasks, as may have been the case in the 1950s. Now, when government demands for R&D, it competes with private agents.

Figure 3: Impulse-response sequence for price-adjusted data since 1984





Response to a shock of the G_MO in the range of one standard deviation of the corresponding error size. Confidence bands correspond to a confidence level of 68% (one standard deviation). Data sample: 1984Q1 through 2018Q4.

Source: Fred Economic Data St. Louis FED, own calculations.

6. Conclusion

The results of Deleidi and Mazzucato are probably driven by the nature of deflation and the inclusion of data from the early years after World War II. Insofar as actual price-adjusted variables are considered, there is no longer any evidence of a "supermultiplier" in the U.S. data. For data from 1984 onward, there is also evidence of "crowding out" of private research and development spending. This result should not be overestimated in view of the existing methodological limitations. However, it may not be claimed that evidence from the U.S. macro data for the prominent role of government investment as a driver of innovation can be found by means of an SVAR as used in Deleidi and Mazzucato.

Annex 1: Data Source and Preparation

For the baseline variant, the following variables were downloaded from the Fred Economic Data St. Louis FED database.

- GDP: Gross Domestic Product, Billions of Dollars, Quarterly, Seasonally Adjusted Annual Rate (-> GDP)
- GCE: Government Consumption Expenditures and Gross Investment, Billions of Dollars, Quarterly, Seasonally Adjusted Annual Rate (-> G_MO+G_R)
- Y006RC1Q027SBEA: Gross Private Domestic Investment: Fixed Investment: Nonresidential: Intellectual Property Products: Research and Development, Billions of Dollars, Quarterly, Seasonally Adjusted Annual Rate (-> R&D)
- Y076RC1Q027SBEA: Government Gross Investment: Federal: National Defense: Gross Investment: Intellectual Property Products: Research and Development, Billions of Dollars, Quarterly, Seasonally Adjusted Annual Rate (-> G_MO)
- GDPDEF: Gross Domestic Product: Implicit Price Deflator, Index 2012=100, Quarterly, Seasonally Adjusted

First, G_R is calculated by subtracting Y076RC1Q027SBEA from GCE. Then, all four variables are deflated using GDPDEF.

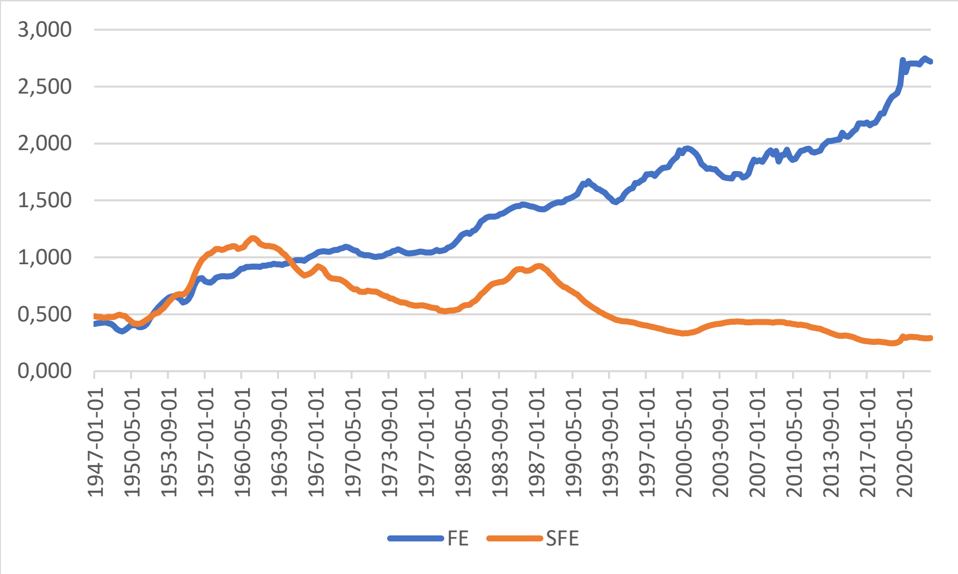
At the same time, price-adjusted chain indices are available for all variables and are used in the alternative estimates.

- GDPC1: Real Gross Domestic Product, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate (-> GDP)
- GCEC1: Real Government Consumption Expenditures and Gross Investment, Billions of Chained 2012 Dollars, Quarterly, Seasonally Adjusted Annual Rate (-> G_MO+G_R)
- Y006RA3Q086SBEA: Real Gross Private Domestic Investment: Fixed Investment: Nonresidential: Intellectual Property Products: Research and Development (chain-type quantity index), Index 2012=100, Quarterly, Seasonally Adjusted (-> R&D)
- Y076RA3Q086SBEA: Real Government Gross Investment: Federal: National Defense: Gross Investment: Intellectual Property Products: Research and Development (chain-type quantity index), Index 2012=100, Quarterly, Seasonally Adjusted (-> G_MO).

To calculate price-adjusted government spending excluding military research and development (G_R) spending, the following calculation steps are performed. The prior quarter changes in GCEC1 and G_MO are calculated. Since GCEC1 is the aggregate, this is the weighted sum of the prior quarter changes in G_R and G_MO. The weights correspond to the nominal values of the respective previous year. Since the previous quarter changes of GCEC1 are available, the equation is solved for the previous quarter changes of G_R. These are thus calculated and from them the price-adjusted index can be obtained, which is rebased to 2012.

Annex 2: Research and development expenditure relative to economic output

Figure A2.1: Share of research and development expenditure in gross domestic product in %



Source: Fred Economic Data St. Louis FED, own calculations.

Literature

Deleidi, M. und M. Mazzucato (2021). Gezielte Innovationspolitik und der Supermultiplikator: Eine empirische Bewertung von zielgerichteten Politiken in der US-Wirtschaft. Research Policy 50(2), S. 104-151.

Kilian, L. and H. Lütkepohl. Structural vector autoregressive analysis. Themes in modern econometrics. Cambridge University Press.

Sims, C.A., J.H. Stock und M.W. Watson (1990). Inference in linear time series models with some unit roots. Econometrica 58(1), S. 113-144.

Stock, J.H. und M.W. Watson (2002). Hat sich der Konjunkturzyklus verändert und warum? NBER Working Paper Series Nr. 9127.