# MACS30000 Assignment 9

**Dr. Richard Evans**
Submitted by: Junho Choi
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## Problem 1

In Brumm and Scheidegger (2017), the authors do not necessarily set out a research "question."[1] Rather, they seek to provide one potential remedy to a major problem in solving large economic (especially macroeconomic) models using programming or other computer-based applications – curse of dimensionality (B&S 2017, p. 1576; Ponder n.d.). Curse of dimensionality, at least in this context, refers to the "exponential rise in time and space required to compute... [a] solution" as there are more variables (or dimensions) added to the model (Rust 1997, p. 489). Brumm and Scheidegger's suggested method of lifting this curse is to use "adaptive sparse grids (ASGs)," which is an update to the standard sparse grid methodology. The use of ASGs is also paired with a "hybrid parallelization scheme" which enables to the computation process to be more efficient (B&S 2017, p. 1576).

The authors of the paper describe what an ASG is in detail, and how it is an improvement from the "classical sparse grids" (B&S 2017, pp. 1579–1587). They also emphasize on the fact that the use of ASGs allows one to account for potential problems such as occasionally-binding constraints and discrete choices (B&S 2017, p. 1584). In addition, they elaborate on how the ASG method could be more useful when compared with other preexisting methods (B&S 2017, pp. 1578–1579). For researchers seeking to apply not only ASG but also other useful methods in computational economics, I believe that these sections of the paper are extremely valuable as they provide an overview of a number of methods. A potential researcher may use such a resource to start understanding where and how to tackle large-scale economic models and finding solutions to them. Certainly, one may be able to argue that their literature review section should be longer to fully expose what the shortcomings of predecessor models were; however, this I believe is part of the job that potential readers have to conduct, following the guidelines that authors have given.

While their description of ASG is thorough, one may question its usefulness without further examples. In an attempt to dismiss such concerns, the authors provide two cases where ASG can be applied to and its use enhances preexisting analyses using other methods (B&S 2017, pp. 1587–1602). The very first example has to do with one of the key models in macroeconomics, the international real business cycle (IRBC) model. In addition to providing a thorough walk-through of the model setup and application process, the authors reemphasize the aforementioned advantage that the ASG method can be uti-

[1] For the sake of convenience, I will abbreviate the last names "Brumm and Scheidegger" as "B&S" when citing the said authors' works.

lized in cases with occasionally-binding constraints. They accomplish this by specifying the model to have irreversible investments (i.e. all investments have nonnegative values) and showing that with or without such constraints, ASG outperforms the classical sparse grids (B&S 2017, pp. 1593–1597).

The second example has to do with menu-cost models, which are described to be "at the center of an ongoing debate about real effects of monetary policy" (B&S 2017, p. 1598). Yet in relation to the application of ASGs, this example is actually showcasing ASG's capability to cover discrete-choice models. The authors extend a two-good model by Midrigan (2011) into a three-good one, and reveal that the use of ASG is more apt in "capturing the high kurtosis of the price distribution" (B&S 2017, pp. 1600–1602). Yet to provide a slight criticism for this example, the discussion of why a jump from a two-good setting to a three-good one is a significant achievement could have been better elaborated. To someone who is not familiar with the literature, such an improvement could be considered minor as it seems to only increase dimensionality by one. However, accouting for the cross and own price elastiticies, income elasticities, and expenditure shares, the curse of dimensionality from a two-good to three-good setting is rather a challenging one; the "curse" intensifies as one seeks to look at even more goods (Jaffe et al., 2018).

While I believe that these two examples are extensive and detailed enough to illustrate the advantages that the usage of ASG has over other types of computational methods, there can be criticism towards the selection or number of examples that were given in the paper. For instance, some may argue that the choice of menu-cost and IRBC models are too narrow in their scope for the usage of ASG in economics. However, a counter-argument to the statement may be that the real business cycle model is, in general, very popular model that is not only used and discussed in the academia but also in policy-making and international organizations such as the IMF (Plotnikov 2017). In addition, as this is a paper geared towards introducing the ASG method in economics as well as showcasing some of its advantages over its predecessors, it would be unfair (and impossible) to argue that the authors would have to cover *all* possible examples.

Aside from these analytical criticisms, the authors are clear in their style and language (as well as having no major typos). One very minor criticism may be made where the mathematical equations are written together with the text. For people who are not well acquainted with the models, certain variables and notations may need more clarification as to what they mean. However, this is not to say that any information was omitted; a careful inspection was good enough to yield relevant and necessary information to understand the paper.

Thanks to this, even a novice in computational economics such as myself was able to understand a bulk of the paper and was inspired to think of potential applications of the ASG methodology. For instance, it could be interesting to think about the global housing market dynamics using the ASG methodology. In an IMF research bulletin, researchers Ahir, Kang, and Loungani (2014) raise the question of how the housing markets may be

affected by foreign investment. As the housing market is a part of the overall economy with often-irreversible investment (i.e. once houses or buildings are built, they are likely to depreciate but unlikely to be demolished), one may be able to set up an ASG framework that is akin to the "unsmooth" IRBC model that was introduced in Brumm and Scheidegger (2017). That such housing investments could be made by foreign entities tells one that the model should or may cover multiple countries; this would inevitably require a high level of computational power, which the use of ASG might be suitable for. In addition, one may want to introduce adjustment costs in the stock of housing or building units, which also are described in Brumm and Scheidegger (2017, p. 1588).

Another potential research question that is more of a "local" (as opposed to global) problem is to understand how different household debt categories affect the national economy. National household debt level has been continuously writing in the recent years (despite the contraction around the Great Recession), which poses as a threat to future credit of the households as well as the economy in general, potentially (Federal Reserve Bank of New York 2018). I understand that at this point, it would be more efficient to use standard econometric methodologies as data points as well as dimensions of the model are small. However, should researchers acquire more information and data points about the structure of household debt in the future, it would be a worthwhile attempt to utilize the ASG framework and yield results that are applicable to economic policy.

Even without the signal that this paper was considered for (and published in) a very respectable journal (Econometrica), I am astounded by the quality of the material as well as the writing in general. To reiterate, not only does the paper exhibit a detailed description of the ASG methodology, but it also seeks to let the readers understand how it could perform to be superior to other methodologies in computational economics especially when there exists a problem of high dimensionality (or "curse of dimensionality").

## References


Ahir, Hites, Heedon Kang, and Prakash Loungani. 2014. "Seven Questions on the Global Housing Markets." *IMF Research Bulletin*.

Brumm, Johannes, and Simon Scheidegger. 2017. "Using Adaptive Sparse Grids to Solve High-Dimensional Dynamic Models." *Econometrica* 85 (5), 1575-1612.

Federal Reserve Bank of New York. 2018. "Total Household Debt Rises for 16th Straight Quarter: Auto Loan Balances Climb Again; Student Loan Delinquencies Continue to Improve." *Federal Reserve Bank of New York Press Release*, August 14.

Plotnikov, Dmitry. 2017. "What Prevents a Real Business Cycle Model from Matching the U.S. Data? Decomposing the Labor Wage." *IMF Working Paper* WP/17/201.

Ponder, Mark. n.d. "Adaptive Sparse Grids." Accessed December 13, 2018. https://mark-ponder.com/tutorials/adaptive-sparse-grids/.

Rust, John. 1997. "Using Randomization to Break the Curse of Dimensionality." *Econometrica* 65 (3), 487-516.