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OpenIGEM Work Progress Report: September 2019

Summary:

This note describes the work done by Dale Jorgenson Associates (DJA) on the Open Source IGEM Project for the period from October 2018 through September 2019. However, it should be noted that the work assignment continuing this effort was only finalized in late December 2018 and a subsequent stop-work order was in effect until the end of January 2019. Thus, the bulk of progress described below occurred from February through September of this year.

The version of OpenIGEM produced under this project is a model referred to below as IGEM NAICS36. It is about 95% complete and resides on a public repository hosted by GitHub (github.com), a widely-used and well-established site for making open-source code available. GitHub allows convenient source code management, including version control.

The major tasks in developing the model are summarized as follows. (1) Complete documentation of the IGEM NAICS36 model and data, including an algebraic appendix of equations that serves as a reference for coders. Provide documentation of the Sym language used to define the model's sets, variables, parameters and equations. (2) Implement the IGEM NAICS36 model in Sym. (3) Provide the GEMPACK code for the model produced by Sym. (4) Provide IGEM NAICS36 data and parameter input files for GEMPACK. (5) Demonstrate how a base case is established using the IGEM NAICS36 code, data and parameters in the GEMPACK software. (6) Demonstrate the construction and solution of an example policy case.

Prior to this phase of the project we established the public repositories for OpenIGEM NAICS36 and Sym. The OpenIGEM repository is https://openigem.github.io and the repository for Sym is https://pjwilcoxen.github.io/sym/. During the project phase ending 30 September 2019, we have revised and extended the repositories as discussed below.

Revisions to Sym:

- Revised Sym to provide improved error messages for various errors in input sym files.
- Extended Sym to support GEMPACK's homotopy feature, which will provide a convenient and powerful tool for building equilibrium baselines from input data that is not itself in equilibrium. A typical use of this feature would be building a new intertemporal baseline after updating projections of future exogenous variables.
- Upgrade Sym's handling of parameters and variables without explicit GEMPACK header names in their declarations.
- All of the changes have been incorporated into the Sym GitHub repository.

Revisions to the NAICS36 Sym code:

- Continued coding and revisions in Sym that: (a) define sets for variables, (b) define variables, (c) define parameters, (d) contain major subsets of equations (e.g., the remaining investment, government, and trade modules) and (e) the equations governing market values, quantities and balances, national accounting and intertemporal behavior.
- The sets, variables and parameters in support of the current set of equations are fully coded. The producer, household, investment, government, trade, factor and national accounting modules are complete inclusive of their intertemporal aspects. Only coding of the market values, quantities and balances and the intertemporal household and investment Euler equations remains to be completed.
- The full set of updated code can be found in the *sym* subdirectory of the NAICS36 repository.

Revisions to the NAICS36 dataset:

- The first phase of development used single-year datasets for testing. During this phase we extended the data handling programs to include a time dimension. We then built an annual-frequency baseline dataset for OpenIGEM using the existing IGEM NAICS model from 1990 through 2130. The results can be found in the *data* subdirectory of the NAICS36 repository.

- We built tools for flexibly extracting subsets of years from the full dataset and converting them to GEMPACK header array files. The ability to select subsets of years is needed because OpenIGEM will usually not be solved on an annual basis.
- We used the full dataset and the tools above to build a complete set of data for an initial 10-period version of the model. The result can be found in the *data/p10a* subdirectory of the NAICS36 repository.

Progress in building the executable model:

- We used Sym to build a nearly-complete Tablo version of the model. The result can be found in the *tablo* subdirectory of the NAICS36 repository.
- We used GEMPACK's Tablo program to convert the Tablo version of the model to Fortran code. We then compiled and linked the Fortran code to produce an executable version of NAICS36. The model could be run but would require data for a few recently-added variables that were not in IGEM NAICS. However, it would not be usable for economic analysis since as noted above, it is missing some equations that have yet to be coded in Sym.
- The current executable can be downloaded from the *releases* area of the NAICS36 repository. As noted, however, it is not ready for use in analysis.

Next steps:

The next steps for the project are as follows:

- Add Sym code for the remaining equations and variables.
- Build initial input data for newly added variables that were not present in IGEM NAICS.
- Construct and test the base case for the model. In doing so, we will evaluate the impact of different choices for the number of periods in the simulation.
- Construct, test, and document one or more example policy cases.

The NAICS36 repository will be updated accordingly. After completion of these steps, a fully open-source, working version of the NAICS36 model will be available for use by anyone.