Bridging the Temporal Gap: A Comparative Analysis of Matrix Updating Techniques for the Portuguese Economy (2010-2023)

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The persistent lag in the release of official National Accounts, typically lagging several years, presents a fundamental challenge for Input-Output (IO) modeling. This temporal gap is particularly unfavorable during periods of rapid structural change (like COVID-19 pandemic and subsequent inflationary shocks), rendering historical coefficients outdated for contemporary policy analysis. This study, using Portugal (2010-2023) as a case study, investigates which non-survey matrix updating techniques most accurately and robustly project Supply and Use Tables (SUTs) across varying matrix resolutions and periods of economic shock?

In this paper, we benchmark iterative biproportional scaling algorithms â€“ specifically classical RAS and Generalized RAS (GRAS) â€“ against constrained optimization frameworks. The latter group includes Sign-Preserving Absolute Differences (SPAD), Sign-Preserving Squared Differences (SPSD), and various weighted and normalized refinements such as Improved Normalized Squared Differences (INSD) and Improved Weighted Squared Differences (IWSD). The empirical validation utilizes the official Portuguese SUTs as base data, testing algorithmic performance at two distinct levels of granularity: macro-aggregated resolution (80Ã—88) and high-resolution micro-level (431Ã—125). This analysis allows for a novel assessment of how matrix sparsity influences algorithmic convergence and accuracy. To evaluate algorithmic accuracy, we employ a suite of five error metrics: Mean Absolute Deviation (MAD), Weighted Absolute Differences (WAD), Mean Absolute Percentage Error (MAPE), and Root Mean Squared Error (RMSE). These error metrics are utilized to assess absolute error and scale sensitivity, where lower values indicate closer overall alignment with the observed SUTs. Complementarily, Correlation Coefficient (CORR) evaluates structural similarity, with higher values signaling a stronger agreement in the pattern of inter-sectoral flows. Together, these measures provide a balanced, multidimensional view of algorithmic performance.

Our results establish a relevant performance stratification. Contrary to the theoretical expectation that complex optimization yields typically superior fidelity, the study demonstrates that GRAS (a biproportional method) and INSD (a normalized optimization algorithm) consistently outperform other techniques across error metrics. A â€œtop tierâ€• comprising GRAS, INSD, and RAS proved most capable of preserving economic structure, while optimization methods such as SPAD and WSD frequently produced larger error magnitudes, often distorting specific sectors like Wood Products and Mining. Notably, GRAS emerged as the most robust engine for handling mixed-sign accounting realities â€“ such as changes in inventories â€“ avoiding the mathematical instabilities observed in standard RAS during shock periods.

A critical contribution of this research is the identification of a â€œResolution Paradoxâ€•. We observe a structural divergence in the optimal estimation strategy based on matrix density. For aggregated, dense matrices (80Ã—88), a â€œMeans-basedâ€• specification (averaging prior years) yields superior results by smoothing economic fluctuations in continuous inter-sectoral flows. However, for high-resolution, sparse matrices (431Ã—125), the â€œGap 1â€• specification (relying on the immediately preceding year) is demonstrably superior. We argue that averaging in high-resolution contexts introduces â€œartificial densificationâ€• â€“ creating â€œghost transactionsâ€• in cells that should remain structural zeros. Consequently, the immediate past serves as the most reliable predictor for sparse regional supply chains, allowing the model to adapt instantly to structural breaks rather than retaining a â€œmemoryâ€• of obsolete technological relations.

Stressâ€‘testing the models under 2018-2023 volatility revealed a â€œVolatile Constraint

Propagationâ€• effect. In highâ€‘resolution matrices, standard RAS collapsed during the 2021 shock because it could not accommodate extreme fluctuations in exogenous constraints â€“ Investment and Exports â€“ producing sharp errors (RMSEâ‰ˆ0.37; MAD>1.51). GRAS and INSD remained stable throughout, keeping RMSEâ‰¤0.04, MADâ‰¤0.79, and MAPE at 8.2% and 9.3%, respectively. Partialâ€‘information tests showed that removing these volatile constraints â€“ treating Investment and Exports exogenously to the process â€“ significantly improved the interâ€‘industry estimates, reducing MAD to 0.233â€“0.457 and RMSE to 0.010â€“0.025.

In conclusion, this study challenges the utility of complex weighted optimization for regional IO updating, advocating instead for the Generalized RAS (GRAS) method using a Gap 1 specification. This approach minimizes entry-wise absolute errors, preserves the sparsity essential for regional modeling, and ensures resilience against economic shocks.