A simple economic forecasting approach outperforms the IMF at global and regional scales

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Abstract

Authoritative economic forecasts, such as by the International Monetary Fund (IMF), have historically tended to be biased towards over-projecting growth and under-projecting inequality. These forecasts form the basis for projections of other societally important quantities such as greenhouse gas emissions and poverty rates. We develop a simple differential-equation-based approach to forecasting global and regional economic growth, and show that its early-21st-century forecasts would have been more precise and more accurate than the IMF's, on 3-to-5-year forecast horizons. Looking to 2100, our approach projects per-capita GDP near the lower ends of ranges of IPCC scenarios and expert opinion, with moderate income convergence driven largely by slow growth in rich countries. All else equal, our projections would imply a world in 2100 with less severe climate change, but less affluence—and thus potentially less resilience and adaptive capacity—than some other forecasts might suggest.

Recent IMF forecasts have been biased high on growth, and low on inequality

The IMF's economic growth projections have historically been biased high on average, especially on long time horizons and in developing regions (Fig. 1)[1]. Thus, they have also been biased low on inequality. Reasons for bias include challenges predicting recessions, assuming convergence of GDP to potential GDP, over-projection of development program success, and political pressures[1,2,3].

IMF forecasts inform the Shared-Socioeconomic Pathway (SSP) economic growth projections[4], causing them to be similarly biased over this period. (Fig. 1)[1]. The SSP projections are widely used in climate change research, and their positive bias in projecting economic growth has caused their baseline scenarios to over-project CO_2 emissions[5].
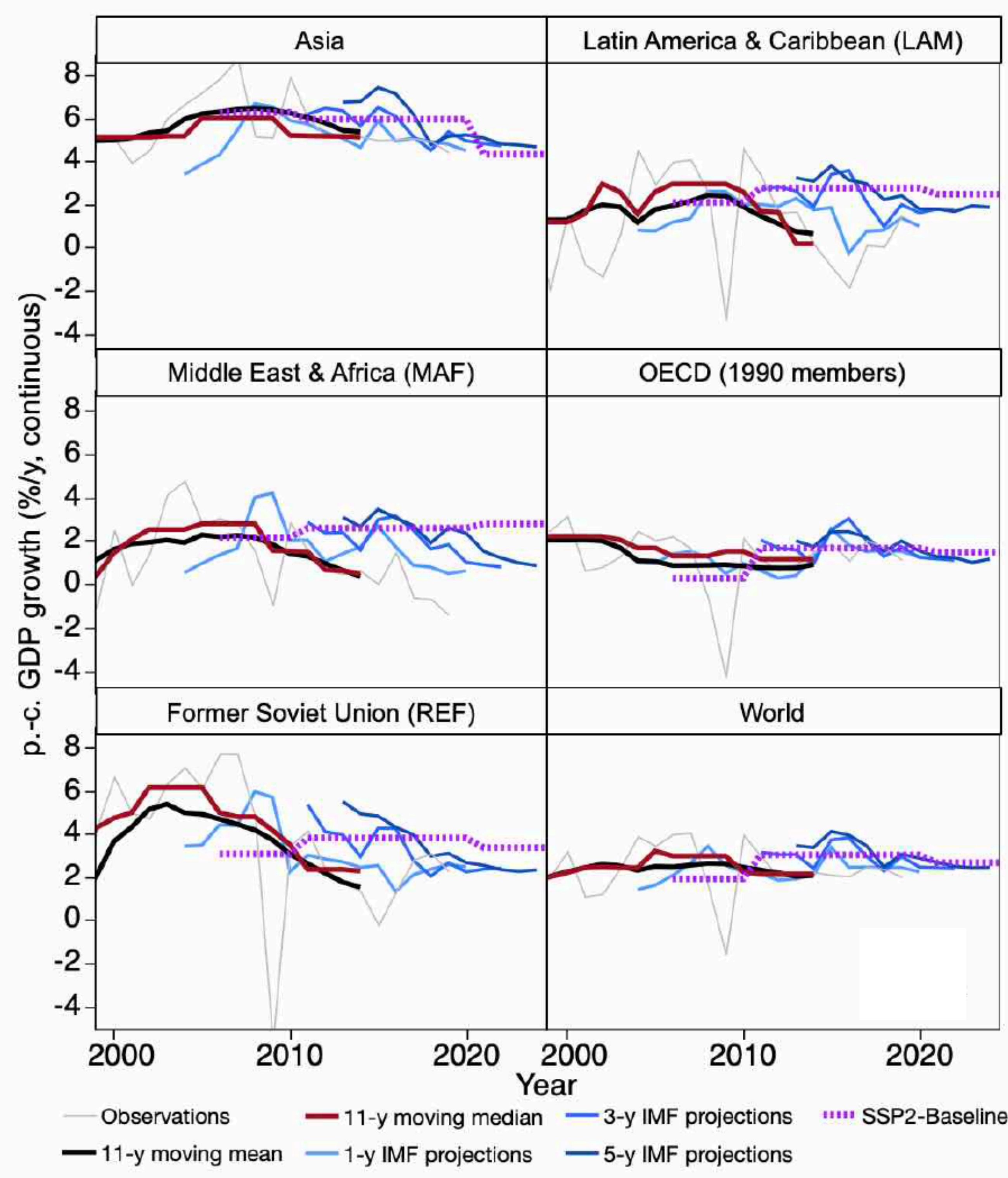

Fig. 1 (fig. 4A in Burgess et al.[1]). Comparison of observations to IMF and SSP projections of real per-capita GDP growth, at global and regional scales.

A differential-equation-based approach to regional per-capita GDP forecasting

Our approach to forecasting measures and extrapolates the relationship between the growth rate of per-capita GDP and its level, using a Kuznets curve (Fig. 2). We then project per-capita GDP forward using a numerical differential-equation solver, based on this fitted relationship. This approach was first used by Tilman et al.[6] to project global food demand, and is based on an earlier observation by Baumol[7] that the relationship between the growth rate of per-capita GDP and its level is well-described by a Kuznets[8] function. Indeed, we tested several other functions and found the Kuznets function fits best. Tilman et al.[6] fit this function to data from 7 income-based groupings of 100 countries from 1961 to 2006 (Fig. 2).
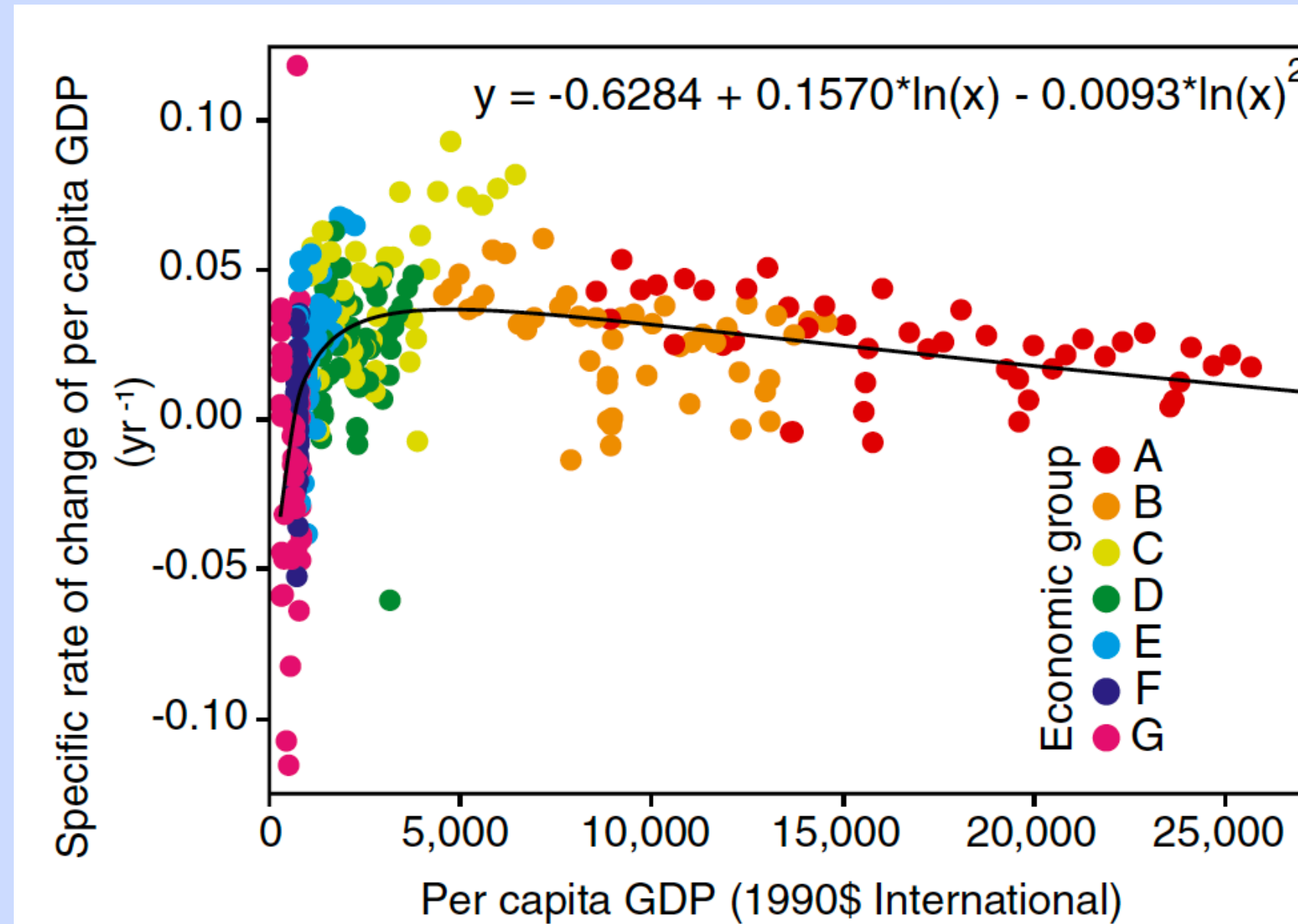

$$y = -0.6284 + 0.1570 \cdot \ln(x) - 0.0093 \cdot \ln(x)^2$$

Fig. 2 (fig. S1 in Tilman et al.[6]). A Kuznets fit of the relationship between per-capita GDP growth and per-capita GDP, using data from 7 economic groupings of 100 countries from 1961-2006.

Comparison to IMF forecasts

We applied this Kuznets-based approach—with an added correction for variation increasing the mean when projecting forward, and fit to data from 167 countries, from 1961 to each of 2004-2016[9]—to create counterfactual projections to compare to the IMF's projections[10] on 1-to-5-year forecast horizons. We aggregated to 7 economic groupings, chosen using Ward's[11] hierarchical agglomerative clustering algorithm. We then projected per-capita GDP forward at the country level, and aggregated these projections—and the IMF's—to the levels of the world and SSP regions. The Kuznets approach produced both more accurate and more precise forecasts at these levels than the IMF, on 3-to-5-year horizons (Fig. 3), with a slight negative bias overall, driven by under-projecting Asian growth over this period. The Kuznets approach was slightly positively biased (but less so than the IMF) in the former Soviet Union (REF) and the Middle East and Africa (MAF), and highly accurate in the OECD and Latin America and the Caribbean (LAM).
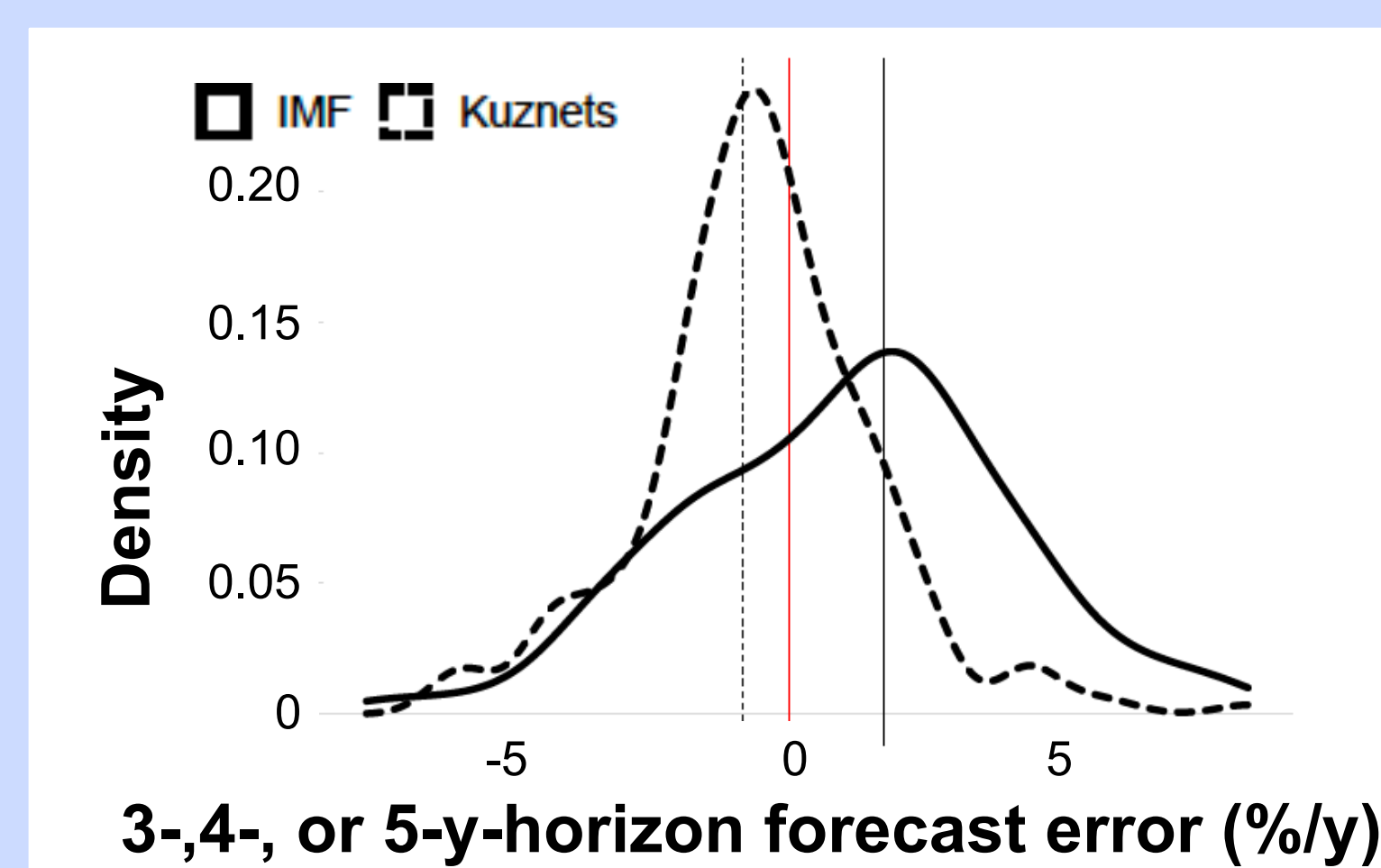

Fig. 3. Comparison of error distributions in 3-to-5-year global per-capita GDP growth forecasts between the IMF (black, solid) and the Kuznets (black, dashed) approach. Black vertical lines indicate medians, and the red vertical line indicates zero error, for reference.

Economic projections to 2100

We project per-capita GDP forward to 2100—starting in 2016—using the fitted Kuznets curve at the country level, and aggregating to SSP regions—and the global scale—using the UN's medium population scenario[12]. Fig. 4A shows region-level projections. Fig. 4B compares our global projections to those of the five SSP baseline scenarios, projected using the AIM/CGE integrated assessment model[13].
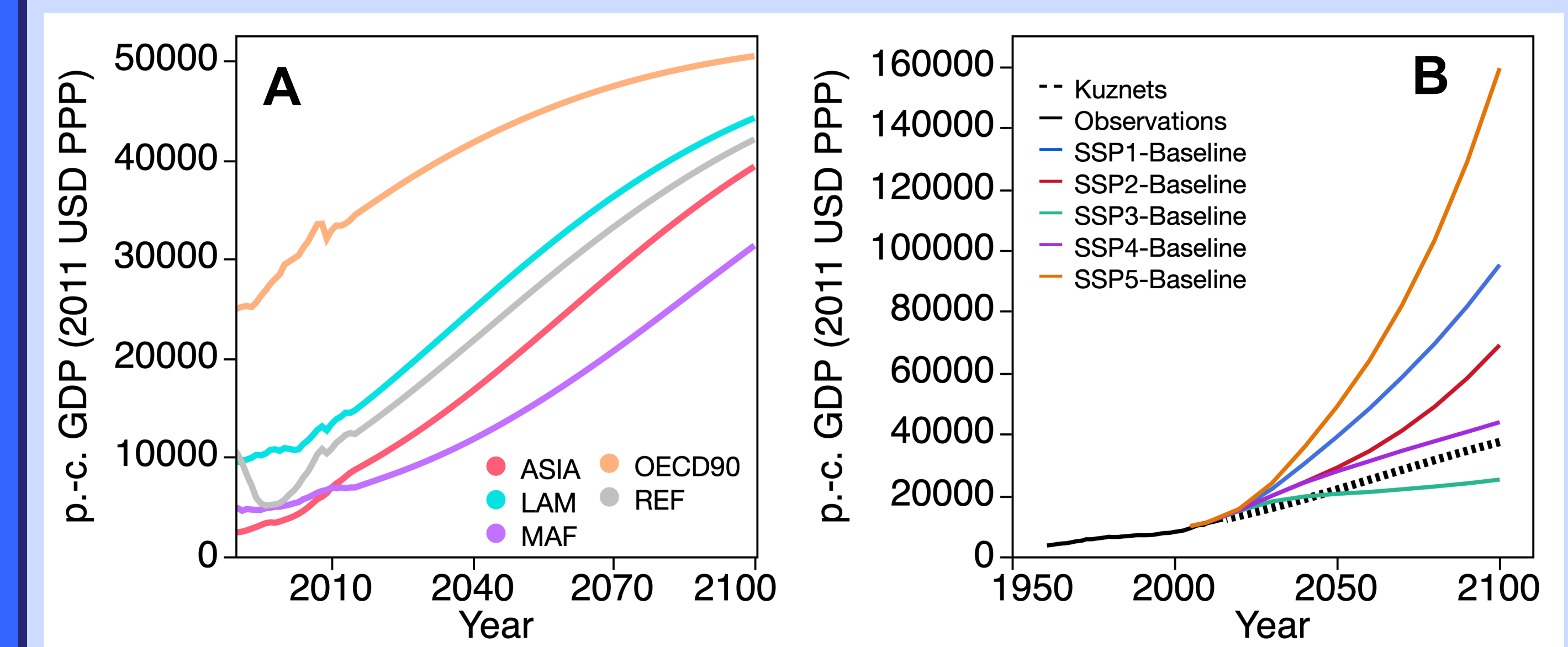

Fig. 4. Comparison of Kuznets-based projections of per-capita GDP: (**A**) at the level of SSP regions (observations[9] before 2015; projections after), and (**B**) at the global scale, compared to the five SSP baseline scenarios[4,13].

Implications

Our Kuznets-based approach to forecasting per-capita GDP growth fits recent data (out of sample) better than the IMF's 3-5-year forecasts at the regional and global scale. Looking to 2100, our approach projects global per-capita GDP on the low end of the SSP range—larger than only SSP3 ("Regional Rivalry"[3]). Notably, our approach projects per-capita GDP in 2100 over 4x lower than SSP5, suggesting 2100 CO_2 emissions substantially lower than in SSP5-8.5, even if that scenario's high carbon intensity materializes. Our Kuznets approach projects moderate (compared to the SSPs[4]) income convergence between poor and rich countries, driven largely by slow growth in the OECD—slower than in all SSP scenarios[4,13].

Long-run economic forecasting is rife with uncertainties[14], which our approach and projections do not resolve. Our projections may also suffer from biases. For instance, our data suggest that the Kuznets projection method would have been biased, in recent years, slightly low globally due to a bias in Asia, and slightly high in the Middle East and Africa. Should these trends continue, global per-capita GDP would be higher—and inequality greater—than we project. However, our current projections do not account for the COVID-19 pandemic, and thus could also be biased high. We are currently working on robustness checks accounting for these sources of error.

References
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