World Economic Dynamics and Technological Change: On Projecting Economic Growth*

S. Şerban Scrieciu**

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** Cambridge Centre for Climate Change Mitigation Research (4CMR), Department of Land Economy, University of Cambridge (UK)

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Structure

- Key features of long-run economic growth processes
- Projecting economic growth: a methodological approach
- The E3MG example
- Concluding remarks

Key historical features of long-run economic growth

- Ongoing fundamental evolutionary change

- Non-linear
- Dynamic
- Volatile
- Non-equilibrium

Figure 1: Historical GDP growth rates across Western Europe, 1901-2001

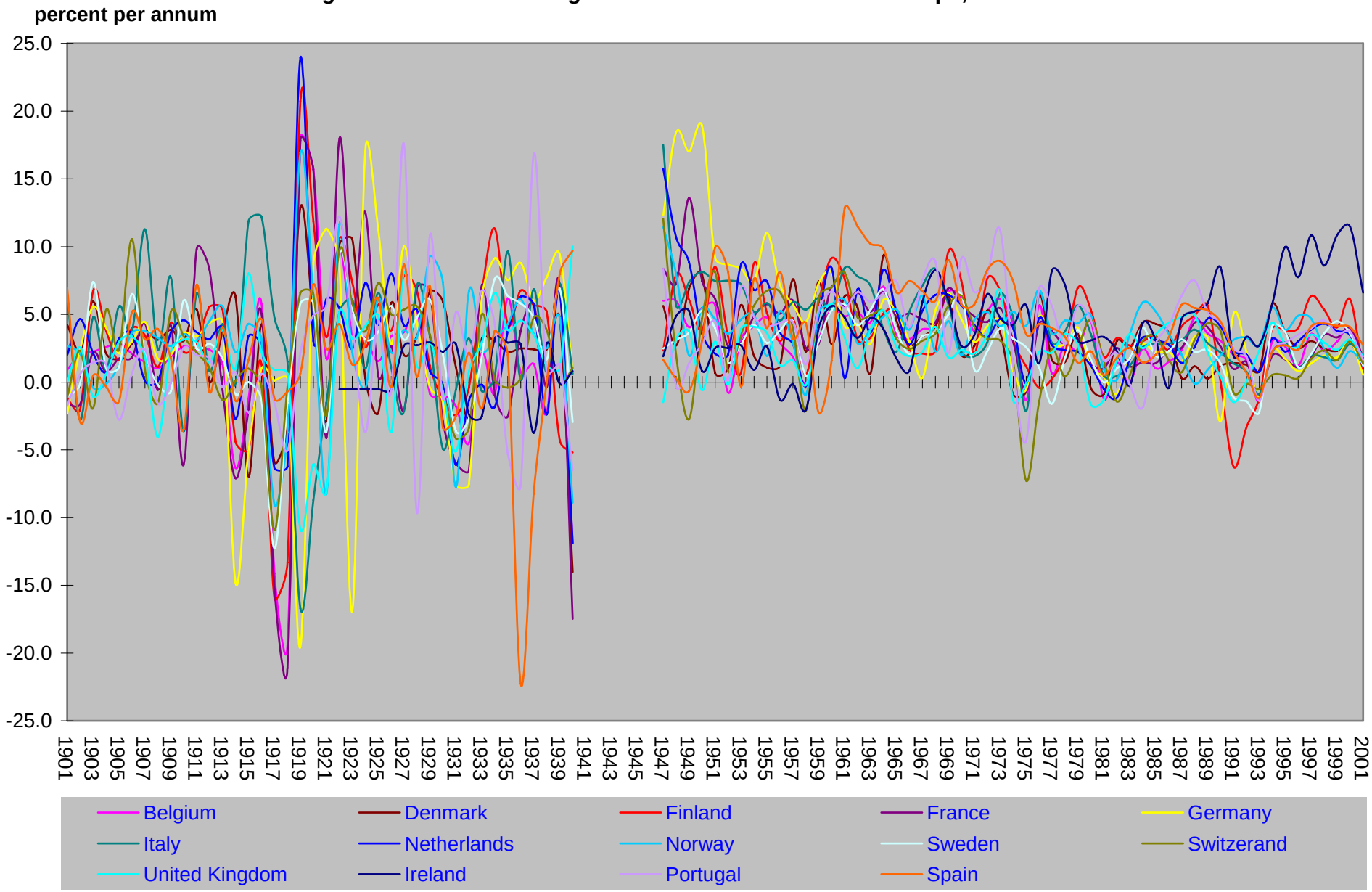

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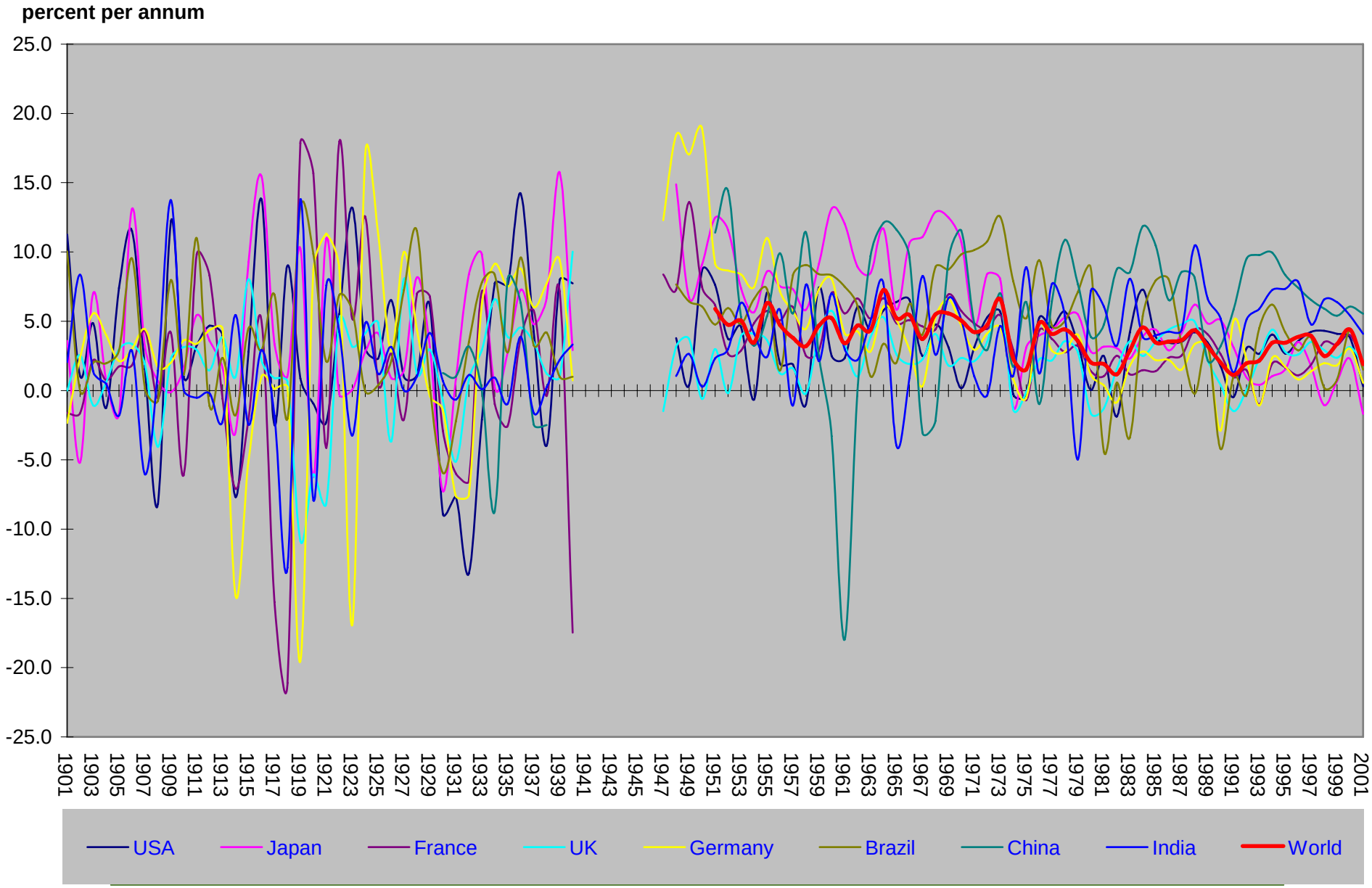
Figure 2a: Historical GDP growth rates across selected economies throughout the world, 1901-2001



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Key historical features of long-run economic growth

- Systematic explanations of growth are provided in theory
- Not empirically validated across time and countries
- Distinct common features to characterise growth
  - Diversity
  - Increasing inequalities
  - Technological progress (TP)
- TP – a necessary factor for growth
- TP – crucial for climate change policy

Projecting economic growth: literature review

- Heterogeneity in forecast models
  - time-horizon of projections
- Taxonomy proposed:
  - Statistical methods
  - Neoclassical growth modelling & accounting (incl. CGE)
  - Macro-econometric modelling
  - Judgemental assessment / consensus agreement

Statistical methods of projecting growth

- Linear regression models
  - Widely employed for ST forecasting (e.g. banks)
  - Impose few restrictions & find patterns
  - Often mechanically extrapolate past relations between GDP and leading indicators
  - Univariate or multivariate statistical techniques (OLS, VAR, statistical filtering)
  - Leading indicator-based models vs dynamic factor analysis

Statistical methods of projecting growth

- Non-linear forecasting
  - E.g. threshold AR models or self-exciting threshold AR models using artificial networks
  - May display superior forecasting performance
  - Accounting for asymmetric behaviour in business cycles
  - In-sample fit versus out-of-sample forecasting

Neoclassical growth models

- Have dominated the mainstream (CD production function approach, CGEs)
- Placed within optimal growth settings
- Projections largely given by assumption
- Dominated by theory & poorly backed by data
- Exogenous LR productivity and technological change
- Problems of interpretation & validity
- Heterogeneity vs aggregation of capital

Macro-econometric models

- Specify full simultaneous systems of econometric equations
- Describe the behaviour of economic variables & relationships
- Draw on both economic theory and statistics
- Arguably fair better in forecasting performance
- May not predict the future but at least improve our understanding of past behaviour
- Their performance has been inextricably linked to developments in time-series analysis
- Potential revival of the approach?

- Macro-econometric models may be based on demand or supply-led economic growth theories

- Combining neoclassical growth theory and general equilibrium with statistics/econometrics (strong assumptions are still imposed: DSGE, Deutsche Bank's Formel-G model)

The E3MG model: a focus on the economic dimensions

At 4CMR we use E3MG (Economy-Energy-Environment Modelling at the Global level)

- Long-term forecasting (up to 2100) of the E3 implications of mitigation actions

Four main advantages:

1. A theoretical Post Keynesian economic view of the long-run
   - "History" approach of cumulative causation and demand-led growth
   - Varying returns to scale & varying degrees of competition
   - Non-equilibrium
   - Not assuming full employment

Treatment of technology in E3MG

Endogenous (induced) technological change

a) Econometric estimation of the impacts of TC on energy demand through accumulated gross investment and R&D (TPIs)

b) Econometric estimation of the impacts of TPI on sectoral export demand

c) Bottom-up energy technology sub-model (ETM) with learning curves and investment in ETs allowing for increasing returns

More on E3MG model structure

2. Highly disaggregated, part. wrt energy & environment industries

3. Econometric grounding of the model (system of 22 dynamic-equations) - cointegration

4. A two-way feedback between economy, energy & environment
   - Hybrid modelling of top-down macro-econometric model & bottom-up energy technology sub-model
   - ETM models the switch btw different ETs based on the price effect on the elasticity of substitution btw competing ETs (Anderson and Winne 2004).

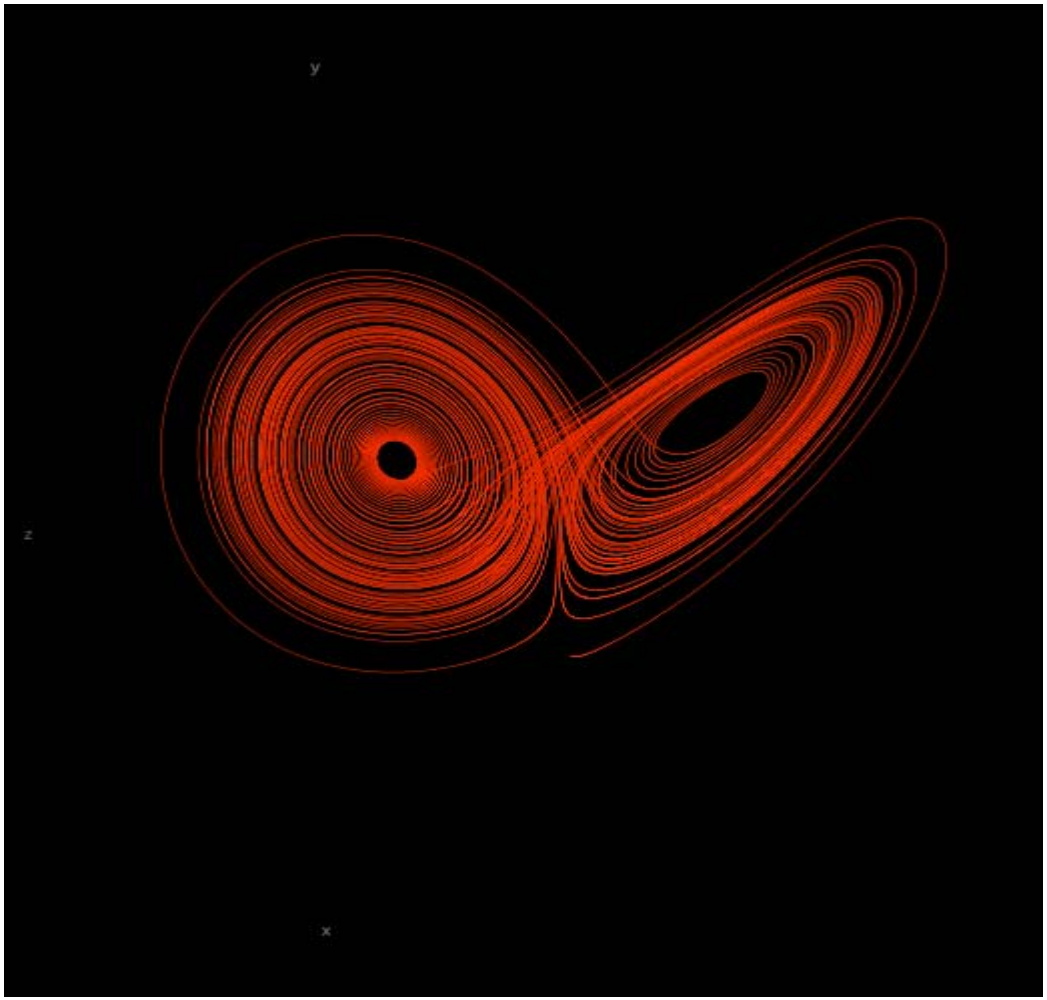
Caveat:

Projections need to be placed within an uncertainty analysis context!

Limited feasible sub-space of variation around the attractor

Visual example of an attractor:

Source: http://en.wikipedia.org/wiki/File:Atractor_Poisson_Saturne.jpg



Example of a strange attractor (Lorenz attractor)

http://en.wikipedia.org/wiki/File:Lorenz_attractor_yb.svg

Fractal made using Sterling 2 program

Source: http://en.wikipedia.org/wiki/File:Hidden_Mandarin_fractal_Sterling2_3365.jpg

Long-term limitations

- Can estimates based on 30-years historical data make useful comments on developments 50-100 years into the future?

- To what extent structural changes/shocks can be predicted?
  - Problem of shifts in the means of variables ("location shifts")
  - Allowing "unanticipated structural breaks in an evolving economic mechanism for which the econometric model is mis-specified in unknown ways"

    Clements and Hendry (2008)

Concluding remarks (1)

- Increasing complexity of economic growth processes
- Need for century-long economic scenarios, particularly from a climate policy analysis viewpoint
- Literature: short to medium-term with a focus on national economies + poor representation of dynamics
- “Known uncertainties” vs “unknown uncertainties” and the treatment of long-run solutions

Concluding remarks (2)

1. Understand the past (update to recent shocks, use econometric techniques to allow for structural breaks and location shifts)

2. Capture international transmission channels and economic interdependence across markets and countries

3. Account for the impact of endogenous TC on LR growth

4. Acknowledge & account for uncertainty, particularly when projecting long-term developments

5. Future long-term story-lines, scientific prediction and poetic imagination (i.e. other approaches including pooling forecasts)

THANK YOU FOR YOUR ATTENTION AND PATIENCE

ANY QUESTIONS / SUGGESTIONS?

sss38@cam.ac.uk