

Debian for Computational Economics

The case of the Dynare project

ESRF Workshop

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Computational Economics ?

- Economics is a social science
- Studies behavior of *agents* (individuals, firms, institutions) and their interaction via production, distribution and consumption of goods and services
- Intersections with sociology, psychology, political science, history
- Until WW2, very little mathematical formalism used in economics (and of course no computers!)
- Computational economics, a field under expansion:
 - ▶ *Modelling*: abstract mathematical representation of an economic system
 - ▶ *Econometrics*: testing the empirical relevance of a model on data
- Both modelling and econometrics can be applied at the *macro* and *micro* levels
- Difficulty: experiments not possible

Macro-economic models

- Dynamic equations linking endogenous and exogenous variables
- Equations derived from economic theory, based on hypotheses (e.g. methodological individualism, full rationality)
- Typical variables: consumption, production, investment, employment rate, interest rate, exchange rate. . .
- Economic agents and variables often aggregated at the sector or country level
- Some equations include the *expectation* of agents about the future values of some variables
- Methods for handling expectations: rational expectations, perfect foresight, partial information
- Size of models in terms of equations and endogenous variables:
 - ▶ Small theoretical models: a few dozen
 - ▶ Large operational multi-country models: several thousands

Dynare: a free software for macro-modelling

- Researcher-friendly language for describing a model and running simulations/estimations
- Implements many algorithms of the comp. econ. literature
- Runs on top of Octave/MATLAB
- C++ preprocessor (parser, symbolic manipulations)
- Numerical techniques employed:
 - ▶ multivariate nonlinear solving and optimization
 - ▶ matrix factorizations
 - ▶ local functional approximation
 - ▶ Kalman filters and smoothers
 - ▶ MCMC techniques for Bayesian estimation
 - ▶ graph algorithms
 - ▶ optimal control

The project

- Free software, licensed under GNU GPL v3
- Started in 1996
- Packaged in Debian since 2009
- Core dev team: currently 6 members
- Outer circle of $\simeq 10$ irregular contributors
- Most devs are academics
- Majority are French-based, but intl cooperation a reality
- Debian used on project servers, and on PCs of several core devs
- Major release cycle $\simeq 18$ months, minor cycle $\simeq 3$ months
- Thorough documentation through user guide, reference manual; comprehensive model database

The community

- Users: academics, students, central bankers, government bodies
- Lots of published research papers use Dynare
- Teaching tool in postgraduate macroeconomic degrees
- Used for policy analysis and economic forecasting in public institutions
- MATLAB dominant in user base; Octave mainly for teaching and in developing countries
- User support through web forum
- Two annual events: summer school; conference

The business model

- Hosted by CEPREMAP (French research centre)
- Direct support by International Monetary Fund (IMF) and Banque de France
- European Commission FP7 project “MonFisPol”
- Support from research network of 8 central banks “DSGE-Net”: have a say on development priorities
- Some consulting services and training provided
- Some funding forwarded to Octave

Debian for Economists

- Proprietary software still dominant, but free software gaining momentum
- Debian contains everything needed by an economist
- Econometrics and statistics: R, Gretl
- Macroeconomic modelling: Dynare
- Typesetting: LaTeX, LyX, LibreOffice
- Numerical analysis: Octave, Scilab, NumPy/SciPy
- Symbolic computations: Maxima
- Programming tools for advanced users (Fortran popular)
- Scope for a new Debian Science metapackage
- Ready-to-use “Debian for Economists” VM provided on Dynare website

SaaS for Central Banks using Debian

- Global Projection Model (GPM)
 - ▶ 6-regions model for world economic forecasts
 - ▶ joint project with the IMF
 - ▶ requires a specific computing environment and significant resources
- Central Banks & financial institutions do not always have a suitable computing environment
 - ▶ Rigid administration or IT department
 - ▶ Missing human resources
- We propose Software as a Service (SaaS)
- Servers based on Debian “Squeeze” 6.0
- Some figures:
 - ▶ 2 servers, 16 logical cores each
 - ▶ 80 economists
 - ▶ 35 central banks and financial institutions all over the world
- Caveat: MATLAB trap

Challenges

- Modelling challenges:
 - ▶ Current models not good at forecasting violent crises
 - ▶ Better models needed for financial sector, panic and herd behaviors
 - ▶ Agent-based models ?
- Escaping the MATLAB trap:
 - ▶ Some free softwares locked in MATLAB, e.g. by the use of new generation of OO programming (`classdef`)
 - ▶ Users like the MATLAB GUI
 - ▶ MATLAB faster
 - ▶ Issues currently being addressed in Octave: implementation of `classdef`, native Qt-based GUI, LLVM-based JIT compiler
- Developing a culture of free software and code sharing in the economic profession