

Introduction

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Administration

- First six weeks considers the construction of dynamic macroeconomic models
- Includes computer tutorial sessions on Friday to solve, estimate, simulate and evaluate these models
- Assessment for the first 6 weeks of study is by written report/paper:
 - Must consider the simulation and/or estimation of a DSGE model that you have constructed
 - Submission date: 11 October 2018 at 15H00
 - No late submissions accepted

Reference Material

- HTML notes provide you with an overview of what is to come
 - Practical implementation with plenty of examples
 - Step-for-step derivations that are relatively easy to follow
- Slides will also be provided although they do not contain as much detail as the notes
- The course outline provides a number of additional references

Overview

- Modern macroeconomic models combine theoretical and empirical developments to align measurement with theory
- Employ microeconomic foundations, representative agents & rational expectations to derive structural parameters
- Facilitates research into the effects of policy interventions in a theoretically consistent manner
- Monetary & fiscal policy focus on application of models that are able to consider the combined effects of different forces in a transparent manner
- During this course we'll maintain strong emphasis on applied work that makes use of this framework
 - Solve, simulate, estimate, evaluate and use these models during the practical sessions

Why policy-makers use these models

- Many different macroeconomic forces influence different markets to provide complex macroeconomic outcomes
- To consider the use of a specific policy intervention, one would need to quantify the net effect of these related forces
- For example, consider the following policy questions:
 - By how much, if at all, will an exchange rate depreciation stimulate the economy?
 - What is the impact of tighter financial regulation on the economy?
 - What is the impact of an increase in government spending?
- To provide realistic answers to these questions macroeconomic models must capture the complexity of modern economies
- To be useful they must do so in a transparent manner
- This is what DSGE models seek to achieve

The state of macroeconomic modelling

- Last 30 years has witnessed phenomenal developments in macroeconomic modelling
 - Include both theoretical & technical advances
 - Use of microfounded representative-agent models gained prominence
- Theoretical developments were spurred by Lucas (1976) critique
- Subsequent research showed how to derive a rational expectations model for investigating important aspects of the business cycle
 - Contributions by Lucas & Sargent (1978), Kydland & Prescott (1982), and Prescott (1986)
- All these individuals have received the Noble prize
- Despite the criticism that has been levied against these models - it is still the dominant framework for policy analysis - with good reason

Historical modelling framework

- Prior to the publication of these important works:
 - Macroeconomic empirical research largely made use of backward-looking linear regression models
 - Cowles Commission model took the form of a large regression model with nearly 400 equations
- Lucas (1976) argued that model parameters that are based purely on historical data:
 - Would not be able to provide insight into the effects of a change in economic policy
 - Since this change would give rise to a new pattern of behaviour that would not have been observed in the past

Lucas (1976) critique

"Given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models."

Present framework

- New direction in empirical macroeconomics lead to the derivation of models with policy-invariant parameters
- They describe certain fundamental aspects of human behaviour (such as those that relate to preferences and constraints)
- Incorporate essential elements that define how individual's make various choices, under any given policy framework, based on microeconomic foundations
- Suggested that this gives rise to 'structural' or 'deep' parameters

Real Business Cycle theorists

- First vintage of models developed by Real Business Cycle theorists
 - Includes the work of Kydland & Prescott (1982), Prescott (1986), King & Rebelo (1999), —emphet al.
- Developed models around the concepts of utility and profit maximisation
- Incorporate many general equilibrium features and several stochastic properties
- Excluded nominal rigidities and other market imperfections

New Keynesian models

- New Keynesian models incorporate several imperfections:
 - Include nominal and real rigidities in the form of sticky prices and wages (amongst others)
- These characteristics seem to be present in the data
 - Evidence may be traced back to Friedman & Schwartz (1963), while Christiano et al. (1999) provide more recent empirical results
 - Shifts in the aggregate demand for goods & services tend to affect output more than that which is prescribed in the Real Business Cycle's perfectly competitive flexible-price economy (Blanchard, 2009)
- Clarida et al. (1999) and Christiano et al. (2005) provide early examples of New-Keynesian models
- This framework is still regarded as being at the forefront of macroeconomic research

Technical Developments

- Assume that agents form rational expectations, such that models need to incorporate forward-looking behaviour
- Requires techniques for approximating the model solution
- Popular variants of these techniques for forward-looking linear difference equations:
 - Blanchard & Kahn (1980), Sims (2001), Uhlig (1999), and Klein (2000)
- Second-order approximations for the model solution are provided by Schmitt-Grohé & Uribe (2004)
- Solutions for models that incorporate Markov-switching behaviour have been developed by Foerster et al. (2016) and Maih (2015)

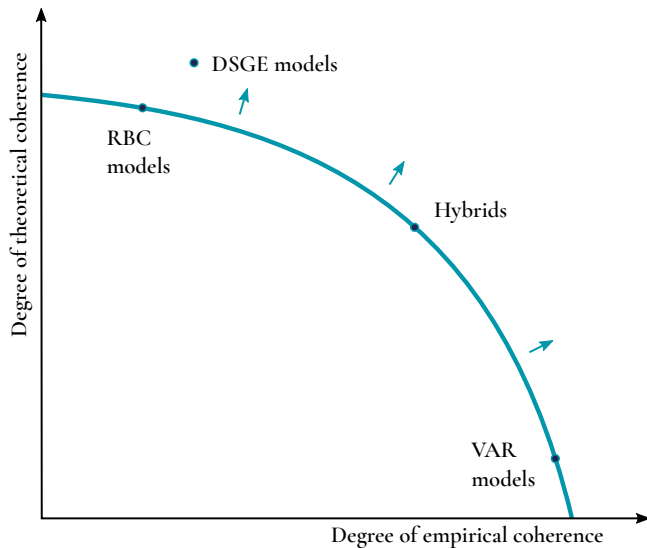
Technical Developments

- Ireland (2004a) showed how to use a state-space framework that allows for the inclusion of both observed and unobserved variables
- The Kalman filter is then used to evaluate the likelihood function of the model after it has been exposed to actual macroeconomic data
- This procedure facilitates parameter estimation using Bayesian, maximum likelihood, or general method of moments techniques
- Sequential Monte Carlo methods are used when we want to preserve the nonlinear features in a model

The birth of DSGE models

- These methodological & technical developments are brought together in: **Dynamic Stochastic General Equilibrium models**
- Elevated theoretical modelling to the forefront of current macroeconomic research
- Pagan (2003) noted that there is usually a trade-off between models that are designed to match theory closely and those that seek to explain historical economic activity
- Over time, this frontier has shifted outwards, largely as a result of the above theoretical, statistical and computational advances

Theoretical and Empirical Trade-off



The birth of DSGE models

- Currently a large degree of convergence in vision and methodology exists (Blanchard, 2009)
- Benassy (2011) summarises the success of this line of research being due to:
 - Rigorous micro-foundations that allow for the possibility that they describe behaviour that may be invariant to policy changes
 - Integration of growth and business cycle theory in a unified framework
 - Ability of the models to integrated results with observed data:
 - ▶ generate impulse response functions
 - ▶ compare correlations and other statistics

Success of DSGE/RBC models

- Consensus lead to large growth in the scale of DSGE models, where current versions incorporate:
 - open-economy features, additional frictions (such as those that pertain to the financial sector), and a larger set of shocks
- Current versions of these models are termed 'medium-scale DSGE models'
 - Examples include: Smets & Wouters (2007), Adolfson et al. (2008a,b), Gali (2010), Gertler & Kiyotaki (2010), Christiano et al. (2010), Del Negro et al. (2013), Alpanda et al. (2018), amongst others

Modern DSGE models

- Provide admirable descriptions of business cycle dynamics and provide valuable insights into the effects of various economic shocks
- Used by central banks and other policy-making institutions to aid policy discussions.
 - Tovar (2009) suggests DSGE models are used in most central banks for policy analysis and forecasting purposes
 - Smets & Wouters (2007) show that their model provides superior forecasts
 - Edge et al. (2010) suggest the FED's current DSGE model outperforms their other models

Parameter estimation

- The parameter values in early RBC models were calibrated to match the unconditional moments of the data or they were drawn from empirical microeconomic findings
- Modern models make use of various parameter estimation techniques where the majority of these employ log-linear first-order approximations for the model solution
 - Reasonably accurate for pre GFC data
 - Allows for convenient evaluation of the model and the generation of forecasts with the use of the Kalman filter
- These procedures make use of formal econometric sampling theory:
 - Either limited information estimators (where Bayesian procedures are preferred) or full information estimators

Pre-crisis Models and the use of Financial Frictions

- Several papers, including Stiglitz (2017), have asserted that pre-crisis DSGE models failed as they did not include financial frictions, liquidity constrained consumers, or a housing sector
- While this is true of most models it is not true of all models
- For example, Carlstrom & Fuerst (1997) and Bernanke, Gertler, & Gilchrist (1999) develop models with credit market frictions:
 - They show that the models exhibit a “financial accelerator” mechanism where credit markets work to amplify shocks, when the firms ability to borrow is limited by the value of net worth
- In addition, Iacoviello (2005) specifies a DSGE model with nominal loans and collateral constraints tied to housing values:
 - This paper preceeds the large post-crisis DSGE literature on the aggregate implications of housing market booms and busts

Failure to Predict the Financial Crisis

- Pre-crisis DSGE models have also been criticised for not predicting the vulnerability of the global economy to the recent GFC
- However, this critique should be considered in light of the fact that there is still ongoing debate about specific causal factors that precipitated the GFC
- The precise role played by expectations, the subprime market, declining lending standards in mortgage markets, and overly-loose monetary policy is a matter for discussion

Failure to Predict the Financial Crisis

- Although DSGE models failed to provide a signal about the increasing vulnerability of the U.S. economy to a crisis - the same is true for the broader failure of the economics community
- The overwhelming majority of academics, regulators and practitioners did not appreciate the size and vulnerability of the shadow banking sector
- The widespread belief was that if a country had deposit insurance, bank runs were a thing of the past
- The failure was to allow a small shadow-banking system to promulgate into a massive, poorly-regulated sector that was not protected by deposit insurance or lender-of-last-resort backstops

Failure to Predict the Financial Crisis

- In addition, most of the pre-crisis models that incorporated financial frictions suggested that these modifications had little effect (when guided by pre-crisis data)
- Hence the mainstream models sought to include other frictions, which appeared to have more prominent effects
- We now consider some of the modifications that have been proposed to capture particular features of the GFC in the DSGE framework

Financial Frictions

- Gertler & Kiyotaki (2015) and Gertler, Kiyotaki, & Prestipino (2016) develop a DSGE model of a rollover crisis in the shadow banking sector, which triggers fire sales
- While theories of collateral constrained borrowers have been described in Christiano, Motto, & Rostagno (2014) and Cúrdia & Woodford (2016)
- These models suggest that firms borrow from their creditors to finance investment using standard debt contracts
- Hence a rise in risk leads to an increase in the spread between the interest rate at which firms borrow and the risk-free rate
- That rise is accompanied by a decline in borrowing and aggregate investment, which could precipitate a recession

Housing Sector

- There are now a number of DSGE models that show how the housing sector may have an important influence over the business cycle:
- Liu, Wang, & Zha (2013) provide a specification to show that the value of a firm's land and capital could place a constraint on the amount that they can borrow
- Iacoviello (2005) and Iacoviello & Neri (2010) show the importance of shocks to the housing sector, where the value of housing constrains household borrowing
- Berger et al. (2015) also consider models with financial frictions to analyse the response of consumption to changes in house prices

Identifying the Causes of the Crisis and the Path of Recovery

- Several researchers have also sought to identify the specific shocks that triggered the financial crisis and the propagation mechanism
- Christiano, Eichenbaum, & Trabandt (2016) suggest that most movements in aggregate real economic activity during the GFC were due to financial frictions interacting with the ZLB
- Similarly, Gust et al. (2017) show that shocks to the demand for risk-free bonds were important during the crisis and its aftermath, while financial frictions had a smaller effect

Fiscal Policy Analysis

- Since DSGE models with nominal rigidities and financial frictions can provide quantitatively plausible accounts of the GFC they have been used to consider the use of alternative fiscal and monetary policies over this period
- One of the key research questions in the post-crisis literature considers how a binding ZLB constraint on the nominal interest rate affects the size of the fiscal spending multiplier?
- Christiano, Eichenbaum, & Rebelo (2011) suggest that when the ZLB is binding the multiplier is much larger than one, while when the ZLB is not binding the multiplier would be below one
- Similarly, Erceg & Lindé (2014) suggest that the results based on lump-sum taxation are robust relative to the situation in which distortionary taxes are raised gradually to pay for the increase in government spending

Monetary Policy Analysis

- With a binding ZLB constraint on the nominal interest rate it is no longer possible to fight the recession with the aid of conventional monetary policy
- Monetary policy-makers considered a variety of alternatives, which included the use of forward guidance as described in Woodford (2003) and Woodford (2012)
- By forward guidance we imply that the central bank keeps the interest rate lower for longer than they ordinarily would
- Carlstrom, Fuerst, and Paustian (2015) note that this type of forward guidance is implausibly powerful in standard DSGE models

Heterogenous Agent Models

- There is a large literature that rejects the concept of a homogeneous representative consumer Euler equation using aggregate time series data
- Motivated by these observations, macroeconomists are exploring the use of DSGE models where heterogeneous consumers face different idiosyncratic shocks and binding borrowing constraints
- Kaplan, Moll, & Violante (2016) use a model where households have uninsurable, idiosyncratic income risk and face binding borrowing constraints to show that a fall in the interest rate may cause the different agents to act somewhat differently
- McKay, Nakamura, & Steinsson (2016) show that risk averse agents who anticipate the possibility of binding borrowing constraints in the future are less responsive to future interest rate changes

Macroeconomic models for other African countries

- Macroeconometric research has been conducted by the South African Reserve Bank since 1974
- The University of Pretoria and the Bureau of Economic Research started to publish results from their respective models shortly thereafter
- These took the form of regression models that represented those of the Cowles Commission
- More recently, a number of DSGE models have been developed for the South African economy
- Early variants include Liu & Gupta (2007), which is based on calibrated version of the Hansen (1985) closed-economy model
- Thereafter models for a small-open economy have been described in Ortiz & Sturzenegger (2007), Steinbach, Mathuloe, & Smit (2009), and Alpanda, Kotzé, & Woglom (2010a, 2010b, 2011)
- Steinbach (2013) describes how these models may be extended to incorporate financial frictions

Macroeconomic models for other African countries

- Slightly different variants include Gupta & Steinbach (2013) that use a DSGE-VAR model structure to show the relative importance of each individual rigidity when forecasting economic variables
- The importance of nonlinearities and Markov-Switching features in DSGE models is described in Balcilar, Gupta, & Kotzé (2013, 2016) and Ivashchenko, Gupta, Çekin & Kotzé (2018)
- Models for other African countries, include Anguyo, Gupta & Kotzé (2018, forthcoming), as well as Peiris & Saxegaard (2007), Berg, et al. (2010a) and Berg, et al. (2010b)

Conclusion

- This course seeks to provide a detailed description of various dynamic macroeconometric models that could be used to assist in the policy-making process
- Where relevant, we will seek to include findings from research that has been conducted for various African economies
- Particular attention will be paid to the use of modern representative agent models that may be used to analyse the business cycle
- These models are used by policy-making institutions to consider the implications of deviations from baseline forecasts and the quantitative implications of the specific policy alternatives
- Over the past 10 years, researchers have devoted themselves to improving the models, while preserving the insights that they provide
- This has ensured that DSGE models remain central to how macroeconomists think about aggregate phenomena and policy, where there is simply no credible complete alternative framework

So let's have some fun!