Successes and shortcomings of dynamic stochastic general equilibrium models

A Critical Discussion of the Relative Successes and Shortcomings of Dynamic Stochastic General Equilibrium Models

From the late 20 th Century, Dynamic Stochastic General Equilibrium (DSGE) models grew exponentially in popularity and prowess, used by an overwhelming proportion of central banks in the developed world (Coenen et al., 2012) to provide (at least) theoretical foundations for advisory policy stances. With the dawn of the financial crisis and Great Recession, several of the models' flaws with regard to forecasting both downturn and recovery were brought to light. However, proponents maintain its superiority to alternatives based on DSGE's fundamental components, which are often a source of major critique. This essay will begin with an explanation of the general DSGE model, in understanding the theory I endeavour to demonstrate reasons for the models widespread success, before the dominant literary critiques and suggested modifications in response are assessed.

In adherence to Lucas' critique of policy variations in traditional Keynesian models' causing systematic fluctuations in both the " optimal decision rule of economic agents and… the structure of econometric models" themselves (Lucas, 1976), DSGE models take their theoretical microfoundations from a representative agent with rational expectations, for whom utility maximisation, subject to a budget constraint, occurs intertemporally. Exogenous, stochastic shocks impact upon these optimality pathways for consumption demand, labour supply and monetary holdings (Dullien, 2009). Deriving pathways through log-linearisation of agents' intertemporal

consumption (Euler) equation at the economy's steady state gives rise to the New Keynesian IS (NKIS) demand function.

$$\gamma_t = E_t \gamma_{t+1} - 1/\sigma (i_t - E_t \pi_{t+1} - r_t^n)$$

(Equation 1. Dullien, 2009. *Appendix*).

Maintaining the microfounded foothold of Real Business Cycle (RBC) models, alongside the Neoclassical, Walrasian assumption of general equilibrium (in which all markets clear instantaneously; Snowdon and Vane 2005), DSGE models attempt to rectify the empirical disparity of some RBC assumptions, by incorporating New Keynesian elements. The first, Calvo pricing, holds that a proportion of firms change prices in each time period, allowing for some level of price-stickiness in the economy (Calvo, 1983). Using constant elasticities of substitution to model aggregate consumption, product heterogeneity is valued, thus allowing for monopolistic competition and firms' mark-up on marginal costs (Dixit and Stiglitz, 1977). Incorporating these assumptions, the economy's supply side is modelled as a New Keynesian Phillips Curve (NKPC).

$$\pi_t = \beta E_t \pi_{t+1} + \kappa \gamma_t$$

(Equation 2. Dullien, 2009)

These equations, and the two aforementioned New Keynesian assumptions, allow for the stabilisation role of monetary policy, in which interest rates are set by an independent central authority in response to fluctuations in output and inflation (compared to the potential and target levels, respectively). The disparity in adjustment times between prices (staggered) and wages

(instant, as the labour market clears) and the deterministic nature of interest rates on demand (NKIS) mean monetary policy is postulated to affect behaviour and the economy’s position.

The observational equivalence in DSGE to traditional macroeconomic theory of lowering interest rates is apparent, with higher demand and output ultimately ensuing. However, the mechanics behind this response and their consequences show clear disparity. As present consumption becomes relatively more attractive, increased demand levels translate to greater labour demand. As the labour market continuously clears by assumption, nominal wages instantaneously rise. With staggered price adjustments, real wages also rise, thus more labour is supplied to meet additional labour demand. Consequentially a full employment equilibrium always ensues as agents intertemporally allocate consumption and leisure for eternity by optimally reacting to economic and labour market conditions.

Allowing endogenous adjustments to money supply, DSGE models could demonstrate significant parallelism to reality, reflecting the private sector’s willingness to accrue debt to undertake investment, and thus the banking sector’s willingness (liquidity) and ability (policy interest rate) to supply credit. An overwhelming limitation of DSGE models however, has been the exclusion of a financial sector from the model, with money supplied simply to meet publicly desired liquidity holdings with no frictional financial intermediaries (Dullien, 2009). The general equilibrium assumption may limit the potential for any meaningful incorporation of money and finance, as money becomes indifferent to any other commodity in the economy. Moreover, any postulated financial sector encompassing rational

expectations creates insurance markets covering all possible future states of the economy, allowing no possibility for endogenous future uncertainties as financial markets are ones of complete information and efficiency (Buiter, 2009).

The linearisation of optimality paths around the steady state assumes away not just “ everything I am interested in” (Charles Goodhart *quoted in* Buiter, 2009) but specifically non-linearity and potentially multiple economic equilibria. In response to additive, stochastic shocks linearised DSGE models exhibit negative feedback loops, returning to the previously determined steady state; suggesting potentially severe policy implications following negative shocks.

The theorised full employment equilibrium, founded upon the underlying Classical labour market, is critiqued in the conclusion that all unemployment must be voluntary; as agents reduce their optimal labour supply level in periods of low demand (due to shocks or raised interest rates) enjoying more leisure at the prevailing real wage. A lack of even recessionary underemployment allows no role for government response, particularly via expansionary fiscal policy, as advised by traditional macroeconomic theories and traditionally-learned economists (Krugman, 2018). With taxation constraining agents’ lifetime budget, rational households lower consumption and leisure in response to foreseen taxation increases necessary to finance government expenditure – whether imminent or delayed (debt financed expenditure). Ricardian Equivalence thus holds theoretically. Deriving individual utility from consumption levels provides the case for solely monetary policy use to influence demand; as fiscal policy may increase

output and employment but interferes with the representative agent’s optimisation, ultimately lowering utility.

A major advantage of the DSGE models is their flexibility. Indeed, the ability of central banks to adapt their model with additional components to better fit the observed economy has been a fundamental source of their popularity. Attempt to rectify the fiscal policy have postulated the existence of ‘ optimising’ households/consumers and ‘ rule of thumb’ consumers (Gali, 2008) – who spend all labour income on present period consumption and solely optimise present period labour supply. Should the proportion of consumers acting as ‘ rule of thumb’ agents be great enough, it is postulated that expansionary fiscal policy will not wholly crowd out private consumption levels at the new equilibrium of higher employment and real wages.

This response to the empirical implausibility of Ricardian Equivalence is an example of how DSGE models differ from alternatives in their ability to be adapted to be more consistent with empirical observations. However, it also highlights a possibly fundamental flaw, as the mechanics of the labour market here still cause employment fluctuations as labour supply reacts to government spending – hence, unemployment is still voluntary even if substantial reduced.

The parameters used in DGSE models – derived in response to the Lucas Critique – are undertaken through a combination of calibration and estimation alongside the use of tight Bayesian priors. Calibration to find prior-known parameters is critiqued to be a rebranded version of Keynesian ‘ identification by assumption’ (Romer, 2016) which was deemed unjustified,

lacking supporting evidence underlying concluded values. Whilst thorough accompanying literature is regularly the basis for derived parameter values, there are often significantly too many to be estimated (Blanchard 2016a). Most notably the use of the same ‘ standard Calvo’ parameters for the unemployment-inflation relationship across different countries has obvious consequences. Furthermore, the standard system estimation misspecification problems apply, and Blanchard notes these are often opaque to the reader of DSGE papers, with poor communication of algebraically-heavy derivations common (Blanchard, 2016a).

Responding to DSGE forecasting futility critiques due to misspecification and informal calibration, econometric frameworks have encompassed both formalised parameter calibration techniques and real frictions. Smets and Wouters (2003) found through analysis of Euro-area data that a large-scale New Keynesian DSGE model, with both real and nominal rigidities, attains a larger marginal likelihood than compared densely parameterized models. Additionally, models incorporating wage market rigidity-contracts (preventing continual, instantaneous clearing) suitably estimate the economy’s response to monetary policy shocks (Christiano et al., 2005).

These labour frictions, however, estimate wage contract renewal on a tri-quarterly basis, despite most negotiations occurring annually (Dullien, 2009). Furthermore, analysis of models’ impulse response functions (response to introduced stochastic trends) finds strong evidence for misspecification in Smets and Wouters’ NK DSGE model, suggesting potentially misleading forecasts and subsequent policy recommendations (del Negro et al., 2007). Whilst relaxed restrictions may account for this error, small changes to

specified Euro-area data are observed to reversal previously observed marginal likelihood rankings (del Negro et al., 2007).

The NKPC equation upon which DSGE is built may be microfounded but also fundamentally flawed – the forward-looking inflation component of the NKPC failing to capture the inherent inertia of inflation – with repairs to do so, almost by assumption, dismissed as unconvincing (Blanchard 2018). Other adaptations of the model, such as encompassing ‘ hand to mouth’ households who optimise on a single-period budget constraint, are often deemed inaccurate representations of true consumer and price/wage setter behaviour (Blanchard, 2016a; Blanchard 2016b).

In an analysis of policy models used by major domestic central banks and international institutions, Coenen et al. (2012) find that a majority use DSGE models. The exception being the FRB-US model of the United States Federal Reserve in which lagged polynomial adjustment cost frameworks allow data to determine the dynamic structure of several parameters and their interactions, from initial microfoundations. Unlike their seminal forefathers (Christiano et al., 2005; Smets and Wouters 2003), many of these policy models also incorporate financial market frictions, with most of those exempt from this following suit after the financial crisis, using integration methods pioneered by Bernanke et al. (Linde et al., 2016). These policy models differ from those in academia in several other ways, namely in accounting for financially-constrained households (between 20 and 50%) who intertemporally allocate consumption and leisure, subject to a period-by-period budget constraint, as well as encompassing a complex fiscal sector

with many different distortionary taxes and types of government expenditure – including transfers directly to households.

DSGE models built on rational expectations restrict the underlying reasons for booms and busts to exogenous, stochastic shocks to the system, which disturb the optimisation of the representative agent (Smets and Wouters, 2007). A growing number of ‘ behavioural’ macroeconomic models assume cognitive limitations of agents. Thus, adaptive learning ensues, with agents evaluating simple forecasting heuristics ex post until the best performing ‘ rules of thumb’ are identified and adhered to (De Grauwe, 2012 pp. 35). This need not be at odds with rational expectations, if adaptive learning is viewed as an appropriate response to increasing levels of complexity agents face in the economy (De Grauwe and Ji, 2017).

Adaptive learning produces endogenous fluctuations in optimism and pessimism when applied to the DSGE model. Furthermore, a dual-causality process is concluded upon in which optimism leads to higher output, which in turn magnifies optimism (De Grauwe and Ji 2019). Importantly, instead of relying on large exogenous disturbances this process endogenizes business cycle explanations and does so with observably close similarity to the non-Gaussian output gap distribution observed in OECD countries (Fagiolo et al., 2008; Fagiolo et al., 2009 *as quoted in* De Grauwe and Ji, 2017).

In summary, as ad-hoc assumptions fail in the deliverance of any central macroeconomic core, DSGE appears the right step in this direction. Their evolution, it seems, may lie in looser microfoundations and different classes of models – with particular advantages to policy use brought about with

relaxed adherence to maximum theoretical purity (Blanchard, 2016a). Policymaking models need not fully diverge from their academic cousins, and can show considerable similarity in shock responses (Coenen et al., 2012) – however consideration of a model's intended purposes should be at the centre of its construction. Successes, whilst limited thus far, will arise though the ability to adapt components in response to criticism and better understanding the complementary role offered by other economic fields.

Appendix

Equations:

E_t : Expectations at time t

γ_t : Output gap at time t

i_t : Nominal interest rate

π_t : Inflation rate

r_t^n : Natural interest rate substituted for discount rate

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