Class 12
Real Business Cycles

NYU LONDON

Intermediate Macroeconomics

C2 Shocks & Propagation

Frisch-Slutsky Paradigm

IMPULSE

PROPAGATION MECHANISM

BUSINESS CYCLES

Most economists agree on what business cycles look like with the key debates being...

What are the impulses generating any particular cycle?
What exactly is the nature of the propagation mechanism?
Should *policymakers offset cyclical fluctuations?*
Can *policymakers offset cyclical fluctuations?*
Do we see problems arising before they occur?

C2 Sources of Business Cycles

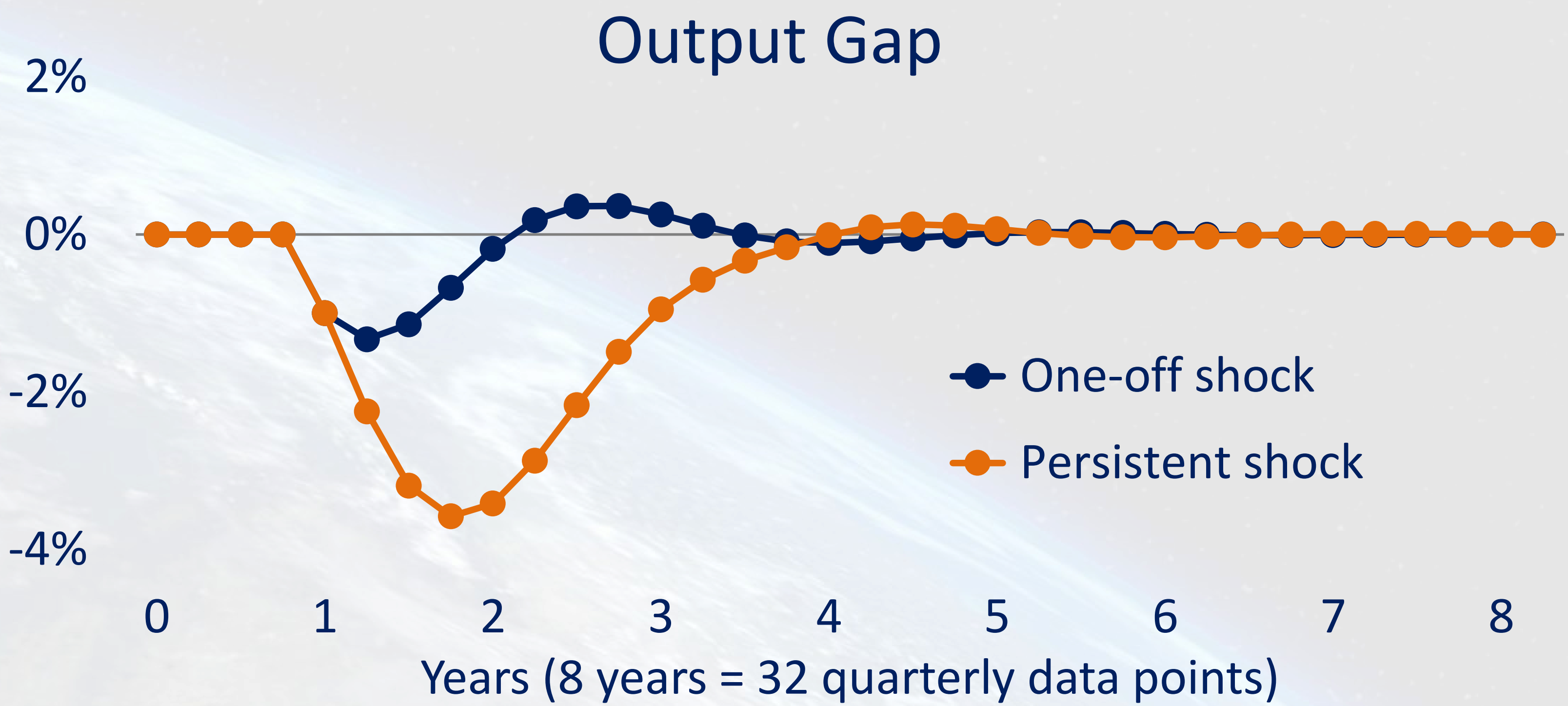
Demand shocks

Changes in **private sector behaviour** can quickly ripple through the economy, creating a business cycle. **Policy intervention** may, or may not work as regards stabilisation (Friedman critique). Sometimes policy will itself be a “shock therapy” to push the economy to a different level.

Supply shocks

Technology and **cost** and **natural** (*eg climate change, disease*) shocks can also create business cycles. However, in some cases, policy intervention might interfere with necessary resource allocation shifts, making the economy worse off.

C2 MA Model & IRFs



Starts in equilibrium (Y=120)
Assume no change in government policy
One-off negative shock worth 1% of potential GDP at start of yr1
Persistent shock also -1% of GDP initially but then gradual fades over 3yrs

[Interactive web app]

Supply Side Stochastics

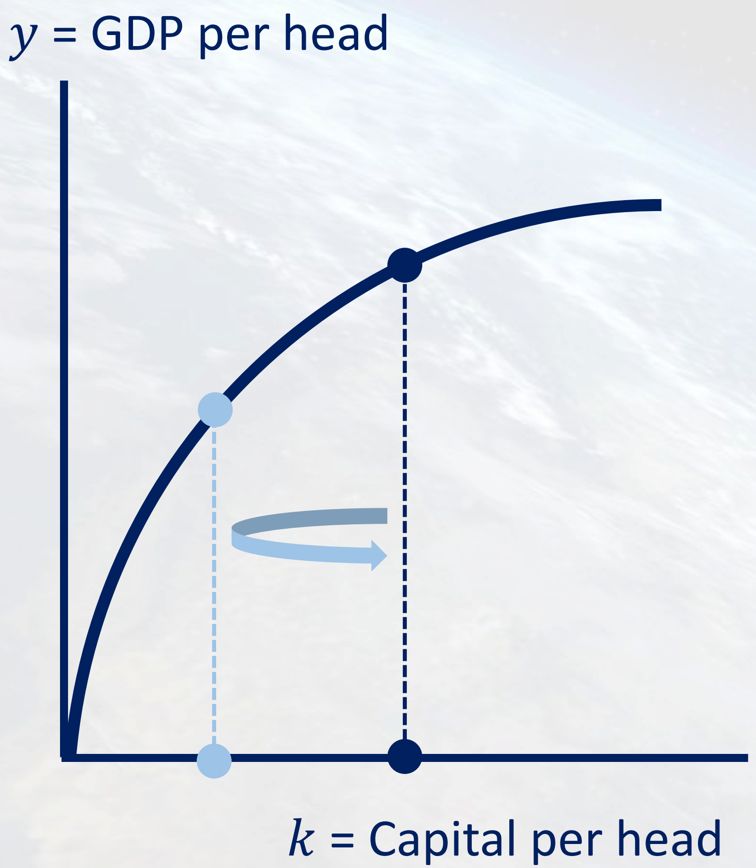
	Positive	Negative
Resource Shock	Discovery of new oil reserves, increasing capital availability Sudden increase in labour force (migration boom)	Natural disaster destroying infrastructure, reducing capital Pandemic reducing labor force participation
Productivity (TFP) Shock	Breakthrough in AI improving production efficiency Institutional reforms enhancing business efficiency	Stricter regulations increasing compliance costs Political instability reducing investor confidence

Shocks can be temporary (one-off or persistent) or permanent

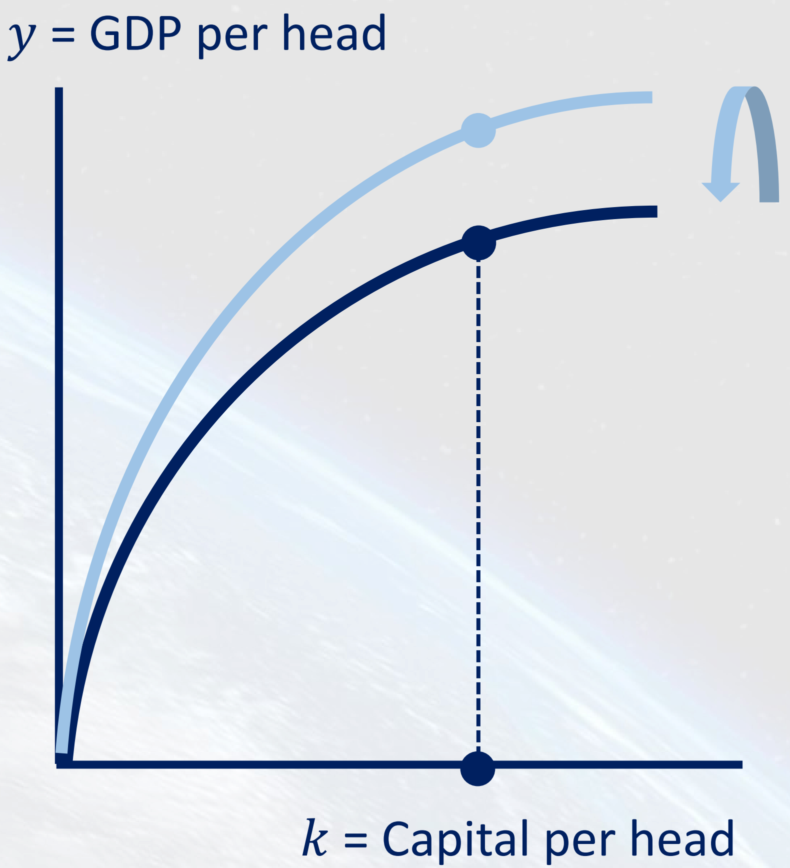
Since permanent shocks can alter the steady state (balanced growth) equilibrium, **business cycle analysis often centres on temporary (typically persistent) shocks**

Supply Side Stochastics

Resource Shock



Productivity (TFP) Shock



Solow & RBC Models

Solow

Fixed savings rate
Exogenous labour supply

Real Business Cycles

Tricky maths!
Microfoundations
Savings endogenous
Labour supply endogenous

Shocks & Cycles

Class 2 Frisch-Slutsky Redux

Real Shocks

Productivity

Household preferences
labour supply/savings

Public spending/taxes

Nominal Shocks

Money supply

Demand for liquidity

Key focus for RBC analysis

Cycles & Productivity

Positive productivity shocks generate booms (above-trend output/jobs)

Negative productivity shocks generate recessions (below-trend output/jobs)

Output always equals equilibrium output

Labour market always clears

Continuous full employment

No involuntary unemployment!

RBC Characteristics

Competitive Price Flexibility

Continuous Equilibrium

Neutral Money (Output/Jobs)

Optimising Representative Agents

Rational Expectations

Time to Build and Aggregate Fluctuations Kydland & Prescott, Nov 1982
Real Business Cycles Long & Plosser, Feb 1983

EXPECTATIONS

Sneak Preview Class 21

Standard Phillips Curve

Inflation today	Outlook for inflation	Excess demand (output gap)	Random stuff eg energy/food price surprises

$$\pi = \boldsymbol{\pi^e} + \gamma(y - \bar{y}) + \epsilon_{PC}$$

What precisely do we mean by “expected inflation”?
... past expectations about what is happening today?
... or today’s views on what might happen in the future?
How are expectations formed?
Does it matter if expectations are disappointed?
Will behaviour change if errors have a systematic pattern?

Expectations Operator

Clearing up timing ambiguities

$$x^e = E_{t-1}x_t$$

previous period's expectation about current value of x

$$x^e = E_t x_{t+1}$$

current expectation about future value of x

$$E_t x_{t-1} = x_{t-1}$$

$$E_t x_t = x_t$$

assuming macro data are published on a timely basis and that no major revisions occur then current expectations about past (and current) values should match actual outturns

Formulating Expectations

Adaptive or Rational?

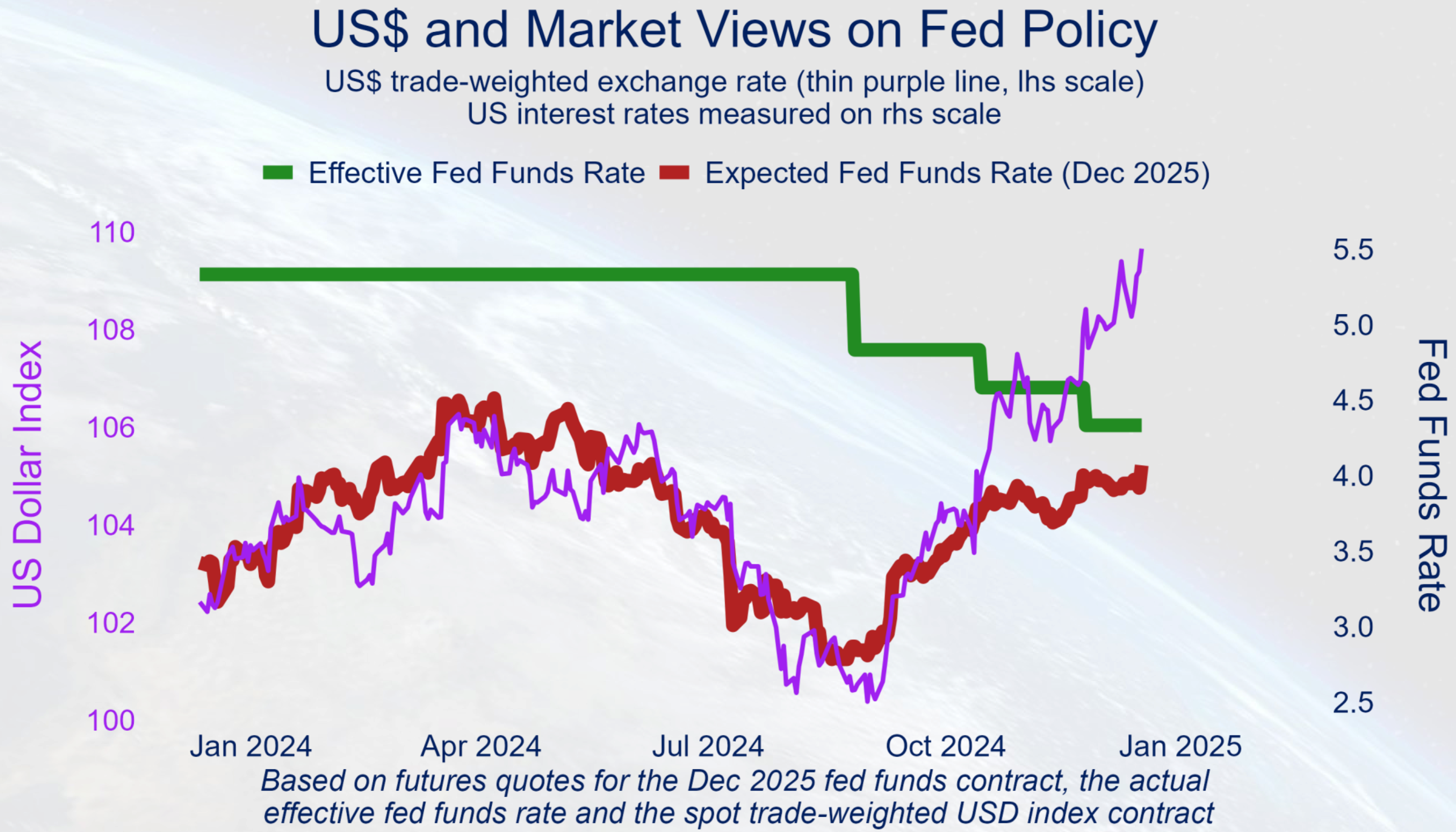
$$E_t x_{t+1} = f(x_t, x_{t-1}, etc)$$

Adaptive approach
Basing expectations on historical patterns

$$E_t x_{t+1} = f(forecasting\ model)$$

Rational approach
Forward-looking
Informed, consistent, unbiased predictions

Real World Expectations



RATIONAL IMPLICATIONS

Lucas Critique

Expectations are endogenous
and forward-looking

When the rules of the game
change so does behaviour

Using past data to predict the future will not
work if authorities alter their policy guidelines

Many forecasting models broke down in the 1970s especially the relationship between inflation and unemployment (the so-called Phillips Curve)

Lucas said such models were naive in assuming that private sector choices would be unresponsive to changes in government and central bank policy rules

Jones textbook, ch13, pp382-383

Time Inconsistency

Unless the authorities make a once-and-for-all self-binding commitment to the optimal policy rule chosen at a specific point in time, private sector agents might expect the authorities to re-optimize at a later date

Time inconsistency can arise because, from the authorities' viewpoint, it might **initially** be optimal to use an announced policy rule (covering current & future time) to "nudge" private sector choices in the near term

However, once private sector agents have committed themselves, the authorities could do better by shifting to a new policy rule.

How can the authorities make private sector agents believe that the policy rule announced today will actually be carried out in future?

Build CREDIBILITY, prove COMMITMENT, adopt BINDING POLICY RULES

Policy Rule Examples

Monetary policy	Cold turkey versus gradualism Money supply and interest rate rules Independent, accountable central banks
Fiscal policy	Multi-year budget plans Index-linked bond issuance External policy auditor/watchdogs
Forex policy	Dollarisation Currency board Irrevocably fixed exchange rates

RBC MODELS

Real Business Cycles

Business cycles reflect productivity (supply) shocks

Fluctuations are a market-clearing phenomenon

Policy intervention hinders required adjustments

RBC in Action: Technology

A positive technology shock would generate an outward shift in an economy's production possibility frontier. Productivity improvements would boost real wages and, probably, encourage more labour supply.

So output will be boosted by:
direct impact of the technology shock, and,
indirect impact of the rise in labour supply

Part of the increased output will be saved (and invested), boosting the capital stock and further increasing incentives for additional labour supply. Eventually the impact dies out but in the intervening years a **real business cycle** will be observed.

Two key points about such cycles

Cycle is supply-side driven

Policy intervention likely to be sub-optimal

RBC Model Components

Pulling Together Earlier Class Material

Labour supply choice
Utility maximising household
Cobb-Douglas production function
Marginal productivity & factor rewards
Euler equation & intertemporal consumption
Capital accumulation (fundamental equation)

Specific Numerical Assumptions

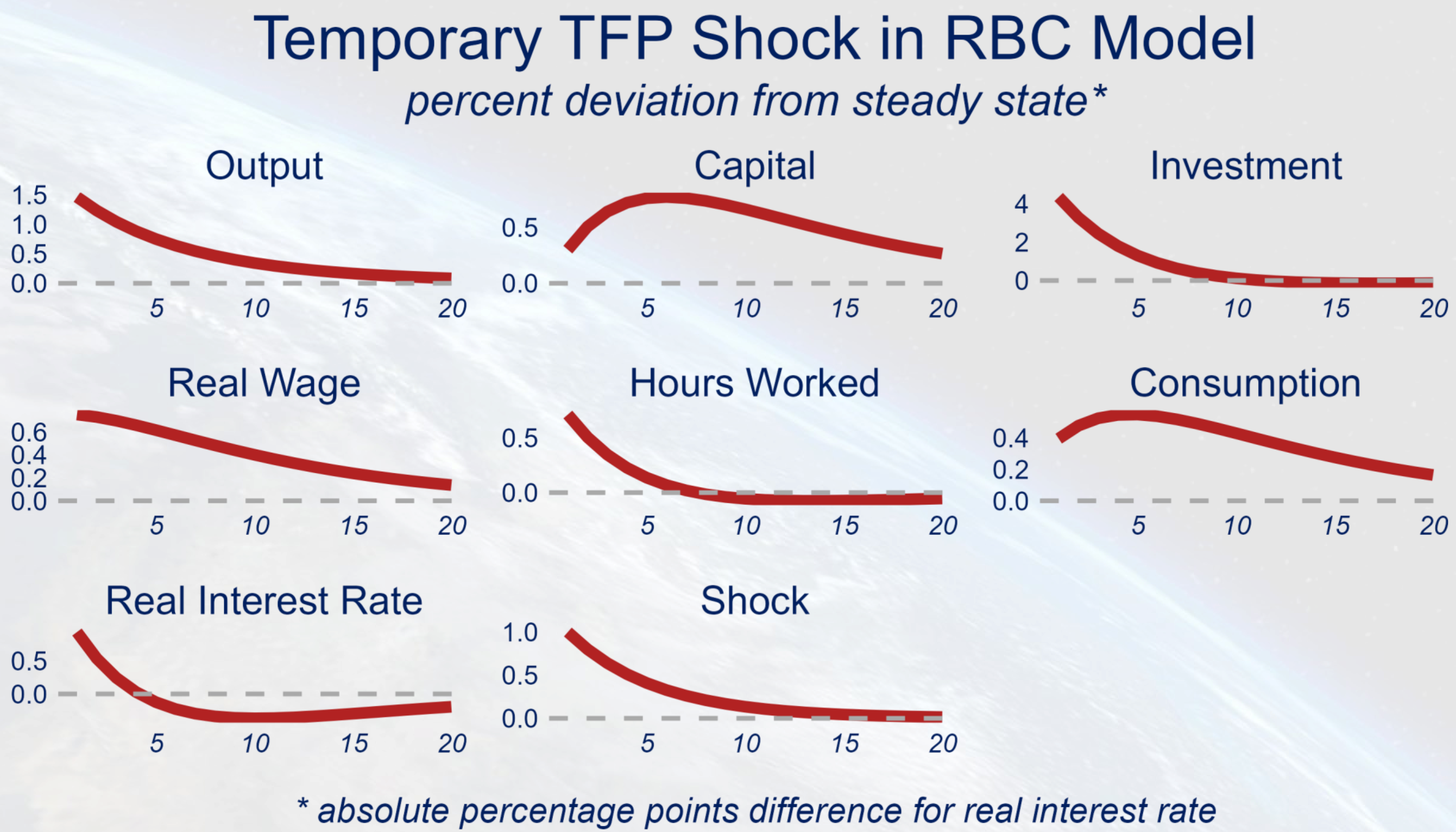
Capital share	35%
Rate of time preference	2%
Steady state growth (TFP)	1%
Depreciation rate	6%
Normal working day	8hrs

The model has 11 variables, of which 3 are forward-looking, requiring specialist software to solve (covered in advanced/postgraduate macro courses). The steady state value of R-Star generated is 3% which, less the rate of time preference, equals steady state growth. The steady state savings ratio is 27%.

For this course, you only need to focus on interpreting the output - specifically, the impact on key endogenous variables when we shock the economy.

To do this, we look at **impulse response functions** tracking i) a temporary, positive technology shock, and, ii) a temporary increase in government spending.

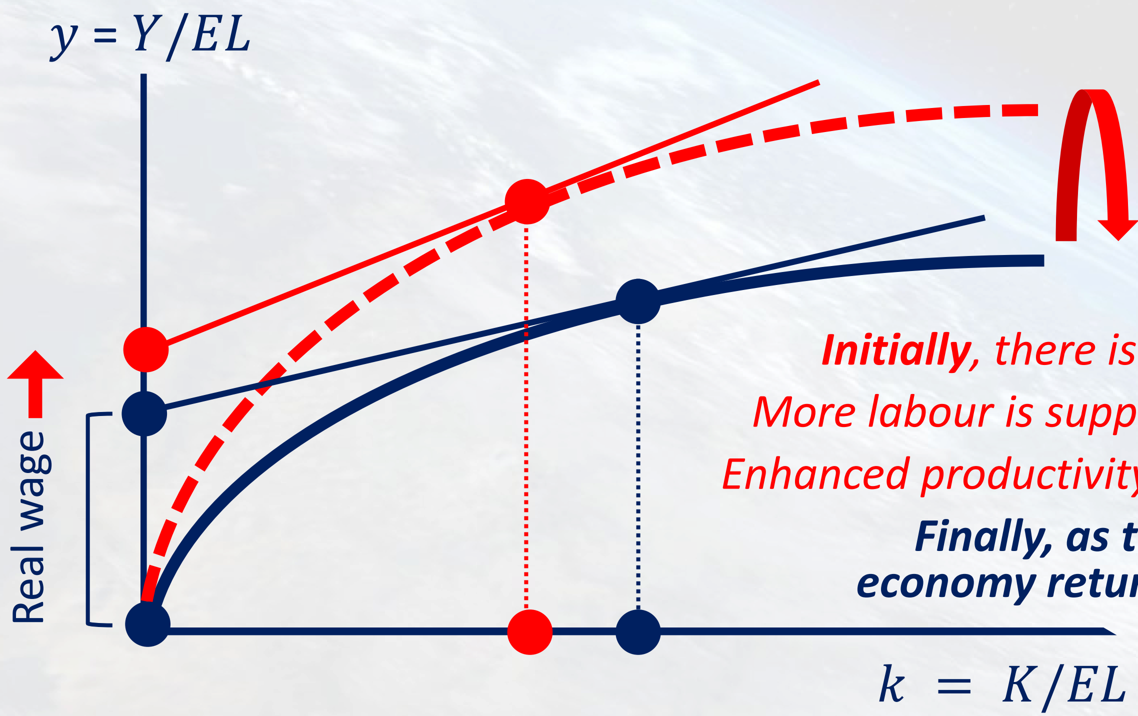
Standard Simulation



Temporary TFP Shock

$$Y(t) = A(t)f(K(t), L(t))$$

Positive TFP shock increases output for given levels of inputs = supply-side driven upswing



On **impact**, GDP, APL and real interest rates rise; something resembling a business cycle then follows before original equilibrium finally restored

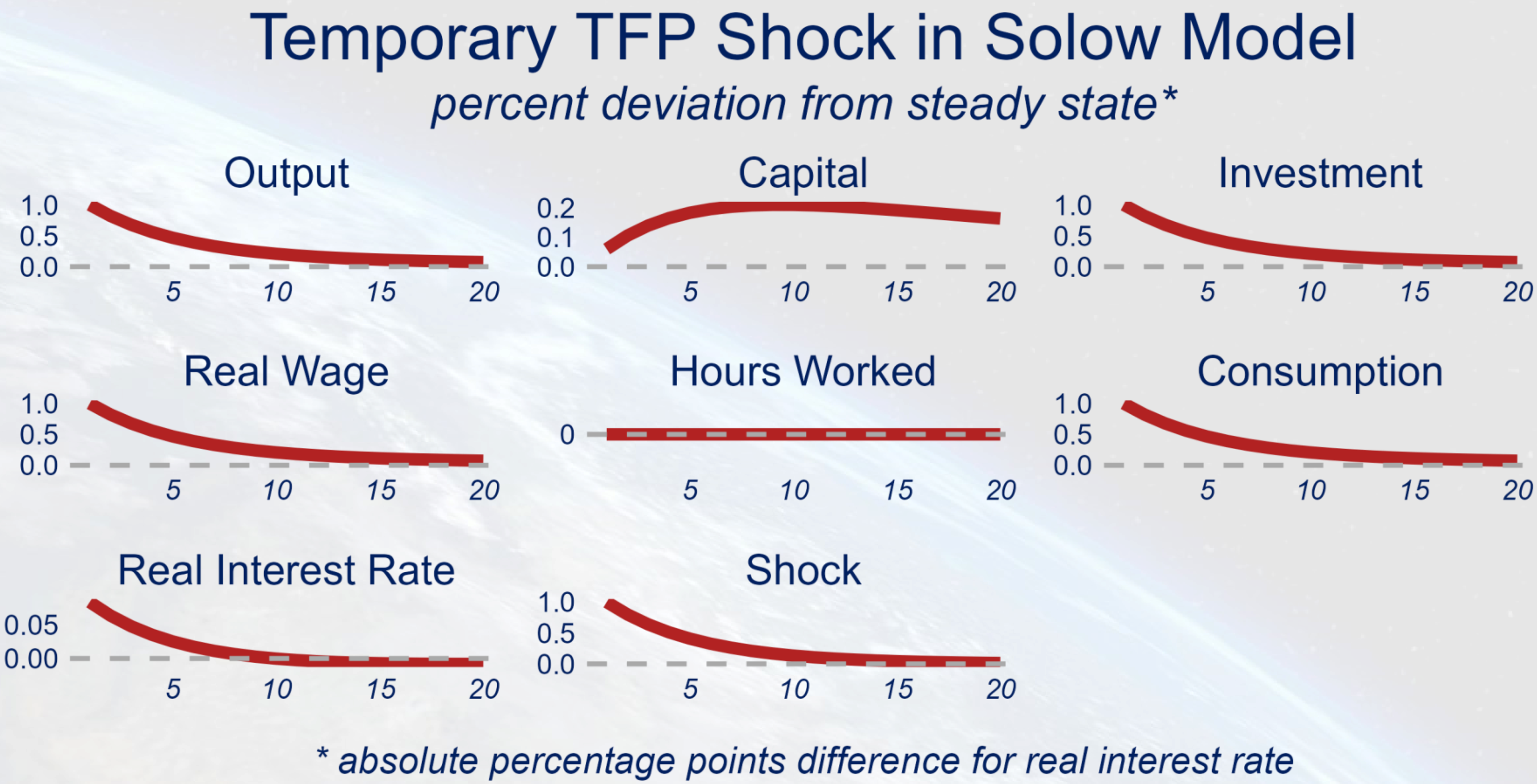
***Initially**, there is a lower capital intensity*

More labour is supplied given higher real wages

Enhanced productivity delivers a GDP/jobs upswing

Finally, as the shock fades, the economy returns to its original state

Compare with Simple Solow



Similar assumptions are made to those in the earlier RBC model (capital exponent, depreciation rate) but here labour is fixed as is the savings ratio (assumed to be 25%). An illustrative spreadsheet is available on the course website

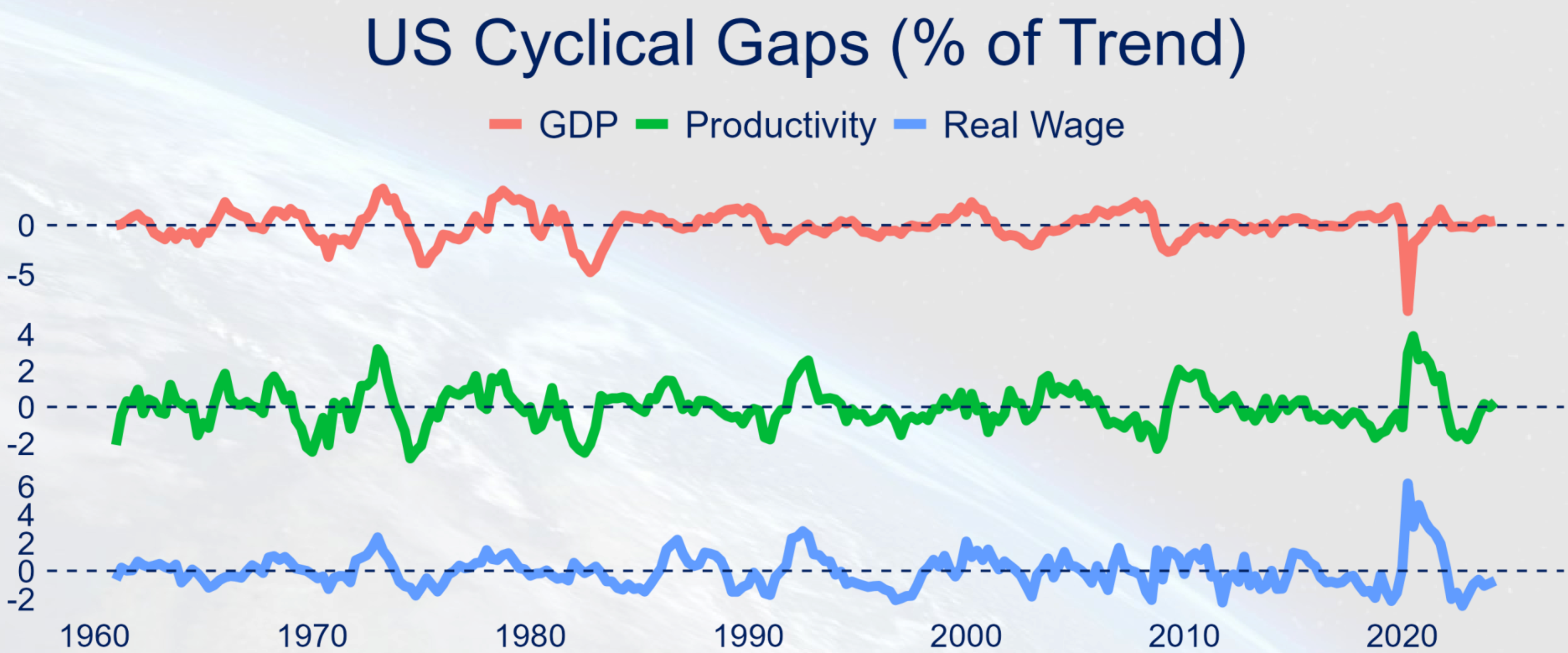
RBC Predictions

If RBC theorists are right that most cycles are generated by TFP shocks then the model predictions of…

procyclical employment
procyclical real wages
procyclical productivity

… should be reflected in the data

Data Exploration I



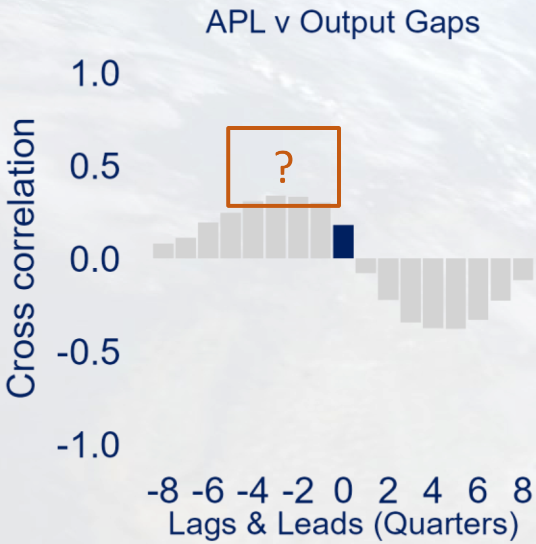
FRED codes: GDPC1, GDPPOT, OPHNFB, COMPRNFB
Data transformations and graphics using R

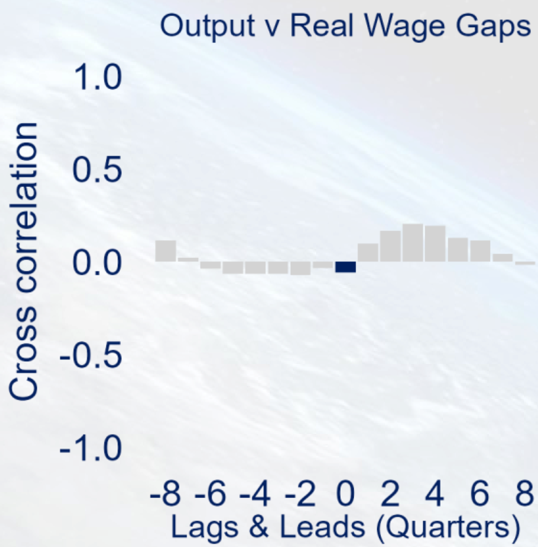
Cyclical gaps were calculated using a popular smoothing technique called the [Hodrick-Prescott filter](). For GDP the HP filtered gaps have around a 75% correlation with the "official" numbers implied by the CBO's estimates of potential GDP.

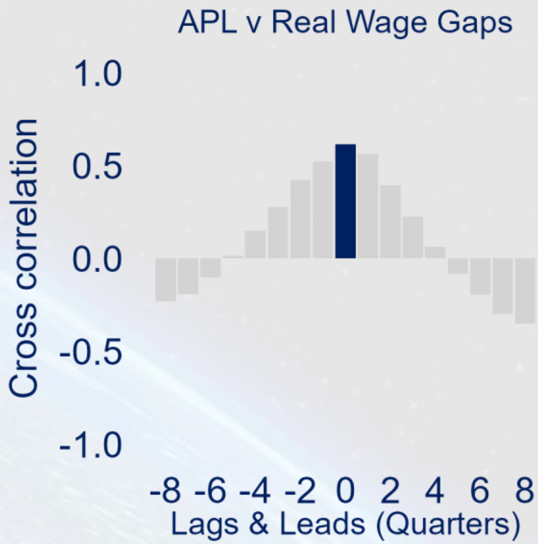
Data Exploration II

The contemporary correlation of estimated cyclical gaps for US GDP and productivity (APL = average product of labour) is less than 30% and that between GDP and real wage gaps is effectively zero. The correlation between real wage and productivity gaps is 50%. **Even when leads and lags are considered, the data suggest that the RBC "big idea" about the source of business cycles is incomplete.**

Solid bars refer to contemporaneous correlation (not necessarily the strongest)





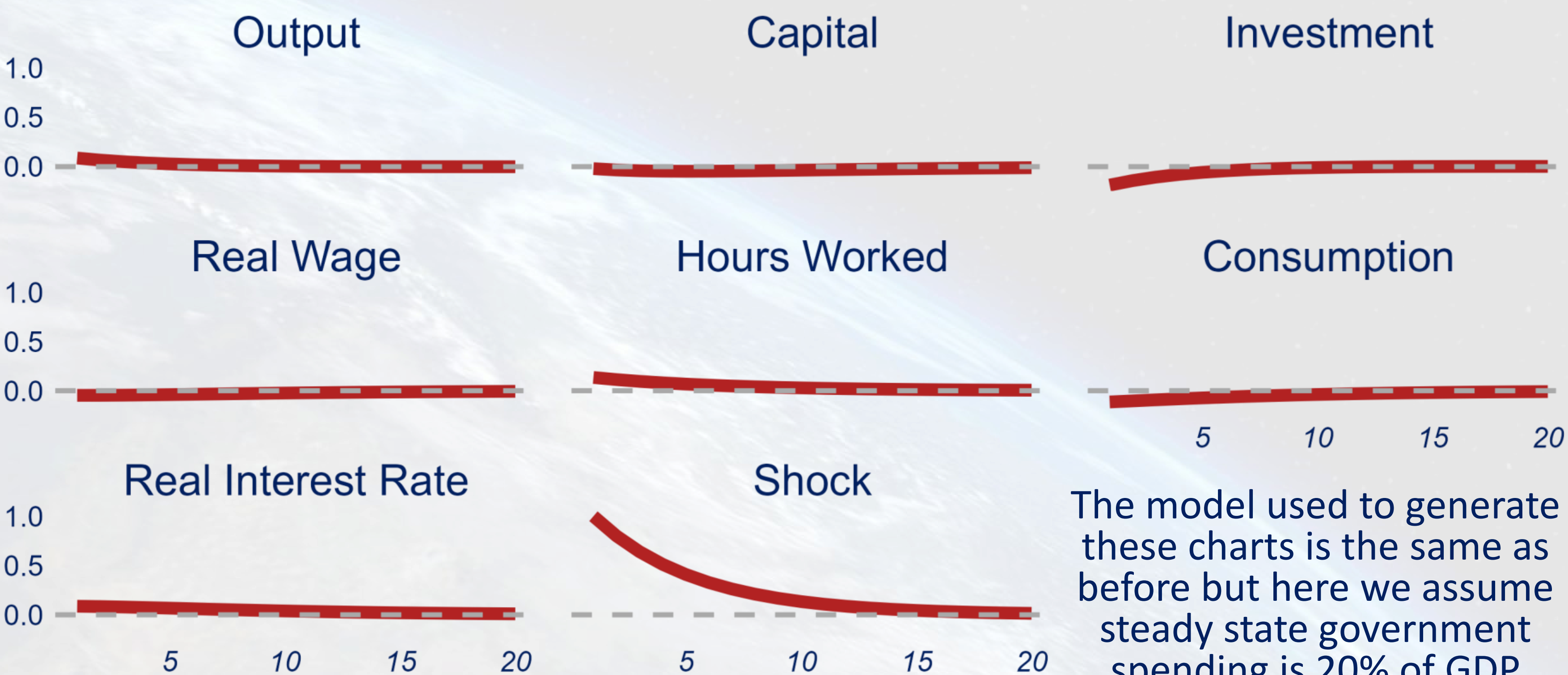


? ***Interpretation:*** *large cross-correlations for negative values on the horizontal axis suggest that the first named variable is a leading indicator for the second named variable (and vice versa). So, the left diagram suggests +ve APL shocks lead to +ve output gap outcomes, around 1yr in advance.*

RBC Crowding Out

Temporary Government Spending Shock

*percent deviation from steady state**



The model used to generate these charts is the same as before but here we assume steady state government spending is 20% of GDP

** absolute percentage points difference for real interest rate*

RBC Too Extreme?

Partial theory

Poor data support

Sticky prices?

Market failures?

But not all bad!

Supply shocks matter
Forward looking behaviour
Policy credibility important
(in sync with 80s political zeitgeist)

RBC & DSGE Models

RBC

Supply focus
Mainly tech shocks
Ideal, complete markets

DSGE

Frisch-Slutsky redux
More reality & "grit"
New Keynesian features
Resampling (Bayesian)
Computing power

Optional Extras on Rational Expectations in Currency & Interest Rate Markets

Rational Expectations

Forex Application: Interest Rate Parity

INITIAL, period t

Two countries with floating currency regimes,
Same price levels, inflation rates/targets & interest rates, zero risk
Equilibrium exchange rate (real & nominal)

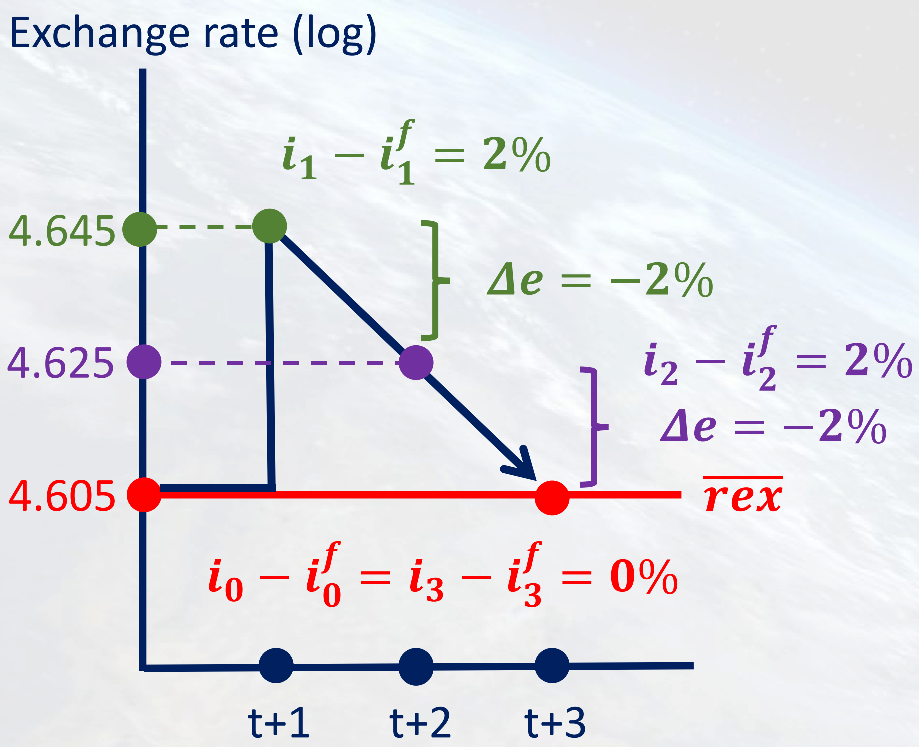
$$E_0 = \frac{E_0 P}{P^f} = \overline{REX} = 100; \; \log E_0 = e_0 = \overline{rex} = 4.605$$

$\Delta \log E = \Delta e =$ % change in exchange rate

UNANTICIPATED SHOCK, period t+1

Home one-period (annual) interest rate increases by
2% (200bp) and now fully expected to remain elevated
at that level for both period t+1 and t+2. Credible forward
guidance points to original interest rate being restored in period t+3

Currency Overshooting



Interest Rate Parity (IRP)

$$e = e^e + i - i^f \Rightarrow$$

$$e^e - e = \boldsymbol{\Delta e} = -(\boldsymbol{i} - \boldsymbol{i^f})$$

Forward-looking % change in currency equals interest rate differential but with opposite sign

Higher home interest rate means that spot rate jumps and forward discount created. Market forces ensure that positive yield gain in any period is offset by currency loss in the same period.

But how big is the spot rate jump?
2%? No, answer is 4% since the rate differential persists for two periods
= FX overshooting

Solving for RE

Simple trick

Work *backwards* since we know that exchange rate and interest rate differential will return to previous equilibrium from period $t+3$

Also assume perfect foresight (special case of rational expectations)

Ambiguous and varies through time! Hence why we use the expectations operator

Post-shock markets fully expect the exchange rate to be back in equilibrium in t+4

$$e_4 = 4.605 \Rightarrow E_4 = 100.0$$

$$E_{t+3}(e_{t+4}) = \boxed{e^e} = e_3 - \left(i_3 - i_3^f\right) = e_3 - 0.00 = \boxed{4.605} \Rightarrow e_3 = 4.605 \Rightarrow E_3 = 100.0$$

$$E_{t+2}(e_{t+3}) = e^e = e_2 - \left(i_2 - i_2^f\right) = e_2 - 0.02 = 4.605 \Rightarrow e_2 = 4.625 \Rightarrow E_2 = 102.0$$

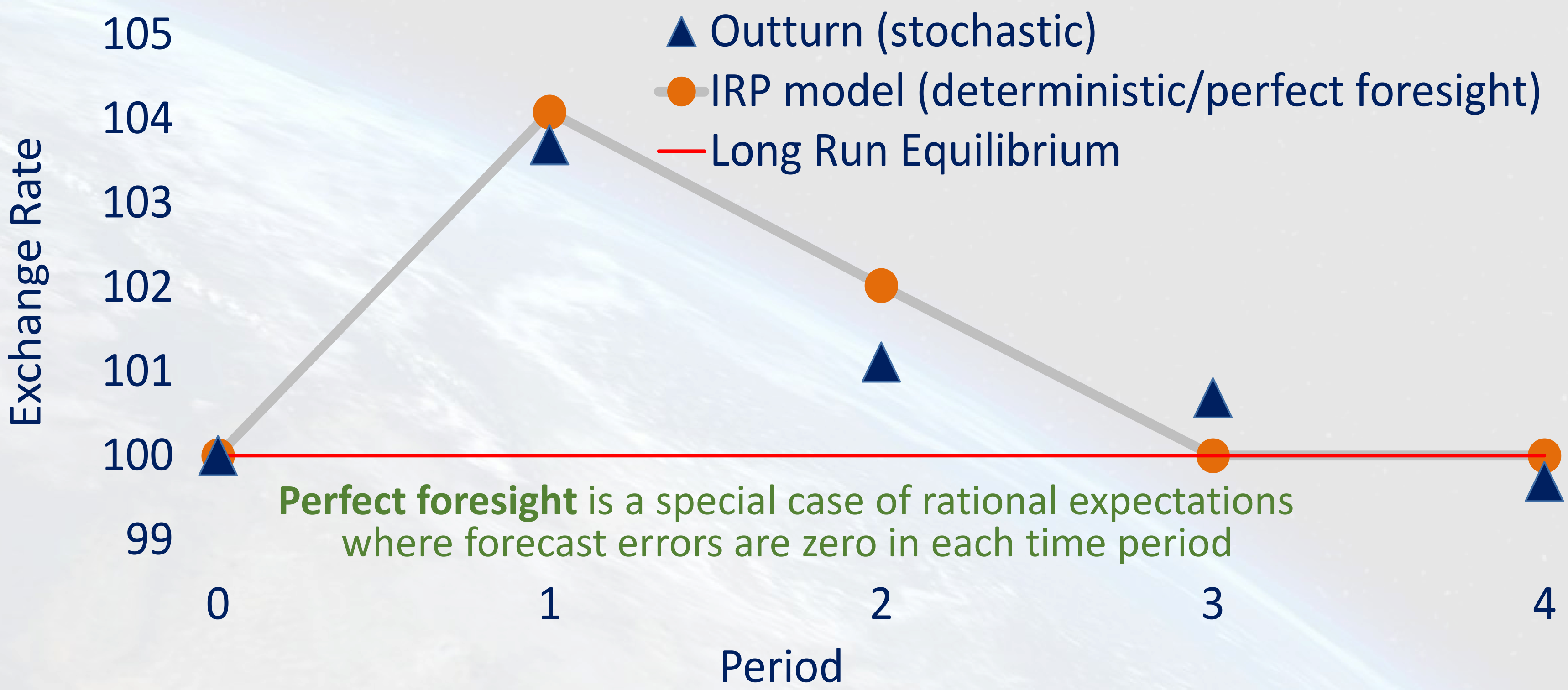
$$E_{t+1}(e_{t+2}) = e^e = e_1 - \left(i_1 - i_1^f\right) = e_1 - 0.02 = 4.625 \Rightarrow e_1 = 4.645 \Rightarrow E_1 = 104.1$$

$$E_{t+0}(e_{t+1}) = e^e = e_0 - \left(i_0 - i_0^f\right) = e_0 - 0.00 = 4.605 \quad e_0 = 4.645 \Rightarrow E_0 = 100.0$$

Note that once the shock is absorbed in $t+1$ then

$E_{t+1}(e_{t+3}) = E_{t+2}(e_{t+3})$ and $E_{t+1}(e_{t+4}) = E_{t+2}(e_{t+4}) = E_{t+3}(e_{t+4}), etc$

Adding Stochastics



Excel-driven simulation assuming that "errors" follow normal distribution with zero mean and unit standard deviation