Answers and Questions

Econ 314: Project 1
Trends, Cycles, and Turning Points

Examining the Growth Data
The Growth Experience

GDP Growth in 20 Countries
Linearity in levels or logs: France

![Graph showing the growth of GDP and log GDP over time in France](attachment:image.png)
Linearity in levels or logs: Ireland
Cycle Turning Points

GDP Growth in the UK

Peaks

Troughs

lgdp

Fitted values

1940 1960 1980 2000 2020

year

13 13.5 14 14.5

13 13.5 14 14.5

Fitted values
Compounding and Growth Rate Formulas

Measuring Growth Rates
Trend growth vs. average growth

- Trend rate is slope of best-fit line
- What is average growth rate?

From period 0 to 2:

\[
\bar{g} = \frac{(\ln GDP_2 - \ln GDP_1) + (\ln GDP_1 - \ln GDP_0)}{2} = \frac{\ln GDP_2 - \ln GDP_0}{2}.
\]
Trend growth vs. average growth

- Trend rate is slope of best-fit line
- What is average growth rate?

From period 0 to T:

\[
\bar{g} = \frac{(\ln GDP_T - \ln GDP_{T-1}) + \ldots + (\ln GDP_1 - \ln GDP_0)}{T} \\
= \frac{\ln GDP_T - \ln GDP_0}{T}.
\]
## Trend and average growth rates

<table>
<thead>
<tr>
<th>Country</th>
<th>Trend growth</th>
<th>Average growth</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Annually comp</td>
<td>Continuously comp</td>
<td></td>
</tr>
<tr>
<td>Argentina</td>
<td>2.40%</td>
<td>2.84%</td>
<td>2.69%</td>
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<td>Australia</td>
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<td>3.78%</td>
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<td>3.33%</td>
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<td>4.03%</td>
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<td>3.40%</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>4.87%</td>
<td>5.01%</td>
<td>4.82%</td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>4.47%</td>
<td>4.69%</td>
<td>4.51%</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>4.10%</td>
<td>4.60%</td>
<td>4.43%</td>
<td></td>
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<tr>
<td>United Kingdom</td>
<td>2.38%</td>
<td>2.52%</td>
<td>2.47%</td>
<td></td>
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<tr>
<td>United States</td>
<td>3.18%</td>
<td>3.34%</td>
<td>3.26%</td>
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</tr>
</tbody>
</table>
Trend growth vs. average growth

\[ \ln GDP_T - \ln GDP_0 \]

\( T \)

\( \text{Actual Log GDP - Egypt} \)

\( \text{Fitted values} \)
Is Trend Growth Stable?
Is the trend stable?

Single Trend for Japan

Year
1940 1960 1980 2000 2020

LGDP

Fitted values
Is the trend stable?

Stability Test for Japan

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 58</th>
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</thead>
<tbody>
<tr>
<td>Model</td>
<td>42.0122524</td>
<td>3</td>
<td>14.0040841</td>
<td>F( 3, 54) = 3803.57</td>
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<tr>
<td>Residual</td>
<td>0.198818807</td>
<td>54</td>
<td>0.00368183</td>
<td>Prob &gt; F = 0.0000</td>
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<tr>
<td>Total</td>
<td>42.2110712</td>
<td>57</td>
<td>0.740545109</td>
<td>R-squared = 0.9953</td>
</tr>
</tbody>
</table>

Adj R-squared = 0.9950

Root MSE = 0.06068

| lqdp | Coef.   | Std. Err. | t   | P>|t| | [95% Conf. Interval] |
|------|---------|-----------|-----|------|----------------------|
| year | 0.0848916 | 0.0017893 | 47.44 | 0.000 | 0.0813043 0.0884789 |
| d    | 117.6017  | 4.095852  | 28.71 | 0.000 | 109.39 125.8133 |
| dyear| -0.059565  | 0.0020801 | -28.64 | 0.000 | -0.0637353 -0.0553948 |
| _cons| -153.1541 | 3.509732  | -43.64 | 0.000 | -160.1907 -146.1175 |
Is the trend stable?

Two-Piece Trend for Japan

- Lgdp
- Fitted values
Cyclical series with unstable trend

Cyclical GDP with single trend

Year

GDP

1940 1960 1980 2000 2020
Cyclical GDP: Split trend

Japan Cyclical GDP with 2 Trends

clgdp
dgdp
0
-0.5
-1
0.05
0.1
0.15
1940 1960 1980 2000 2020

Year
Are there two breaks?

Three-Piece Trend for Japan


LGDP: Fitted values

- Igdp
- Fitted values
Cyclical series with two breaks

Japan Cyclical GDP with Three-Piece Trend
## Pre- and post-1973 trend growth rates

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>3.45%</td>
<td>1.88%</td>
<td>-1.57%</td>
</tr>
<tr>
<td>Australia</td>
<td>4.69%</td>
<td>3.39%</td>
<td>-1.30%</td>
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<tr>
<td>Canada</td>
<td>4.49%</td>
<td>2.82%</td>
<td>-1.67%</td>
</tr>
<tr>
<td>Chile</td>
<td>4.09%</td>
<td>4.96%</td>
<td>+0.87%</td>
</tr>
<tr>
<td>Finland</td>
<td>4.49%</td>
<td>2.43%</td>
<td>-2.06%</td>
</tr>
<tr>
<td>France</td>
<td>4.97%</td>
<td>2.16%</td>
<td>-2.81%</td>
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<tr>
<td>Ireland</td>
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<td>4.63%</td>
<td>+1.51%</td>
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<tr>
<td>Italy</td>
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<tr>
<td>Japan</td>
<td>8.49%</td>
<td>2.53%</td>
<td>-5.96%</td>
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<td>Mexico</td>
<td>6.32%</td>
<td>2.80%</td>
<td>-3.52%</td>
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<tr>
<td>Spain</td>
<td>6.63%</td>
<td>2.87%</td>
<td>-3.77%</td>
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<tr>
<td>United Kingdom</td>
<td>2.64%</td>
<td>2.41%</td>
<td>-0.23%</td>
</tr>
<tr>
<td>United States</td>
<td>3.60%</td>
<td>3.01%</td>
<td>-0.59%</td>
</tr>
</tbody>
</table>
Hodrick-Prescott filter: Japan

HP Filter (lambda=100) for Japan

![Graph showing Hodrick-Prescott filter for Japan's GDP](#)
Hodrick-Prescott filter: Ireland

HP Filter for Ireland

Year

lgdp

H_lgdp_sm_1

1940 1960 1980 2000 2020
Separating trend and cyclical components

- No “correct” way to do it
  - Obvious changes in underlying growth rate should be tracked in the trend component
  - Obviously temporary deviations from the trend should be left in the cyclical component

- Piecewise linear trends
  - Assume discrete changes in trend rate
  - Appropriate where discrete event (revolution?) can be assumed to cause change

- HP filter and other, similar methods
  - Trend rate can change continuously
  - HP trend will, to some extent, follow all changes in series
Conclusions

- Most economies grow
  - Growth explains most of the variation in GDP
- Underlying growth rates vary over time
  - Changes in growth rates may result from specific event at specific date
  - Or may be gradual slowdowns or speedups
- GDP fluctuates considerably around its trend
  - Fluctuations are called “cycles” even if they aren’t
  - Traditional “business cycle” has a period of 3-8 years
- We’ll spend the first section of the course understanding trend growth, then the next section looking at fluctuations around the trend