PART 4 Theory of Economic Fluctuations

4.1 Business Cycles
4.2 The IS-LM model
4.3 The AD-AS model
4.4 (Neo-) Classical Models of Fluctuations,
4.5 (New-) Keynesian Models of Fluctuations
(Neo-) Classical Models of Fluctuations

(Neo-) Classical models assume well-functioning markets with flexible prices and wages. Neo-classical models assume dynamic optimizing decision-making by rational forward looking agents.

Two key questions about business cycles:

- What are the underlying shocks/events?
  
  **real (supply) shocks**
(Neo-) Classical Models of Fluctuations

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Two key questions about business cycles:

- What are the underlying shocks/events?

  **real (supply) shocks**

- What should government policymakers do about them?

  **usually nothing**, economy is *always* at potential output and full employment
Real Business Cycle Theory

Real business cycle (RBC) theory due to F. Kydland and E. Prescott

**Real shocks** to the economy are the primary cause of business cycles, e.g.

- Shocks to the production function
- Shocks to the size of the labor force
- Shocks to the real quantity of government purchases
- Shocks to the spending and saving decisions of consumers (affecting the IS curve)

**Nominal shocks** are shocks to money supply or demand (affecting the LM curve) and are neutral: classical dichotomy.
Real Business Cycle Theory

According the RBC theorists, the largest role is played by shocks to the production function or *productivity shocks* ($A$).

Examples of productivity shocks:
- Development of new products or production techniques
- Introduction of new management techniques
- Changes in the quality of capital or labor
- Changes in the availability of raw materials or energy
- Unusually good or bad weather
- Changes in government regulations affecting production
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**RBC theory**: Most economic booms result from beneficial productivity shocks; most recessions are caused by adverse productivity shocks.
Real Business Cycle Theory

We know from AD-AS analysis that after an decrease in $A$:

- Real wage, employment, output, consumption, and investment decline, while the real interest rate and price level rise
- Output always equals full-employment output
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Is this consistent with the business cycle facts?

YES! (most of them)
Empirical Success of RBC

- If the economy is continuously buffeted by productivity shocks, the theory predicts *recurrent fluctuations in aggregate output*. 

Note: If booms are not due to productivity shocks, we would expect average labor productivity to be countercyclical because of diminishing marginal product.
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- The theory predicts \textit{procyclical consumption and investment}.
- The theory predicts \textit{procyclical average labor productivity}.

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- But Kydland and Prescott disagree and conclude that, apart from certain episodes, prices are countercyclical.
  - Are prices countercyclical and coincident?
  - Or procyclical and lagging?
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- But Kydland and Prescott disagree and conclude that, apart from certain episodes, prices are countercyclical.
  - Are prices countercyclical and coincident?
  - Or procyclical and lagging?
- The surge in inflation during the recessions associated with the oil price shocks of 1973-1974 and 1979-1980 is consistent with RBC theory.
Prices pro- or countercyclical?
The basic insights from the RBC model can be derived from the flexible price AD-AS model.
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But, the contribution of the RBC theorists far exceeds the basic idea that supply shocks drive fluctuations.

Perhaps the greatest contribution is methodological:

1. Microfoundations
2. Rational expectations
3. Lucas critique
4. Quantitative predictions
5. Welfare Analysis
Microfoundations

Microeconomic structure of an RBC model:

- Economy is inhabited by many agents, households and firms.
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- Economic decision making depends on preference and technology parameters, instead of reduced from parameters such as $I_r, MPC,...$
- All markets are competitive
- In general equilibrium, prices are such that all markets clear at all times
Rational expectations

- Economy is subject to random events: stochastic shocks
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- Agents are forward looking: their decisions in period $t$ depend on expectations about $t + 1$, $t + 2$, ...

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  **Agents use all available information to make the best possible forecast of the values of future variables.**
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Motivation: People intelligently pursue their economic self-interests

If people expectations are not rational, the economic plans people make would not be as good as they could be
Lucas critique

RBC models are robust to the Lucas’ critique to macroeconomic policymaking.
Lucas critique

RBC models are robust to the **Lucas’ critique** to macroeconomic policymaking.

Many models used for the evaluation of macro policies use the IS-LM/AD-AS framework:

**Step 1**  An econometric model estimates the parameters of the IS-LM model (slopes and intercepts of the IS,LM,AD,AS curves) through statistical analysis of the data.

**Step 2**  Projections are made of exogenous variables (variables outside the model), like oil prices and changes in productivity, that shift the curves.

**Step 3**  The model is solved for the values of endogenous variables, such as $Y$, $N$, and $r$ for different possible policy actions.
Example: the DRI model

Data Resources Incorporated/DRI model: estimates of the fiscal multipliers in the IS-LM model under 2 different assumptions of the reaction of monetary policy.

<table>
<thead>
<tr>
<th>Assumption About Monetary Policy</th>
<th>VALUE OF MULTIPLIERS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal interest rate held constant</td>
<td>$\Delta Y/\Delta G$</td>
<td>1.93</td>
<td>$\Delta Y/\Delta T$</td>
</tr>
<tr>
<td>Money supply held constant</td>
<td>$\Delta Y/\Delta G$</td>
<td>0.60</td>
<td>$\Delta Y/\Delta T$</td>
</tr>
</tbody>
</table>

*Note: This table gives the fiscal-policy multipliers for a sustained change in government purchases or in personal income taxes. These multipliers are for the fourth quarter after the policy change is made.*

Lucas critique

Lucas’ critique to this approach:

When policymakers evaluate their policies, they need to know how people’s expectations will respond to the policy change.

Traditional methods of policy evaluation, as described above, do not adequately take into account the impact of policy on expectations.
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Traditional methods of policy evaluation, as described above, do not adequately take into account the impact of policy on expectations.

A change in policy may change the slopes of the IS, LM, AD, AS curves and therefore invalidate the estimates of those slopes based on historical data.

RBC models address these issues as agents reoptimize after a change in policy under rational expectations.
Quantitative predictions

A major element of RBC theory is that it attempts to make quantitative, not just qualitative, predictions about the business cycle.

RBC theorists use the method of *calibration* to work out a detailed numerical example of the theory:

- First they write down specific production and utility functions explaining the behavior of people in the economy;
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- First they write down specific production and utility functions explaining the behavior of people in the economy;
- Then they use existing micro studies and macro data to choose numbers for parameters, for example, $\alpha = 0.3$;
- Next they simulate what happens when the economy is hit by various shocks to different sectors of the economy;
- These computer simulations match post-World War II data really well.
Actual versus simulated volatilities of key macroeconomic variables
Actual versus simulated correlations of key macroeconomic variables with GNP
Welfare Analysis

Because the economy is modeled through utility maximization, it is possible to conduct welfare analysis.

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The supply shocks are not always desirable. But once they occur, fluctuations in output, employment, and other variables are the optimal responses to them.
Effects of Fiscal Policy

Neoclassical models do not predict that fiscal policy is neutral.

- Changes in government spending have wealth effects on labor supply (+) and private consumption (-).
- Changes transfers and lump-sum Taxes are neutral (Ricardian Equivalence)
- *Proportional* Labor or Capital Income Taxes distort decisions and discourage working and investment.

Yet, activist fiscal policy is undesirable because it decreases welfare.
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An Increase in G with income effects on labor supply.
Criticisms of RBC theory

Critique 1: Elasticity of labor supply is small
Criticsims of RBC theory

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If the labor market always clears/prices are flexible, then changes in output are determined by

\[
dY = \left( F_K + \frac{F_N ND_K}{1 + \frac{ND_w}{NS_w}} \right) dK + \left( F_A + \frac{F_N ND_A}{1 + \frac{ND_w}{NS_w}} \right) dA \quad \text{(Long run GE)}
\]

If the production function is \( F(A, K, N) = AK^\alpha N^{1-\alpha} \) and labor supply is \( N = w^\xi \) where \( \xi > 0 \) is a constant, then

\[
\Rightarrow \frac{dY}{Y} = \frac{1 + \xi}{1 + \alpha \xi} \frac{dA}{A} + \alpha \frac{1 + \xi}{1 + \alpha \xi} \frac{dK}{K}
\]
This comes from solving:

\[ Y = AK^\alpha N^{1-\alpha} \Rightarrow \frac{dY}{Y} = \frac{dA}{A} + \alpha \frac{dK}{K} + (1 - \alpha) \frac{dN}{N} \]  

(Production)

\[ N = w^\xi \Rightarrow \frac{dN}{N} = \xi \frac{dw}{w} \]  

(Labor Supply)

\[ w = A \left( \frac{K}{N} \right)^\alpha \Rightarrow \frac{dw}{w} = \frac{dA}{A} + \alpha \frac{dK}{K} - \alpha \frac{dN}{N} \]  

(Labor Demand)
Criticisms of RBC theory

\[
\frac{dY}{Y} = \frac{1 + \xi}{1 + \alpha \xi} \frac{dA}{A} + \alpha \frac{1 + \xi}{1 + \alpha \xi} \frac{dK}{K}
\]

\(\xi = wNS_w/N\) is the wage elasticity of labor supply (aka the intertemporal elasticity of substitution of labor), and reflects the slope of the labor supply curve.

- \(\xi\) high: large response of \(N\) to changes in real wage
- \(\xi\) low: small response of \(N\) to changes in real wage

For a given supply shock \(\frac{dA}{A}\), the response of output \(\frac{dY}{Y}\) is bigger the larger is \(\xi\).
Criticisms of RBC theory

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RBC theory can only successfully explain large movements in output if $\xi$ is high
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RBC theory can only successfully explain large movements in output if $\xi$ is high.

Problem: Most microeconomic estimates point to $\xi$ very small!
Critics of RBC theory suggest that except for the oil price shocks of 1973, 1979, and 1990, there are no productivity shocks that one can easily identify that caused recessions. One RBC response is that it doesn't have to be a big shock; instead, the cumulation of many small shocks can cause a business cycle.
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$$\frac{\Delta Y_t}{Y_t} = \frac{\Delta A_t}{A_t} + \alpha \frac{\Delta K_t}{K_t} + (1 - \alpha) \frac{\Delta N_t}{N_t}$$

Does the Solow residual measure technology shocks?

The Solow residual is strongly procyclical in U.S. data

This accords with RBC theory, which says the cycle is driven by productivity shocks
The Solow Residual

![Graph showing the Solow Residual and Output Growth over the years 1960 to 2000. The Solow residual and output growth are represented by blue and green lines respectively.](image-url)
Criticisms of RBC theory

But should the Solow residual be interpreted as a measure of technology?

If it is a measure of technology, it should not be related to factors that do not directly affect scientific and technological progress, like government purchases or monetary policy.

But statistical studies show a correlation between these.
Criticisms of RBC theory

Measurement problems: labor hoarding and varying capital capacity utilization

Measured productivity can vary even if the actual technology does not change:
  - Capital and labor are used more intensively at times
  - More intensive use of inputs leads to higher output
Criticisms of RBC theory

Measurement problems: labor hoarding and varying capital capacity utilization

Measured productivity can vary even if the actual technology does not change:

- Capital and labor are used more intensively at times
- More intensive use of inputs leads to higher output
- Define the utilization rate of capital $u^k$ and the utilization rate of labor $u^n$
- Define capital services as $u^kK$ and labor services as $u^nN$
Criticisms of RBC theory

Rewrite the production function as

\[ Y = A(u^K K)^\alpha (u^n N)^{1-\alpha} \]

The measured Solow residual is now \( A(u^K)^\alpha (u^n)^{1-\alpha} \)

So the Solow residual is not just \( A \), but depends on \( u^K \) and \( u^n \).
Criticisms of RBC theory

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So the Solow residual is not just \( A \), but depends on \( u^k \) and \( u^n \).

Utilization is procyclical, so the measured Solow residual is more procyclical than is the true productivity term \( A \)

- Labor hoarding: firms keep workers in recessions to avoid incurring hiring and firing costs
- Hoarded labor does not work as hard, or performs maintenance
- The lower productivity of hoarded labor does not reflect technological change, just the rate of utilization
Criticisms of RBC theory

Alternative Measurements of Technological Shocks:

1. Jordi Gali (American Economic Review 2000): Technology shocks are only long run determinant of labor productivity

The study by J. Gali suggests that a technological innovation leads to a decrease in hours worked!

Basu, Fernald and Kimball also find that a technological innovation leads to a decrease in hours worked.

source: Basu, Fernald and Kimball, Are Technological Improvements Contractionary, American Economic Review 96(5).
Criticisms of RBC theory

Critique 3: Money is not neutral
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RBC critics note that reductions in money growth are almost always associated with periods of high unemployment and low output. If money is neutral, why does the data show that money is a leading, procyclical variable?
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RBC proponents: reverse causation, i.e. the money supply is endogenous: Suppose output is expected to fall. Central bank reduces money supply in response to an expected fall in money demand

The lower money growth does not cause the higher future output.

If so, money can be procyclical and leading even though money is neutral
Criticisms of RBC theory

So is money neutral?

Friedman and Schwartz have extensively documented that often monetary changes have had an independent origin; they were not just a reflection of changes or future changes in economic activity.

These independent changes in money supply were followed by changes in income and prices. The independent origins of money changes include such things as gold discoveries, changes in monetary institutions, and changes in the leadership of the Fed.
Criticisms of RBC theory

So is money is neutral?

More recently, Romer and Romer documented additional episodes of monetary nonneutrality since 1960.

One example is the Fed’s tight money policy begun in 1979 that was followed by a minor recession in 1980 and a deeper one in 1981.

That was followed by monetary expansion in 1982 that led to an economic boom.

So money does not appear to be neutral.
Event study in the spirit of Friedman and Schwartz

Effect of Monetary Tightening on Industrial Production (Left) and Unemployment (Right)
Other Evidence from Various Models

Estimates of the response to an unexpected change to the federal funds rate:

- Bernanke and Gertler (JEP 1995): reduced form model (vector autoregressions)
- Christiano, Eichenbaum and Evans (JPE 2006): reduced form model (vector autoregressions) and estimated structural model (impulse response matching)
- Smets and Wouters (AER 2007): estimated structural model (Bayesian methods)

‘Consensus’ view:

- Monetary policy changes have sizeable real effects
- But: Monetary policy ‘shocks’ contribute little to the business cycle.
Source: Bernanke and Gertler (Journal of Economic Perspective 1995)
Fig. 1.—Model- and VAR-based impulse responses. Solid lines are benchmark model impulse responses; solid lines with plus signs are VAR-based impulse responses. Grey areas are 95 percent confidence intervals about VAR-based estimates. Units on the horizontal axis are quarters. An asterisk indicates the period of policy shock. The vertical axis units are deviations from the unshocked path. Inflation, money growth, and the interest rate are given in annualized percentage points (APR); other variables are given in percentages.
under the estimated monetary policy reaction function, the Fed responds quite aggressively to emerging output gaps and their impact on inflation. This is reflected in the fact that at the short- and medium-term horizon more than 60 percent of variations in the nominal interest rate are due to the various demand and productivity shocks, in particular the risk premium shock (third panel of Figure 1). Only in the long run does the wage mark-up shock become a dominant source of movements in nominal interest rates.

In the light of these results, it is interesting to see to what extent our model can replicate the empirical correlation function between output and inflation as, for example, highlighted in Galı´ and Gertler (1999). Figure 5 plots the empirical correlation function of output (detrended using the Hodrick-Prescott filter) and inflation (estimated over the period 1966:1–2004:4), as well as the median and the 5 percent and 95 percent equivalent generated by the model’s posterior distribution. In order to generate this distribution, 1,000 draws from the posterior distribution of the model parameters are used to generate artificial samples of output and inflation of the same sample size as the actual data-set. For each of those 1,000 artificial samples, the autocorrelation function is calculated and the median and 5 and 95 percentiles are derived. Figure 5 clearly shows that the DSGE model is able to replicate both the negative correlation between inflation one to two years in the past and current output, and the positive correlation between current output and inflation one year ahead. Moreover, the correlations generated by the DSGE model are significantly different from zero. Decomposing the cross-covariance function in contributions by the different types of shocks, we find that the negative correlation between current inflation and future output is driven primarily by the price and wage mark-up shocks. In contrast, the positive correlation between the current output gap and future inflation is the result of both demand shocks and mark-up shocks. Monetary policy shocks do not play a role for two reasons. First, they account for only a small fraction of inflation and output developments. Second, as shown in Figure 6, according to the estimated DSGE model, the peak effect of a policy shock on inflation occurs before its peak effect on output.

C. The Effect of a Productivity Shock on Hours Worked

Following Galı´ (1999), there has been a lively debate about the effects of productivity shocks on hours worked and about the implications of this finding for the role of those shocks in US business cycles. Galı´ (1999), Francis and Ramey (2005), and Galı´ and Pau Rabanal (2004) have argued that due to the presence of nominal price rigidities, habit formation, and

**Figure 6. The Impulse Responses to a Monetary Policy Shock**

*Note:* The solid line is the mean impulse response; the dotted lines are the 10 percent and 90 percent posterior intervals.
Criticisms of RBC theory

Critique 5: Wages/Labor Productivity are not (strongly) procyclical

Note: Vanishing Procyclicalilty after mid 80's
Criticisms of RBC theory

Critique 6: Prices and wages are not flexible
Criticisms of RBC theory

Critique 6: Prices and wages are not flexible

- RBC theory assumes that wages and prices are completely flexible, so markets always clear.
- RBC proponents argue that the degree of price stickiness occurring in the real world is not important for understanding economic fluctuations.
- RBC proponents also assume flexible prices to be consistent with microeconomic theory.
- Critics believe that wage and price stickiness explains involuntary unemployment and the non-neutrality of money (more on this later)
Evidence for sticky nominal wages

Daly and Hobijn (SF Fed working paper 2013)

Figure 1. Distribution of 12-month log wage changes in 2006 and 2011.

Figure 3. The U.S. wage Phillips curve: 1986-2012.
Evidence for sticky goods prices

Steinsson and Nakamura (Quarterly Journal of Economics 2008)

TABLE II
FREQUENCY OF PRICE CHANGE BY MAJOR GROUP IN 1998–2005

<table>
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<tbody>
<tr>
<td>Processed food</td>
<td>8.2</td>
<td>10.5</td>
<td>9.0</td>
<td>10.6</td>
<td>65.4</td>
<td>25.9</td>
<td>3.3</td>
<td></td>
<td>25.5</td>
<td>54.7</td>
<td>57.9</td>
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<td>Unprocessed food</td>
<td>5.9</td>
<td>25.0</td>
<td>3.5</td>
<td>25.4</td>
<td>61.2</td>
<td>37.3</td>
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<td>53.3</td>
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<tr>
<td>Household furnishing</td>
<td>5.0</td>
<td>6.0</td>
<td>16.1</td>
<td>6.5</td>
<td>62.9</td>
<td>19.4</td>
<td>4.6</td>
<td></td>
<td>20.6</td>
<td>49.0</td>
<td>66.8</td>
<td>21.2</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Apparel</td>
<td>6.5</td>
<td>3.6</td>
<td>27.3</td>
<td>3.6</td>
<td>57.1</td>
<td>31.0</td>
<td>2.7</td>
<td></td>
<td>30.1</td>
<td>36.1</td>
<td>87.1</td>
<td>34.5</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Transportation goods</td>
<td>8.3</td>
<td>31.3</td>
<td>2.7</td>
<td>21.3</td>
<td>45.9</td>
<td>31.3</td>
<td>2.7</td>
<td></td>
<td>22.2</td>
<td>44.0</td>
<td>8.0</td>
<td>2.7</td>
<td></td>
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<tr>
<td>Recreation goods</td>
<td>3.6</td>
<td>6.0</td>
<td>16.3</td>
<td>6.1</td>
<td>62.0</td>
<td>11.9</td>
<td>7.9</td>
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<td>13.7</td>
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<td>Other goods</td>
<td>5.4</td>
<td>15.0</td>
<td>6.1</td>
<td>13.9</td>
<td>73.7</td>
<td>15.5</td>
<td>5.9</td>
<td></td>
<td>20.6</td>
<td>61.3</td>
<td>32.6</td>
<td>15.3</td>
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<tr>
<td>Utilities</td>
<td>5.3</td>
<td>38.1</td>
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<td>49.4</td>
<td>53.1</td>
<td>38.1</td>
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<td>49.4</td>
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<tr>
<td>Vehicle fuel</td>
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<td>87.6</td>
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<td>87.4</td>
<td>53.5</td>
<td>87.6</td>
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<td>53.4</td>
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<td>Travel</td>
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<td>52.2</td>
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<td>Services (excl. travel)</td>
<td>38.5</td>
<td>6.1</td>
<td>15.8</td>
<td>8.8</td>
<td>79.0</td>
<td>6.6</td>
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<td>9.1</td>
<td>76.8</td>
<td>3.1</td>
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<td>All sectors</td>
<td>100.0</td>
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<td>11.0</td>
<td>21.1</td>
<td>64.8</td>
<td>19.4</td>
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<td>57.1</td>
<td>21.5</td>
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Notes. All frequencies are reported in percent per month. Durations are reported in months. Fractions are reported as percentages. Regular prices denote prices excluding sales. “Weight” denotes the CPI expenditure weight of the major group; “median freq.” denotes the weighted median frequency of price change. It is calculated by first calculating the mean frequency of price change for each ELI and then taking a weighted median across ELIs within the major group using CPI expenditure weights. The other median statistics in this table are calculated in an analogous manner: “median impl. dur.” is equal to $-1/\ln(1-f)$, where $f$ is the median frequency of price change. “Mean freq.” denotes the expenditure weighted mean frequency of price change; “frac. up” denotes the median fraction of price changes that are price increases; “frac. price ch.” and “frac. obs.” denote the expenditure weighted mean fraction of price changes that are due to sales and fraction of observations that are sales. The sector weights add up to 97.4% because used cars are not included in any sector.

‘Consensus’ view:

- Evidence for nonnegligible nominal rigidities.