

## Topic 7: Business Cycle Facts

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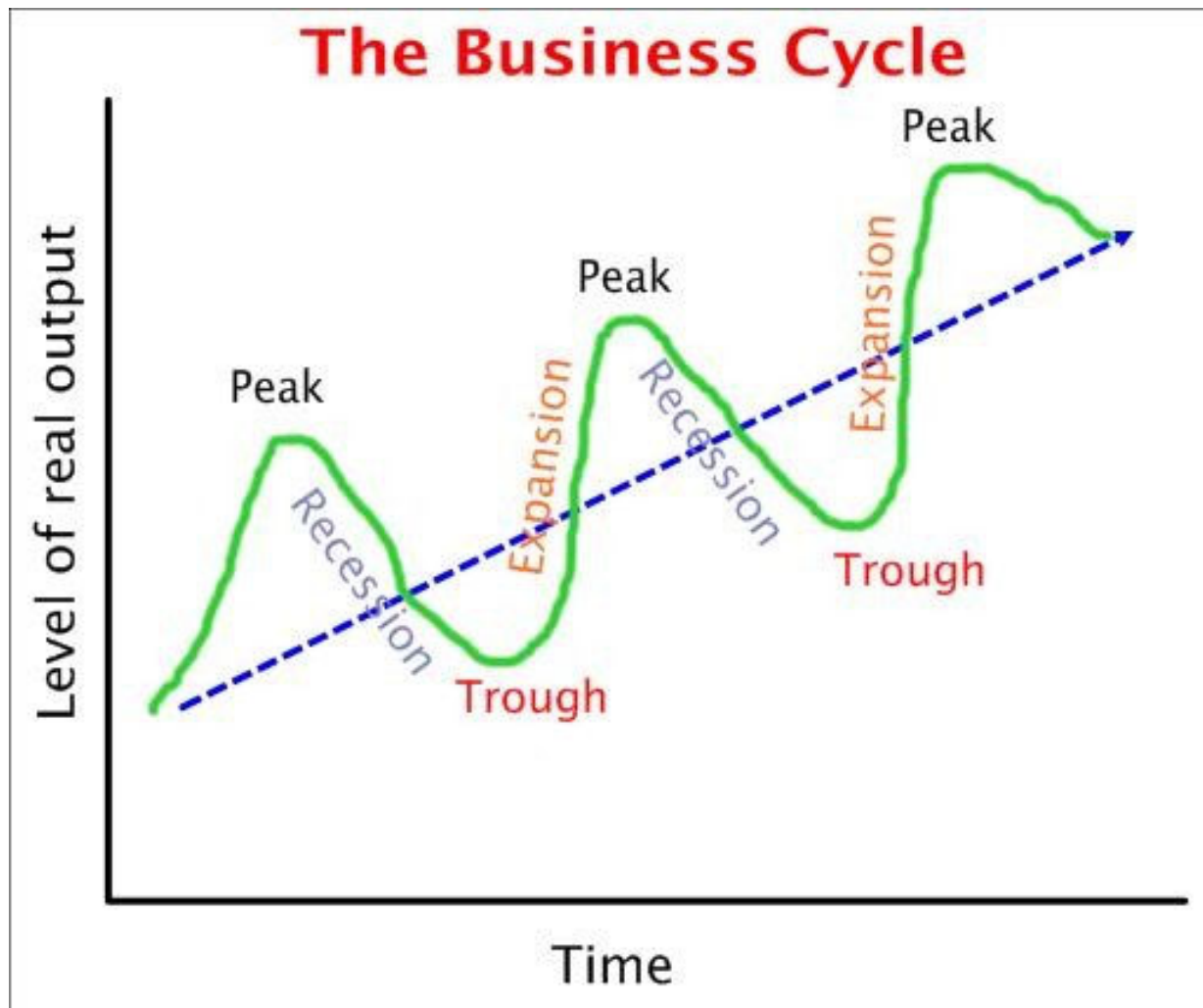
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Office Hours:

Thu 3:30-5:30

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# Notes on Recessions and Expansions

Expansions feature rising real GDP and employment and a falling unemployment. Recessions the opposite.

There is no formal definition of a recession, but a rule of thumb that works well for the U.S. is that a recession is when real GDP falls 2 quarters in a row

The U.S. spends more time expanding (87% of months) than contracting (13% of months). Similarly, in the U.S., expansions are longer on average (58 months) than recessions (11 months). We are in the midst of a record-long expansion (124 months).

For countries with faster (or slower)  $Y$  growth than the U.S., the rule of thumb based on  $Y$  growth is not so useful. They focus, instead, on defining recession as periods in which the unemployment rate rises sharply. Examples include fast-growing countries such as China and slow-growing countries such as Spain and Italy.

# Cyclicality

Procyclical  $\equiv$  goes up in expansions, goes down in recessions

e.g.  $Y$ ,  $C$ ,  $I$ ,  $N$  (relative to trend), firm entry rate

Acyclical  $\equiv$  no clear correlation with the cycle

e.g. the real interest rate  $r$  and the inflation rate  $\pi$

Countercyclical  $\equiv$  goes down in expansions, up in recessions

e.g.  $u$  (the unemployment rate), firm exit rate

# Four Facts About Business Cycles

1. Volatility is increasing in a good's durability

Corollary: Investment is more volatile than consumption (especially consumer services)

2. Inventory Investment declines sharply in recessions
3. Prices and wages are sticky in the short run
4. An “inverted yield curve” predicts recessions

# Why is Investment so Cyclical?

To increase the growth rate of the capital stock by 1% in one year, one needs a bigger than 1% increase in the flow of investment.

**Why?** Investment (say 15% of GDP) is smaller than the Capital Stock (say 200% of GDP).

This reflects durability ( $\delta \ll 1$ ).

**Upshot:** The more durable the K (or consumer good), the more cyclical the flow of I (or durable C).

**Review Question:** Consider our exogenous growth / endogenous investment / exogenous N model. Suppose there is a permanent 1% increase in the level of TFP.

What is the % increase in Y, K and I in the long run?

$$Y = A^{\frac{1}{1-\alpha}} \left( \frac{K}{Y} \right)^{\frac{\alpha}{1-\alpha}} N \Rightarrow \ln Y = \frac{1}{1-\alpha} \ln A + \frac{\alpha}{1-\alpha} \ln \left( \frac{K}{Y} \right) + \ln N$$

$$\Rightarrow \Delta \ln Y = \frac{1}{1-\alpha} \Delta \ln A + \frac{\alpha}{1-\alpha} \Delta \ln \left( \frac{K}{Y} \right) + \Delta \ln N$$

$$\Rightarrow \Delta \ln Y = \frac{1}{1-\alpha} \cdot 1\% + \frac{\alpha}{1-\alpha} \cdot 0\% + 0\% = \frac{1}{1-\alpha} \%$$

$$\Rightarrow \Delta \ln Y = \Delta \ln K = \Delta \ln I = \frac{1}{1-\alpha} \%$$



**New Question:** Assume that  $\alpha=1/3$ ,  $g_A=0$ ,  $g_N=0$  and  $\delta=0.10$ . Suppose there is a permanent 1% increase in the level of TFP.

What % increase in I is needed to reach the LR K *in 1 year*?  
(Assume K and I were at their steady state values beforehand.)

# **Plot of investment vs. time in the previous Q**

## Example 1: Houses

Suppose there are 100 million homes.

1 million are built and torn down each year ( $\delta = .01$ ).

Now suppose you want 101 million homes next year, a 1% increase in the stock.

**Q: Required % increase in new housing construction?**

**A:** 100% increase from 1 to 2 million homes ( $= 1/\delta \cdot 1\%$ ).

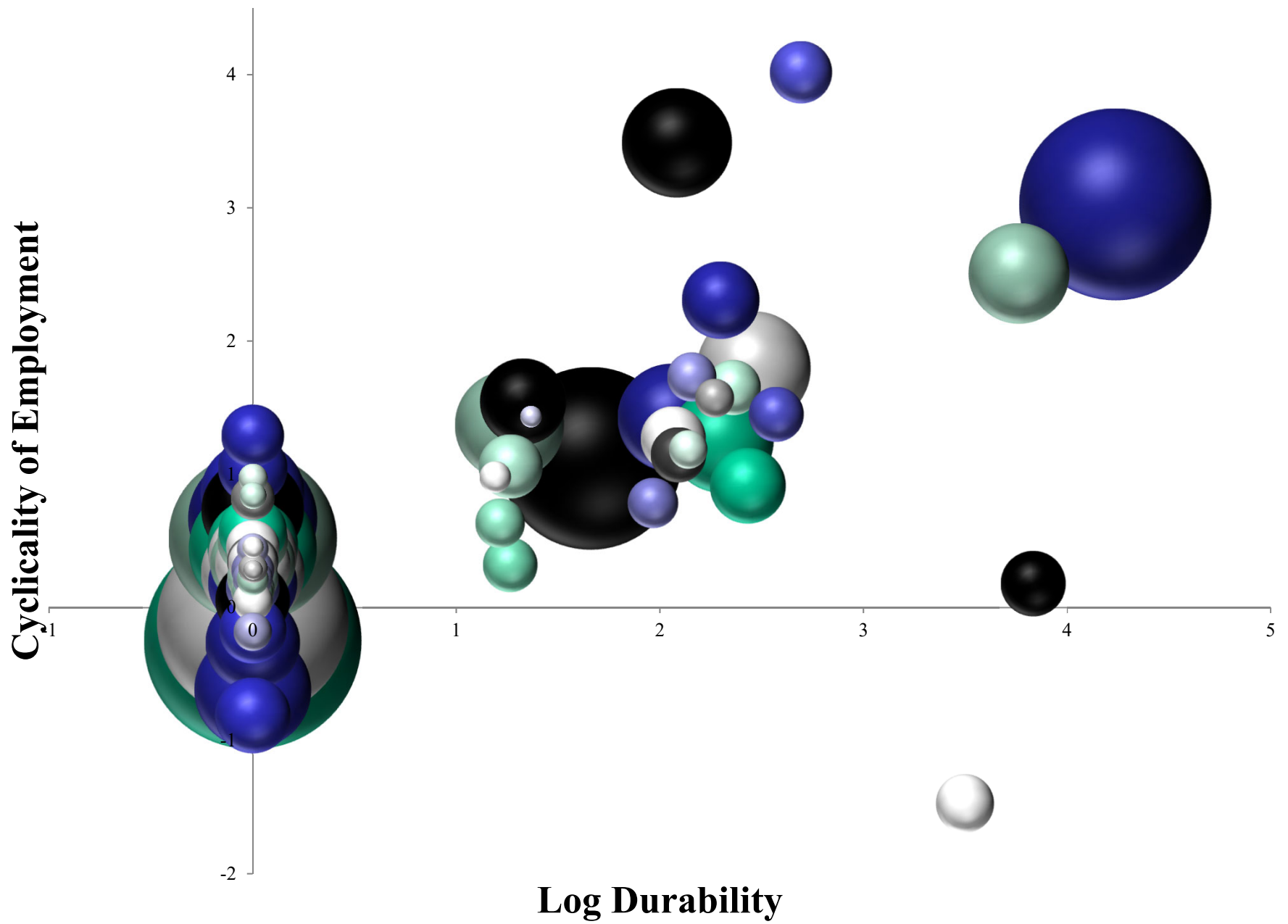
## Example 2: Rental Cars

Say the industry has a fleet of 10 million cars. It junks 2 million every year and buys 2 million new ones ( $\delta = .20$ ).

Now suppose your industry wants to expand its fleet to 10.1 million cars, a 1% increase in the stock.

**Q: Required % increase in new car purchases?**

**A: 5% increase from 2 to 2.1 million cars ( $= 1/\delta \cdot 1\%$ )**



# Notes on Durability and Volatility

The expected life of a product in years is  $1/\delta$ .  $\delta$  is the annual depreciation rate.

Our calculation of trying to change the stock by 1% in a single year is for exposition purposes. In reality, things like production capacity (and interest rates) can slow down the transition so that the surge in investment occurs over (say) 5 years rather in a single-year burst.

But the math illustrates the basic idea: the more durable a product (the higher is  $1/\delta$ ), the larger the stock relative to the investment flow. Thus we need a bigger % change in the investment flow to move the stock by a given percentage (1% in our examples).

This works on the down side as well. A firm can cut back on its investment a lot on % terms without losing its entire stock. This same logic applies to consumer durables, and is why consumer durables spending (like new car purchases) are much more volatile than spending on perishables (e.g. fresh food) and services – for which  $\delta = 1$ .

# Inventory Investment

$\text{Inventories}_t \equiv$  stock of inventories at the beginning of  $t$ .

$$\text{Inventories}_{t+1} \equiv \text{Inventories}_t + Y_t - \text{Sales}_t$$

$$\Rightarrow Y_t \equiv \text{Sales}_t + \text{Inventories}_{t+1} - \text{Inventories}_t.$$

$$\text{Inventory Investment} \equiv \Delta \text{Inventories}$$

# Target Inventory/Sales

**Myth:** Firms use inventories to smooth production in the face of temporary movements in sales. Production is less volatile than sales.

**Reality:** Production is *more* volatile than sales. Firms increase inventories in booms as if they want to keep Inventory/Sales constant.

Why? First, work-in-progress inventories.  
Second, final goods inventories facilitate sales.



# Inventory Investment in Recessions

Inventory Investment as a % of the decline in GDP:

1981-1982	114%
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1990-1991	56%
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2000-2001	NA
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2007-2009	46%
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# Why is Inventory Investment so Cyclical?

If sales change unexpectedly and persistently (and production is determined before sales are realized), then sellers need to adjust production for the new level of sales \*and\* to restore the desired inventory/sales ratio.

**Upshot:** Production is *more* volatile than Sales.

Production tends to dive after excess inventories build up, and recover after excess inventories are worked off.

Question: A firm has 50 units of inventory going into period  $t$ , a target inventory-sales ratio of 0.5, and expects to sell 100 units indefinitely. It sets production equal to 100 before seeing sales.

(a) Suppose period  $t$  sales disappoint and come in at 90.  
What is the firm's inventory level at the beginning of  $t+1$ ?

Continuing the previous question ...

(b) What level of production will the firm choose in  $t+1$ , assuming it now expects to sell 90 units indefinitely?

Continuing the previous question ...

(c) What level of production will the firm choose for  $t+2$  onward assuming sales do stay at 90 units in  $t+1$  onward?

Continuing the previous question ...

(d) Plot sales, inventories, and output in  $t-1$ ,  $t$ ,  $t+1$ ,  $t+2$ , ...

# Prices are Sticky

In the U.S., the typical consumer price changes every 4 months or so (8 months if one excludes temporary price discounts).

The typical producer price also changes every 8 months.

Prices are even stickier in the Euro Area, changing closer to once a year.

See the survey in Klenow and Malin (2011).

# Wages are Sticky

Wages are even stickier than prices, typically changing once a year in the U.S. and Euro Area.

Wage declines are uncommon even in economies with low inflation.

The two are related: labor-intensive goods exhibit the stickiest prices.



# RBC Models vs. New Keynesian Models

RBC (Real Business Cycle) models assume flexible prices and wages in the SR and in the LR.

New Keynesian models assume sticky prices and wages in the SR (flexible prices and wages in the LR).

New Keynesians are the majority of business cycle researchers. RBC modelers are a distinct minority.

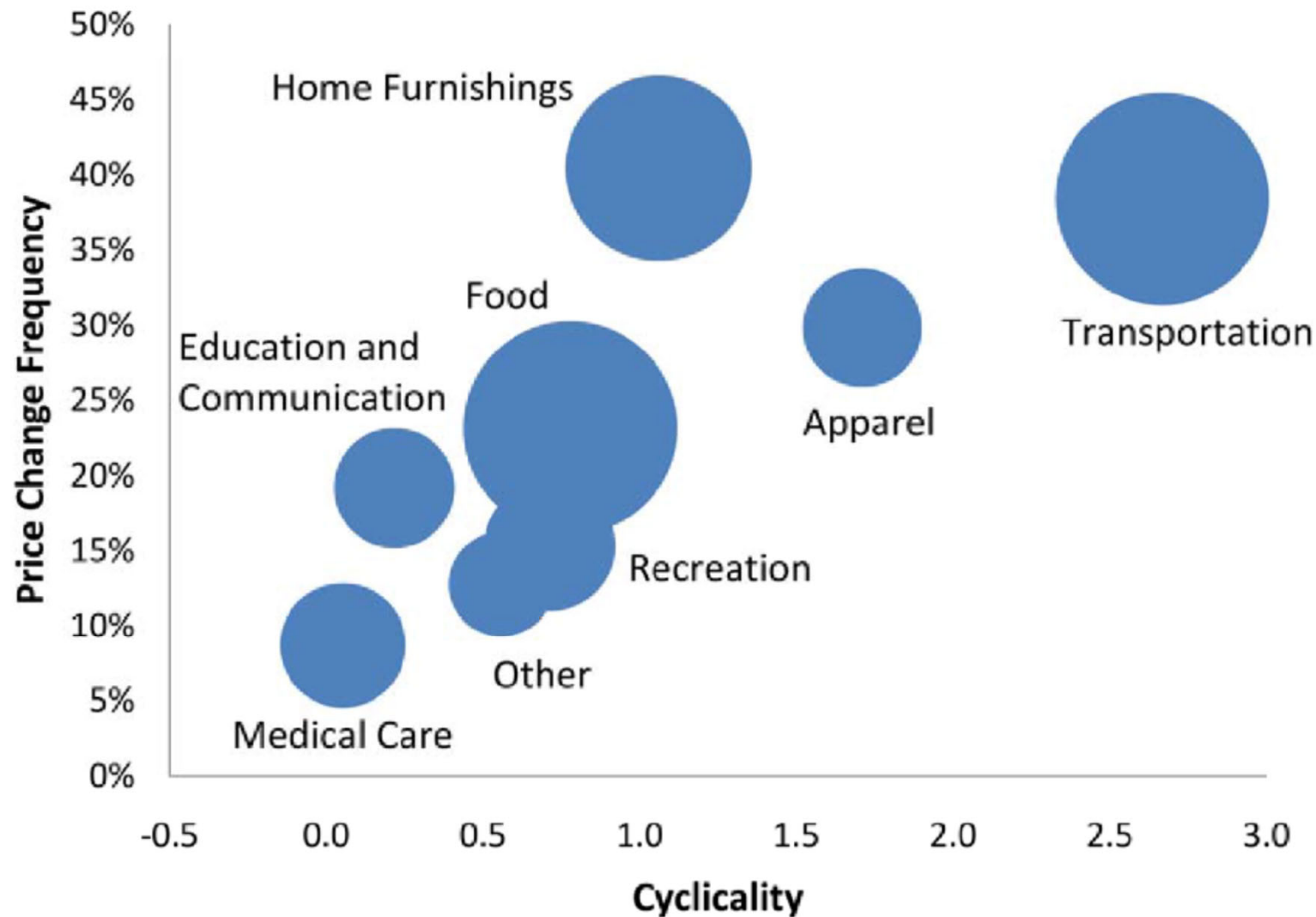
Later we will talk about New vs. *Old* Keynesians.

# Why Do RBC Models Exist?

Some macroeconomists are skeptical that price and wage stickiness matters a lot for business cycles:

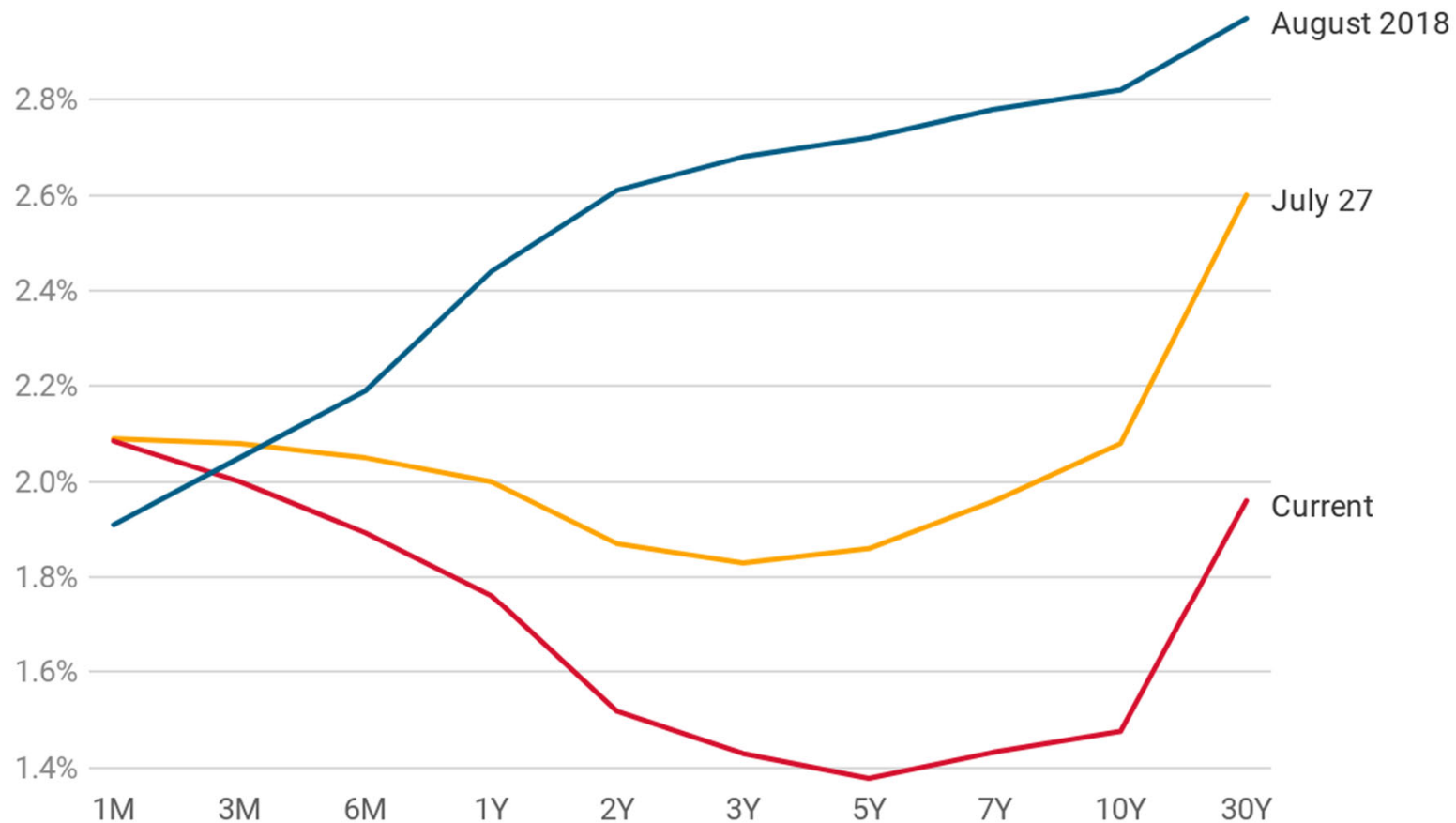
- Prices are stickiest for services (not so cyclical) and most flexible for durables (very cyclical).
- Wages are sticky for existing employees, but are more flexible for new hires (and the hiring rate is very cyclical).

# Price Flexibility vs. Output Cyclical in the CPI



# U.S. Treasury Yield Curve

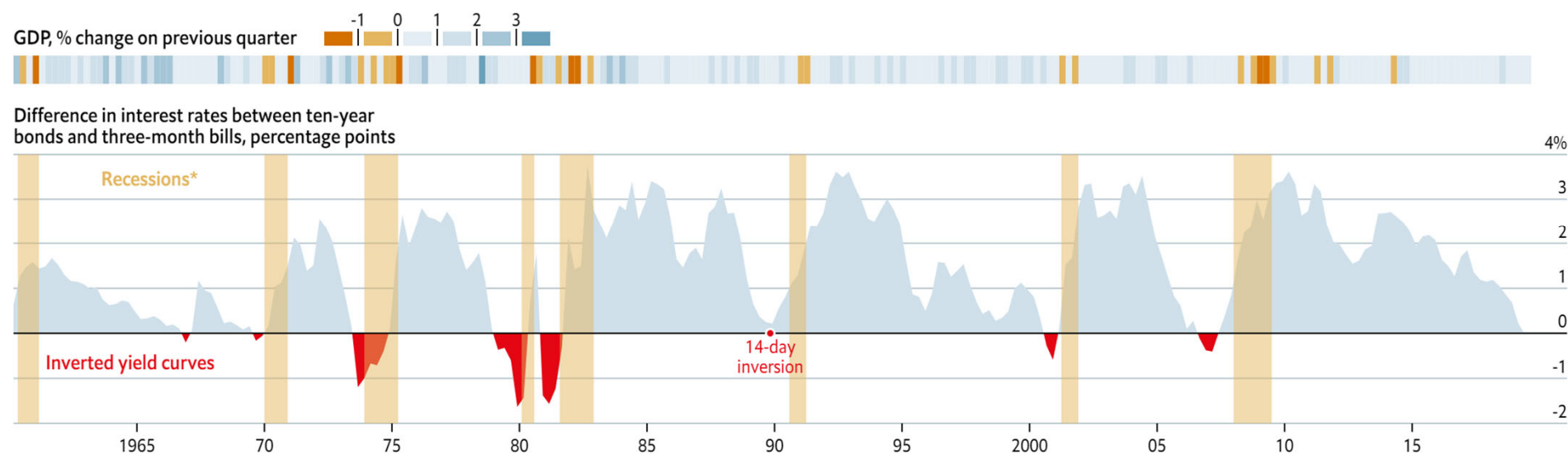
## Yield Curve Inversion



Source: FactSet • Created with Datawrapper

**Long rates are averages of short rates**

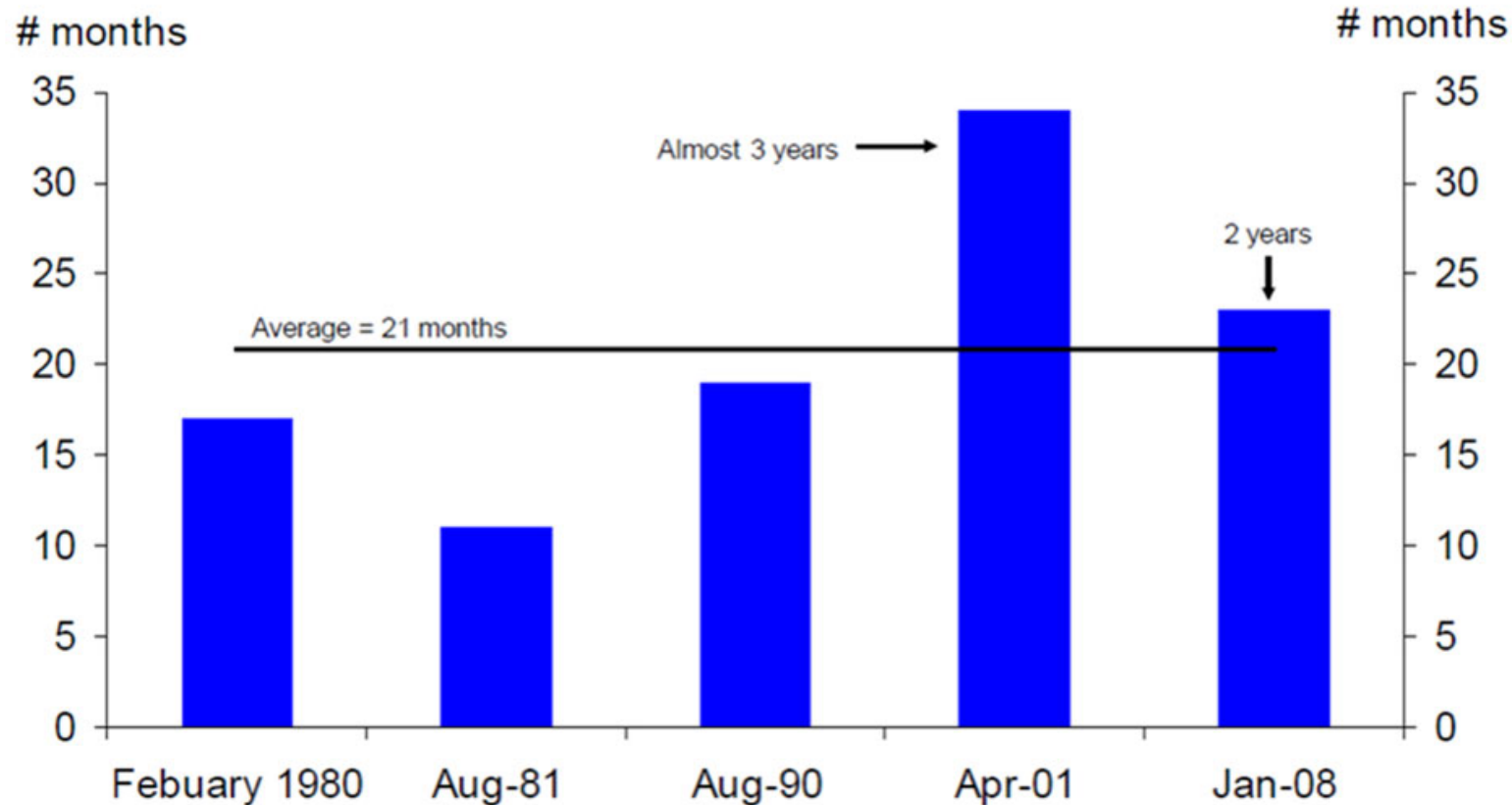
# The 10 year Treasury bond minus the 3 month T-bill rate and recessions, 1960 to the present



It takes one to three years from 2s-10s  
yield curve inversion until recession begins



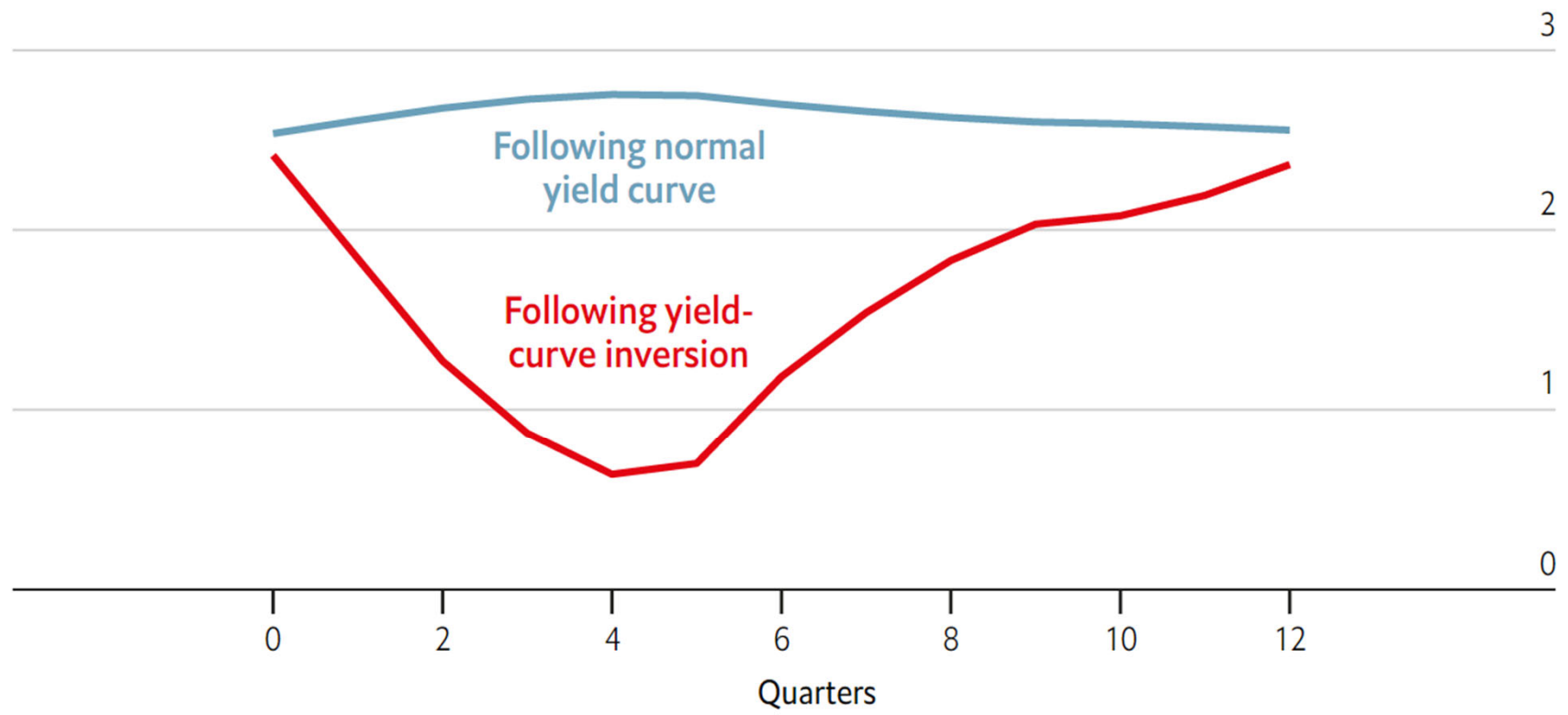
### Time from 2s-10s yield curve inversion until recession starts



Source: FRB, Haver Analytics, DB Global Research

## GDP % change on a year earlier

Average of 17 OECD countries, 1960-2019, weighted by GDP



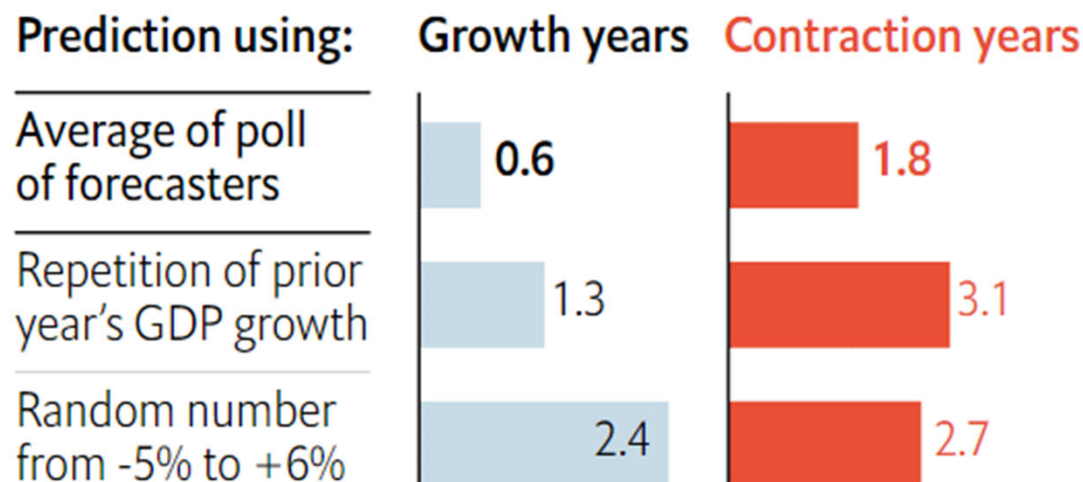


# Wait, are economists' forecasts any good?

...their projections are better than  
simplistic alternatives

Absolute prediction error, percentage points

Average across all forecast time periods



## Key Points

Investment and durable consumption are highly volatile over the business cycle.

The more durable the I or C, the bigger the % change in expenditures needed to achieve a given % change in the stock.

Inventory investment is often procyclical because firms are working off excess inventories in recessions and building up inventories in booms.

## Key Points (continued)

U.S. prices change every 8 months are so, wages closer to once a year. Prices and wages are even stickier in the Euro Area.

New Keynesian models feature sticky prices and wages in the SR. RBC models feature flexible prices and wages even in the SR.

Prices and wages are flexible in the LR in New Keynesian models.

## Key Points (continued)

The Yield Curve is the relationship between the yield (nominal interest rate) and time-to-maturity on bonds.

The Yield Curve is usually upward-sloping. When it is inverted, long run rates are below short rates.

This results when future short rates are expected to fall below current short rates.

An inverted yield curve has predicted past recessions in the U.S. and in other OECD countries.