Monetary Policy & Interest Rates

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Where do interest rates come from? I doubt this was your first question when you were growing up, but you probably have an opinion about it now. Most people say they're set by the Fed — or the appropriate central bank if you're in another country. There's some truth to that, but it can't be that simple: we had interest rates before the Fed was established, and if anything they varied more then than now. It's probably better to say that the Fed "manages" interest rates: they vary the supply of money to set the interest rate they think is appropriate, consistent with market conditions — interest rates reflect, after all, the behavior of private borrowers and lenders as well as the Fed.

We outline how this works, starting with a review of interest rates (there are lots of them) and moving on to monetary policy as practiced in most developed countries this days. Along the way we show how you would expect new information about (say) inflation or economic growth to affect interest rates.

Interest rates

Here's a quick review of interest rates: real and nominal, short and long, riskfree and risky. There's lots more of this kind of thing around, but that will do it for us.

Real and nominal. It may not strike you at first, but interest rates have units. The interest rates we're used to are reported in currency units: a one-period bond pays currency later in return for currency now. That's one of the reasons interest rates differ around the world: if countries have different currencies, their interest rates are measured in different units. Since they're measured in currency units, we refer to them as nominal interest rates, just as GDP measured in currency units is referred to as nominal GDP.

It's traditional, as we saw in the "Inflation" notes, to decompose a nominal interest rate i into a real interest rate r and expected inflation π:

$$i \;=\; r + \pi. \tag{1}$$

The real interest rate is therefore "corrects" the nominal rate for the loss of purchasing power reflected in the inflation rate. In words: a nominal interest rate of 5% delivers greater purchasing power in a year if the inflation rate is 2% than if it is 5%.

Short and long. Bonds differ, of course, by maturity: that's the idea behind the "term structure of interest rates," a popular finance topic. If we consider a bond of maturity m years, the price and (nominal) interest rate or yield are related by

$$q_m = 100/(1+i_m)^m.$$

The interest rate has been annualized — that's what the exponent does — but it applies to a bond whose maturity can be something besides one year. Note, too, that we've reported the interest rate for a zero-coupon bond. That's standard practice. Coupon bonds have payments at multiple dates, which muddies the concept of maturity.

Interest rates on long bonds often differ from those on short bonds. Long rates are higher than short rates on average, but not always. We commonly attribute the difference to two factors. The first is expected differences in interest rates over the life of the bond: if we expect short-term interest rates to rise over the life of the bond, then its interest rate should be higher as a result. The second is risk. Long bonds have greater exposure to the risk of changing interest rates. Their price and yield therefore incorporate adjustments for this risk. We could express this in an equation as

$$i_m = \text{Expected Future Short Rates} + \text{Risk Premium}.$$

The concepts here are intentionally somewhat fuzzy, but we could make them more precise with some work, similar to the appendix to "Business Cycle Indicators."

Long-term interest rates have a similar distinction between real and nominal. The equation is the same with the appropriate maturities noted:

$$i_m = r_m + \pi_m.$$

For example, the expected inflation rate in this case is the one that applies to the period from now to m years from now.

Credit risk. That's enough for now, but there's another source of risk that comes up later in the course: the possibility that the borrower defaults. We tend to ignore that in the US Treasury market, although credit default swaps now price in some such risk. With bonds issued by banks, corporations, and foreign "sovereigns" (governments), the risk can be substantial. We might see, for example, that interest rates on Argentine or Russian government bonds are several hundred basis points above US Treasuries of similar maturity. (A basis point is a hundredth of a percent.)

Mechanics of monetary policy (review)

We'll come back to interest rates shortly, but now we turn to monetary policy, which plays a central role in their short-term movements. Central banks control the quantity of currency in circulation (money, for our purposes). We show here how that works, then move on in later sections to describe how they use their control over money to influence interest rates. Our analysis of the central bank's control of the money supply involves the balance sheets of the treasury, the central bank, and individuals and firms. You've seen this before, but it's important enough to run through again. We'll see it again when we look at fixed exchange rates.

Day-to-day monetary policy in most countries consists of what we term *open market operations*: purchases of sales by the central bank of government debt (bonds). At any point in time, the treasury's balance sheet looks something like

Treasury

Assets		Liabilities	
		Bonds	200

the central bank's looks like

Central bank

Assets		Liabilities	
Bonds	100	Money	100

and the private sector's looks like

Private sector

Assets		Liabilities
Money	100	
Bonds	100	
Other	500	

If it seems strange to treat money as a liability of the central bank, think of it as a bond with the unusual feature that its nominal interest rate is zero. That's what it is, which makes it a good deal for the borrower.

An open market purchase of bonds results in an increase in bonds held by the central bank and an equal increase in its monetary liability. The private sector does the opposite: it sells bonds to the central bank, reducing its holdings of bonds and increasing its holdings of money (currency). For example, a central bank purchase of 20 worth of bonds would change the balance sheets to

Central bank

Assets		Liabilities	
Bonds	120	Money	120

and

Private sector

Assets		Liabilities
Money	120	
Bonds	80	
Other	500	

Note that this doesn't change anyone's net worth: it's a portfolio shift, which changes only the composition of assets and liabilities. The result is an increase in the amount of money in private hands, since the private sector (the other side of this transaction) has reduced its holdings of government bonds and increased its holdings of money. Similarly, an open market sale of bonds would reduce the amount of money in private hands.

Managing the interest rate (optional)

We describe monetary policy in terms of managing the short-term interest rate, which is nearly universal but different from what we've done before (namely, control the money supply). If you're willing to take on faith that increases in the money supply or money growth reduce short-term interest rates, we recommend you **go straight to the next section**.

Let's think through the impact of a change in the supply of money. We modify the quantity theory equation to allow velocity to depend on the interest rate. One version is this:

$$M_t/P_t \;=\; Y_t/V(i_t). \tag{2}$$

Here (as before) M is the supply of money (think currency as usual), P is the price level (think price index), Y is real output (GDP), and V is velocity. What's new is that we've made velocity a function of the nominal interest rate. Let's say that velocity increases if the interest rate is high, as people avoid non-interest-bearing money. Equivalently, they decrease their demand for real money holdings (M/P) when we increase the interest rate.

What happens if (say) the central bank increases the supply of money M? In the long run, the price level adjusts and we get a proportional increase in P. Nothing else changes. That's the logic of the quantity theory taken literally. In the very short run (a few days, say), we might guess that production plans won't change (Y is fixed) and we generally think prices won't change either (P is fixed). Then the result must be a decline in the interest rate, as we see in Figure 1. In words: by introducing more

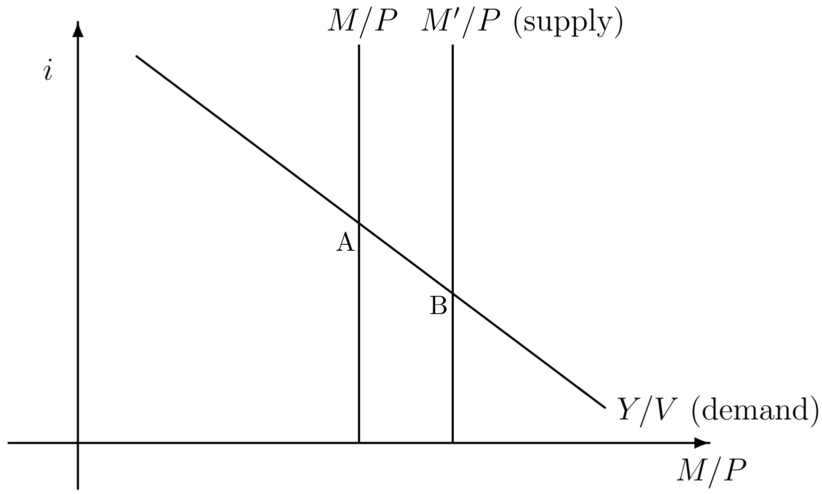

Figure 1: Supply and demand for money. The very short-run impact of an increase in the money supply is a shift right in the vertical supply curve (M/P) and a movement down the demand curve (L) from A to B.

money into the financial system, the central bank increases liquidity, driving down interest rates. In practice, central banks do the reverse — they vary M until they get the interest rate they want — but the effect is the same. The most important point here is that we can think of changes in the interest rate as reflecting changes in the money supply. Put this way, there's little difference between changing the money supply and changing the interest rate.

One last thought: context matters here. If the context is relatively stable prices, changes in the money supply affect the interest rate as described. But if an increase in the money supply is interpreted as a sign that the central bank is abandoning price stability, then we could see an increase in the supply of money raise the interest rate rather than lower it. That's why you hear central bankers talk about "anchoring expectations" and "maintaining credibility" for stable prices. More on that shortly.

Goals of monetary policy

If the tools of monetary policy are the money supply and the short-term interest rate, what is the goal? Should central banks focus on inflation, growth, or some combination? This, in turn, raises the question of what they're capable of doing. There is clear evidence that monetary policy affects inflation, at least over periods of several years. Persistent high inflation is invariably associated with high rates of money growth. There is also clear evidence that countries with high and variable inflation rates have poor macroeconomic performance, although the cause and effect are less clear: is high inflation the cause of poor economic performance, or the result?

With these facts in mind, most countries charge their central banks with producing stable and predictable prices. In practice, this is typically understood to mean a stable inflation rate of about 2% a year.

In the US, the Federal Reserve Act asks the Fed "to promote the goals of maximum employment, stable prices, and moderate long-term interest rates." This is, to be sure, the usual political mush: the Fed should accomplish "all of the above." The term maximum employment is interpreted to mean that the Fed should act to reduce the magnitude and duration of fluctuations in output and employment. What role does monetary policy play in these fluctuations? In the long run, expert opinion is that the impact is close to zero: the long-term growth rate of the economy depends on its productivity and institutions, not its monetary policy. But in the short run, expansionary monetary policy (high money growth, low interest rate) probably has a modest positive effect on employment and output. The connection is fragile, in the sense that too much much monetary expansion seems to lead not to higher output but to high inflation, higher interest rates, and perhaps lower output. Most experts suggest, therefore, that central banks (including the Fed) should emphasize price stability and give secondary importance to output and employment.

One of the arguments in favor of price stability is that our attempts to do more has been notably unsuccessful. Ben Bernanke put it this way in a speech at NYU:

> The early 1960s [were] a period of what now appears to have been substantial over-optimism about the ability of [monetary] policymakers to 'fine-tune' the economy. Contrary to the expectation of that era's economists and policymakers, the subsequent two decades were characterized not by an efficiently managed, smoothly running economic machine but by high and variable inflation and an unstable real economy, culminating in the deep 1981-82 recession. Although a number of factors contributed to the poor economic performance of this period, I think most economists would agree that the deficiencies of ... monetary policy — including over-optimism about the ability of policy to fine-tune the economy ... — played a central role.

See link. Or as I prefer: economists should be humble about what we can accomplish (and remember, we have a lot to be humble about).

The focus on price stability is often expressed as a desire for predictability: firms, investors, and workers all need to have a clear picture of future inflation, hence future monetary policy, since the consequences of current decisions depend on it. Built into this statement is a belief that many such decisions — prices of bonds, wages and salaries, long-term supply contracts — are expressed in units of currency, whose future value depends on policy. It's therefore helpful for policy to be predictable, so that these decisions can be made on their economic merits rather than guesses of future policy. As Bernanke suggests, the unpredictability of policy in the 1970s was a factor in the poor macroeconomic performance of that decade. Hyperinflations are an extreme example, in which even day-to-day price changes are wildly uncertain. t In such conditions, capital markets typically either disappear or shift to another currency.

With these ideas in mind, many central banks now follow procedures that focus on price stability (so that people can make long-term decisions) and transparency (so that its actions are well understood). Details vary. Some countries have followed money growth rate rules, in which the target growth rate of the money supply was announced in advance. Others have targeted inflation rates, typically for periods of several years. In developing countries, fixed exchange rates are a common device, in which a currency is tied to one thought to be more predictable. Most commonly, there has been a move toward interest rate rules that connect (at least approximately) interest rates set by central banks with inflation and (possibly) output.

The Taylor rule: the bond trader's guide to monetary policy

One way to make monetary policy predictable and transparent is to follow a rule. The rule tells us how policy will be set, at least approximately, both now and in the future, which makes policy more predictable to market participants, including bond traders.

John Taylor, a Stanford economist and former treasury official, suggested in 1993 that an interest rate rule would provide a relatively simple summary of monetary policy in many countries. It's a guideline really, not a rule, but it nevertheless goes by the name "Taylor rule." It consists of the following equation:

$$i_t \ = \ r^* + \pi_t + a_1(\pi_t - \pi^*) + a_2(y_t - y_t^*), \tag{3}$$

where i_t is the short-term nominal interest rate, r^* is a target real interest rate, π_t is the inflation rate, π^* is the target inflation rate, y_t is (the log of) real output, and y_t^* is the target level of output (also in logs). The parameters (a_1, a_2) indicate the sensitivity of the interest rate to inflation and output.

This is a lot to swallow the first time you see it, so let's work our way through it piece by piece, as applied in the US:

- Nominal interest rate i. Standard practice in the US is to use the "fed funds rate." In the US, commercial banks and other "depository institutions" have accounts (deposits) at the Federal Reserve that are referred to as fed funds. They trade these deposits among themselves in an overnight fed funds market.

The Fed currently indicates its policy stance by setting an explicit target for the interest rate on these trades and performs open market operations to bring the market rate close to the target. This rate anchors the very short end of the yield curve.

- Target real interest rate r^*. Experience suggests that the real fed funds rate (nominal rate minus inflation) has averaged about 2% over the last two decades, but it moves around over time, both over long periods of time (real interest rates were unusually high in the 1980s and low in the 2000s) and over the business cycle. Most people simply set $r^* = 2\%$. The first component of the target fed funds rate is thus the target real rate (2%) plus the current inflation rate, thus giving us a nominal interest rate target.

- Inflation deviation $(\pi - \pi^*)$. The next term is a reaction to the difference between current inflation (π) and the target (π^*). If the target is 2% and actual inflation is 3%, then we increase the nominal fed funds rate by $a_1\%$. Typically $a_1 > 0$, meaning that we increase the interest rate in response to above-target inflation. Why? Because higher interest rates are associated slower money growth and therefore (eventually) lower inflation. Larger values of a_1 indicate more aggressive reactions to inflation. Since inflation enters directly and as part of this term, any increase in inflation leads to a greater increase in the nominal interest rate. This "overreaction" is intended to keep the inflation rate from exploding.

- Output deviation $(y - y^*)$. The final term is a reaction of the interest rate to deviations of output from its target. Some people use a smooth trend for y^* or a measure of potential output, an official estimate of how much output the economy would generate if firms operated at capacity. If we think of the world as the AS/AD model, then the target might be what the economy would generate if wages and prices weren't sticky — whatever that is! The Fed's goal, in this case, is to offset the impact of those frictions on output. The practical difficulty is distinguishing increases in y from increases in y^*. My preference is to use the difference in the year-on-year growth rate from its mean. This is easier to measure, but has the same issue: that it's not obvious that our measure (the mean) is the same as out target ("potential output").

- Parameters (a_1, a_2). Taylor suggested $a_1 = a_2 = 0.5$, giving equal weight to inflation and output deviations. Some recent studies find larger values of a_1 and smaller values of a_2 — say $a_1 = 0.75$ and $a_2 = 0.25$.

That's the rule. The bond traders' perspective is that it's a reasonable guide to how short-term interest rates respond to data releases, as bond traders respond to how they see monetary policy reacting to new information about economic conditions. If a high inflation number comes out, the interest rate goes up. Why? Because they know that this will lead the central bank to raise the short-term interest rate. Even if the Fed doesn't respond immediately, long yields may rise in anticipation of future interest rate changes. Ditto a high output number: short- and long-term interest rates rise. The timing may differ somewhat from the rule, but its overall impact should be similar.

There are two issues you run across in practice. One is that the Fed (or other central bank) may deviate from the rule, perhaps on principle, perhaps because of special circumstances. Despite its widespread use, no central bank is on record saying that it follows such a rule. The other is the difficulty in determining y^*. If output goes up, do we decide that the economy is overheating and raise the interest rate? Or do we decide that productivity has gone up, increasing the growth of the economy and y^*? That's exactly the issue that faced the Fed in the late 1990s. Some felt that the rule dictated higher interest rates, but Greenspan argued that y^* had gone up because productivity growth had accelerated. This goes back to our distinction between supply and demand shocks. In the AS/AD framework, demand shocks should generally be resisted, but supply shocks should be accommodated.

Quantitative easing, credit easing, and signalling the future

If the short-term interest rate falls to zero, or close to it, is the central bank powerless? This issue came up in Japan in the 1990s and much of the developed world in 2008-09. The answer is no, but let's review the logic — and the collection of acronyms that go along it.

The so-called *zero lower bound* (ZLB) is a practical limit on how low nominal interest rates can go. Why can't they go lower? Because currency guarantees a nominal interest rate of zero, so there's no reason to accept anything lower. Transactions costs and regulations that give preference to short-term government securities have let interest rates go a little below zero, but as a practical matter that's the limit.

If you follow (say) a Taylor rule and it indicates a negative interest rate, what do you do? Your first guess might be that you're stuck: zero is it. But remember: you can always increase the money supply, even if it doesn't lead to a fall in the nominal interest rate. This change in the quantity of money is generally referred to as *quantitative easing* (QE). For those of us who grew up thinking about monetary policy in terms of the supply of money, this has a back-to-the-future ring to it: isn't that how we used to talk? The key is the new terminology, which makes an old idea sound modern. That marketing lesson apparently works as well in economics as with consumer products.

In contrast to QE, which increases the size of the central bank's balance sheet, *credit easing* (CE) shifts the composition of the balance sheet from default-free assets toward assets with credit risk. A classic example of CE is for the central bank to sell Treasury debt and buy mortgage-backed securities of the same maturity. Only the mix of assets has changed. CE is thought to lower the cost and increase the supply of credit, particularly when private markets are illiquid.

Another approach to policy at the ZLB is to commit future monetary policy to keeping interest rates low. If policymakers believe that inflation will stay below their target, they can promise to keep their interest rate target low for an extended period. The Fed has used some *policy duration commitments* several times since 2008.

Executive summary

1. Most central banks use interest rates as their primary policy tool.
2. Theory and experience suggest that monetary policy should emphasize price stability and predictability.
3. The Taylor rule is an approximate description of how central banks set interest rates: they raise them in response to increases in inflation and output.
4. When interest rates hit zero, central banks can still implement policy through quantitative easing, credit easing, or commitments of future policy actions.

Review questions

1. Consider the following information about inflation and US interest rates.
   (a) If we ignore the difference between actual and expected inflation, what was the real interest rate in each case? When was it highest?
   (b) What is the real interest rate now? Does it value strike you as unusual? Why or why not?

	Inflation Rate	One-Year Yield
1980		
1990		
2000		
2010		

2. How does a central bank increase the money supply? What is the likely effect on the short-term interest rate?

   Answer. It purchases government bonds from private agents, giving them money in return. An increase in the money supply reduces the short-term interest rate. The argument is that this increases liquidity in markets, reducing the rate. It depends on an overall environment of price stability.

3. If the inflation rate rises, how would a central bank following a Taylor rule respond? Why?

   Answer. It would raise the interest rate. Note that the interest rate rises by more than one-for-one with inflation.

4. (optional) In some countries, including the US, we can find r directly from inflation-indexed bonds. For these bonds, coupons and principal are adjusted for inflation: if prices increase 5%, then coupons and principal are increased 5%. Show that the yield on such a bond is, in fact, the real interest rate r.

   Answer. Apply the definitions. What is the price now? What is the payment one year from now?

5. The Cleveland Fed has a beautiful chart that describes the asset side of the Fed's balance sheet since January 2007. What features of the chart represent quantitative easing (QE)? Which represent credit easing (CE)?

   Answer. The large increase in the size of the Fed's asset positions in 2008 represent QE. CE is less striking in its timing, but the increase in mortgage-backed agency debt (brown) in 2009 is a good example. The subsequent increase in long-term treasury purchases (yellow) is a reversal of the policy.

If you're looking for more

For more on the art and science of monetary policy:

- Bernanke's speeches are typically clear and thoughtful. See esp
  - "Constrained discretion," February 2003.
  - "The Logic of monetary policy," December 2004.
  - "Implementing Monetary Policy," March 2005.

  Here's the complete list of Fed speeches.

- The Cleveland Fed's *Taylor rule guide*.

Appendix: Central banks and the money supply (optional)

This is a standard piece of macroeconomic theory that ties up a loose end: the connection between monetary policy (currency and the equivalent issued by central banks) and the kinds of money used by individuals and firms to make transactions (bank deposits as well as cash). Not required, but we often get questions about it so here it is.

Monetary aggregates

The quantity theory tells us we should control the money supply, but it doesn't tell us what money is or how we would control it. If money includes things like checking accounts that individuals choose for themselves, how can we say the central bank controls it? Being clever people, economists have come up with several definitions of money, which isn't all that helpful when you think about it.

Here are the most popular definitions:

- The monetary base (we call this MB, but some call it M0). This consists of currency held by the public and banks, including deposits at the central bank (one of several things we'll run across that are called *reserves*).
- M1. This is the monetary aggregate that conforms most closely with our theory, in which "money" is what we use for transactions. It consists of currency checking accounts.
- M2. This is a broader aggregate that seems to be the current favorite. It includes currency, checking accounts, and time deposits. Why time deposits? Because we found that people could switch back and forth between them to quickly and easily that it didn't make sense to treat them differently.

There are more. Most countries report an M3, too, and lots of variations. The bottom line: most of what people think of as money isn't currency, but deposits at banks. If we want to understand money, we need to think about banks.

Money and the banking system

The objective of this section is to provide a link between the monetary aggregates used in our theory (think of this as M2) and the part of "money" that is under the direct control of the central bank (the monetary base MB).

To get ourselves warmed up, let's look at the balance sheets of the central bank and the private sector in an economy that has no banking system. Then we'll go on to see how a banking system changes the analysis. Let us say that the private sector has a balance sheet something like

Private Sector

Assets		Liabilities and Net Worth	
Currency	100	Net worth	8600
Treasury bills	500		
Equity	8000		

[In real life, this would be much more complicated, but since this is theory we can go easy on ourselves. The central bank might look like

Central Bank

Assets		Liabilities	
Treas bills	100	Currency	100

For practice, show how these balance sheets change if the central bank increases the supply of currency by 10.

Now let's add banks and interpret "money" as including bank deposits. A possible configuration is:

Private Sector

Assets		Liabilities and Net Worth	
Currency	50	Bank Loans	150
Bank Deposits	200	Net worth	8600
Treasury bills	500		
Equity	8000		

Central Bank

Assets		Liabilities	
Treas bills	100	Currency	50
		Reserves	50

Banks

Assets		Liabilities	
Reserves	50	Deposits	200
Loans	150		

You'll note that net worth is zero for the central bank (it's "owned" by the Treasury) and banks (they're owned by shareholders). Banks in real life would have other liabilities as well, including equity and bonds.

What is money here? A useful example of a monetary aggregate in this economy is

$$M \;=\; CU \text{ (currency)} + D \text{ (bank deposits)}.$$

[This is simpler than we saw in the real world, since we only have one type of deposit. With more than one type of deposit we would have more than one type of money and a more complicated theoretical setup.] The central bank, on the other hand, controls the monetary base,

$$MB \;=\; CU \text{ (currency)} + RE \text{ (reserves)}.$$

We now have a framework in which can at least talk about the difference between money and the monetary base.

We can derive a relation between the monetary base MB and the monetary aggregate M if we make some assumptions about behavior. Let us say, first, that private agents like to hold cash and bank deposits in some strict proportion:

$$CU/D = \gamma,$$

where γ is some number that we take to be roughly constant. (We can always check.) The idea is that we make some transactions with cash, others with checks, and the proportions of the two don't change much. Let us also assume that banks hold a constant fraction of their deposits as reserves:

$$RE/D = \rho.$$

Even if there were no minimum reserves, banks might be expected to hold some fraction of deposits in cash as part of their day to day business.

From these two ratios, we can derive a relation between the monetary aggregate and the monetary base. Their definitions are

$$\begin{aligned} MB &= CU + RE &= \gamma D + \rho D \\ M &= CU + D &= \gamma D + D. \end{aligned}$$

Taking the ratio gives us

$$M \;=\; \left(\frac{1+\gamma}{\gamma+\rho}\right) MB.$$

The expression in brackets is referred to as the money multiplier, since we generally see that the stock of money is a multiple of the monetary base. In the US, for example, the multiple is about 3 for M1 and over 10 for M2.

We now have an answer to our question: if the ratios ρ and γ are approximately constant, then by controlling the monetary base the Fed exerts indirect control over the broader monetary aggregates. In that sense, we can speak loosely about the central bank "controlling" M2 and other aggregates. And if the ratios change, that's useful information that we can explore separately.