



Aggregate demand and supply

ECON 302, Intermediate Macroeconomics

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Introduction

- In previous classes we discussed how to construct the IS and LM curves
- We also showed how the full employment was attained (FE)
- In this class we will show how to construct the aggregate demand starting from the IS-LM equilibrium
- We will discuss how the aggregate supply is derived and cover one of the oldest and most relevant discussion in macroeconomics: Classical vs Keynesian economics ([link](#))

- At the end of this lecture you should know how to construct the aggregate demand and understand what variables might shift it.
- You should also understand how to find the aggregate supply and what elements might shift it.
- An important point will be to understand the difference between the short and long aggregate supply and how this temporal horizon affects the slope of the supply.
- At the end of this class you should understand how the equilibrium output and prices are attained and how it might fluctuate in the short run, keeping track of key macroeconomic variables such as consumption, savings, investment, money real balances, interest rates, wages, etc.

A basic exposition of part of the material in this lecture can be found in

- [Abel et al. \(2018, Chapter 9, 10, 11\)](#)
- [Mankiw \(2009, Chapters 10, 11 and 13\)](#)

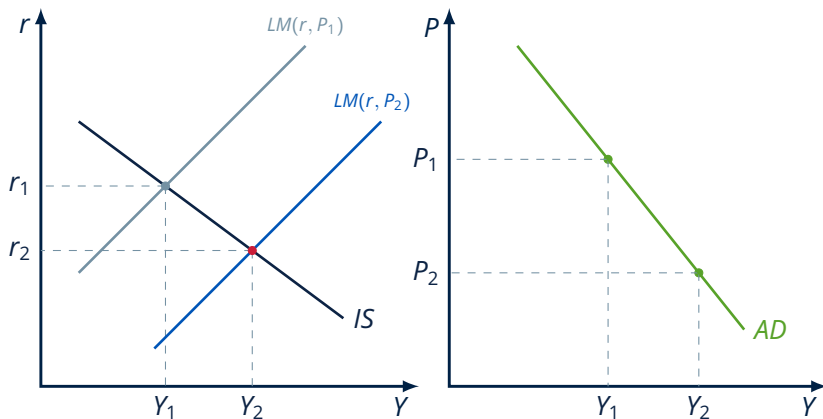
Aggregate demand

- The IS curve reflects the equilibrium in the goods market (Investment = Savings)
- The IS shows the negative relationship between real interest rates and output.
- The IS shifts to the right when:
 - Future marginal productivity of capital increases.
 - Increase in expected future income.
 - Increase in government expenditures.
 - Fall in taxes to income or investment.
- Prices do not affect the IS curve.

- The LM curve reflects the equilibrium in the money/asset market (Liquidity preferences = Money supply)
- The LM shows the positive relationship between real interest rates and output.
- The LM shifts right and down when:
 - Nominal money supply (M^s) increases.
 - Expected inflation increases.
 - Price level decreases.
 - Other elements that would reduce the demand for money e.g. ATMs
- Note that the price level shifts the LM curve

- Note that only the LM depends on the goods price level P
- For any price level, the IS-LM intersection of the IS and LM determines *output* and *real interest rate*
- Different price level will generate different output levels
- This relationship corresponds to the [Aggregate Demand](#) (AD), which negatively correlates price level with output.

Figure 1: Aggregate demand derivation



The aggregate demand in a linear world

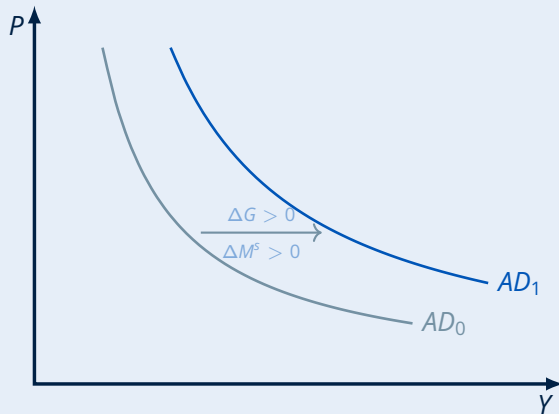
- Assume a linear version of our aggregate expenditures equals to output:
 $Y = c_0 + c_1 Y + i_0 - i_1 r + G$, and a linear version of our money demand:
 $L(i, Y) = L_0 + L_1 Y - L_2 r$
- The IS corresponds to $Y = \frac{c_0 + i_0 + G}{1 - c_1} - \frac{i_1}{1 - c_1} r$
- The LM corresponds to $M^s = P \cdot [L_0 + L_1 Y - L_2 r]$
- Using the equality IS=LM leads to the aggregate demand:

$$AD : Y = \frac{M^s i_1}{P(L_1 i_1 + L_2(1 - c_1))} + \frac{L_2(c_0 + i_0 + G) - L_0 i_1}{L_1 i_1 + L_2(1 - c_1)}$$

- What would happen if government expenditures or money supply increase?

Aggregate demand: Monetary and fiscal policy

Figure 2: Fiscal or monetary expansion



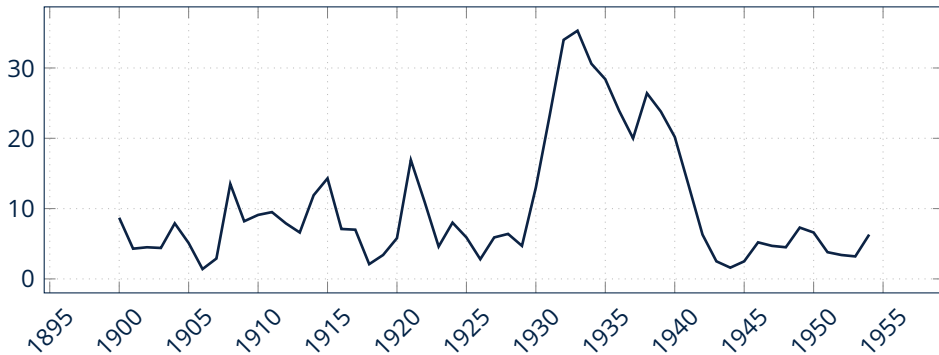
Aggregate supply

- When we covered the labor market, we analyzed the perfect competition and frictionless version of it.
- When the labor market reaches its equilibrium, output is determined by the production function and the labor input.
- What would happen if prices changed? Nothing
 - Increases in the goods price are offset by increases in nominal wages
 - The real wage or labor input do not depend on nominal variables
- This is the the [Classical](#) version of the economy, in which prices and quantities instantaneously self-adjust¹

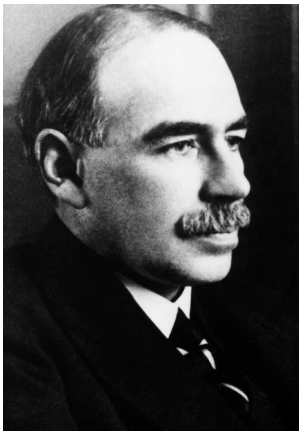
¹Take a look at this [link](#) if you want to read more about history of the economic thought

- Classical economists argued that observed unemployment was “natural”, until 1929

Figure 3: Unemployment during the great depression, US



Source: [Lebergott \(1957\)](#), Table 1



"In the long run we are all dead"

— Sir John Maynard Keynes

Prices are fixed in the short run

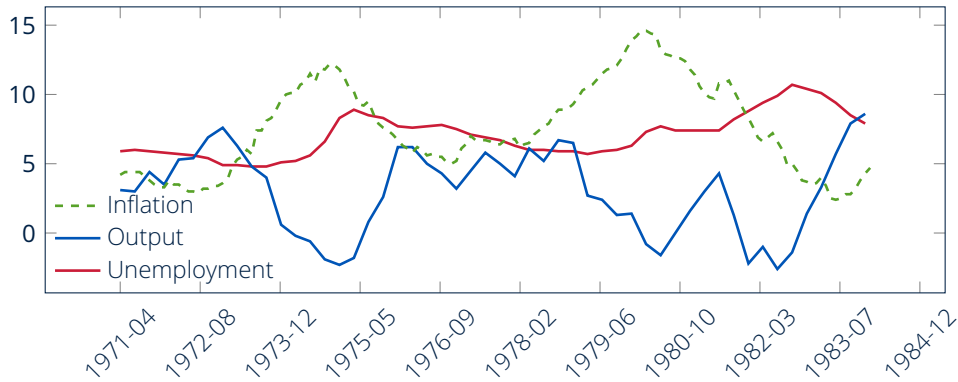
Pessimist wave

- Assume investors think that future productivity will fall
- This reduce investment and therefore output
- Less workers are hired at the same wages: unemployment.
- Households adjust by consuming less, output drops again
- Government austerity makes things worst
- Productivity is actually lower

Aggregate supply

- Keynes ideas were widely accepted. Until 1970's Stagflation

Figure 4: Stagflation, US



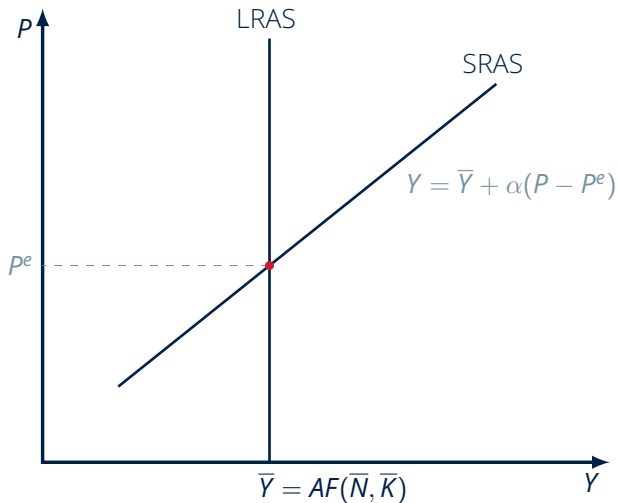
Source: Federal Reserve Bank of St. Louis

- In the long run all prices adjust and output corresponds to *full employment*. In this state the aggregate supply is vertical
- In the short run
 1. Sticky wages
 2. Imperfect information
 3. Sticky prices
- We will show how these three models lead to a positive sloped aggregate supply of the form

$$Y = \bar{Y} + \alpha(P - P^e) \quad (1)$$

where P^e is price expectations, and $\bar{Y}$ is full employment output

Figure 5: Aggregate Supply



- Assume a labor market in which employers and employees have to bargain nominal wages (no perfect competition)
- They do it sporadically since this process is costly (what would affect this?)
- Inflation is not known and what really matters is real wages, therefore expectations on future prices must be set.
- The negotiated nominal wage is

$$W = \omega P^e$$

where ω is the target real wage and P^e is price expectation

- The nominal wage is usually higher than the labor market clearing (union power and efficiency wages)
- Once prices materializes the firm decides how many workers it will hire.

- The real wage is:

$$\frac{W}{P} = \omega \frac{P^e}{P}$$

where P^e/P is the difference between the expected price and the materialization of it

- The optimal labor demand is $\frac{W}{P} = AF_N(N, \bar{K})$. Replacing the optimal labor input in the production function yields output as a function of prices.
- If $P = P^e$, then real wage equals the targeted one and the economy is in full employment (natural unemployment)
- If $P > P^e$, then real wage is lower than targeted and unemployment is lower than natural
- If $P < P^e$, then real wage is higher than targeted and unemployment is higher than natural

Sticky wages and Cobb-Douglas production function

- Assume the production function is $Y = AN^\gamma$
- The labor demand is $N^d = \left(\frac{W}{\gamma P}\right)^{\frac{1}{1-\gamma}}$
- That means that output will be $Y = A \left(\frac{W}{\gamma P}\right)^{\frac{\gamma}{1-\gamma}}$
- By definition when $P = P^e$, $N = \bar{N}$ and $Y = \bar{Y}$
- Linearizing output around the full employment yields

$$Y = \bar{Y} + \alpha(P - P^e) \quad \alpha > 0$$

what is a linearization?

- In this model prices move freely to allow market clearing. But not all the prices are observed all the time (expectations about the non-observed prices are needed)
- Households consume a variety of goods which are supplied by different producers.
- Each household produces one good. Their real labor income is the value of the good they sell relative to the price of the goods they consume.
- They know the price of the good they sell, but they do not observe the prices of other goods at the moment they decide how much to produce.

- Producers don't know if demand pressure to the good they produce is driven by inflation or by preferences (i.e., they don't know if their prices are going up because all the prices are going up, or because people like their good more)
- If a producer thinks the relative price of her good is increasing, then she will produce more. (the sacrificed leisure is well compensated by consumption)
- If the increase in price is driven by inflation (i.e., relative prices are not changing), she will keep production at the same level.
- If the relative price decreases, she will produce less.

- How does this story relate to the equation $Y = \bar{Y} + \alpha(P - P^e)$?
- When households' expectations are met ($P = P^e$), they correctly guessed what part of their price change is due to inflation and they reach the natural level of production ($Y = \bar{Y}$)
- When inflation is higher than expected ($P > P^e$), their production is higher than natural since they think, mistakenly, that their relative price is going up. (can all the relative prices go up at the same time?)
- When inflation is lower than expected ($P < P^e$), production is lower than natural.

Bakery: do you know the muffin man?

- The price of a muffin is the baker's nominal wage; the price of muffins relative to the general price level is the baker's real wage
- The baker knows very well the trend of muffin prices but does not know much about other goods sold in Drury Lane. He needs to infer what the relative price will be.
- If the price of muffins rise 2% and the baker thinks inflation is 2%, there's no change in the relative prices, so there's no change in the baker's labor supply
- But if the baker expects other prices to increase by 2%, and sees the price of muffins rising by 6%; then the baker will work more in response to the wage increase.

Aggregate supply: short run, sticky prices

- Some firms might not change their prices freely. For example, because of menu costs.
- Assume the household consumes several goods which are imperfect substitutes.
- Firms can choose quantity and price subject to their demand (note that this is not perfect competition). Assume the pricing rule to be

$$p_f = P + a(Y - \bar{Y})$$

- Assume a proportion ξ of firms have to announce their price in advance and stick to it. Assume next period output to be natural, therefore a pricing rule $p_s = p^e$
- The average price is $P = (1 - \xi) [P + a(Y - \bar{Y})] + \xi p^e$
- Rearranging terms we get

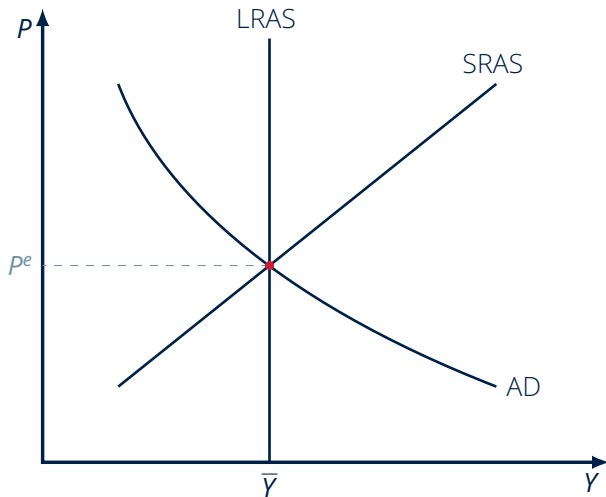
$$Y = \bar{Y} + \underbrace{\frac{\xi}{(1 - \xi)a}}_{\alpha} (P - p^e)$$

- The three models presented above yield the same aggregate supply but have profound differences.
- For example, In the sticky wages model, an increase in output must be accompanied by a decrease in real wages, this is not supported by the data (changes in real wages are positively correlated with output)
- Sticky prices, on the other hand, gets the positive correlation of wages and output.
- Sticky wages produces unemployment, but sticky prices nor imperfect information do (matching and search discussion)
- None of the models excludes the others, so the world could be a combination of the three.

Short vs long-run equilibrium

- Now that we know the differences between short and long run aggregate supply, we can account for the short and long-run *equilibrium* of the economy
- The way in which we discussed the SRAS does not permit us to analyze the dynamics from the short to the long run. The important part to remember is that the rigidities will be overcome with time, and expectations will be met in the long run (we assume rational expectations)
- The main difference between Keynesian and Classical economists is how long does it take for prices to adjust. The speed at which this adjustment occurs is much debated
- In the Classical world expectations and prices adjust quickly
- In the Keynesian world (extreme) the short run supply is flat, and output is determined by the intersection of the IS and LM.

Figure 6: Long run equilibrium

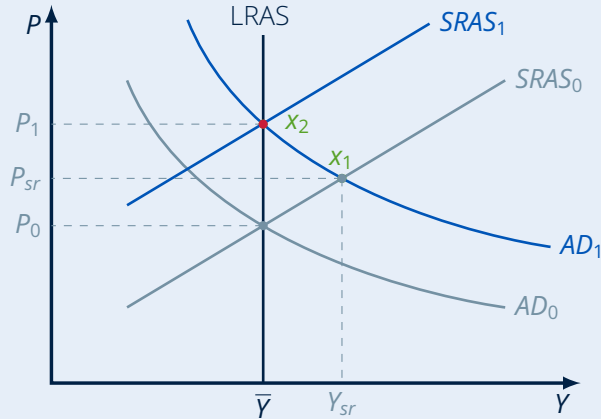


- If the economy is not in the long run equilibrium, prices and expectations are still adjusting.
- In this case output is defined by the intersection of the SRAS and aggregate demand (how would this look in the IS-LM-FE framework).
- In the short run the labor market might not be in equilibrium.
- When output is lower than natural, unemployment is higher than natural. To the right, there's excess of demand (unemployment lower than natural).

From the short to the long run

- Assume the economy is initially in the long run equilibrium.
- Then, there's an unforeseen positive demand shock. Demand shifts to the right.
- Assume SRAS or LRAS do not change.
- In the short run output and prices are higher.
- In the long run output does not change, prices are higher.

From the short to the long run (cont.)



- Note that the example above we assume there is no long run effect in the labor supply.
- It delivers higher output and prices in the short run.
- If output is temporarily higher, then income is temporarily higher.
- If the increase is significant, it might have PVLR effects. (This argument is used to explain why G might be positively correlated to GDP even when prices adjust quickly. Board.)
- If PVLR changes $\implies$ labor supply changes.
- Be conscious about this because it can change the answer of a question.

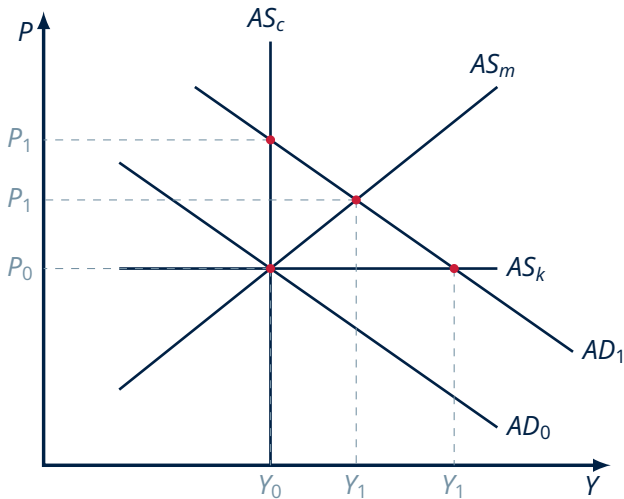
Economic policy and short run fluctuations

- Should the government do something about the cycles we observe in the short run?
- Can the government do something about the cycles we observe in the short run?
- We will see that if prices adjust quickly, expansionary fiscal or monetary policy will lead to higher prices.
- If prices adjust slowly, then increases in G or M^d will lead to higher output in the short run.

Monetary policy expansion

- Assume the Central Bank decides to increase the monetary base by ϵ_M
- This constitutes a shift of the money supply to the right.
- The LM shift to the right and up.
- The aggregate demand shifts to the right.
- If the slope of the aggregate supply is zero, output increases and prices are fixed.
- If the slope of the aggregate supply is positive but bounded, output and prices increases.
- In the long run (vertical AS), output does not change and prices increases.

Figure 7: Monetary expansion



Monetary neutrality

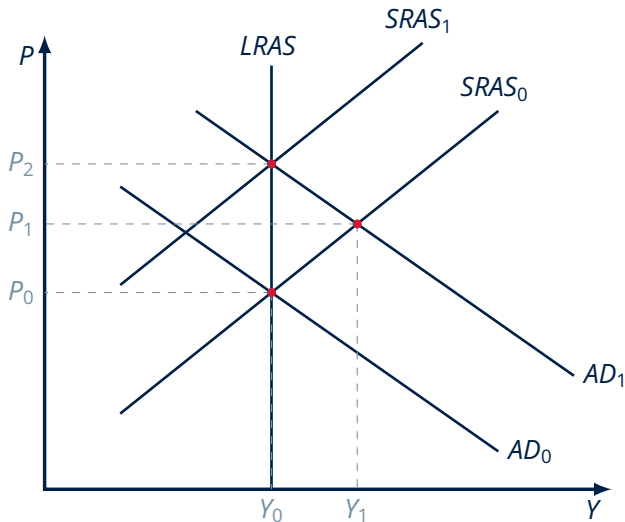
"Is the idea that a change in the stock of money affects only nominal variables in the economy such as prices, wages, and exchange rates, with no effect on real variables, like employment, real GDP, and real consumption."

- If the aggregate supply is not vertical, then money is not neutral
- In our model this happens in the short run.
- In the long run money would be neutral.

Monetary neutrality

- Suppose the economy begins in general equilibrium, but then the money supply is increased by 10%
- This shifts the AD curve upward by 10% because to maintain the aggregate quantity demanded at a given level, the price level would have to rise by 10% so that real money supply wouldn't change and would remain equal to real money demand.
- In the short run, with the price level fixed, equilibrium occurs where **AD_1** intersects **$SRAS_0$** , with a higher level of output.
- Since output exceeds full employment output, over time firms raise prices and the short-run aggregate supply curve shifts up to **$SRAS_1$** , restoring long-run equilibrium
- The result is a higher price level (by 10%)
- Money is neutral in the long run, as output is unchanged

Figure 8: Monetary expansion



Summary

- From the equilibrium of the goods market we obtain the IS curve
- From the equilibrium in the money market (or assets market) we get the LM curve
- From the combination of both we get the aggregate demand
- From the competitive labor market clearing we get the full employment line and a vertical aggregate supply curve (Classical story).
- In this case money is neutral and all real variables can be found by the clearing of the goods and labor market (intersection of IS and FE)
- Monetary and fiscal policy would change prices and aggregate expenditure composition.

- When markets are not competitive and there is price rigidities then aggregate supply is not vertical
- The slope depends on how fast prices adjust.
- If prices do not adjust at all (Keynesian story) then aggregate supply is flat
- Here government macroeconomic policy can manage the demand (should it?)
- The full Keynesian tale could not forecast stagflation in the 70's (why?)
- When prices adjust imperfectly, aggregate supply has a positive slope

- With the theory we built in this class you can analyze what economic fluctuations to expect if we observe exogenous shocks (examples?)

References

- Abel, A., Bernanke, B., Kneebone, R., and Croushore, D. (2018). *Macroeconomics, Eighth Canadian Edition*. Pearson Education Canada, 8th edition.
- Lebergott, S. (1957). Annual estimates of unemployment in the united states, 1900-1954. In *The Measurement and Behavior of Unemployment*, pages 211–242. National Bureau of Economic Research, Inc.
- Mankiw, N. G. (2009). *Macroeconomics*. Worth Publishers, 7th edition.

Linear approximation

- Looking close enough, any smooth curve looks like a line.
- First order Taylor approximation:

$$F(x) \approx F(a) + F'(a)(x - a)$$

where a is the point around which you would like to find a solution and $F'(a)$ is the first derivative of F evaluated in a

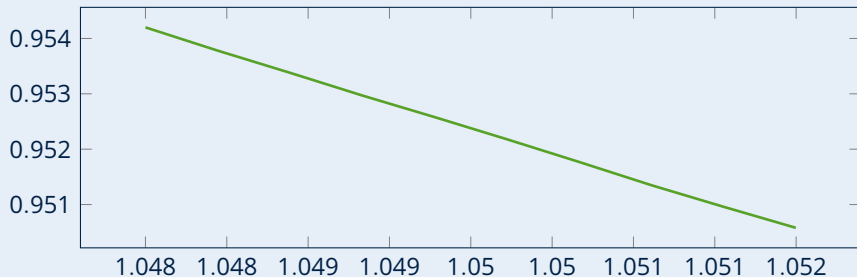
- In our example $F(x) = \left(\frac{W}{\gamma x}\right)^{\frac{\gamma}{1-\gamma}}$ and $a = p^e$
- Noting that $\bar{Y} = \left(\frac{W}{\gamma p^e}\right)^{\frac{\gamma}{1-\gamma}}$ we get

$$Y = \bar{Y} + \underbrace{\left[\frac{\gamma}{1-\gamma} \frac{\bar{Y}}{p^e} \right]}_{\alpha} (p - p^e)$$

- Accuracy depends on F 's curvature and how far x is from a

[Back to the example](#)

Looking close enough to $1/x$ around 1.05



[Back to the example](#)