

Macroeconomics: Intro and the IS-LM Model

14.02 Notes ¹

March 3, 2014

¹These slides are NOT a substitute for chapters 2-5 of the book. They are meant to give you a more concise and analytical presentation of the IS-LM model but many aspects of the model that are discussed in the book are not in these slides, and we shall assume you have read the book.

Macroeconomics

To understand

- how the financial crisis hit the real economy
- how the government – through its monetary and fiscal policies – was able to alleviate the effects of the financial shock on the economy

we need a model of the economy. Not of a single market, but of entire economy. This is what macroeconomics is about: constructing models of the aggregate economy and then using them to understand the effects of

- external shocks
- policies

We start from the definition of the economy's *aggregate* output

GDP: The economy's aggregate output. Three ways to measure GDP: the example of an economy consisting of only two firms

Steel company

Revenues		100\$
Expenses		
	wages	80\$
Profit		20\$

Car company

Revenues		200\$
Expenses		
	wages	70\$
	steel	100\$
Profit		30\$

1. GDP is the value of final goods (cars in the example) produced in the economy in a given period. Value of cars sold = 200\$. See this merging the two companies

Steel company+Car company

Revenues		200\$
Expenses		
	wages	150\$
Profit		50\$

2. GDP is the sum of the value added in the economy in a given period: 200\$

Steel company

Revenues		100\$
Expenses		
	wages	80\$
Profit		20\$

Car company

Revenues		200\$
Expenses		
	wages	70\$
	steel	100\$
Profit		30\$

- steel company: value added = 100\$

- car company: value added = 200\$ - 100\$ (steel bought) = 100\$

3. GDP is the sum of incomes (profits plus salaries) in the economy in a given period: 200\$

Steel company

Revenues	100\$
Expenses	
wages	80\$
Profit	20\$

Car company

Revenues	200\$
Expenses	
wages	70\$
steel	100\$
Profit	30\$

- incomes in the steel company: $80\$ + 20\$ = 100\$$

- incomes in the car company: $70\$ + 30\$ = 100\$$

Nominal and real GDP

year	quantity of cars	price of cars	nominal GDP	real GDP in 2005\$
2004	10	20,000\$	200,000\$	240,000\$
2005	12	24,000\$	288,000\$	288,000\$
2006	13	26,000\$	338,000\$	312,000\$

From nominal to real GDP and the Chain Index

You can compute the change in real GDP from year t to year $t + 1$ in two alternative ways

$$\frac{Y_{t+1}}{Y_t} = \frac{P_t Q_{t+1}}{P_t Q_t}$$

or

$$\frac{Y_{t+1}}{Y_t} = \frac{P_{t+1} Q_{t+1}}{P_{t+1} Q_t}$$

the two ways of computing it are obviously identical

From nominal to real GDP and the Chain Index

With two goods, Y_1 and Y_2 , the two ways of computing the change in real GDP from year t to year $t + 1$ are no longer identical:

$$\left(\frac{Y_{t+1}}{Y_t}\right)' = \left(\frac{P_{1,t}Q_{1,t+1} + P_{2,t}Q_{2,t+1}}{P_{1,t}Q_{1,t} + P_{2,t}Q_{2,t}}\right)$$

$$\left(\frac{Y_{t+1}}{Y_t}\right)'' = \left(\frac{P_{1,t+1}Q_{1,t+1} + P_{2,t+1}Q_{2,t+1}}{P_{1,t+1}Q_{1,t} + P_{2,t+1}Q_{2,t}}\right)$$

if you divide through $\left(\frac{Y_{t+1}}{Y_t}\right)'$ by $P_{1,t}/P_{2,t}$ and $\left(\frac{Y_{t+1}}{Y_t}\right)''$ by $P_{1,t+1}/P_{2,t+1}$ you

can verify that the two ways of computing the change in real GDP from year t to year $t + 1$ are equal only if $P_{1,t}/P_{2,t} = P_{1,t+1}/P_{2,t+1}$. Since the relative price of goods changes over time, this condition will in general not be satisfied. Thus the two expressions will give you two different changes in real GDP.

From nominal to real GDP and the Chain Index

The chain index addresses the problem by simply defining the change in GDP as the weighted average of the two

$$g_{(01/00)} = .5 \left[\left(\frac{Y_{t+1}}{Y_t} \right)' + \left(\frac{Y_{t+1}}{Y_t} \right)'' \right]$$

Finally it is customary to compute the change in real GDP using an index that is (arbitrarily) set to be equal to 100 in a "base" year, say the year 2000:

$$\text{chain index}_{2000} = 100$$

$$\text{chain index}_{2001} = 100 * g_{(01/00)}$$

The Model of the Goods (and Services) Market (Model 1)

We proceed in steps, starting from the simplest model and then making more complicated (realistic) by relaxing assumptions.

Model 1: The Goods market

- 1 market: the market for goods and services
- 1 variable to determine: the level of production, or output ($Y = GDP$)
- 1 equilibrium condition to determine it:

Supply of $Y =$ Demand for Y

Supply of Y

- The economy is closed: no goods are exported or imported
- The price of Y is fixed

$$P(Y) = \bar{P} = 1$$

- Therefore (for the time being)

$$\$Y = Y$$

What does this assumption mean:

- Output is determined by demand: at the fix price $\bar{P} = 1$ firms produce any amount of Y needed to satisfy demand

Demand for Y

$Z \equiv \text{Consumption } (C) + \text{Investment } (I) + \text{Government Spending } (G)$

The 3 components of demand:

- Consumption is a function of disposable income (income net of taxes)

$$C = c \left(Y^{Disposable} \right) = c_0 + c_1(Y - T)$$

c_1 is the marginal propensity to consume

- Taxes, Government Spending and Investment are assumed to be exogenous

$$T = \bar{T}, \quad I = \bar{I}, \quad G = \bar{G}$$

Consumption Function

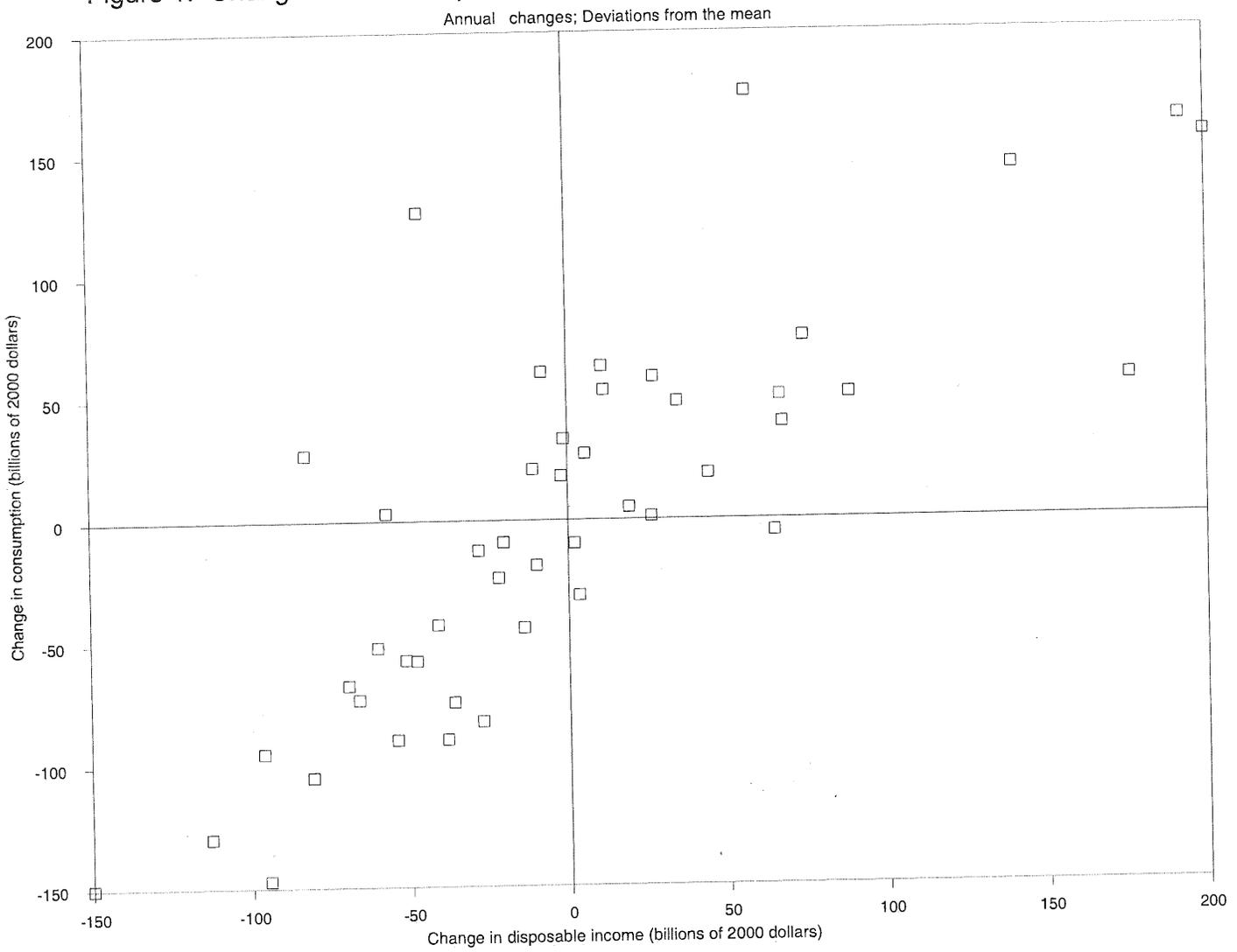
Consumption is a function of disposable income (income net of taxes)

We shall assume a linear relationship

$$C = c \left(Y^{Disposable} \right) = c_0 + c_1 (Y - \bar{T})$$

where c_0, c_1 ($c_0 > 0, 0 < c_1 < 1$) are positive parameters

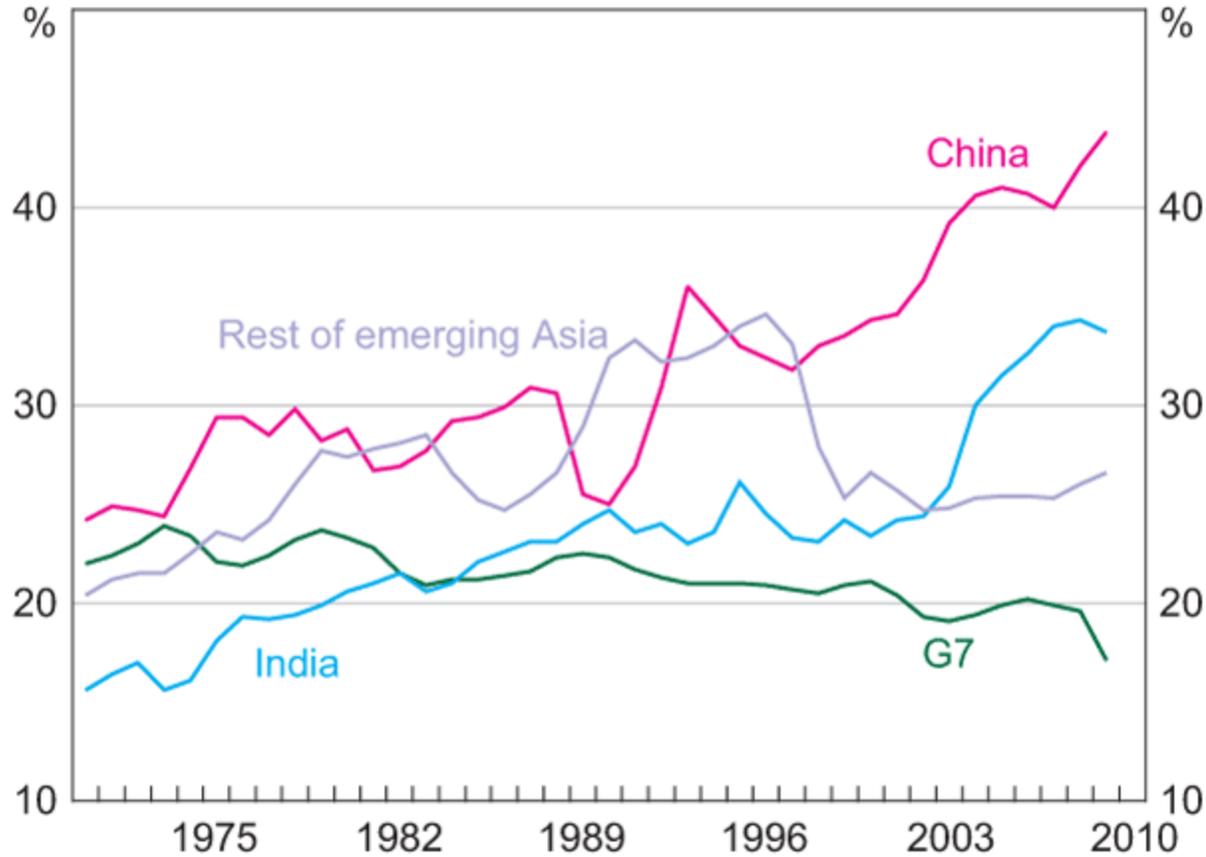
Figure 1. Changes in Consumption versus Changes in Disposable income, 1970-2006



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Investment Ratios

Per cent of nominal GDP



Source: United Nations

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Solving the Model

- Variables

- ▶ 3 exogenous variables: \bar{T} , \bar{I} , \bar{G}
- ▶ **1 endogenous variable:** Y
 - ★ once you know Y , $C = c_0 + c_1(Y - \bar{T})$ determines C

- Equations

- ▶ **1 equation: the market clearing condition, $Y = Z$**

- With 1 equation and 1 endogenous variable the model can be solved

- What can move this economy away from an equilibrium?

- ▶ *policy*, shifts in \bar{T} or in \bar{G}
- ▶ *shocks*, shifts in firms' or consumers' confidence, *i.e.* shifts in \bar{I} or c_0

Equilibrium in the Goods Market

- The "equilibrium" level of Y is the level that clears the market, i.e. makes supply equal to demand

$$Y = Z = C + \bar{T} + \bar{G} = c_0 + c_1(Y - \bar{T}) + \bar{T} + \bar{G}$$

- Thus the level of Y that clears the market is

$$Y = c_0 + c_1(Y - \bar{T}) + \bar{T} + \bar{G}$$

Solving for the market equilibrium

$$C = c_0 + c_1(Y - \bar{T}) \quad C = c_0 + c_1Y - c_1\bar{T}$$

with

$$c_1 < 1$$

solving for Y

$$Y = \frac{1}{1 - c_1} (c_0 + \bar{I} + \bar{G} - c_1\bar{T})$$

$(c_0 + \bar{I} + \bar{G} - c_1\bar{T})$ is **Autonomous spending**

Autonomous spending is spending that does not depend on Y

$\frac{1}{1 - c_1} > 1$ is the **Keynesian multiplier**.

Inventories

So far we have assumed

$$Output_t = \sum Final\ Sales_t$$

where t refers to some year.

What if not all output produced in year t is sold in year t ? Consider two extreme cases:

$$\sum Final\ Sales_t = Output_{t-1}$$

or

$$Output_t = \sum Final\ Sales_{t+1}$$

$$(Output_t - \sum Final\ Sales_t) = \Delta Inventories_t$$

$\Delta Inventories$ are called *Inventory Investment*. (Note Inventories are not part of demand)

Comparative Statics Exercises

- Shifts in policy: \bar{G} or \bar{T} or both
- Shifts in confidence
 - ▶ consumers' confidence can shift c_0
 - ▶ firms' confidence can shift \bar{I}
- Remember

$$Y = \frac{1}{1 - c_1} (c_0 + \bar{I} + \bar{G} - c_1 \bar{T})$$

Table. GDP, Consumption, and Forecast Errors, 1990–1991

Quarter	(1) Change in real GDP	(2) Forecast error for GDP	(3) Forecast error for c_0	(4) Index of Consumer Confidence
1990:2	19	-17	-23	105
1990:3	-29	-57	-1	90
1990:4	-63	-88	-37	61
1991:1	-31	-27	-30	65
1991:2	27	47	8	77

Columns (1) to (3): Billions of 1992 dollars. Source: Olivier Blanchard, "Consumption and the Recession of 1990–1991," *American Economic Review*, May 1993.

An example of the effects of a policy shift: President Obama's 2009 Stimulus Program

- Total package: US\$ 800 bn (5,7% of 2008 GDP)
- Composition of the package
 - ▶ $2/3 \Delta G > 0$: 533 US\$ bn
 - ▶ $1/3 \Delta T < 0$: - 266 US\$ bn
- Effect of the package on Y for different values of c_1

$$c_1 = 0.3 \quad c_1 = 0.6$$

multipliers

$\frac{dY}{dG} = \frac{1}{1-c_1}$	1.4	2.5
$\frac{dY}{dT} = -\frac{c_1}{1-c_1}$	-0.4	-1.5

Effects of President Obama's 2009 Stimulus Program under Model 1

- $c_1 = 0.3$: $(1.4) \cdot (533) + (0.4) \cdot (266) = 852$ *US\$bn* (6.1% of *GDP*)
- $c_1 = 0.6$: $(2.5) \cdot (533) + (1.5) \cdot (266) = 1.731$ *US\$bn*
(12.3% of *GDP*)

Christina Romer's Assumptions: Effects on Y of 1\$ of higher G or 1\$ of lower T in period 0

(professor Christina Romer was President Obama's first Chairperson of the Council of Economic Advisers. Homework: Compute the multipliers Christina used to get these numbers)

Quarter	G	T	Quarter	G	T
1	1.05	0.00	7	1.54	0.93
2	1.24	0.49	8	1.57	0.99
3	1.35	0.58	9	1.57	0.99
4	1.44	0.66	20	1.57	0.99
5	1.51	0.75	11	1.57	0.99
6	1.53	0.84	12	1.55	0.98

A useful exercise: the Balanced-Budget Multiplier

What is the effect on Y of an increase in G fully financed by a corresponding increase in T

$$dG = dT$$

$$Y = c_0 + c_1(Y - \bar{T}) + \bar{I} + \bar{G}$$

$$dY = c_1(dY - dT) + dG$$

$$dT = dG$$

$$dY(1 - c_1) = dT(1 - c_1)$$

$$dY = dT = dG$$

the multiplier is 1. You still get a positive effect, but not bigger than 1: the private sector (Consumption) does not move, thus there is no "multiplier effect".

Investment equals Saving: An Alternative Way of Thinking About Goods Market equilibrium

Start from Private Saving

$$S^{\text{Pr}} \equiv Y^D - C \equiv Y - \bar{T} - C$$

Now add the Saving by the Government ($\bar{T} - \bar{G}$)

Total Saving in the economy is

$$S^{\text{Pr}} + S^{\text{Pu}} = (Y - \bar{T} - C) + (\bar{T} - \bar{G}) = Y - C - \bar{G}$$

But from Goods Market Equilibrium we know that $(Y - C - \bar{G}) = I$.

Thus

$$S = S^{\text{Pr}} + S^{\text{Pu}} = I$$

The "Paradox" of Saving

Suppose consumers decide to save more at any level of Y . This means that c_0 falls. What happens to Saving ?

$$S^{PR} = -c_0 + (1 - c_1)(Y - \bar{T})$$

As c_0 falls consumers tend to save more, but their income Y will also be lower, which will reduce S . What is the net effect? Remember that – when there is equilibrium in the goods market – saving is equal to investment

$$I = S^{PR} + (\bar{T} - \bar{G}) = S$$

then the net effect is zero.

Model 2 - The IS-LM Model

- So far the only variable in the private sector that could respond to shifts in policy (dT or dG) or in "confidence" (dI or dc_0) is consumption
- What else could respond?
 - ▶ prices ? NOT in the **Short Run**. Prices are slow to respond. Our assumption that prices are fixed is, as we shall see, not too bad. We shall study what happens when prices respond in the **Medium Run**
 - ▶ financial markets? YES: the price of financial assets responds instantaneously to news.
- We thus extend the model adding a financial sector

Introducing Financial Markets

- Financial markets include many assets with decreasing degrees of liquidity. From the most liquid (money) to the less liquid (equity)
 - ▶ cash, demand deposits, saving deposits, money market mutual funds, government bonds, corporate bonds, equity
- Start from the essentials. Assume there are only two financial assets
 - ▶ "money" (cash, demand deposits), that pays no interest
 - ▶ bonds, that pay an interest rate i per period
- Think of the problem of how to allocate a given amount W between bonds and cash: the higher the interest the larger the fraction of W you will want to keep in bonds, and thus the more often you will go to the bank to sell bonds and get cash.

The demand for financial assets

- Demand for "money" (M^d), the most liquid asset

$$M^d = L(Y, i)$$

we shall assume $L(Y, i) = f_1 Y - f_2 i$ with f_1, f_2 ($f_1, f_2 > 0$) two positive parameters, so that

$$M^d = f_1 Y - f_2 i$$

- Demand for Bonds (B^d)

$$B^d = W - M^d$$

where W is your wealth, which is divided between money and bonds.
Note: given W , if you know M^d you do not need a second equation to compute B

"Stock" and "Flow" variables

So far we have introduced two types of variables in our model

- Flow variables. Y , C : these are measured as flows per unit time. For instance C is consumption per period, e.g. per year
- Stock variables. B , W , M : these are stocks at any moment in time

Equilibrium in the financial market

- As we said, one equilibrium condition is enough — because once we know M , given W , we know $B = W - M$
- Equilibrium requires that the demand for money, M^d , equals the quantity of money that the central bank has put in the economy, which, for the time being, we assume to be a fixed quantity \bar{M}

$$M^d = \bar{M}$$

$$M^d = L(Y, i) = \bar{M}$$

- this equation determines the interest rate i for any given level of Y and \bar{M}

Closing the model

How does i affect the economy?

- We focus on one channel only: **Investment**
- Assumption: Investment depends on
 - ▶ i , the cost firms face to borrow the funds needed to acquire new machines, build a new plant, etc
 - ▶ Y , the level of demand

$$I = I(i, Y) = d_1 Y - d_2 i$$

with d_1, d_2 ($d_1, d_2 > 0$) two positive parameters

The structure of Model 2: the IS-LM Model

- 4 exogenous variables: \bar{T} , \bar{I} , \bar{G} , \bar{M}
- 2 endogenous variables: Y , i
- Equations
 - ▶ 2 equilibrium conditions
 - ★ equilibrium in the goods market $Y = Z$
 - ★ equilibrium in the financial market $M^d = \bar{M}$
- With 2 equations and 2 endogenous variables, the model can be solved
- What can move this economy away from an equilibrium?
 - ▶ policy, shifts in \bar{T} , \bar{G} , \bar{M}
 - ▶ shocks, shifts in firms' or consumers' confidence, *i.e.* shifts in \bar{I} or c_0

Solving the IS-LM Model

Two equations

- equilibrium in the goods market

$$Y = Z$$

gives you the **the IS Curve**

$$Y = Y(i)$$

- equilibrium in the financial market

$$M^d = \bar{M}$$

gives you **the LM Curve**

$$i = i(Y)$$

- two equations and two unknowns: the model is solved

Multipliers in the IS-LM Model

$$\frac{dY}{dT} = \frac{-c_1}{(1 - c_1 - d_1) + d_2 \frac{f_1}{f_2}} < 0$$

$$\frac{dY}{dG} = \frac{1}{(1 - c_1 - d_1) + d_2 \frac{f_1}{f_2}} > 0$$

$$\frac{dY}{dM} = \frac{1}{(1 - c_1 - d_1) \frac{f_2}{d_2} + f_1} > 0$$

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