Macroeconomics · 2025-26 · Problem set 1

Reminder on the money multiplier model:

$\mathbf{E}$	stands for cash
$\mathbf{R}$	stands for reserves
$\mathbf{M0}$	is the monetary base (the sum $\mathbf{E} + \mathbf{R}$)
$\mathbf{D}$	stands for deposits
$\mathbf{M1}$	is the money stock (the sum $\mathbf{E} + \mathbf{D}$)
r	is the reserve ratio $\mathbf{R}/\mathbf{D}$
l	is the liquidity ratio $\mathbf{E}/\mathbf{D}$
mm	is the money multiplier $\mathbf{M1}/\mathbf{M0}$.

1. Money multiplier model

Cash is half of reserves. Reserves are twice as large as deposits. $\mathbf{M1}$ is 100. If possible, calculate $\mathbf{M0}$, cash, reserves, deposits and the money multiplier. If not, explain why it is not possible.

2. Money multiplier model

(i) With $\mathbf{M1} = 1000$, $\mathbf{M0} = 500$, $r = 3/8$ and deposits 800, calculate the liquidity ratio, cash and the money multiplier. (ii) Recalculate $\mathbf{M1}$ if the central bank sells T-bills worth 100.

3. Money multiplier model

(i) With $\mathbf{M1} = 1200$ and $\mathbf{M0} = 300$, find the reserve ratio r and the money multiplier if r is half the liquidity ratio. (ii) Recalculate $\mathbf{M1}$ if the central bank purchases T-bills worth 100.

4. Money multiplier model

Find the reserve ratio and the money multiplier if the monetary base is 350, deposits 1000 and the liquidity ratio $1/4$.

5. Money multiplier model

Find the money multiplier and $\mathbf{M0}$ if $\mathbf{M1} = 1200$, the reserve ratio is $1/10$ and cash is 200.

6. Money multiplier model

If possible, calculate cash and the reserve ratio if the money multiplier is 4 and the sum of cash and diposits is four times reserves.

7. Money multiplier model

If possible, calculate the liquidity and reserve ratios from the data below, published by the Bank of England; if not possible, explain why not or what information is missing.

https://www.bankofengland.co.uk/explainers/how-is-money-created

8. Creation of bank money

Explain if there is any contradiction (and if so, what it is) in the following explanation (taken from the website of the Spanish central bank, the *Banco de España*).

> "Most of the money we use is created by commercial banks when they lend money. When a commercial bank issues a new loan to its customers and credits their current accounts with the corresponding amount, it is creating 'inside money'. This money will be used to buy goods or make investments and will eventually end up being deposited in other bank accounts. Conversely, when customers pay off their debts, that inside money is destroyed.
>
> To ensure that this process does not repeat itself endlessly and that the money in circulation does not exceed the desired amount (which would have an adverse impact on price stability and lead to inflation), the process of creating money is controlled and regulated by central banks and other supervisory authorities. Central banks set their official interest rates, influencing the amount of money that commercial banks create. Additionally, there are various regulations regarding bank capital and solvency, as well as minimum reserve requirements, which limit the creation of bank money." [Emphasis added]

https://www.bde.es/bde/es/areas/polimone/Preguntas-y-respuestas-frecuentas-sobre-la-politica-monetaria/definicion-y-funciones-del-dinero/como-se-crea-el-dinero.html

9. Creation of bank money

On 8 December 2011, the then Vice-President of the European Central Bank, Vítor Constâncio, in a speech at the *26th International Conference on Interest Rates*, said:

> "Central bank reserves are held by banks and are not part of money held by the non-financial sector, hence not, *per se*, an inflationary type of liquidity. There is no acceptable theory linking in a necessary way the monetary base created by central banks to inflation. Nevertheless, it is argued by some that financial institutions would be free to instantly transform their loans from the central bank into credit to the non-financial sector. This fits into the old theoretical view about the credit multiplier according to which the sequence of

money creation goes from the primary liquidity created by central banks to total money supply created by banks via their credit decisions.

In reality the sequence works more in the opposite direction with banks taking first their credit decisions and then looking for the necessary funding and reserves of central bank money. As Claudio Borio and Disyatat from the BIS [The Bank for International Settlements] put it: 'In fact, the level of reserves hardly figures in banks' lending decisions. The amount of credit outstanding is determined by banks' willingness to supply loans, based on perceived risk-return trade-offs and by the demand for those loans'. In modern banking sectors, credit decisions precede the availability of reserves in the central bank. As Charles Goodhart pointedly argued, it would be more appropriate talking about a 'Credit divisor' than about a 'Credit multiplier'." [Emphasis added]

https://www.ecb.europa.eu/press/key/date/2011/html/sp111208.en.html

(i) Is the above explanation consistent with the textbook money creation model?

(ii) Does the speech present an orthodox or heterodox view of the process of bank money creation? [In the orthodox view, the central bank determines the money stock $\mathbf{M1}$ and, hence, deposits; and, moreover, banks lend cash. In the heterodox view banks create the form of money they lend: deposits.]

Reminder on the 45-degree model:

$\mathbf{C}$	stands for aggregate private consumption
$\mathbf{I}$	stands for aggregate private investment
$\mathbf{G}$	stands for public expenditure
$\mathbf{EX}$	stands for aggregate exports
$\mathbf{IM}$	stands for aggregate imports
$\mathbf{NX}$	stands for net aggregate exports (the difference $\mathbf{EX} - \mathbf{IM}$)
$\mathbf{T}$	stands for tax revenue
$\mathbf{TR}$	stands for transfers (from the public to the private sector)
$\mathbf{AD}$	stands for aggregate demand (where $\mathbf{AD} = \mathbf{C} + \mathbf{I} + \mathbf{G} + \mathbf{EX} - \mathbf{IM}$)
$\mathbf{Y}$	stands for aggregate income (or, alternatively, GDP)
$\mathbf{Y}_d$	stands d for aggregate disposable income (where $\mathbf{Y}_d = \mathbf{Y} + \mathbf{TR} - \mathbf{T}$)
$\mathbf{S}$	stands for aggregate savings (that is, $\mathbf{S} = \mathbf{Y}_d - \mathbf{C}$)
c	is the propensity to consume
s	is the propensity to save (that is, $s = 1 - c$)
$\bar{\mathbf{C}}$	stands for autonomous (exogenous, constant) aggregate private consumption
$\bar{\mathbf{I}}$	stands for autonomous (exogenous, constant) aggregate private investment
$\bar{\mathbf{G}}$	stands for autonomous (exogenous, constant) public expenditure
$\overline{\mathbf{EX}}$	stands for autonomous (exogenous, constant) aggregate exports
$\overline{\mathbf{IM}}$	stands for autonomous (exogenous, constant) aggregate imports

10. 45-degree model

The aggregate private consumption function is

$$\mathbf{C} = \bar{\mathbf{C}} + c\,\mathbf{Y}_d.$$

The aggregate private investment function is

$$\mathbf{I} = \bar{\mathbf{I}}.$$

In addition,

$$\mathbf{G} = \bar{\mathbf{G}}$$

$$\mathbf{T} = \bar{\mathbf{T}}$$

$$\mathbf{TR} = \overline{\mathbf{TR}}$$

$$\mathbf{EX} = \overline{\mathbf{EX}}$$

$$\mathbf{IM} = \overline{\mathbf{IM}}.$$

(i) Find the equilibrium value of GDP and the expenditure multiplier if $\bar{\mathbf{C}} = \bar{\mathbf{I}} = \bar{\mathbf{G}} = \bar{\mathbf{T}} = \overline{\mathbf{TR}} = \overline{\mathbf{EX}} = \overline{\mathbf{IM}} = x$ and $c = x/10$.

(ii) Represent the model graphically, identifying the GDP equilibrium value.

(iii) Compute the public deficit to GDP ratio in equilibrium.

(iv) What change in $\bar{\mathbf{G}}$ duplicates the equilibrium value of GDP? Represent graphically the model before and after the change in $\bar{\mathbf{G}}$.

(v) What change in net aggregate exports $\overline{\mathbf{NX}}$ duplicates the equilibrium value of GDP?

(vi) What change in the tax revenue $\bar{\mathbf{T}}$ duplicates the equilibrium value of GDP?

(vii) If $x = 5$, calculate the value of GDP (a) closest to the equilibrium value of GDP and (b) consistent with the fiscal rule that the ratio of public deficit over GDP is not larger than 10%.

(viii) How do the expenditure multiplier and the equilibrium GDP change if transfers are lowered to zero?

(ix) What is the effect on the equilibrium value of GDP of duplicating the propensity to consume? Represent graphically the model before and after the change in the propensity when $x = 5$.

(x) If $x = 5$, calculate the change in the equilibrium value of GDP using the expenditure multiplier if $\bar{\mathbf{I}}$ is reduced by 20%. By what percentage does GDP vary?

(xi) Verify that, in equilibrium, net private savings $\mathbf{S} - \mathbf{I}$ equals public deficit $\mathbf{G} + \mathbf{TR} - \mathbf{T}$ plus net exports $\mathbf{NX}$.

(xii) Is it true that $\mathbf{S} - \mathbf{I} = \mathbf{G} + \mathbf{TR} - \mathbf{T} + \mathbf{NX}$ always holds?

(xiii) Having $\mathbf{S} - \mathbf{I} > \mathbf{0}$ means that the private sector increases its financial wealth. Is it possible for the private sector to increase its financial wealth while the public sector balances its budget (that is, public deficit $\mathbf{G} + \mathbf{TR} - \mathbf{T}$ is zero) when net exports $\mathbf{NX}$ are zero?

(xiv) Prove that conditions $\mathbf{Y} = \mathbf{DA}$ and $\mathbf{S} - \mathbf{I} = \mathbf{G} + \mathbf{TR} - \mathbf{T} + \mathbf{NX}$ yield the same GDP value.

11. A non-conventional 45-degree model

Net exports **NX** are zero. The private sector is represented by the functions

$$\mathbf{C} = \bar{\mathbf{C}} + c\,\mathbf{Y}_d$$

and

$$\mathbf{I} = \bar{\mathbf{I}}.$$

The public sector is represented by the functions

$$\mathbf{G} = \bar{\mathbf{G}}$$

$$\mathbf{TR} = \overline{\mathbf{TR}}$$

and

$$\mathbf{T} = t\,\boldsymbol{Y}$$

where the tax rate t is a number between zero and one.

(i) Set $c = 4/5$ and $t = 1/5$. Measuring $\boldsymbol{Y}$ on the horizontal axis, represent graphically and simultaneously the net private savings function

$$\mathbf{NPS} = \mathbf{S} - \mathbf{I}$$

and the public deficit function

$$\mathbf{PD} = \mathbf{G} + \mathbf{TR} - \mathbf{T}$$

(recalling that $\mathbf{S} = \mathbf{Y}_d - \mathbf{C}$).

(ii) Find the formula that gives the value of $\mathbf{Y}$ that satisfies $\mathbf{NPS} = \mathbf{PD}$.

(iii) Show that the formula in (ii) coincides with the one obtained from the condition $\mathbf{Y} = \mathbf{AD}$.

(iv) Using the formula in (ii), find the derivative of $\mathbf{Y}$ with respect to $\overline{\mathbf{TR}}$. Does an increase in $\overline{\mathbf{TR}}$ cause a rise or a fall in $\mathbf{Y}$?

(v) Answer (i), (ii), (iii) and (iv) if the private and public sectors are represented by the following functions, where $\alpha = 1/5$ and $\beta = 4/5$ (and now defining $\mathbf{Y}_d = \mathbf{Y}$).

$$\mathbf{C} = \bar{\mathbf{C}}$$

$$\mathbf{I} = \bar{\mathbf{I}} + \alpha\mathbf{Y}$$

$$\mathbf{G} = \beta\mathbf{Y}$$

$$\mathbf{TR} = \overline{\mathbf{TR}}$$

$$\mathbf{T} = \bar{\mathbf{T}}$$

(vi) Consider the above two models. (a) Analyse graphically in each model the effect on $\mathbf{Y}$ of a fall in private investment $\bar{\mathbf{I}}$. (b) Analyse graphically in each model how to recover the initial value of $\mathbf{Y}$ by changing transfers $\overline{\mathbf{TR}}$.
[Hint: in one model, an expansionary fiscal policy is needed; in the other, a contractionary fiscal policy does the job.]

12. Exchange rates, appreciation, depreciation

Tables T1, T2 and T3 below (taken from the website http://www.x-rates.com/) show exchange rates. In T1, for example, €1 is worth \$1.35357: the exchange rate is 1.35357 \$/€. Also in T1, the inverse of this rate is 0.73879 \$/€: one dollar is worth 0.73879 euros.

(i) Does the euro appreciate or depreciate against the dollar when moving from T1 to T2? By how much?

(ii) Identify any currency against which both euro and dollar appreciate between T1 and T2.

(iii) Find a currency that, in the transition from T1 to T2, appreciates relative to the dollar but depreciates relative to the euro (or vice versa).

(iv) In the minute that passed between T2 and T3, which currencies depreciated and which currencies appreciated?

	USD	GBP	CAD	EUR	AUD
USD	1	0.63804	0.99588	0.73879	0.96732
GBP	1.56729	1	1.56082	1.15789	1.51607
CAD	1.00414	0.64069	1	0.74185	0.97133
EUR	1.35357	0.86364	1.34799	1	1.30933
AUD	1.03378	0.65960	1.02952	0.76375	1

T1 | Refresh in 0:38 | Feb 07, 2013 06:49 UTC

	USD	GBP	CAD	EUR	AUD
USD	1	▲0.74859	▼1.36737	▲0.86082	▼1.42026
GBP	▼1.33585	1	▼1.82660	▲1.14993	▼1.89725
CAD	▲0.73133	▲0.54747	1	▲0.62955	▼1.03868
EUR	▼1.16168	▼0.86962	▼1.58844	1	▼1.64989
AUD	▲0.70410	▲0.52708	▲0.96276	▲0.60610	1

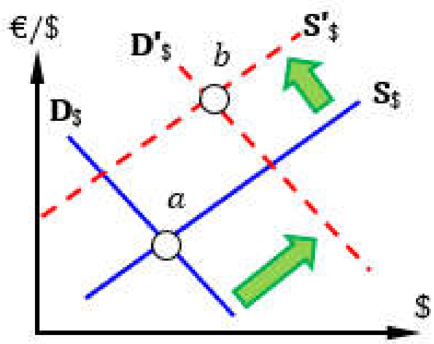
T2 | Refresh in 0:46 | Mar 03, 2026 23:32 UTC

	USD	GBP	CAD	EUR	AUD
USD	1	▼0.74859	▼1.36733	▼0.86081	▲1.42040
GBP	▲1.33585	1	▼1.82654	▼1.14991	▲1.89744
CAD	▲0.73135	▲0.54748	1	▲0.62956	▲1.03881
EUR	▲1.16170	▲0.86963	▼1.58842	1	▲1.65007
AUD	▼0.70403	▼0.52703	▼0.96264	▼0.60603	1

T3 | Refresh in 0:55 | Mar 03, 2026 23:33 UTC

13. Currency market model

The currency market model shown on the right would represent the market from the perspective of a US citizen, since the model exhibits the supply of dollars and the demand for dollars.



(i) Explain if, in the passage from *a* to *b*, the euro appreciates or depreciates against the dollar.

(ii) Suggest an event that could justify the transition from *a* to *b* and explain why the event shifts the two functions as shown.

(iii) Represent graphically the same situation from the perspective of a euroarea citizen, that is, drawing the supply of euros function and the demand for euros function.

14. Currency market model and Turkey 2018

Recep Tayyip Erdoğan was the favourite to win the presidential and parliamentary polls on 24th of June, 2018. In a Bloomberg interview Erdoğan declared that he would assume more responsibility for conducting monetary policy in case of winning the elections. The obvious inference was that this would compromise central bank independence. Immediately after the publication of these declarations the Turkish lira lost almost a one percent value with respect to the dollar (in 2018, from January to June, the lira had dropped 14% against the dollar).

(i) Using a graphical representation of the currency market model, where liras exchange for dollars, explain how and why Erdoğan's claims, supporting an interest rate cut in the presence of a high and rising inflation rate, could make the lira depreciate versus the dollar.

(ii) On Saturday, 26th of June, Erdoğan made a call on Turkish citizens to convert their dollars and euros to liras: 'Together we will foil this plot,' he said. Explain if this convertion would make the lira appreciate of depreciate against the dollar.

https://www.ft.com/content/12b806c0-6268-11e8-a39d-4df188287fff

15. Currency market model

Consider the graphical representation of the currency market model in which the exchange rate is measured in $/€ and the functions are the supply of euros and the demand for euros. In that graphical representation justify how each of the following events modifies the functions and alters the exchange rate.

1. The euroarea receives a significant number of immigrants from the US
2. The Federal Reserve buys US T-bills
3. The Federal Reserve and the ECB purchases euroarea T-bills
4. The Federal Reserve buys US T-bills and the ECB sells US T-bills
5. The Federal Reserve buys euroarea T-bills and the ECB sells US T-bills
6. The Federal Reserve conducts expansionary open market operations
7. Foreign investors liquidate financial investments in the euroarea (capital flight)
8. The reduction of the number of tourists coming from the US
9. An increase in the US GDP
10. An increase in the US GDP while the euroarea GDP decreases
11. An increase in the euroarea CPI
12. An increase in the euroarea CPI and US CPI
13. Germany leaves the euroarea
14. The euroarea establishes capital controls on the currency markets
15. The US declares war on the euroarea
16. The US removes advantages (tax cuts) previously given to foreign investors
17. The US raises tariffs on euroarea goods

16. Currency market model

Suggest events causing the changes below and specificy the effect (if not ambiguous) on the exchange rate (increases can be reinterpreted as shifts to the right of the corresponding function and decreases as shifts to the left).

(i) Supply of euros does not change, demand for euros decreases.

(ii) Supply of euros decreases, demand for euros increases.

(iii) Supply of euros increases, demand for euros decreases.

(iv) Supply of euros and demand for euros both increase.

17. Purchasing power parity

Calculate the purchasing power parity exchange rate (adopting the dollar as the home currency) if the nominal exchange rate is 2 €/$, the euroarea CPI is 200 and the US CPI is 100.

18. Purchasing power parity

Find the purchasing power parity exchange rate (when the euro is the home currency and indirect quotation is adopted) if the nominal exchange rate is 2 €/$, the euroarea CPI is 200 and the US CPI is 600.

19. Over/undervaluation

By how much is the euro over or undervalued with respect to its purchasing power parity level if $e = 2$ $/€ and the US price level doubles the euroarea price level?

20. Over/undervaluation

Fill out the following table, where P is the euroarea CPI, P^* is the US CPI, e_{PPP} is the exchange rate (in $/€ units) ensuring purchasing power parity, e is the equilibrium exchange rate (also in $/€ units) in the currency market and the last column is to indicate the percentage of overvaluation or undervaluation of the euro against e_{PPP}.

P	P^*	e_{PPP}	e	Overvalued/undervalued (%)
100	200		1	
100	200		2	
100	200		½	
150	150		2	

21. Over/undervaluation

The exchange rate is $e = 2$ $/€.

(i) Calculate the new exchange rate that makes the dollar appreciate with respect to the euro by 50%.

(ii) Find the exchange rate e' such that going from e' to e makes the euro appreciate with respect to the dollar by 20%.