Macroeconomic Theory 102
Winter 2015 - François Geerolf
Midterm 2
Wednesday, February 25, 2015
Time Limit: 75 Minutes

Last Name: _____

First Name: _____

Teaching Assistant: _____

Student ID Number: _____ Signature _____

Test A

This exam contains 10 pages (including this cover page). You can earn 100 points.

Instructions:

1. Print your Last name, First Name, Teaching Assistant Name (as a reminder, teaching assistants are: Flavien Moreau, Keyyong Park, Matias Vieyra, and Gabriel Zaourak), Student ID Number and Signature at the top of this page.
2. The only items which should be on your desk are pencils and/or pens. NO other items are allowed. Place any other item UNDER your desk. Calculators are NOT allowed.
3. Once the exam begins, you are not allowed to leave the room until you hand in your exam.

Good luck ! Budget your time wisely ! (skip the question or even the exercice if you get stuck)

Grade Table (FOR TEACHER USE ONLY)

Question	Points	Score
1	30	
2	15	
3	5	
4	50	
Total:	100	

Multiple Choice (30 points)

1. (30 points) Mark box if true - each multiple choice question has only one right answer.

   (a) (2 points) If P_t is the price level in time t, then inflation is calculated as:
   - ◯ $1/P_t$
   - ◯ P_{t+1}/P_t
   - ◯ $P_{t+1} - P_t$
   - ◯ P_t/P_{t+1}
   - √ $(P_{t+1} - P_t)/P_t$

   (b) (2 points) In the United States, money is backed by:
   - ◯ oil
   - ◯ gold
   - ◯ silver
   - √ **no physical commodity**
   - ◯ None of these answers are correct.

   (c) (2 points) According to the quantity theory of money, the price level is:
   - ◯ Exogenous
   - ◯ Determined by the money supply only
   - √ **Determined by the ratio of the effective quantity of money to the volume of goods**
   - ◯ Indeterminate in the long run
   - ◯ Determined by the volume of goods produced

   (d) (2 points) Net worth is equal to a bank's
   - ◯ investments minus deposits
   - ◯ cash plus reserves
   - ◯ deposits plus loans
   - ◯ loans minus capital
   - √ **total assets minus total liabilities**

   (e) (2 points) Using the IS curve $\tilde{Y}_t = \bar{a} - \bar{b}(R_t - \bar{r})$, in the long run, $\bar{a}$ _____ and _____, so that _____.
   - ◯ equals one; $R_t = \bar{r}$; the economy is in recession
   - ◯ is greater than one; $R_t > \bar{r}$; the economy is at its long-run equilibrium
   - √ **equals zero; $R_t = \bar{r}$; the economy is at its long-run equilibrium**
   - ◯ equals one; $\bar{b} = \bar{a}$; the economy is expanding
   - ◯ equals one; $R_t = 1$; the economy is in recession.

   (f) (2 points) Consider the consumption function $C_t/\bar{Y}_t = \bar{a}_c + \bar{x}\tilde{Y}_t$. If $\bar{x} = 0.5$, a 2 percent demand shock:

◯ raises short-run output by 1 percent
◯ raises short-run output by 0.5 percent
√ **raises short-run output by 4 percent**
◯ reduces short-run output by 4 percent
◯ has no impact on short-run output

(g) (2 points) With adaptive expectations, the Phillips curve can be written as:
√ $\Delta\pi_t = \bar{\nu}\tilde{Y}_t$
◯ $\Delta\pi_t = \pi_{t-1} + \bar{nu}\tilde{Y}_t$
◯ $\pi_t = \pi_{t+1} + \bar{\nu}\tilde{Y}_t$
◯ $\Delta\pi_t = \bar{\nu}u_t$
◯ $\pi_t = \pi_{t-1}$

(h) (2 points) Which of the following best describes why the aggregate demand curve slopes downward ?
◯ If the central bank observes a low rate of inflation, the monetary policy rule dictates an increase in the real interest rate. The high interest rate reduces output by reducing investment demand in the economy.
◯ If the central bank observes a high rate of inflation, the monetary policy rule dictates a decrease in the real interest rate. The low interest rate increases output by reducing investment demand in the economy.
√ **If the central bank observes a high rate of inflation, the monetary policy rule dictates an increase in the real interest rate. The high interest rate reduced output by reducing investment demand in the economy.**
◯ If the central bank observes a low rate of inflation, the monetary policy rule dictates a decrease in the real interest rate. The low interest rate reduces output by reducing investment demand in the economy.
◯ None of these answers is correct.

(i) (2 points) The adjustment process back to the steady state in the short-run model hinges on the:
◯ rate of unemployment
◯ immediate reaction to a change in the inflation rate
◯ consumers' response to inflation shocks
◯ government's response to inflation shocks
√ **slow adjustment of inflation reflected in the aggregate supply curve.**

(j) (2 points) Which of the following represents the AD curve with a financial friction?
√ $\tilde{Y}_t = \bar{a} - \bar{b}\bar{f} - \bar{b}\bar{m}\,(\pi_t - \bar{\pi})$.
◯ $\tilde{Y}_t = \bar{a}(1 + \bar{b}\bar{f}) - \bar{b}\bar{m}(\pi_t - \bar{\pi})$.

◯ $\tilde{Y}_t = \frac{\bar{a}}{\bar{b}\bar{f}} - \bar{b}\bar{m}(\pi_t - \bar{\pi})$
◯ $\tilde{Y}_t = \bar{a} - \bar{m}\bar{f} - \bar{b}\bar{m}\,(\pi_t - \bar{\pi})$.
◯ $\tilde{Y}_t = \bar{a} - \bar{f} - \bar{b}\bar{m}\,(\pi_t - \bar{\pi})$.

(k) (2 points) The Fisher equation is given by:
◯ $u_t - \bar{u} = -(1/2)\tilde{Y}_t$
◯ $\bar{P}_t^* = \frac{\bar{M}_t\bar{V}}{\bar{Y}_t}$.
◯ $\Delta\pi_t = \bar{\nu}\tilde{Y}_t + \bar{o}$
◯ $i_t = R_t - \pi_t$.
√ $i_t = R_t + \pi_t$.

(l) (2 points) When the central bank announces expansionary monetary policy and all other economic agents build this into their decision making, as a consequence _____ with no economic benefit; this is called the _____ problem.
◯ output rises; policy lag
◯ unemployment rises; time inconsistency
◯ expectations rise; adaptive expectations
√ **inflation rises; time inconsistency**
◯ inflation rises; discretionary

(m) (2 points) In the presence of rational expectations, the central banks' willingness to battle inflation:
◯ causes future inflation
◯ becomes a determinant of past inflation
◯ undermines the ability to fight inflation
√ **becomes a determinant of expected inflation**
◯ weakens the central government.

(n) (2 points) If the government gives firms a temporary investment tax credit:
◯ firms will invest now rather than in the future
◯ it will increase $\bar{a}_i$
◯ it will increase $\bar{a}$
√ **All of these answers are correct**
◯ None of these answers are correct

(o) (2 points) Suppose we assume that initially $\bar{a} = 0$, $\bar{b} = 0.5$, $R_t = \bar{r} = 5\%$; if $\bar{a}_c$ rises 2 percent and the real interest rate falls 2 percent, short-run output:
◯ falls 2 percent
◯ rises 1 percent
√ **rises 3 percent**
◯ falls 1 percent
◯ does not change

Exercice 1 (15 points)

2. (15 points) Consider the following balance sheets for three hypothetical financial institutions, bank A, bank B and bank C.

Bank A's Balance Sheet

Assets		Liabilities	
Cash	600	Deposits	1400
Loan to bank B	500		
Mortgage-Backed Securities	400		
Total assets	___	Total Liabilities	___
		Equity (net worth)	___

Bank B's Balance Sheet

Assets		Liabilities	
Cash	1000	Deposits	900
Loan to bank C	500	Loan from Bank A	500
Total assets	___	Total Liabilities	___
		Equity (net worth)	___

Bank C's Balance Sheet

Mortgage-Backed Securities	800	Deposits	200
		Loan from Bank B	500
Total assets	___	Total liabilities	___
		Equity (net worth)	___

(a) (2.5 points) Fill in the missing entries in the balance sheets (denoted ___).

Solution: 1500,1400,100 (2) and 800,700,100.

(b) (2.5 points) What is the leverage ratio in each bank?

Solution: The leverage ratio of the first bank and second bank (Bank A and B) are given by: 1400/100=14/1. That of Bank C is given by: 700/100=7/1.

(c) (10 points) Suppose housing prices fall sharply and the mortgage-backed securities as a consequence fall in value by 50%. Assume that banks first make good on their deposits, before actually repaying other banks. Calculate bank A's new net worth. (be careful, two banks hold Mortgage-Backed Securities !)

Solution: Bank A's net worth falls to -300: 200 is lost directly through MBS, 200 is lost through Bank C's MBS (Cushion of 200 of net worth in between).

Exercice 2 (5 points)

3. (5 points) According to the life-cycle/ permanent-income hypothesis, consumption depends on the present discounted value of income. An increase in the real interest rate will make future income worth less, thereby reducing the present discounted value and reducing consumption. To incorporate this channel into the model, suppose the consumption equation is given by:

$$C_t = \bar{a}_c \bar{Y}_t - \bar{b}_c (R_t - \bar{r}) \bar{Y}_t.$$

Derive the IS curve for this new specification.

Solution: As always start with the definition of GDP, and divide both sides by $\bar{Y}_t$:

$$\frac{Y_t}{\bar{Y}_t} = \frac{C_t}{\bar{Y}_t} + \frac{I_t}{\bar{Y}_t} + \frac{G_t}{\bar{Y}_t} + \frac{EX_t}{\bar{Y}_t} - \frac{IM_t}{\bar{Y}_t}.$$

Plug the equations in Table 11.1 given in the slides to replace each one of these components, and get short-run output:

$$\begin{aligned}
\frac{Y_t}{\bar{Y}_t} - 1 &= \bar{a}_c - \bar{b}_c (R_t - \bar{r}) + \bar{a}_i - \bar{b} (R_t - \bar{r}) + \bar{a}_g + \bar{a}_{ex} - \bar{a}_{im} - 1 \\
&= \underbrace{\bar{a}_c + \bar{a}_i + \bar{a}_g + \bar{a}_{ex} - \bar{a}_{im} - 1}_{\bar{a}} - (\bar{b}_c + \bar{b})(R_t - \bar{r}) \\
\tilde{Y}_t = \frac{Y_t}{\bar{Y}_t} - 1 &= \bar{a} - (\bar{b}_c + \bar{b})(R_t - \bar{r})
\end{aligned}$$

So the new IS curve is:

$$\tilde{Y}_t = \bar{a} - (\bar{b}_c + \bar{b})(R_t - \bar{r}).$$

Exercice 3 (50 points)

4. (50 points) Take the usual AS/AD model, ruling out Aggregate Demand shocks, so with $\bar{a} = 0$, but assuming a one-time, unexpected oil price shock $\bar{o}_0 > 0$. One time means that the oil price shock lasts only for one period, in period $t = 0$, and that $\bar{o}_t = 0$ for all subsequent $t \in \{1, 2, ...\}$. Unexpected means that the economy was originally in steady-state, and in particular that $\pi_0 = \bar{\pi}$. Unless otherwise noted, agents have adaptive expectations about inflation. The economy is described by an AS/AD model. In particular, the AS curve is given by (be careful about the convention on the timing of the oil shock $\bar{o}_{t-1}$!):

$$\pi_t = \pi_t^e + \bar{\nu}\tilde{Y}_t + \bar{o}_{t-1}.$$

The AD curve is the standard one used throughout the course.

(a) (5 points) What are the values of π_1 and $\tilde{Y}_1$ in terms of the parameters of the model? (in particular the size of the oil price shock, $\bar{o}_0$)

Solution: The AS/AD equations are:

$$\pi_1 = \bar{\pi} + \bar{\nu}\tilde{Y}_1 + \bar{o}_0$$
$$\tilde{Y}_1 = -\bar{b}\bar{m}\left(\pi_1 - \bar{\pi}\right).$$

Using the second equation to plug in the first, one gets:

$$\tilde{Y}_1 = -\bar{b}\bar{m}\left[\bar{\nu}\tilde{Y}_1 + \bar{o}_0\right] \quad \Rightarrow \quad \tilde{Y}_1 = -\frac{\bar{b}\bar{m}}{1 + \bar{b}\bar{m}\bar{\nu}}\bar{o}_0.$$

Using this to replace in one or the other equation, one gets:

$$\pi_1 = \bar{\pi} + \frac{\bar{o}_0}{1 + \bar{b}\bar{m}\bar{\nu}}.$$

(b) (5 points) Show analytically[1] the effect of a more agressive monetary policy on inflation and short-run output in period 1: do inflation and short-run output increase or decrease with a more agressive monetary policy?

Solution:

$$\frac{\partial \pi_1}{\partial \bar{m}} = -\frac{\bar{b}\bar{\nu}}{(1 + \bar{b}\bar{m}\bar{\nu})^2}\bar{o}_0.$$
$$\frac{\partial \tilde{Y}_1}{\partial \bar{m}} = -\frac{\bar{b}}{(1 + \bar{b}\bar{m}\bar{\nu})^2}\bar{o}_0.$$

[1] That is, in mathematical terms.

Both decrease. Since inflation was increasing initially, this means there is a more muted response of inflation. To the contrary, since output was already decreasing, this means that the response of short-run output is actually more important. With a more agressive monetary policy, the bulk of the adjustment goes through unemployment, and a decrease in short-run output. (Note: of course, adaptive expectations neglect the fact that if monetary policy was expected to be agressive, then people may anticipate that inflation will be lower in future periods, which on the contrary mitigates the needed adjustment of short-run output).

(c) (5 points) Illustrate this on two graphs with the AS/AD curves: show one AS/AD diagram with a soft monetary policy, and next to it another AS/AD diagram with an agressive monetary policy. Show π_1 and $\tilde{Y}_1$ as well as the long run values of inflation and short-run output on these graphs.

Solution: See TA section.

(d) (5 points) Eliminating $\tilde{Y}_t$ from the AS/AD model, find a difference equation[2] for π_t, for $t \in \{2, 3, ...\}$.

Solution: Because people have adaptive expectations, he have the following equations:

$$\pi_t = \pi_{t-1} + \bar{\nu}\tilde{Y}_t + \bar{o}_{t-1}$$
$$\tilde{Y}_t = -\bar{b}\bar{m}\left(\pi_t - \bar{\pi}\right).$$

Solving this system of two equations and two unknowns (where the unknowns are $(\tilde{Y}_t, \pi_t)$), it is easy to show that inflation follows the following difference equation:

$$\pi_t = \frac{1}{1+\bar{b}\bar{m}\bar{\nu}}\pi_{t-1} + \frac{\bar{b}\bar{m}\bar{\nu}}{1+\bar{b}\bar{m}\bar{\nu}}\bar{\pi} + \frac{1}{1+\bar{b}\bar{m}\bar{\nu}}\bar{o}_{t-1}.$$

Moreover we have that $\bar{o}_{t-1} = 0$ for all $t \in \{2, 3, ...\}$, because the shock is a one time shock. So finally:

$$\forall t \in \{2, 3, ...\}, \quad \pi_t = \frac{1}{1+\bar{b}\bar{m}\bar{\nu}}\pi_{t-1} + \frac{\bar{b}\bar{m}\bar{\nu}}{1+\bar{b}\bar{m}\bar{\nu}}\bar{\pi}$$

(e) (5 points) Substracting $\bar{\pi}$ on both sides in the difference equation for π_t, show that

[2] A difference equation is an expression of an economic quantity as a function of its previous (lagged) values, generally the value in the previous period. For example π_t expressed as a function of π_{t-1} is a difference equation for π_t

$\pi_t - \bar{\pi}$ satisfies a simpler difference equation than π_t.[3] Solve for this difference equation. This should give you an expression for π_t as a function of π_1. Then replace π_1 with the value found in question (a), to get π_t as a function of time and the parameters of the model.

Solution: We have:

$$\pi_t = \frac{1}{1+\bar{b}\bar{m}\bar{\nu}}\pi_{t-1} + \frac{\bar{b}\bar{m}\bar{\nu}}{1+\bar{b}\bar{m}\bar{\nu}}\bar{\pi} \quad \Rightarrow \quad \pi_t - \bar{\pi} = \frac{1}{1+\bar{b}\bar{m}\bar{\nu}}\left(\pi_{t-1} - \bar{\pi}\right).$$

This difference equation iterates (just as those in the Romer model) through:

$$\pi_t - \bar{\pi} = \left(\frac{1}{1+\bar{b}\bar{m}\bar{\nu}}\right)^{t-1}(\pi_1 - \bar{\pi}).$$

Using the expression for π_1 in the previous question:

$$\pi_1 = \bar{\pi} + \frac{\bar{o}_0}{1+\bar{b}\bar{m}\bar{\nu}},$$

This gives:

$$\pi_t = \bar{\pi} + \left(\frac{1}{1+\bar{b}\bar{m}\bar{\nu}}\right)^{t}\bar{o}_0.$$

(f) (5 points) Use the (AD) curve to then calculate $\tilde{Y}_t$ as a function of time and the parameters of the model.

Solution: We use the AD curve which is:

$$\tilde{Y}_t = -\bar{b}\bar{m}\left(\pi_t - \bar{\pi}\right).$$

with the espression found in question (f):

$$\tilde{Y}_t = -\bar{b}\bar{m}\left(\frac{1}{1+\bar{b}\bar{m}\bar{\nu}}\right)^{t}\bar{o}_0.$$

(g) (5 points) Numerical Application: Suppose the parameters of the AS and AD curves take the following values: $\bar{o}_0 = 2\%$, $\bar{a} = 0$, $\bar{b} = 1/2$, $\bar{m} = 1/2$, $\bar{\nu} = 1/2$, and $\bar{\pi} = 2\%$. Solve for the value of short-run output and the inflation rate for the first 2 years after the shock. (express your result as a single fraction, since you do not have a calculator !)

[3] Simpler in the sense that you can solve for it. For example, a simple difference equation is one of the form $u_t = \rho u_{t-1}$, whose solution is $u_t = \rho^{t-1}u_1$.

Solution: Therefore, numerically:

$$\frac{1}{1+\bar{b}\bar{m}\bar{\nu}} = 8/9.$$

Time	**Inflation π_t**	**Short-Run Output $\tilde{Y}_t$**
0	2 %	0 %
1	$2+ 8/9 * 2 = 34/9\%$	$-4/9\%$
2	$2+ ((8/9)^2) * 2 = 290/81\%$	$-32/81\%$

(h) (5 points) Calculate how much realized inflation differs from expected inflation, or $\pi_t - \pi_t^e$, for any $t \geq 1$, in this model. Simplify the expression so that its sign appears clearly.[4]

Solution: We have that:

$$\pi_t - \pi_t^e = \pi_t - \pi_{t-1} = \left(\frac{1}{1+\bar{b}\bar{m}\bar{\nu}}\right)^t \bar{o}_0 - \left(\frac{1}{1+\bar{b}\bar{m}\bar{\nu}}\right)^{t-1} \bar{o}_0$$

$$\pi_t - \pi_t^e = -\frac{\bar{b}\bar{m}\bar{\nu}}{(1+\bar{b}\bar{m}\bar{\nu})^t}\bar{o}_0 < 0$$

(i) (5 points) Why are these adaptive expectations where $\pi_t^e = \pi_{t-1}$ considered as "non rational" ? What is irrational about them?

Solution: Agents consistently overestimate what inflation will be next period. They don't understand that inflation tomorrow will be determined by the reaction of the central bank, which will tighten monetary policy in the face of too high inflation and therefore lower inflation. That is irrational. Moreover, this is a mistake that agents could learn not to make over time, as they are always making the same mistake, in the same direction. But under adaptive expectations, they do not.

(j) (5 points) What would $\pi_t - \pi_t^e$ be equal to under rational expectations?

Solution: Under rational expectations, we would have:

$$\pi_t - \pi_t^e = 0.$$

[4]That is, it should be clear from your expression of $\pi_t - \pi_t^e$ whether it is positive or negative