Lecture IX Economics 202A Fall 2007

Today I am going to go over two articles. The first is by Fehr and Tyran, on Money Illusion.

And the second is by Gregory Mankiw on small menu costs. It is another version of near rationality.

I will go over that insofar as time permits.

**But I also want to discuss what is happening in the current economy.
I will give an assessment, and then I thought we would open the question to class discussion.**

Fehr and Tyran have adapted the monopolistic competition model that we saw last time to use it as the basis for an experiment.

The basic question is whether there is money illusion.

And if there is money illusion, can we say something about its nature?

I think that the conclusion from their article is that there is secondary money illusion, and that can be just as effective in changing equilibrium outcomes as primary money illusion.

You will see what I mean by that.

**To begin, they construct an economy in which the Profits of individual i depend on:
p_i, p_{-i} and M.**

**where p_i is the price charged by i,
p_{-i} is the vector of prices charged by everyone other than i.
and M is the money supply.**

So that $\Pi_i = \Pi_i(p_i, p_{-i}, M)$.

Real returns will be homogeneous of degree 0 in p_i, p_{-i} and M.

A doubling of all prices and also of the money supply will leave all real returns totally unchanged.

The framework is exactly the same as we saw last time.

One starts off with an initial money supply: M_0.

Then one allows subjects to play the initial game for some time, which is for 10 or 20 rounds, until the prices chosen by the players converge to an equilibrium.

Most importantly the average price level, $\bar{p}$ converges to $\bar{p}_0^*$.

Then change the money supply from M_0 to M_1. And then see how rapidly the price level converges to its new long-run equilibrium.

In the absence of money illusion it should converge immediately.

There are two types of payoffs: *real* payoffs, which are denoted R, and

***nominal* payoffs, which are denoted N.**

There are also two types of opponents: computer opponents, denoted C.
and human opponents, denoted H.

This gives Fehr and Tyran four variants of their experiment.

1. RC.

In RC, the payoff functions are given to the subjects in real terms.
And, in RC, the players are told that the other players will be a Computer.
The computer will choose their prices to maximize their profits according to a rule.
R stands for *Real* and C stands for *Computer.*

2. RH

In RH the payoff functions are given in real terms.
The players are told that other players are human.
As before R stands for *Real*, but H stands for *Human.*

3. NC

In NC the payoff functions are given in *Nominal* terms.

The players are told that other players are a computer following a maximizing rule.

4. NH

In NH the payoffs are expressed in *Nominal* terms.
This time, however, the other players are *Human.*

Let me describe the experiment when there is a decrease in the money supply.

There are four subjects in a group.

Each group had two types of subject:

an *x*-type that will set a low price, and
a *y-type* that will set a high price.

Pre-shock: $M_0 = 42$.
Post-shock: $M_1 = 14$.

The money supply is divided by 3, so all equilibrium nominal variables will also be divided by 3.

In RC, NC: Play is for 10 rounds with computerized opponents, both pre and post shock.

In RH, NH: Play is for 20 rounds with human opponents, both pre and post shock.

Subjects in each period choose p_i as an integer between 1 and 30.

Before they play they tell the experimenter their expectation of the average price of their opponents, which is $\bar{p}^e_{-i}$. [Note: there is a bar over the p. These bars may be hard to see.]

Subjects were also asked to choose a number from 1 to 6 expressing their degree of confidence about $\bar{p}^e_{-i}$. [There is a bar over the p.]

Subjects were given the payoff in matrix form.
The matrix gives the payoffs for each feasible integral combination of

$$1 \leq p_i \leq 30, \quad 1 \leq \bar{p}_{-i} \leq 30.$$

[illustrate on Blackboard].

After each round subjects were told their individual returns—that is, their individual profits, π_i —and they were also the average prices of other players, which is $\bar{p}_{-i}$.

The payoff structure to all respective players was common knowledge.

Before beginning the experiment subjects were given a training session. This involved computation of their own payoff and the payoffs of their opponents for given strategies.

Especially, in the nominal treatments subjects had to compute the *real* payoffs from their *nominal* payoff tables.

It turns out that subjects were able to do that.

In the treatments with computerized components subjects were told that the decisions of the other three players in the group would be made by pre-programmed computers.
It showed how the computer would respond to a choice of p_i, for $1 \leq p_i \leq 30$.
The computer is playing the Nash solution.

The pre-shock period establishes the long-run equilibrium of the economy.
Then the nominal shock occurs, and players are given new payoff tables.
The new payoff tables correspond in this case to the *lower* money supply.

FN: There is a small but probably inconsequential problem. After change in the money supply there are more choices above the optimal.

Let me summarize everything by a Table.

[Distribute Table].

The table gives a summary of everything that is going on in these experiments.

Let's first go to Panel A.

The nominal profits are her real profits times the average price level of the other players.

The real returns to i are her real profits.

Each person is in a group size of 4.

Each person learns the previous average price of others and her own profits in the previous period.

The equilibrium real payoff is 40.

In each period a price is chosen from 1 to 30.

Go for 10 rounds pre and post shock with computerized opponents.

Go for 20 rounds pre and post shock with human opponents.

Pre-shock (in Panel B):

Initial money supply M_0 is 42.

The average equilibrium price is 18.

The equilibrium price for type *x* is 9.

The equilibrium price of others for a type x is 21.

The equilibrium price of type *y* is 27.

The equilibrium price of others for type *y* is 15.

Then in Panel C, the money supply is reduced to 14.

And all of these equilibrium values are likewise decreased to 1/3 their former values.

Here are a few more details.

There were 130 subjects. They were paid about $28 on average for a total cost of about $5000.

There also must have been many pilot runs, because there are several indicators that the experiment did not work initially.

The results can be summarized as follows.

	RC	NC	RH	NH
$\bar{p}$ before shock	18.0	17.0	18.0	18.2
$\bar{p}$ after shock				

Round

1	6.0	8.1	9.1	13.1
2	7.0	7.4	7.7	12.9
3	6.0	6.8	7.4	11.4
4	6.0	6.4	6.9	10.4
5	6.0	6.9	7.0	9.9
6	6.0	6.8	6.6	10.2
7	6.0	7.5	6.3	9.7
8	6.0	6.8	6.4	9.1
9	6.0	6.5	6.3	8.7
10	5.9	6.5	6.8	8.6
20			6.2	7.0

Our focus should be on the fourth column, which gives the results from the experiments with *nominal* frames for the returns and *human* opponents.

We see that when there is a decrease in the money supply it takes a long time before there is convergence to equilibrium when there are human opponents and also when returns are expressed in nominal terms.

Fehr and Tyran can establish that this is what is occurring here because they have asked their subjects their expectations in the previous round: $\bar{p}^e_{-i}$.

They find that 84 % of subjects choose p_i to maximize their payoffs, given $\bar{p}^e_{-i}$ in the post-shock periods in RH experiments and about 80 % in the NH experiments.

Where does the nominal rigidity come from?

It seems to come from subjects' beliefs that *others* would interpret high *nominal* payoffs as high *real* payoffs.

Fehr and Tyran asked subjects their agreement with the statement:

"I believed that the *other* subjects would interpret high nominal payoffs as an indicator of high *real* payoffs."

30 % strongly agreed.
25 % weakly agreed.

Remember that one would want no one at all to agree to get absence of money illusion.

Now let's look at what happens when there is a positive money supply shock.

The interesting cases occur with human subjects.

In this case the equilibria are:

$\bar{p}_0^* = 12.5$

$\bar{p}_1^* = 25.0.$

What do we find?

Round	RH	NH
-1	12.5	13.1
+1	24.3	20.5
2	24.8	22.8
3	24.9	24.1
4	25.0	24.8
5	25.0	25.0
6	25.0	25.1
7	25.0	25.2
8	25.0	25.1
9	25.0	25.0
10	25.0	25.2

So F & T find *very* little effect (and even a small amount of overshooting) in the Nominal Human treatment.

They explain this because their subjects think that other subjects will have money illusion. They think that when others see a high *nominal* payoff they will then set a price that is higher. That explains the pattern whereby there is under-adjustment with the *decrease* in the money supply, and even a slight over-adjustment with an *increase* in the money supply.

With an *increase* in the money supply the fact that players think their opponents will have upward money illusion will offset, or more than offset, the reasons for slow adjustment. We see here that it leads to *very rapid* adjustment to the new equilibrium.

I have a few comments.

1. *A technical comment.* Why are there two types of players rather than one? Apparently, with only one type of player there is the possibility that everyone can

be better off than in the equilibrium, if all charge a lower price.
Such cooperation, although nonequilibrial, potentially results in nonconvergence to the long-run equilibrium.

2. In the computer treatments, the computer plays Nash and subjects are supposed to understand how the computer plays, so this may induce them to play Nash also.
This may be one of the reasons that the C-rounds, the computer rounds, converge so quickly to the new equilibrium.

3. The *increase* in money supply and prices seems to me to give the *wrong* result.
You want the players to have *sticky* prices.

One reason that Fehr and Tyran may get this solution is because the *lab* induces the utility functions.
The payoff matrices are telling people what they *should be* maximizing.

But in the real world there may be a *nominal* component to utility.

People may have some emotional attachment to nominal prices.

There may be inhibitions to firms' raising prices, even when demand has risen.

The result everyone wants to show is that when M goes up by a fraction ϵ, prices go up by less than ϵ.
This is what makes monetary policy effective.

This does not occur here and that is a problem for their experiment.

How would one get a model where prices go up by less than M?

4. What is left then is a co-ordination problem.

This model suggests that Rational Expectations solutions may be Bad Game Theory.

Rational expectations relies on the Nash solution.

But with many, many players all of whom have to make assumptions about each others' behavior the assumptions about such a Nash solution are unbelievable.

It must encompass what I believe about your behavior and that of a million other people.

It simultaneously depends on their respective beliefs about my and figuratively 999,999 others.

5. There may be something flawed with the experiment.
It may not address the Phillips Curve frame in which people set wages and/or prices with the following simple frame.
They make their decisions in real terms and then adjust nominal variables by inflationary expectations.
Without very serious money illusion such a frame may then lead to a natural rate of unemployment.
There are probably some experiments to do, where such a mental frame is induced.

Just to give an example, Bill Dickens and I did such an experiment.
We gave compensation professionals differing hypothetical data and then asked them what wage increase they would give to employees.
Some of the data given to these compensation professionals was the expected rate of inflation and the wage increases of comparable others.
We found a point estimate of .7 the coefficient on inflationary expectations, but we needed a very large sample size to get statistical significance that the coefficient was different from one, for reasons I shall not describe here.

Regarding Fehr and Tyran I think this is a great paper.
It has a new research methodology for looking at the issue of money illusion, which is central to how the macroeconomy works

$$$$$$$$$$$$$$$$$$$$$$$$$$

NOTES ON THE CURRENT ECONOMY.

★★★★★★★★★★★★★★★

Now, I will go over the small menu costs model of Gregory Mankiw, which is very similar to the model of near rationality that we saw in the last class.

Suppose there is a cost for changing prices.
This is called a *menu cost*, since it *could be* viewed as the price of printing a new menu.

The change in welfare due to the menu cost may be, however, an order of magnitude larger than the menu cost itself.

Let's consider a monopolist with a constant cost curve and a linear demand curve.

$

MC

MR D

quantity

Profits = shaded area.

Consumer surplus = xxxxx'd area

TAKE NEW PANEL ON BB

Now let's assume that p_m is the old price, but the demand has shifted out to D′.

<p_m'>

<A>

p_m

<D> <B>

MC

MR′ D′

<q_m′> q_m

Now let's compare two situations. In one situation the monopolist charges the same price as before, which is p_m, and satisfies demand at that price.

At that price the quantity sold is q_m.

MARK <q_m>

The monopolist could change her price.
If she did so the optimal price would be p_m', with optimal quantity sold, q_m'.

<MARK THEM>.

The monopolist will make that change in price if the gain from making that change exceeds the menu cost.

The monopolist's gain is the area A - B from raising the price.

LABEL A, LABEL B, LABEL D

Her new optimum profits would be A + D.
Her profits at the old price would be D + B.
The difference is A - B.

Let z be the menu cost.

If z > A - B, the menu cost will inhibit the change in price.

The gain in welfare from *not* changing prices is B + C.

This is the gain in producers' plus consumers' surplus on the increased goods sold.

LABEL C.

Let ϵ be the shift in demand.
At the initial price, for small ϵ, B $\cong$ A, so A - B $\cong$ 0.

The gap A - B is second order in ϵ.

***But* the change in welfare is first order. It is proportional to ϵ.**
The change in welfare is a trapezoid: PICTURE IT.

***Thus* a menu cost may inhibit a price change that results in a change in welfare an order of magnitude larger than the menu cost.**

Using the notation of near rationality, in this example,

$$\Pi^m - \Pi^n = 2\ C.$$

POINT TO C.

You can see that the area C is higher order compared to B.
B is a sliver with *base* proportional to ϵ.
C is a triangle with *base* and *height both proportional to ϵ.*

How do we know? We can set up the following example.

$$D = a - b\ p$$

$$C = c\ q = c\ (a - b\ p).$$

We can find an initial price p.

We then find the maximizing price if there is an upward shift in D.

$$D' = a + \epsilon - b\ p.$$

Then we can find $\Pi^m - \Pi^n = \epsilon^2 / 4b$.

This is twice the area of C, which is $\epsilon^2 / 8b$.

This yields the conclusion that: the change in welfare due to the failure to

maximize is an order of magnitude greater than the welfare losses of those who do not maximize.

Footnote:

$$\Pi^m = p\,(a + \epsilon - b\,p) - c\,(a + \epsilon - b\,p)$$

To find the profit maximizing price take the derivative with respect to p and set it equal to zero.

$$a + \epsilon - b\,p - b\,p + b\,c = 0.$$

$$2\,b\,p = a + \epsilon + bc.$$

$$(p_m - c)\,q_m - (p_n - c)\,q_n =$$

$$= \epsilon^2 / 4b$$

$$p_m - p_n = \epsilon/2b$$

$$q_m - q_n = \epsilon/2$$

The triangle C has Area:

$$\tfrac{1}{2}\,(\epsilon/2b)(\epsilon/2) = \epsilon^2/8b.$$

So

$2C = (p_m - p_{n)}$ $(q_m - q_{n)}$ $= \epsilon^2/4b$.

So Area (A - B) = Area (2C).

End Footnote

I will make a few more comments about near rationality.

On the reading list there is an article by Blanchard and Kiyotaki that expands on the one by Janet and myself.

They do the same thing with a few exceptions.
The major difference is that they derive their results from basic optimizing assumptions.

1. First, they assume that firms produce output according to a CES production function with n types of labor.

2. The utility of goods of household of type j, which is the supplier of labor of type j, is

where C_{ij} is the consumption of good i by household j
M_j is money holdings of household j
N_j is the labor supply of household j.

3. Households maximize utility subject to a budget constraint.

4. Firms set prices to maximize profits.

5. Unions of type j choose the wage of type j to maximize the utility of households of type j.

***Quite* surprisingly one can solve the model totally because the CES form of the *utility* function gives a constant elasticity of demand for goods. And the CES production function also gives a constant elasticity of demand for labor.**

The interest in having a system derived from utility functions and production functions is that it allows explicit welfare calculations.

If you want a yet simpler model Ball and Romer have a variation in which the producers are all yeoman farmers. They use their own labor to produce goods

along with inputs from other firms.

This is *yet easier* than Blanchard and Kiyotaki and one can still do the welfare analysis.

FN

Gil Mehrez has written a Berkeley thesis on the following topic.

What happens if realistically, the cost of changing the quantity of labor employed is much larger than the cost of changing prices.

In a menu cost model this again makes money neutral.

But if firms have U-shaped cost curves in which current labor can be used to produce more output, but at more than the minimum long-run average cost, money is no longer neutral and increases in demand result in increases in output. He has analyzed this problem in an elegant way.

End Footnote