8
Macroeconomic Experiments

Francisco Lagos and Ernesto Reuben

Introduction[1]

Unlike microeconomic models and game theory, which frequently aim to obtain generalizable results, macroeconomic models are usually built to analyze very concrete aspects of reality and are seldom generalizable to other fields.

For many years the controlled manipulation of macroeconomic variables to understand the effects of institutions or alternative policies was considered, in practical terms, to be impossible. Therefore, many considered that macroeconomic matters could not be addressed with laboratory experiments. However, laboratory methods are today increasingly used to answer macroeconomic issues. This change has been due partly to changes in macroeconomic modeling and partly to improvements in the technology used to design more complex laboratory experiments.

Below we summarize some of the most relevant laboratory experiments in the field of macroeconomics, across three different areas. The first part focuses on monetary economics. The second explores some relevant aspects of international trade. Finally, the third provides a discussion on the use of laboratory experiments to test macroeconomic policies.

Monetary economics

Experimental studies on monetary economics are based on the different uses of money in market economies. It is argued that money

P. Branas-Garza et al. (eds.), *Experimental Economics*

plays three roles: first, as a store of value; second, as a medium of exchange; and third, as a unit of account. In this section we summarize multiple experimental studies designed to investigate theories related to each of these different uses of money.

Money as a store of value

Experiments exploring the role of money as a store of value aim to understand questions such as: how can an object with no intrinsic value be used as a store of value? And, how can the optimal price and quantity of such an object be established, given that it does not have a consumption value on its own?

A good experimental study exploring these questions is Hens *et al.* (2007).[2] The authors focus on testing whether an object that plays the role of money can achieve a stable value. Their study is closely related to a well-known case where 150 couples exchanged baby-sitting duties with one another (for a detailed description see Sweeney and Sweeney, 1977). The benefits from their agreement are obvious:

- The couples who are not planning to go out on a certain night can easily baby-sit for another couple's children;
- This allows other couples to have a very well-deserved night out.

Clearly, for the agreement to work, there must be a system protecting it from any abuse. For this reason, the organizers introduced a natural solution: they issued coupons equivalent to an hour of baby-sitting. If couple *A* baby-sits for couple *B*, then *B* pays *A* in coupons which, afterwards, *A* may use another day to get any available couple to baby-sit for them. In other words, they create their own currency.

When the system was launched, the organizers surprisingly found that it was prone to collapse. On the one hand, if they issued too few coupons, couples would tend to hoard them (that is, they would save too much), which as a result led to a low demand for baby-sitting and a collapse of the system (a recession). On the other hand, if they issued too many coupons it resulted in excess demand for baby-sitting and a dramatic decrease in the amount of baby-sitting hours couples were willing to offer for a coupon (inflation).[3]

In the experiment of Hens *et al.* (2007), in each period, subjects' preferences for a perishable good are randomly determined (either with a strong or a weak preference) and they must decide whether

they want to buy or sell units of the good. To buy units of the good, a subject must have coupons (this constraint is precisely what gives coupons value), and sales of goods increase a subject's holdings of coupons. The unique prediction with rational expectations and an infinite horizon is that a subject opts to buy goods depending on his preferences in the current period as follows:

- Case 1: If a subject has a strong preference, he always buys units of the goods.
- Case 2: If a subject has a weak preference, but his coupon holdings are sufficiently high, the subject also buys units of the goods.
- Case 3: If a subject has a weak preference and his coupon holdings are *not* sufficiently high, the subject sells units of the goods to acquire more coupons.

It is straightforward to show that there is a unique optimal quantity of coupons that maximizes the number of trades possible and, therefore, social welfare. The authors used the amount of coupons in the experimental economy as the manipulation variable. In general, Hens *et al.* (2007) reported that the theory is widely corroborated: subjects' strategies coincided well with the strategies described above. Furthermore, exogenous increases in the total amount of coupons in the economy led at first to an increase in the volume of trade. But eventually, as it continued increasing, it was followed by a stark decrease in the demand for coupons, because subjects were not interested in accumulating any more coupons. Finally, the amount of coupons from which the volume of trade starts decreasing corresponds with the optimal quantity of coupons predicted by the theoretical model. This experiment nicely illustrates the difficulty central banks face in determining an optimal quantity of money in the economy.

Money as a medium of exchange

As a medium of exchange, money must serve as a store of value, but clearly there are many other objects that are stores of value but are not media of exchange. Therefore to understand the role of money, it is especially important to understand why other objects with higher rates of return do not substitute for money as a medium of exchange.

The overlapping-generations model is a well-known environment that provides money with a role both as a store of value and as a

medium of exchange (Samuelson, 1958). Camera *et al.* (2003) use this model to investigate whether money is substituted as the medium of exchange when there is another object, a bond, that can play the role of storing value and that also bears interest (the bond was conceived so that it paid certain dividends in each period and had no terminal date). The equilibrium prediction in this context is that individuals will exclusively use the object offering the highest rate of return (the bond) as a medium of exchange and will abstain from using the other object (money). However, Camera *et al.* (2003) propose two complementary hypotheses to explain why some individuals could continue using money in this context:

- Accumulation;
- Habit.

The first is the accumulation hypothesis, which establishes that bonds are hoarded and not used as media of exchange because people want to receive the bonds' dividends. This hypothesis is tested by comparing two treatments; one where bonds are traded before dividends are paid (i.e., the subject buying the bonds gets the dividend) and another where bonds are traded after dividends are paid (i.e., the subject selling the bond gets the dividend). If the accumulation hypothesis is true, there must be more subjects using money as a medium of exchange in the treatment where bonds are traded before dividends are paid.

The second is the habit hypothesis, which establishes that subjects use money instead of bonds because "old habits die hard." This hypothesis is tested by comparing two treatments: one where subjects first play with money as the sole store of value before bonds are introduced, and another where both money and bonds are introduced from the beginning.

Camera *et al.* (2003) find substantial support for the habit hypothesis: money coexists with bonds as a medium of exchange in treatments where subjects begin with money as the sole medium of exchange and bonds are introduced afterwards. In addition, in line with the accumulation hypothesis, it is more frequent for money and bonds to coexist when dividends are paid after bonds are traded. If dividends are paid before bonds are traded, and both money and bonds are introduced simultaneously, subjects exclusively use bonds as the sole medium of exchange.

Money as unit of account

Money's role as a unit of account is uncontroversial. Clearly, prices are typically quoted in terms of money units and not in terms of, say, olives. However, this poses a problem, as money typically depreciates in value over time due to inflation, while, generally, the value of products, such as olives, is kept constant. To avoid this problem, most macroeconomic models presume that, in their transactions, economic agents evaluate all choice variables in real terms: that is, they are not subject to money illusion. However, data from surveys (Shafir *et al*., 1997) or simple introspection suggests that this assumption does not always hold. Experimental studies of money as a unit of account do not only study whether some individuals are prone to money illusion, but also how well they assess the consequences money illusion has on the behavior of prices in markets.

Imagine a consumer who finds, to his surprise, that his salary has doubled overnight, but he lives in a country where, like his salary, all prices have also doubled. Will the consumer feel richer today and behave differently than yesterday? The traditional assumption suggests that, because the salary increase is purely nominal and, in real terms, there is no change, the consumer will not change his behavior. However, experimental studies by Fehr and Tyran show that thinking in nominal terms is common and that, in some circumstances, it can have noticeable effects on market prices.

Consider Fehr and Tyran (2001) as an example.[4] In this experiment subjects repeatedly interact in a game where they compete in an oligopolistic market (see Chapter 2). In each period, a subject's income depends on his chosen price and the average price chosen by the other subjects. The market was designed so that it has a unique equilibrium and, importantly, there are strategic complementarities in the choices subjects make. In other words, the optimal strategy for each subject has a positive relationship with the average price chosen by the other subjects, so that if the average price increases, subjects have incentives to increase their own price.[5] Because the market demand function is mathematically complex, each subject simply received a table indicating his income for each price he may choose and for each realized average price. In this way, it was not complicated for subjects to find their optimal strategy.

The main purpose of this experiment is to see how subjects react in this market to a nominal *shock*.

1. From period 1 to 20, subjects first play with a table where the equilibrium price is 18 points.
2. From period 21 to 40, all subjects get a new table where the equilibrium price is six points (the nominal *shock*).

Even though prices have changed in nominal terms, because the incomes are relative to the average price, in real terms subjects are in the same situation. Fehr and Tyran (2001) design four treatments. In the first treatment, subjects receive tables containing prices in real terms, so that it is a trivial task for them to calculate the optimal strategies before and after the nominal *shock*. In the second, subjects receive tables containing prices only in nominal terms; thus, they must exert a little more effort if they want to calculate the optimal strategy after the nominal *shock*. Treatment differences in subjects' behavior after the nominal *shock* can be attributed to money illusion.

Finally, the third and fourth treatments are identical to the first and second, except that subjects play against computer "players," knowing they have been programed so that they always play optimally in real terms.[6] By using virtual players with a pre-programed strategy, the authors make sure that the subjects know that other players do not suffer from money illusion. By doing so, it is possible to disentangle the effect when subjects suffer from money illusion from the effect when subjects believe that others (but not they) suffer from money illusion.

The experimental findings show that, in three of the four treatments, after the (fully anticipated) nominal *shock*, prices are immediately adjusted to the new equilibrium. Only in the treatment with nominal income tables and human players did this not occur. In this treatment, price adjustment is considerably more sluggish (see Figure 8.1).

These findings are interesting because they suggest that even when subjects have no problems converting their nominal incomes into real incomes (when they play against computerized players there is no difference between the real table and the nominal table treatments), money illusion can have prominent effects on prices, in markets with strategic complementarities, simply because subjects believe there are

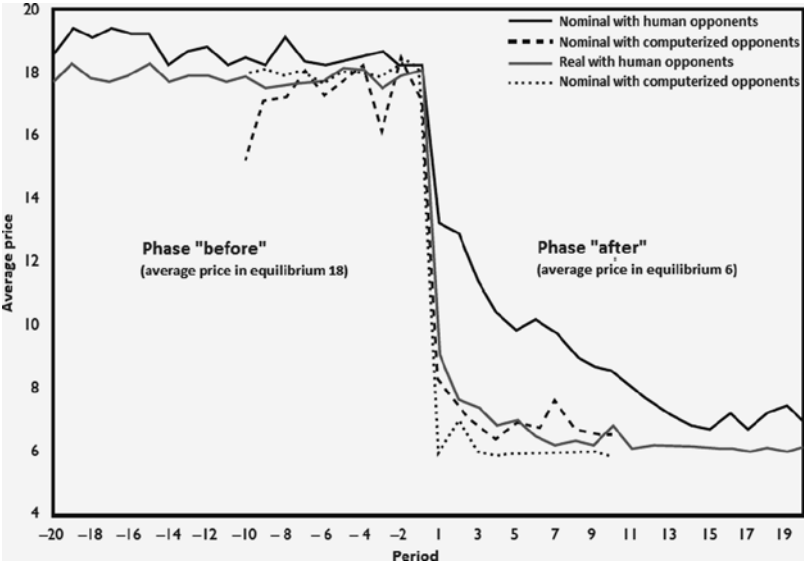

Figure 8.1 Money illusion in Fehr and Tyran (2008)

other subjects playing as if nominal incomes were the same as real incomes.[7]

In summary, money illusion has important effects on market prices when participants have incentives to "follow the crowd." Nonetheless, while money illusion and the market's strategic environment are interesting explanations for nominal price stickiness, most macroeconomists point to other sources to explain this phenomenon, including friction in the acquisition and dissemination of information or costly price adjustment. Experimental studies that investigate the relevance of these other mechanisms will be an important source of future research.

Our knowledge of the way money acts in the economy is fundamental, but in spite of this, our knowledge of how the uses of money are affected by multiple variables is still limited. Some of the questions for which we do not have fully satisfactory answers include: what is the optimal amount of money in the economy and when and why is there hyperinflation? What are the effects when money is seen in nominal terms by some but not by all economic

agents? The experiments discussed in this chapter provide plausible answers to some of these questions, but there is still a lot of work to be done.

International trade

Another field of the macro-economy in which experimental methods have played a relevant role is that of international trade. Noussair, Plott and Riezman (1995) (see Chapter 1) conducted the first experimental attempt to create and study some of the most relevant features of international trade.

In an exchange environment guided by multiple interacting markets, the main objective of this ambitious study was to experimentally draw a distinction between aspects such as the comparative advantage law, factor price equalization, production efficiency and the effect of taxes on international transactions. The authors consider two environments:

- The first one, motivated by the *Ricardian* model of international trade: labor is the only input.
- The second is one where both capital and labor are used as inputs in production.

In both environments there are two countries and within each country two types of agents: consumers and producers. There are equal numbers of consumers and producers in each country (four consumers and four producers).

In the first environment, consumers own the only production factor, L, and have induced preferences to consume the final goods labeled as Y and Z. Producers have, as well, an initial endowment of L to produce and sell the final goods Y and Z. Additionally, all agents may attempt to obtain benefit by speculating both with their inputs and their outputs (final goods). Production factors are not mobile across countries and the final goods Y and Z can be exchanged between them. The two countries differ only in their production technologies. Country 1 has a comparative advantage in the production of good Y, and country 2 has a comparative advantage in the production of good Z. Table 8.1 contains the main experimental parameters for both environments.

Table 8.1 Experiment Noussair, Plott and Riezman (1995)

		Scenario 1	**Scenario 2**
Provisions	Consumers, country 1	L1 = 2	L1 = 5, K1 = 3
	Consumers, country 2	L2 = 2	L2 = 3, K2 = 5
	Producers, country 1	L1 = 1	L1 = 0, K1 = 0
	Producers, country 2	L2 = 2	L2 = 0, K2 = 0
Production technology	Country 1	*Y = 3L, Z = L*	*Y = L, Z = K*
	Country 2	*Y = L, Z = 2L*	*Y = L, Z = K*

The economy works as follows:

- Consumers sell their initial endowment of *L* to producers in their same country, and afterwards they buy units of *Y* and *Z* produced by either country.
- Consumers gain utility (money) both by consuming as well as through the benefits generated from speculation.
- Producers in each country buy *L* from the consumers in their country, and they can use *L* to produce *Y* and *Z*, which subsequently they can sell to consumers from either country.
- The produces obtain utility (money) both from their production activities as well as from the benefits generated from speculation.

While some experimental sessions allowed for free international trade others imposed a tax for trading between countries.

Capital, *K*, is added to the second environment as an input to production and both countries have identical linear production technologies but different endowments of capital and labor. In environments 1 and 2 there were six and eight markets operating simultaneously, respectively. Each variable had its own market (for instance, the final good *Y1* produced in country 1 had its own market). These markets were implemented using computerized double auctions (see Chapters 1, 3 and 4).

The main hypothesis tested in environment 1 is the law of comparative advantage. The competitive model predicts, for this law, that countries 1 and 2 will exclusively produce goods *Y* and *Z*, respectively, and each country completely specialize in exporting the good

it produces. In accordance with the competitive model, the prices of the two goods should be equalized across countries and the prices of inputs should equalize to their marginal productivities. Such predictions can be contrasted to the inefficient outcome under autarky, where there is no trade between countries and, hence, specialization does not emerge.

In environment 2, the competitive model predicts that both countries will produce both final goods. However, in accordance with the model, country 1 will specialize in exporting good *Y*, and country 2 will specialize in exporting good *Z*. Under free-trade conditions, prices of the goods are equalized across countries, implying convergence in the prices of the factors. Such equalization does not take place in the autarkic model.

The main finding from this pioneering work is to experimentally observe, for the first time, that the law of comparative advantage accurately predicts patterns of commerce and trade. In the *Ricardian* environment there is nearly complete specialization by producers in the two countries, and in the environment with capital, the two countries are net exporters of the good for which they have a comparative advantage. In general, the qualitative predictions of the model are confirmed. Convergence processes are observed and such convergence occurs faster for quantities than for prices. According to these experiments, there is not much support for the autarkic model.

Using a simpler design, Noussair, Plott and Riezman (1997) conducted the first experiments exploring the behavior of the economy in international finance markets. More concretely, the aim of these experiments was to better understand the ability of the competitive equilibrium model to predict and control prices and exchange rates.

Once again, there are two countries and each of them produces two final goods *Y* and *Z*.

However, unlike the previous experiment, there are no longer any factor inputs or production processes. Each country was populated by six subjects:

- Three of whom were sellers of (endowed with) good Y and buyers of good Z.
- The other three were sellers of (endowed with) good Z and buyers of good Y.

In addition, each buyer is indifferent, in terms of utility, between acquiring *Y* or *Z* in his home country or in the foreign country. All subjects were endowed with a large amount of cash (only) in their home currency, and foreign country purchases required acquisition (cash) in advance of the foreign currency. Therefore, in this economy there are two countries with six agents each, two goods, and two types of currency, which are only valuable to agents in their own country. Subjects' preferences were induced to value both goods and the home currency only (the end-of-session redemption value of any foreign currency holdings was zero). In each country, markets in the two goods and foreign currency were implemented using computerized double auctions (see Chapters 1, 3 and 4).

Further restrictions designed to force the use of the international finance market were imposed. First, buying and selling in a country must take place using the local currency. Second, no agent was allowed to export but all agents were allowed to import. That is, in order to buy in the other country, agents must use the financial market and purchase foreign currency using their local currency. Once they had purchased goods in the other country, they could transport them to their country without cost and, once there, they could either consume them or re-sell them in the local currency.

The exchange rate – that is, the price of the currency from country 1 in terms of the currency from country 2 – was determined so that the balance of payments would be in equilibrium. Thus, the exchange rate could equate the demand and supply for currencies in both countries, arising out of the flow of international transactions. Given this, the main hypothesis tested concerns the law of one price (which guarantees purchasing power parity). The alternative hypothesis is again, as in the autarkic model, where the no-trade outcome is realized, and the law of one price does not hold.

The authors conclude that these experiments solidly reject the autarkic model. They find that, in general, most aspects of the competitive model work fairly well, but some do not. For instance, they find that exchange rates quickly converge to the equilibrium values predicted by the competitive model, although the prices for some goods do not converge. On the other hand, the law of one price fails to obtain. The authors' conjecture is that this failure does not arise because of the competitive equilibrium model, but because of different speeds of convergence of prices in the two domestic markets.

Fisher (2001), in a subsequent paper, revisits the issue of the law of one price and purchasing power parity by constructing a greatly simplified version of the experiment in Noussair, Plott and Riezman (1997). In Fisher's design, there are:

- Two types of goods: green and red.
- Two types of currencies: green and red.

There are two countries and each produces only a single good. The green goods are available at an elastic supply at a constant price (in green currency) in each period, and the red goods are available at an elastic supply at a price (in red currency) announced at the beginning of each period. In essence, the supply of goods in the market is perfectly controlled by the experimenter. In addition, red and green currencies are exchangeable in the market.

Even though each subject was endowed with a large supply of the green currency, in each period there was a fixed (and, therefore, perfectly inelastic) supply of red currency in the market. After the price of the red good was announced, the supply of red currency was auctioned off in a "second-price, sealed bid auction" (see Chapter 3). The market-clearing price (equal to the second lowest bid submitted) of a unit of red currency in terms of green currency was interpreted as the nominal exchange rate for that period.

Once the exchange rate was determined, subjects were free to buy units of green and red goods. Fisher's main hypothesis was – a relative version of purchasing power parity – that the nominal exchange rate is constant between periods. A second hypothesis was – absolute purchasing power parity – that the real exchange rate equals the marginal rate of substitution between foreign and domestic goods.

Fisher finds convincing empirical evidence for both the relative and absolute versions of purchasing power parity. This finding confirms the conjecture of Noussair, Plott and Riezman (1997) as to why they do not find support in their experiments for purchasing power parity. That is, the divergence in convergence of prices of goods in both domestic markets appears to be relevant and must be considered when designing laboratory experiments.

Macroeconomic policies

Because it is normally impossible (and ethically questionable) to experiment with real macroeconomic policies, the laboratory provides an ideal environment to examine the possible impact macroeconomic policies may have before they are applied. In this section we discuss two areas where laboratory experiments have been used.

Credible commitments

An important practical macroeconomic policy issue concerns the way to overcome problems related to the use of discretionary policies, which are optimal (for the policy makers) in the short term, but not in the long term. A clear example of this problem arises in models where policymakers have incentives to create inflation aiming to reduce unemployment (the well-known Phillips curve). Kydland and Prescott (1977) show how these types of discretionary policies generate a situation where the policymakers ratify the inflation expectations of the citizens, resulting in an excessive level of inflation and no improvement in unemployment.

If the policymakers were able to credibly commit to a zero-inflation policy, the problem would be avoided and the social optimum could be implemented. In theory, Barro and Gordon (1983) solve this problem by modeling the situation as an infinitely repeated game between the policymakers and the citizens. In their model, players use strategies so that the policymakers have a reputation that allows them to implement the socially optimal policy (as in all infinitely repeated games, many other equilibria also exist). The experiments of Van Huyck *et al.* (1995, 2001) were designed to test these theoretical ideas.

Van Huyck *et al.* (1995, 2001) use a game that captures, in a very simple way, the three situations mentioned above. They are concerned with policymaking in situations where the policymakers:

- Have no way to commit.
- Are able to credibly commit.
- Are able to credibly commit to maintain their reputation in an infinitely repeated game.

In each stage of the game there are two periods and two players. In each repetition, subjects are randomly assigned roles as either policymakers or citizens.

In the first period of a repetition, the citizen is endowed with an income, Y, and must decide how much of this to consume in this period, $C_1 \geq 0$, or invest, $I \geq 0$, at a return rate, $r > 0$. The amount available for consumption in the second period, $C_2 \geq 0$, depends on the investment in period 1 and the fraction transferred to the policymaker through a tax rate, m, concretely, $C_1 = (1 - m)(1 + r) \times I$.

In the treatment simulating the situation without credible commitments, the policymaker chooses the tax rate *after* the citizen has made an investment choice. In this case, the optimal choice for the policymaker is to choose the highest tax, $m = 1$, and therefore it is optimal for the citizen to invest nothing, $I = 0$.

In the treatment simulating the situation with credible commitments, the policymaker chooses the tax rate *before* the citizen has made an investment choice. In this case, the policymaker has the incentive of choosing a lower tax rate to stimulate the citizen to make a positive investment (in fact, the policymaker chooses the tax rate maximizing the social welfare: $m^* = r / (1 + r)$ and $I^* = Y$).[8]

Finally, in the treatment simulating the infinitely repeated game, subjects play indefinitely without any credible commitments: they repeatedly interact in fixed pairings and have a sufficiently high probability of continuation so that there is an equilibrium supporting the social optimum.

The findings verify higher investment levels and, in general, they are closer to the social optimum in treatments with credible commitment than in those without them (or without repetition), which are closer to the no-investment equilibrium. Treatments with indefinite repetition show intermediate investment levels.

In other words, the authors find that reputation is an imperfect substitute for a credible commitment mechanism. This is an important finding because outside the laboratory we do not, generally, have good mechanisms to make policymakers commit and, instead, we settle for reputation-based mechanisms.

Fiscal policies

Riedl and van Winden (2001, 2007) design an experiment to examine if unemployment benefits can generate vicious cycles of unemployment and cause deterioration in the general economy.[9] Concretely, they experimentally study how the economy works in countries where unemployment benefits are financed by a tax rate applied to labor

income, as in many developed countries. They consider two types of economy: closed and open. In the open economy there are two countries, one is relatively small and the other is relatively large.

There are consumers and producers in both economies. Each consumer is endowed with K units of capital and L units of labor, which they can sell to the producers as inputs of production. In addition, for each unit of unsold labor consumers get an unemployment benefit. They can use the unemployment benefits to buy in the final goods market. Consumers obtain utility (money) from the two final goods, Y and Z and from "leisure": that is, from the unsold units of labor.[10] The goods Y and Z are produced in two separate sectors. Producers in these sectors need K and L as inputs, which they transform into final goods through their production technologies.[11] The technologies for the two goods differ because the production of X is relatively more dependent on capital, while the production of Y is relatively more dependent on labor. Producers gain utility (money) from what they sell (once the production cost has been discounted). The cost of labor includes a tax rate proportional to the wage.

- There are four markets in the closed economy: two factor markets (for K and L) and two final goods markets (for Y and Z).
- The same markets are present in the open economy, but both the one for capital and the one for the final good Y are open markets (exposed), while the one for labor and the one for the final good Z are domestic markets (protected).

In both economies, markets were implemented using computerized double auctions (see Chapters 1, 3 and 4). In addition, while the number of consumers and producers was the same for both countries in the open economy, the consumers in the *large* country were endowed with seven times more units of K and L than consumers in the *small* country.

The authors find experimental evidence supporting the negative economic effects of using taxes applied to wages as a means to finance unemployment benefits. In addition, they find that employment can be promoted using the budget deficit. However, once the wage tax is forced to adjust for the budget to be in equilibrium, both the level of real GDP and other economic indicators, tend to slowly stabilize to a substantially low level that does not reach the equilibrium prediction.

Van der Heijden *et al*. (1998) test a possible explanation for the stability of the social security system through a voluntary "social contract" between successive generations. The authors design an individual decision-making mechanism over transfers in an experimental environment between overlapping generations, in which the current generation can monitor and react to transfers made by the previous generation. With this aim, in one treatment they provide subjects with information about the level of transferences (pensions) of the previous generation; and in a second treatment this information is not given. In both treatments, each subject (generation) P_t decides how much to transfer (pension) to subject P_{t-1} and, likewise subject P_{t+1} decides how much to transfer to subject P_t, and so on. Subjects live for two periods. In the first period (when they are young), subjects are endowed with nine units, from which only seven can be transferred. In this period, the *young* subjects decide how much to transfer to the current *old* subjects. The units the young subjects do not transfer are used for their own consumption. In the second period (when they are old), subjects receive a non-transferable endowment of one unit plus the units transferred to them by the current *young* subjects. In addition, subjects had induced preferences for a stable consumption in both periods.

The main finding in these experiments suggests that the level and stability of the transfers system does not rely on the possibly of controlling (monitoring) transferences from previous generations. That is, the availability subjects have to maintain transfers from the young to the old seems to be independent of the possibility they have to know about the choices previously made. In addition the authors find scant evidence supporting the effect of rewards or punishments between generations.

Conclusions

Empirical studies of macroeconomic models are notably hard to conduct. In general, researchers cannot directly observe the behavior of economic agents and they can only infer, indirectly, the effects of macroeconomic policies. In addition, evidence that is consistent with a particular theory can also be consistent with other alternative theories based on very different assumptions. Laboratory experiments provide the advantage of convincingly discarding alternative

theories, without forgetting they have the necessary limitation of studying very simple economies (in comparison to a real economy). By way of contrast, empirical data is much richer but leaves the debate open as to the relevance of different theories. Given that both means of research have advantages and limitations, it is best to use them as complementary tools. For instance, experimental findings can be used to reinforce the interpretation given to empirical data and conversely, empirical research can inspire new laboratory experiments.

Notes

1. We want to thank John Duffy for his excellent review of the literature on macroeconomic laboratory experiments, contained in a chapter that will appear in the next volume of the *Handbook of Experimental Economics, Volume 2*, edited by John H. Kagel and Alvin E. Roth, under the title "Macroeconomics: A Survey of Laboratory Research." This work has been a guide for the elaboration of our chapter.
2. McCabe (1989) and Deck *et al.* (2006) use similar designs to study the role of money as a store of value.
3. Due to the multiple problems mentioned above, the number of families partaking in the agreement has decreased from over 250 in the 1970s to less than 20 in 2010.
4. Other articles in this area include: Fehr and Tyran (2007, 2008) and Noussair *et al.* (2007).
5. A good example of a market with strategic complementarities is an oligopolistic market, in which agents compete in quantities.
6. Additionally, instead of playing for 40 periods, in these treatments subjects only played for 20 periods (ten periods before and ten after the nominal *shock*).
7. In a subsequent article, Fehr and Tyran (2008) show that this effect is due to strategic complementarities. That is, they demonstrate that even with human players, if there is strategic substitution in the market, the adjustment of prices is very quick.
8. Letters marked with a star $m^*$and I^* refer to the values of m and I that maximize the players' incomes keeping in mind that both of them act optimally. In other words, in the equilibrium of the game.
9. This research project was developed for the Dutch Ministry of Social Affairs and Employment. The authorities specifically requested the authors to develop laboratory experiments to assess the formulation of their macroeconomic policies.
10. The consumer's preferences are induced by a linear-logarithmic version of a Cobb-Douglas utility function.
11. The production functions are discrete approximations of a CSE (constant substitution elasticity) production function.