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Federal Reserve Bank of Cleveland

Rethinking the Welfare Cost of Inflation

by Ben Craig and Guillaume Rocheteau

During the past 25 years, average inflation in advanced countries has fallen, from 9 percent in the first half of the 1980s to 2 percent since 2000. The same disinflation trend has been observed among developing countries, where inflation fell from 31 percent in the first half of the 1980s to less than 6 percent since 2000 (see figure 1). This phenomenon is even more remarkable if one looks at Latin America and transition economies over the past 10 years: Inflation has been reduced from three-digit numbers (more than 100 percent) to about 10 percent in 2003. This "global disinflation," as economist Kenneth Rogoff calls it, has occurred thanks to institutional changes such as greater independence of central banks, improved monetary regimes, and better macroeconomic policies. However, none of these changes is costless. The United States, for example, went through a major recession and a period of high unemployment during the early 1980s as inflation was brought down. For this process to be worthwhile, it must be the case that even moderately high inflation rates of, say, 10 percent, generate substantial costs to society.

Yet assessing the costs of long-run inflation has proved difficult. A wide variety of estimates has been proposed. At the outset of the 1980s, Stanley Fischer suggested that the annual cost of 10 percent inflation was about 0.3 percent of gross domestic product (GDP) every year, while Nobel Prize winner Robert Lucas figured it was about 0.45 percent of GDP. More recently (2000), Lucas revised his estimate upward, to slightly less than 1 percent of GDP. Some economists believe that even this last number underestimates the true cost of inflation. Ricardo Lagos and Randall Wright are a case in point. Their recent study (to be published in 2005) gives measures for the welfare cost of inflation ranging from 1 to 5 percent of GDP. To put this in context, consider the median U.S. household. It earns about $45,000 a year. The cost of inflation for this household, according to these estimates, would be between $450 and $2,250 a year.

This *Commentary* presents the ways economists see and measure the costs of anticipated inflation. We will first describe the idea of the "welfare triangle"—the traditional method used to capture the problem and generate the cost estimates. It was developed by Martin Bailey and used subsequently by Milton Friedman (another Nobel Prize winner), Stanley Fischer, and Robert Lucas. Then we will take a look at the strategy Lagos and Wright developed. It is based on an entirely different approach—the search model of monetary exchange. This new approach yields a surprising result: We will see that inflation may be more costly than economists used to think.

New models of monetary economies, developed in the last 15 years, suggest that traditional measures of the welfare cost of inflation may underestimate the true loss that inflation inflicts on society. According to these models, the cost of 10 percent inflation ranges from 1 to 5 percent of real income.

The "Welfare Triangle"

Money provides some services to society by facilitating exchange. The cost of inflation corresponds to a reduction in these services. Because inflation erodes the purchasing power of money balances, individuals tend to conduct their transactions with fewer money balances as the inflation rate increases. For instance, they resort to alternative payment arrangements, such as credit or barter, which can be less efficient or more costly. They also buy the services of financial intermediaries to help manage their cash balances. Milton Friedman offers the following example, one that gave rise to the term *shoe-leather cost of inflation*: "A retailer can economize on his average cash balances by hiring an errand boy to go to the bank on the corner to get change for large bills tendered by customers. When it costs ten cents per dollar per year to hold an extra dollar of cash, there will be a greater incentive to hire the errand boy, that is, to substitute other productive resources for cash" (1969, p.14). In all cases, real resources are spent in an effort to avoid the costs associated with holding non-interest-bearing money balances, and, in Robert Lucas's words, these resources "are simply thrown away, wasted on a task that should not have been performed at all" (2000, p. 247).

To measure the cost of inflation, economists need to get a sense of the nonpecuniary benefits generated by a stock of money and assign them some equivalent value in dollars. Typically, the way economists measure the convenience that one enjoys by holding cash is with the nominal interest rate (which is approximately the sum of a real interest rate and the anticipated inflation rate). That is, economists reason that holding cash is convenient because it can facilitate exchange, and people are willing to give up something for that convenience. What they are willing to give up is what they could have earned had they put the cash to some nonrisky money-making use, namely, had they invested it in the safest interest-bearing asset available. As an example, if the interest rate on government securities is 10 percent, then the services provided by holding an additional dollar should be worth 10 cents a year. To simplify the following discussion, we will assume

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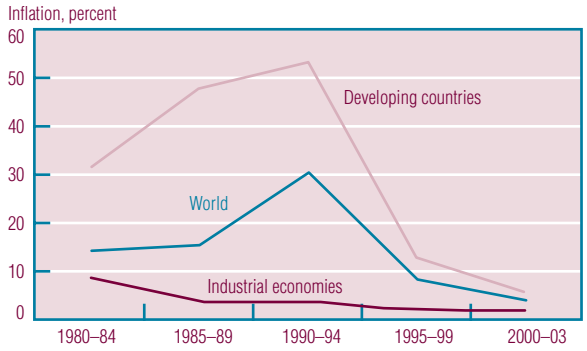
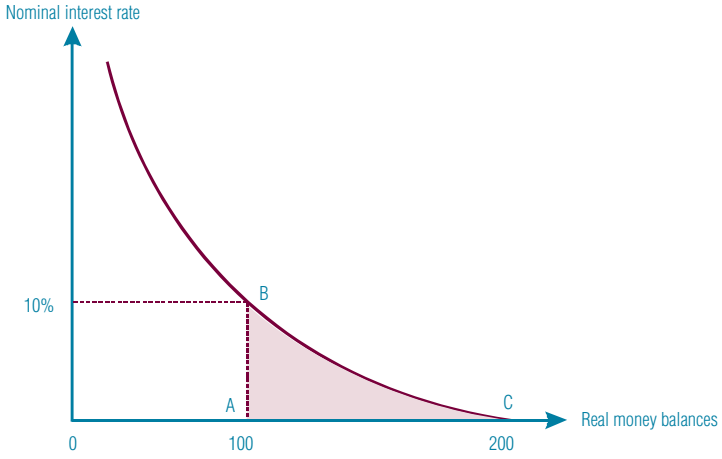
FIGURE 1: GLOBAL DISINFLATION



SOURCE: World Economic Outlook databases of the International Monetary Fund. Taken from Rogoff (2003).

FIGURE 2: THE WELFARE TRIANGLE



that the real interest rate is close to zero so that we can use the terms "inflation rate" and "interest rate" interchangeably. It doesn't affect the conclusions.

If the nominal interest rate measures the nonpecuniary benefit that money gives people, we can estimate the cost of inflation by calculating how much of that benefit is lost when inflation rises. The benefit lost is a function of the fact that people hold less money (in real terms) as the rate rises; less money held equals less of its benefit obtained. In figure 2, we represent the relationship between the interest rate and the stock of real money balances in the economy. (This relationship is referred to as the *money demand function*.) When the stock of real balances is 100 (just an arbitrary point along the possible values of money balances), the benefit that one enjoys by holding an additional dollar is measured by the interest rate that corresponds to 100 real balances on the money demand curve (in this case, 10 percent). Equivalently, it is the length of the segment between points *A* and *B*. The total benefit provided by real balances can then be identified as the area under the money demand curve (that is, the sum of all segments under the curve). The maximum total productivity of real balances occurs when the interest rate is zero, because at this point, one loses nothing by holding money (the level of real balances in figure 2 corresponding to this point is 200). As Milton Friedman showed using this image, the welfare cost of inflation is thus minimized when the nominal interest rate is zero (a famous result known as the *Friedman rule*).

If the interest rate increases from 0 to 10 percent, then individuals economize on their use of real money balances. In figure 2, real balances fall from 200 to 100. The area under the money demand relationship, the "triangle" *ABC* in figure 2, measures the welfare cost of having a positive interest rate of 10 percent relative to zero. Equivalently, it captures the loss to society in terms of lost production and wasted resources due to the fact that people reduce their real money balances from 200 to 100.

To measure the welfare triangle, one needs to estimate the money demand in figure 2 and then compute the area under this curve. This is what Fischer and Lucas did to come up with their estimates. Recall that these were 0.3 to 1 percent of real GDP for a 10 percent inflation. What the welfare triangle method tells us, then, is that a 10 percent inflation could cost the average U.S. household (one at the median in the U.S. income distribution) $450 every single year.

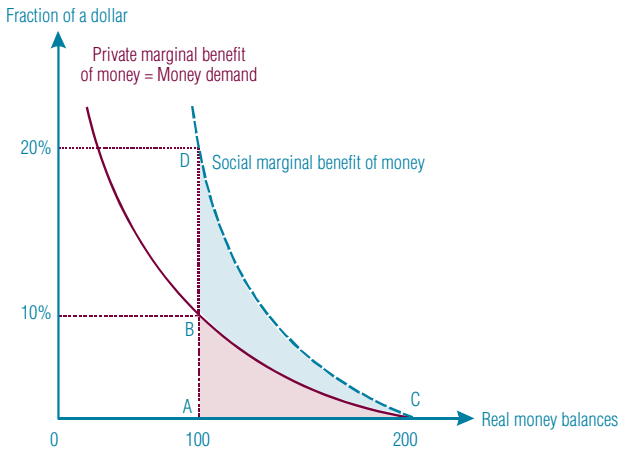
Search for a Money Demand Function

As previously mentioned, the cost of inflation and the benefits of conducting transactions with money are two sides of the same coin. Consequently, an alternative to the Bailey welfare triangle is to think in terms of an economic theory in which the role of money in facilitating exchange is explicitly represented. A theory of monetary exchange makes the cost associated with the reduction in real money balances more transparent and allows one to calculate society's welfare in a more precise way.

One such theory is the search approach of monetary exchange developed by Nobuhiro Kiyotaki and Randall Wright. Search theory emphasizes the transactional role of money. Recently, Lagos and Wright proposed a new framework based on this approach and used it to develop estimates of inflation costs. In these theoretical models, money is useful because it solves a standard problem that arises in trade. It's called the *double-coincidence-of-wants problem*: The buyer does not produce a good that the seller wants to consume. As an example, when an economist takes a taxicab, unless the taxicab driver wants to learn economics, the economist needs to hold money to compensate the driver for the ride.

The cost of inflation is measured by asking the following simple question: How much would someone be willing to pay in order to live in the U.S. economy with price stability instead of the U.S. economy with 10 percent inflation? When the search model is used to answer this question (under the assumption that prices exactly compensate sellers for their production costs), the cost it produces is between 1 and 1.5 percent of GDP per year. This number corresponds broadly to the area under the money demand curve implied by the search model. So the estimate of the cost of inflation provided by search theory is consistent with Lucas's latest numbers.

FIGURE 3: WELFARE TRIANGLE AND THE COST OF INFLATION



The Importance of Price Formation

The search model's estimate of 1 to 1.5 percent of GDP for the cost of inflation is based, as mentioned, on the assumption that prices exactly compensate sellers for their production costs. Different assumptions can be made about how prices are formed, and these matter in estimating the cost of inflation. The assumption that the price compensates sellers only for their production costs implies that all gains from trade are captured by buyers. In the real world, prices are often set as a markup over production costs, so that sellers capture gains from trade.

How do different assumptions for price formation affect the estimates? Consider a simple hypothetical situation in which the gains from trade are shared evenly between buyers and sellers. So if the gains from trade are worth $20, the buyer receives $10 and the seller receives $10. This assumption about price formation is referred to as the *egalitarian solution*.

The welfare cost of inflation under the egalitarian solution is significantly larger than the one given by the money triangle. The cost of 10 percent inflation is about 3 percent of GDP, which is more than twice as big as the highest money-triangle estimate. That increase is quite significant. For the average U.S. household in 2003 (one with the median income), going from 10 percent inflation to price stability would have meant getting the equivalent of almost $1,300 every year—more than the household's 2001 tax refund!

The following example should give some intuition for this result. Consider the taxicab driver and his client. Suppose that a ride is worth $110 to the client and costs the owner of the taxi $90 in terms of gas, depreciation of the car, insurance, time, and so forth. The surplus of a trade is then $20. Suppose that the fare is $100, so that both the client and the taxicab company get a surplus of $10. The return of holding $100 in cash for the client is 10 divided by 100, or 10 percent, while the social return (the return for both the client and the taxicab company) is 20 divided by 100, or 20 percent. If the interest rate is 15 percent, the client's cost of holding $100 is larger than the trade gain of $10. So the client has no incentive to hold cash even though the total surplus of a trade, $20, is larger than the cost of holding $100 when the interest rate is 15 percent.

This point is illustrated in figure 3. The demand for real balances reflects the (marginal) benefits that money provides to the buyer, *AB*, which are smaller than the (marginal) benefits of money for the buyer and the seller, *AD*. As a consequence, when measuring the area under the money demand curve for real balances, the *ABC* area, one underestimates the societal benefits of money, the *ADC* area.

Adding Trading Frictions

The search model's description of the economy can be enriched by incorporating realistic trading frictions, and doing so yields further insights on the effects of inflation. Trading frictions refer to the fact that trading activities require time and are difficult to coordinate. One can incorporate them into the search model by specifying how individuals decide to get involved in market activities, and then one can observe the ways in which these participation decisions tend to be inefficient from the point of view of society. For instance, if an individual decides to become a taxi driver in Cleveland, his decision will hurt other taxi drivers in the area because they will all have to wait longer before they find a client. This effect is called a *congestion externality*. On the other hand, the entry of a new taxicab driver makes it easier for people living in Cleveland to find a taxi because queues and waiting times for taxis are shorter. This effect is called a *thick market externality*. Depending on which externality is more important at the time, the entry of a new taxicab is beneficial or harmful for the Cleveland community.

Inflation will tend to discourage market activities, especially those activities that require holding cash. If there are too many taxicabs in the Cleveland area, a small inflation can be beneficial by inducing individuals to hold less cash, and therefore by reducing the incentives to be a taxicab driver. In this case, the welfare cost of inflation is lower than numbers, such as those above, which do not take market congestion into account. In contrast, if the market is not "thick" enough in terms of having too few taxicabs, inflation exacerbates the trading inefficiencies by discouraging market participation. In this case, the cost of inflation will be bigger than our previous estimates.

When realistic trading frictions are taken into account, one can calculate a large range of estimates for the welfare cost of 10 percent inflation, from less than 1 percent to more than 5 percent of GDP. To get a more precise estimate one needs to identify the trading frictions that dominate real economies. Because little is known about these trading frictions, and because the inflation cost can be huge, it is wise to keep inflation low.

The True Cost of Inflation

We have seen that search models' estimates of the cost of inflation are consistent with those resulting from the standard money-triangle approach, so long as price formation is "competitive" (sellers get no economic profits). In this case, the cost of 10 percent inflation is about 1 percent of the national real income. As soon as we depart from competitive prices, however, the welfare triangle underestimates the true cost of inflation by a factor that depends on the seller's market power. For instance, if gains from trade are

divided evenly between trading partners, the cost of 10 percent inflation is more than twice as big as traditional estimates. Finally, traditional measures are inaccurate when one takes into account realistic trading frictions such as congestion and thick market effects. Overall, the search approach of monetary exchange seems to suggest that inflation may be significantly more costly than previously thought.

Recommended Readings

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