

The Dollar-Euro Exchange Rate and the Limits of Knowledge

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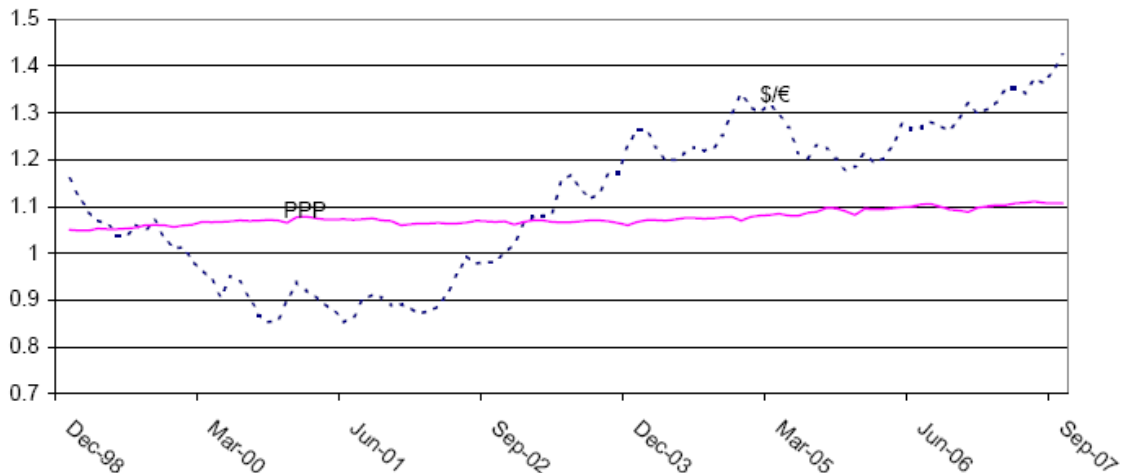
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1. Introduction

When the euro was launched on January 1, 1999, the U.S. dollar-euro (\$:€) exchange rate stood at \$1.16:€1. At that price, the euro was overvalued by roughly 10 percent relative to measures of its purchasing power parity (PPP) level.¹ As Figure 1, which plots the actual and PPP exchange rates from January 1999 through September 2007, shows, the euro's dollar price immediately began to fall steadily.² By June 1999, the exchange rate had reached PPP. But the euro did not stay around this level for long. In October 1999, the value of the euro began a rather persistent swing away from PPP, which lasted more than 2.5 years, reaching a bottom of \$.87 in February 2002. At that price, the euro was undervalued relative to PPP by almost 20 percent.

Figure 1
U.S. Dollar-Euro: 1999-2007



Long price swings that shoot through benchmark levels are characteristic of all assets that trade freely in markets. Indeed, in March 2002, the \$:€ exchange rate began a long upward climb that, except for a substantial counter-movement in 2005, continues to this day. At the time of this writing, the euro's dollar price stands at 1.45, which according to our measure of PPP, is overvalued by almost 30%.

Will the current swing in the \$:€ exchange rate continue in the near term, say, in the coming 3-6 months? What is the longer-term outlook for the euro's dollar price? Unfortunately, the vast majority of empirical exchange rate studies found in the academic literature offer little help in considering such questions, because they presume that the relationship between the exchange rate and macroeconomic fundamentals is invariant –

¹ PPP is a widely used benchmark level for the exchange rate that implies that comparable goods sell at comparable prices in different countries.

² Our measure of the PPP exchange rate is based on *The Economist's* "Big Mac" PPP exchange rate for February 2007, which is 1.1, and CPI inflation rates for the U.S. and the Euro area.

that a fixed set of fundamentals has mattered in exactly the same way over more than three decades of floating currencies. A few studies allow for change in this relationship, but their analyses impose on the data a particular view (sometimes probabilistic) of how exactly it will change. Unable to find empirical support for such exact relationships, economists have concluded that short-run fluctuations in currency values are driven not by macroeconomic fundamentals, but by irrational “noise” traders.

Yet, when business journalists, policy makers, and market participants offer explanations of exchange rate movements, they mainly talk about trends in macroeconomic fundamentals. The euro’s recent rise against the dollar is a case in point: most accounts pin it on the U.S. economy’s growing weakness relative to Europe, a rising interest rate differential (Europe minus U.S.), and a continuing accumulation of dollar-denominated assets by euro-zone countries and others because of enormous U.S. current account deficits.³

2. Lost Fundamentals in Contemporary Economic Models

Why do academic economists believe that short-run currency fluctuations are not connected to macroeconomic fundamentals, whereas the individuals most connected to financial markets obviously do? Our answer is that market participants and observers recognize that the relationship between the exchange rate and macroeconomic fundamentals changes at times and in ways that cannot be fully foreseen.⁴ While they may use economic theory to understand and forecast markets, they recognize that they cannot base their actions solely on a fixed model.

Our academic colleagues, by contrast, limit themselves to searching for models in which the exchange rate relationship is either fixed or changes in mechanical ways. They do so because only such models generate “sharp predictions,” which they believe are the only models worthy of “scientific” status.⁵

The basic premise of our approach, called “imperfect knowledge economics” (IKE), is that the search for sharp predictions of market outcomes is futile. Market participants and policy makers must cope with ever-imperfect knowledge in forecasting the future exchange rate. As a result, our knowledge and our institutions (e.g., the conduct of monetary policy) change over time.⁶ Indeed, capitalist economies provide powerful incentives for individuals to find new ways of thinking about the future and the past. In such a world, it is rather odd for economists to expect that a fixed set of economic

³ For example, see recent issues of *The Economist*.

⁴ This and other arguments in this note draw on our book, *Imperfect Knowledge Economics: Exchange Rates and Risk*, Princeton University Press, August 2007.

⁵ To avoid misunderstanding, whenever we speak of a “sharp” or “exact” prediction, we mean a prediction that entails both a particular value for, say, the exchange rate, as well as the *complete* set of potential values and their associated probabilities.

⁶ Preferences, such as market participants’ aversion to capital losses, most likely change too.

fundamentals would matter in exactly the same way for more than 30 years, or that they could fully prespecify how this relationship might have changed over time.

It is thus not surprising that academic economists have found that their models forecast exchange rates no better than flipping a coin does.⁷ This finding still attracts much attention among academic researchers. Indeed, it is one of the main reasons why they have concluded that markets participants' irrationality, rather than macroeconomic fundamentals, moves currency markets.

But a different view emerges once we recognize that, in a world of imperfect knowledge, economic relationships change at times and in ways that cannot be fully prespecified. Formal empirical analysis reveals not only that the relationship between exchange rates and macroeconomic fundamentals has been unstable during the modern era of floating currencies, but also that the set of fundamentals that matters has changed from one sub-period to another. This finding may be news to academic macroeconomists, but it is hardly surprising for market participants.

3. Understanding Markets in Capitalist Economies

Our empirical findings show that the insistence on searching for only exact relationships between the exchange rate and macroeconomic fundamentals has actually diminished our ability to understand what moves markets. As John Kay put it, "the quest for exact knowledge gets in the way of useful knowledge."⁸

Many market participants no doubt use quantitative models to form exact forecasts of the future exchange rate, for example, that a euro will cost \$1.46 in a week. After all, a currency trader must decide on his market position at each point in time. But, although a market participant may base her trading on exact predictions, she does not arrive at such predictions by relying solely on quantitative models, much less the same model in every time period. In forming her forecasts, a rational individual often combines quantitative models with her own insights concerning the behavior of other market participants, the historical record on exchange rate fluctuations, as well as her evaluation of the impact of past and future decisions by policy officials. And, because market participants act on the basis of different knowledge and intuitions, they adopt diverse strategies in forming and revising their exchange rate forecasts over time.

What markets do, of course, is to account for the myriad distinct bundles of knowledge and intuition in determining economic outcomes. No mathematical model can hope to mimic exactly how this diversity might develop over time. As Karl Popper put it, "we

⁷For a seminal article, see, Richard A. Meese and Kenneth Rogoff, "Exchange Rate Models of the Seventies: Do They Fit Out of Sample?" *Journal of International Economics*, 1983, pp. 3-24. For a recent study reporting difficulties in finding an overarching model relating the exchange rate to fundamentals, see Yin-Wong Cheung, Menzie D. Chinn, and Antonio G. Pascual, "Empirical Exchange Rate Models of the Nineties: Are Any Fit to Survive?" *Journal of International Money and Finance*, 2005, pp. 1150-75.

⁸ "Beware the Fruitless Search for 'Sharp Prediction,'" *Financial Times*, October 17, 2007.

cannot predict, by rational and scientific methods, the future course of our scientific knowledge”⁹ But, although diverse, market participants’ forecasting behavior might display some regularities that last for extended periods of time. If it did not, no economic theory – which implies at least a modicum of generality – would be possible.

The key idea behind IKE is that the most we can hope for in a world of imperfect knowledge is that individual and aggregate behavior exhibit *qualitative* regularities. For example, euro bulls and bears have diametrically opposed forecasts, the former predict a rise, while the latter predict a fall in the euro’s value. Despite drastic differences in how they form their forecasts, however, the ways in which bulls and bears *revise* their forecasting strategies may share certain qualitative features. In our IKE model of currency fluctuations we formalize such regularities with qualitative conditions and show how they help us understand the tendency for the exchange rate to move away from PPP in some periods of time, while reverting back to this benchmark in others. Thus, although IKE jettisons the idea that economic models should be judged by their ability to predict exactly, it does not abandon the key aim of all “scientific” endeavors: distinguishing empirically among alternative explanations of outcomes. Indeed, the qualitative predictions implied by alternative IKE models show that economists can learn more about markets if we ask less of our models – that is, if we abandon the demand for sharp predictions.¹⁰

4. The Near-Term Outlook for the Dollar-Euro Exchange Rate

What does all this mean for the \$:€ exchange rate in the near future? Will the swing away from PPP continue over the next 3-6 months? Conventional economic models have little to say about this question. In fact, models based on the Rational Expectations Hypothesis (REH) predict that protracted swings away from PPP should not even occur. Likewise, although behavioral models attempt to capture how individuals really act, they assume that currency swings stem from the behavior of irrational traders who abandon strategies based on macroeconomic fundamentals.

Our IKE approach recognizes that market participants may draw on different economic theories in selecting fundamental variables that may be useful in forecasting outcomes in different time periods. Moreover, in constructing its models, IKE uses important insights into individual behavior by behavioral economists, psychologists, and other social scientists. But we stress again that these insights should not be formalized with mechanistic rules that – as contemporary behavioral finance models do – fully prespecify how market participants might alter the way they make decisions.

⁹ Karl Popper, *The Poverty of Historicism*, 1957, Routledge, p.xii.

¹⁰ In his 1974 Nobel lecture, Hayek succinctly summarized the promise of IKE: “I confess that I prefer true but imperfect knowledge... to the pretence of exact knowledge that is likely to be false.” See Friedrich Hayek, “Pretence of Exact Knowledge,” in *New Studies in Philosophy, Politics, Economics and History of Ideas*, 1978, University of Chicago Press, pp. 29.

The IKE model that we develop in our book suggests that there are two key factors that one needs to consider in understanding exchange rate fluctuations: movements in macroeconomic fundamentals and revisions of individual forecasting strategies.

4.1 Macroeconomic Fundamentals and Exchange Rate Swings

In our model, the exchange rate is determined by the interplay between the decisions of bulls and bears, who base their forecasts in part on different interpretations of trends in macroeconomic fundamentals. A market participant may well decide that, because the \$:€ exchange rate is, say, 30 percent overvalued relative to PPP, as it currently is, she wants to be a net seller of euros. However, in a world of imperfect knowledge, the gap between the actual and PPP exchange rates is merely one of many fundamental factors that market participants might reasonably rely on in forming their forecasts. Research shows that other fundamental variables that have been important at various times over the past 30 years include domestic and foreign interest rates, GDP growth rates, unemployment rates, current account imbalances, inflation rates, and monetary policy announcements. These variables may exhibit trends that cause market participants in the aggregate to revise their exchange rate forecasts further away from PPP, thereby causing the exchange rate to follow suit. This IKE view of exchange rate swings, therefore, rationalizes the accounts of the euro's recent rise that point to the importance of macroeconomic fundamentals.

4.2 Individuals' Revisions of Forecasting Strategies

Trends in macroeconomic fundamentals are not the only factors that drive currency fluctuations and swings in exchange rates. How and when individuals revise their forecasting strategies also matter. Such decisions can depend on many factors, including prior forecasting success, economic and political developments, emotions, or, as we will suggest shortly, the size of the departure of the exchange rate from PPP. The revision of forecasting strategies and its timing, therefore, is to some extent non-routine, so that modeling such decisions with fully predetermined rules, as contemporary models do, is bound to fail.

In our exchange rate model, we explore the implications of a well-documented phenomenon that psychologists call “conservatism”: individuals tend to revise their beliefs slowly when they are unsure how to think about the problem at hand. Because we formalize this insight with qualitative conditions, our model does not prespecify exactly when or how any individual might revise her forecasting strategy.¹¹ Nevertheless, our

¹¹ Following the contemporary behavioral-finance approach, Barberis, Shleifer, and Vishny construct a fully predetermined model of the equity market that formalizes conservative behavior with a fixed rule. This is tantamount to assuming that market participants systematically under-predict asset price movements in exactly the same way in every time period, thereby systematically foregoing obvious profit opportunities endlessly. Such accounts of financial markets, which presume that traders are grossly irrational, do not provide, in our view, convincing explanations of asset price fluctuations. Unsurprisingly, Fama has found that participants in financial markets sometimes under-predict and at other times over-predict. See Nicholas C. Barberis, Andrei Shleifer, and Robert Vishny “A Model of Investor Sentiment,” *Journal of Financial*

conservative conditions place enough structure on the analysis to deliver qualitative predictions about exchange rate fluctuations.

We find that the exchange rate will undergo a swing either toward or away from PPP in any period of time in which individuals revise their forecasting strategies in conservative ways and trends in macroeconomic fundamentals persist. If a swing is initially toward PPP and the sub-period of conservative forecasting behavior and fundamental trends endure, the exchange rate will eventually shoot through this benchmark level and begin trending away from it on the other side.

4.3 Recognizing the Limits of Economists' Knowledge

This IKE model helps us to consider whether the euro's rise above PPP will continue over the coming 3-6 months by informing us about the key factors that should be kept in mind. The model tells us not only that one should analyze whether current trends in the macroeconomic fundamentals will continue; it also suggests which fundamentals may be relevant and how (in a qualitative way) they might matter.¹² Of course, how market participants might revise their forecasting strategies also matters, and determining this requires forecasting whether the particular set of macroeconomic fundamentals currently moving the market – for example, income levels, interest rates, and current account balances – will continue to be important.

A prediction about whether the current swing in the euro will continue depends on how one implements this IKE theory. For example, most published forecasts predict that current trends in macroeconomic fundamentals that appear to be driving the market are likely to continue, while psychologists tell us that individuals are reluctant to revise their forecasting strategies in dramatic ways. If the market continues to be characterized by these two features, then, according to our model, the euro's value will continue to rise.

Although this prediction seems reasonable to us, others would certainly disagree. The reason for this diversity among observers and market participants is that the best one can do when knowledge is imperfect is to make rigorous, yet only conditional, statements about the future course of the exchange rate. The problem, as we have pointed out, is that no one can fully foresee how market participants and policy makers might alter their decision-making processes. Even if individuals use the same IKE model, their predictions concerning the conditions that will obtain over the near term will, in general, differ, implying that they will arrive at diverse exchange rate forecasts.

Economics, 1998, pp. 307-43, and Eugene F. Fama, "Market Efficiency, Long Term Returns, and Behavioral Finance," *Journal of Financial Economics*, 1998, pp. 319-338.

¹² The qualitative predictions concerning which macroeconomic variables may be important come from additional qualitative constraints on individual forecasting strategies that stem from our specifications of the money and goods markets.

After all, there are bears in the market who are net sellers of euros. Despite the recent run-up in the euro's dollar price, such behavior is not unreasonable. Indeed, as we argue in the next section, it is reasonable to suppose that current trends in macroeconomic variables will not continue forever, and that market participants will not steadfastly revise their forecasting strategies in conservative ways. Our model indicates that if either one of these possibilities occurs, the \$:€ exchange rate could undergo a sustained reversal. By recognizing the limits of economists' knowledge, IKE enables us to understand asset price fluctuations as the interplay between both bulls and bears – a basic feature of markets that contemporary models find difficult to explain without assuming irrationality on the part of market participants.

4.4 Coming to Terms with Imperfect Knowledge

Economists are trained early on to believe that models that do not generate sharp predictions are not worthy of consideration. However, the opposite is true. Models that generate sharp predictions lead to odd conclusions – for example, that exchange rates are driven by irrationality rather than macroeconomic fundamentals. To be useful, economic models need to be consistent with the basic fact about markets: participants hold diverse views about the future course of the payoff-relevant variables. How exactly this diversity translates into prices over time must be left for the markets to determine.

Ultimately, good forecasting is much like good entrepreneurship: it may involve the use of quantitative models, but also relies on one's own "personal" knowledge, intuition, and a bit of luck in spotting profit opportunities. The insight that such endeavors cannot be preprogrammed lay behind Hayek's argument that central planning is impossible *in principle*. Our IKE model of exchange rate fluctuations is useful for forecasting precisely because it is not mechanical; it does not prespecify when forecasting behavior might be conservative or for how long trends in macroeconomic variables might continue. It thus does not prespecify when an exchange rate swing will begin or end. Nevertheless, as we discuss in the next section, our model does imply that exchange rate swings away from PPP are ultimately bounded. It also identifies the important factors that one might consider in thinking about the eventual reversal of the current run-up of the euro.

5. The Longer-Term Outlook for the Dollar-Euro Exchange Rate

As with the near-term outlook for the \$:€ exchange rate, IKE's predictions concerning the euro's longer-term outlook are qualitative. These predictions stem from a new way to model the determinants of risk and to account for the role of historical benchmark levels for individual decisions in asset markets.

5.1 An IKE Specification of the Market Premium

A key component of our IKE model of exchange rate fluctuations is a new specification of the premium on foreign exchange that replaces the usual assumptions of risk aversion

and expected utility theory with what we call “endogenous prospect theory.”¹³ According to endogenous prospect theory, all market participants (both bulls and bears) require a premium for holding open positions in the market that depends on their expectations of the potential losses from speculating. To model how an individual might revise her expectation of the potential loss from speculation, we draw on Keynes’s insight that the tendency of asset prices to undergo long swings that revolve around historical benchmark levels is key to understanding a market participant’s forecasting behavior.¹⁴ Our new specification thus relates the market premium not to the variance of foreign exchange returns, as is usually the case, but to the gap between the exchange rate and its historical benchmark level.

5.2 Bounded Instability: When Will the Current Swing from PPP End?

Conventional exchange rate models treat PPP as the long-run equilibrium value: they imply that market forces invariably push the exchange rate back to PPP, and that, in the absence of shocks, the exchange rate will come to settle at this level. As is evident from Figure 1 and time plots of other floating exchange rates, however, this view of exchange rate fluctuations around PPP has not been borne out. In some time periods, the exchange rate does move persistently back to PPP, but even when it returns fully to this benchmark, there are no market forces that work to maintain it at this level. Instead of settling at PPP, as the conventional view implies, the exchange rate often shoots through this level and begins to trend away from PPP on the other side. The early experience of the euro provides just one recent example of this tendency.

Nevertheless, there is much evidence that, although exchange rates often undergo wide swings away from PPP, sustained counter-movements back to PPP eventually follow. Consequently, market participants, economists, policy makers, and other players often rely on PPP as a useful benchmark for exchange rate fluctuations. Our IKE model of exchange rate swings, with its new specification of risk and the market premium, accords with the empirical evidence and the practice of market players: it implies that, although the exchange rate has a tendency to undergo long swings away from PPP, such swings are ultimately bounded. Sometimes, counter-movements involve a partial return to the PPP benchmark (for example, the euro’s partial reversal in 2005), while at other times they entail a full return, ultimately shooting through the PPP level to begin another swing away from the benchmark.

Although our IKE model does not sharply predict when any swing away from PPP might end, it points to the factors that may be important in analyzing this eventuality. Consider the current swing in the \$:€ exchange rate. While trends in macroeconomic fundamentals and conservative revisions of forecasting strategies may be leading bulls to bid the euro’s dollar price further above PPP, our IKE model of risk indicates that they simultaneously

¹³ Endogenous prospect theory provides a way to represent the experimental findings of Kahneman and Tversky and others in a world of imperfect knowledge. See Daniel Kahneman and Amos Tversky, “Prospect Theory: An Analysis of Decision under Risk” *Econometrica*, 1979, pp. 263-291.

¹⁴ John Maynard Keynes, *The General Theory of Employment, Interest and Money*, Harcourt Brace, 1936.

become more concerned about a sustained counter-movement – that is, they become more concerned about capital losses. This leads them to raise the premium that they require to increase their long positions. According to our model, if the swing away from PPP were to continue, a threshold would eventually be reached at which bulls would become so concerned about a reversal that they would no longer revise their forecasting strategies in conservative ways. At that point, they would either reduce their long positions or abandon them altogether, which would precipitate a reversal in the exchange rate.

Our IKE theory also suggests that the run-up in the euro's dollar price would eventually end even without changes in the ways that market participants revise their forecasting strategies. It implies that the trend in one or more of the causal variables that market participants are using to form their forecasts would eventually reverse direction.

One prospect is that policymakers would eventually act. For example, central bankers might begin to lower the interest rate differential instead of raising it, or the U.S. Treasury, together with the European Central Bank, might step in and begin to buy dollars. Indeed, some policymakers, especially in Europe, have long worried about large and protracted swings in the exchange rate away from PPP. To capture such behavior, our IKE model assumes that there is a threshold beyond which policymakers would alter policy in an attempt to engender a reversal in the market. Two examples of this are the coordinated intervention by central banks and policy changes aimed at bringing down U.S. dollar rates in 1985 and yen rates in 1995.

A second way that a reversal in the \$:€ exchange rate could occur is that the rise in the exchange rate itself eventually influences the trend of some of the casual variables. For example, basic economic theory suggests that a rising \$:€ exchange rate would eventually lead to an improvement (deterioration) in the U.S. (European) current account, which would, in turn, work to reverse current trends in the overall economies. Recent data suggest that such effects are already beginning to occur.

6. A New Policy Proposal for Limiting the Magnitude of Exchange Rate Swings¹⁵

This IKE view of the role of benchmark levels such as PPP – that market participants use these levels in assessing the riskiness of speculation, and, by doing so, keep exchange rate fluctuations bounded – suggests a new channel through which officials can limit the magnitude of exchange rate swings. This new channel, in turn, leads to a novel proposal for managing a floating-rate regime.

As we noted above, although the exchange rate ultimately reverts back to its PPP benchmark, in a world of imperfect knowledge market participants might ignore this possibility in the near term. Instead, they may focus primarily on the trends in other

¹⁵ This section draws on our article "Limiting Exchange Rate Swings in a World of Imperfect Knowledge," in P. Sorensen (ed.), *European Monetary Integration: Historical Perspectives and Prospects for the Future. Essays in Honour of Niels Thygesen*. DJOEF Publishing, 2004.

fundamental variables and thereby push the exchange rate further away from parity. But if central banks announced regularly their concern about significant departures from PPP, as they do now about inflationary prospects, they would likely heighten currency traders' concern that other traders will consider it increasingly risky to hold open positions that imply further movement away from parity levels. This should moderate their willingness to increase their long positions, thereby limiting the magnitude of the currency swing.

To implement this "limit-the-swings" proposal, the central bank would announce its estimate of parity values every month, together with a comprehensive explanation of its estimates. It would also make known to currency traders its concern about excessive departures from its estimated parity values and its readiness to intervene at unpredictable moments by buying or selling currency to impede further departures from PPP. This policy would be even more effective if it were known that more than one central bank – say, the Fed and the ECB – were prepared to intervene.

This strategy does *not* imply that central banks should attempt to confine the exchange rate to a pre-specified target zone. Given the enormous size of daily volumes in currency markets, such attempts almost always fail, leading to currency crises. Instead, our limit-the-swings strategy implies that, as the exchange rate moves further away from parity, central banks should use their reserves to intervene. The possibility of unpredictable interventions would reinforce the effect of the bank's regular announcements of the parity values on traders' perception of increased risk of capital losses.

While this proposal shares some common features with inflation targeting – a popular tool with central banks nowadays – it may actually achieve its goals more effectively. Both involve announcing benchmark levels, departures from which the central bank considers harmful. In both cases, central banks attempt to affect macroeconomic outcomes directly as well as by influencing market participants' expectations. As Milton Friedman emphasized, however, the links between monetary policy and inflation are "long and variable."¹⁶ By contrast, the link between official intervention and exchange rate movements is much more direct and likely to be more potent. To be sure, given massive trading volumes, direct intervention can alter supply and demand for currencies only on the margin. However, the IKE view of risk suggests that the limit-the-swings policy is likely to amplify its effects by diminishing market participants' desire to push the exchange rate away from PPP.

Our proposal to reduce – but *not* eliminate – swings from parity recognizes that price fluctuations may be crucial for markets to ascertain the price of assets that promise an uncertain payoff. But currency swings, if too wide and protracted, can lead to changes in competitiveness and require costly resource allocation. These effects, in turn, lead to calls for protectionist measures on the part of business and the public, which may reduce the benefits from international trade and real economic activity. Only by explicitly

¹⁶ Milton Friedman, "The Lag in Effect of Monetary Policy," *Journal of Political Economy*, 1961, pp. 447-66.

acknowledging the limits to economists' and policymakers' knowledge would monetary and exchange rate policies have a chance of succeeding.