Lecture Note on Exchange Rate Fluctuations

Barry W. Ickes

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Abstract

Why do exchange rates fluctuate as sharply as they do? How do anticipated policies impact on exchange rates? What is the difference between anticipated effects and bubbles?

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1. Introduction

Up to now we have analyzed flexible exchange rates under the assumption that expected changes in the exchange rate were zero. For short-run comparative statics analysis it is useful to assume that $\delta_t = 0$. That is why we write the balance of payments condition as $K = \beta(i - i^*)$. This is useful because we do not have enough structure in the model to determine how expectations about the exchange rate change with exogenous disturbances in the model. A typical comparative statics exercise involves a one-time change in an exogenous variable (such as government spending, the money stock, or foreign output). The future spot rate depends on the value of these variables in the next period. It is most convenient to assume that $\Delta e^e_{t+1} = \Delta e_t$, so that there is no change in expected appreciation.

This is fine for comparative statics, but expectations play an important role in exchange rate determination. If we want to understand why exchange rates fluctuate as much as they do we need to drop this assumption. We need instead to take seriously the fact that the current value of the exchange rate depends on expectations about future values. Does this mean that we cannot say anything interesting? Is anything possible? It turns out that we can build on the framework we have developed and obtain some important insights.

2. Interest Parity Revisited

Let us briefly recall the interest-parity conditions. Recall that covered interest arbitrage implies that:

$$i - i^* = \frac{F_t - e_t}{e_t} \equiv f_t \tag{1}$$

where f is the forward premium. In addition we have the uncovered interest parity condition:

$$i - i^* = \frac{\widehat{e}_{t+1} - e_t}{e_t} \equiv \delta_t \tag{2}$$

where $\widehat{e}_{t+1}$ is the expected spot exchange rate. The UIPC condition is crucial, and we will use it repeatedly.

To make use of the UIPC condition we need to have some model of expectations formation. That is, we need to know how agents form expectations about future exchange rates. The natural assumption to make is that agents form expectations rationally. That is, they estimate the value of future variables based on the information they have in an unbiased manner. They are not perfect in their guesses. But they are not consistent in their errors either.

Rational expectations would appear to be a most sensible hypothesis about how foreign exchange traders behave.[1] There is a lot of money to be made or lost in these markets, and one would expect that biased methods of forming expectations would drive agents out of business. This is not to say that exchange markets are not subject to bouts of speculative fancy. But even bubbles can be the result of rational expectations.

3. Adjustment in the Asset and Goods Markets

Two key assumptions will drive our analysis. These concern the relative adjustment speeds of the asset and goods markets.

Assumption 1 We assume that asset markets clear continuously. They operate like spot markets, with the price clearing each day to balance supply and demand. new in-

[1] Despite the comments of George Soros.

formation tends to impact prices in asset markets right away. Indeed, that is what commentators usually talk about when discussing market movements.

Assumption 2 We assume that goods markets adjust at a slower rate. Goods markets respond to excess demand, but they do not close the gap instantaneously. If output is below the full employment level we expect that the gap will be closed. But this takes time.

4. Exchange Rate Determination

We know put the pieces together to see how exchange rates fluctuate.

4.1. Long-Run Equilibrium

Notice that long-run equilibrium is determined as before. The LL curve still describes combinations of the exchange rate and income that keep the money market in equilibrium. If we assume perfect capital mobility there is only one level of income that will satisfy the money market equilibrium condition:

$$i^* = \frac{1}{h}\left(kY - \frac{M^s}{P}\right) \tag{3}$$

where we have used the perfect capital mobility assumption to substitute i^* for i. We can solve this for Y:

$$\overline{Y} = \frac{1}{k}\frac{M^s}{P} + \frac{h}{k}i^*. \tag{4}$$

which follows because in long run equilibrium $\delta = 0$. From this expression, it is apparent that an increase in the real money stock raises equilibrium income as does an increase in the world interest rate. The latter follows, because higher i^* reduces money demand so that higher income is needed to keep the money market in equilibrium. Hence, combinations of e and Y that keep the money market in equilibrium is vertical in $e - Y$ space.

The goods market equilibrium condition is also as before. Recall that an appreciation of the real exchange rate causes the IS curve to shift to the right. The reason is that a higher real exchange rate switches demand from foreign to domestic goods, thus requiring increased income to keep the goods market in equilibrium. The equation of the IS curve under Perfect Capital Markets is:

$$Y = \alpha(\overline{A} - b(i^* - \pi^e) + \overline{T} + \phi q). \tag{5}$$

Since we are assuming that price levels are fixed, an appreciation of q is equivalent to an appreciation of e. Consequently, combinations of e and Y that keep the goods market in equilibrium will be upward sloping in $e - Y$ space. Call this the YY curve.

Long-run equilibrium is determined by the intersection of the LL curve and the YY curve.

4.2. Short-Run Equilibrium

In the short run we no longer have the condition that $\delta = 0$. Exchange rates may be expected to appreciate or to depreciate. Consequently, it is possible for $i \neq i^*$ and yet no arbitrage opportunities exist. To determine short-run equilibrium in the money market we substitute the interest parity condition (2) into the money market equilibrium condition (3)

$$i^* + \delta = \frac{1}{h}\left(kY - \frac{M^s}{P}\right)$$

or

$$i^* = \frac{1}{h}\left(kY - \frac{M^s}{P}\right) - \frac{\widehat{e}_{t+1} - e_t}{e_t}. \tag{6}$$

We can solve (6) for income:

$$Y = \frac{1}{k}\frac{M^s}{P} + \frac{h}{k}\left(i^* + \frac{\widehat{e}_{t+1} - e_t}{e_t}\right) \tag{7}$$

Notice that for given expected future exchange rates, a lower current rate implies higher current income. If $e_t < \widehat{e}_{t+1}$ the exchange rate is expected to appreciate. This means that the domestic interest rate exceeds the foreign rate. In terms of (7) the term in parentheses – which is just the domestic interest rate – is higher, reducing money demand. For a given money supply equilibrium requires higher income so that money demand is unchanged.

To make use of this apparatus we need to say something about how expectations about future exchange rates are formed. It is clear from (7) that deviations of the spot exchange rate from the expected future rate affect money market equilibrium. To use this we need to model how expectations are formed. The natural assumption to make is that agents form expectations rationally; that is, they use all the information available to them efficiently. Furthermore, we will assume that expectations are mean reverting. Hence, if $e_t < \widetilde{e}$ we assume that agents expect the exchange rate to appreciate, and vice versa. In particular, we will assume that in any period agents expect that some fraction of the gap that is expected to be eliminated in any time period. One way to incorporate this is to suppose that $\widehat{e}_{t+1}$ is the long-run equilibrium value of the exchange rate.[2] Call this $\widetilde{e}$. But we can't just substitute $\widetilde{e}$ directly for $\widehat{e}_{t+1}$ because output only adjusts gradually to its full equilibrium value. We can use this fact, however. If output closes θ of the gap in the next period, then so should the exchange rate. This follows because once output reaches its full equilibrium value so does the exchange rate. Then we can write, $\delta = \theta\left(\frac{\widetilde{e}-e_t}{e_t}\right)$.

Why would θ be less than one? That is, why would it take longer than one period for the exchange rate to return to its equilibrium value? The reason is that we have assumed that goods markets adjust slower than money markets. Hence, if output adjust slowly to its equilibrium value the exchange rate must as well. This is apparent from (7) because it is the only other endogenous variable. Hence we can think of θ as a measure of the adjustment speed of the goods market.

We can now re-write (7):

$$Y = \frac{1}{k}\frac{M^s}{P} + \frac{h}{k}\left[i^* + \theta\left(\frac{\widetilde{e}-e_t}{e_t}\right)\right] \tag{8}$$

Recall that when $e_t = \widetilde{e}$ we have $Y = \overline{Y}$. Now we have seen that when $e_t < \widetilde{e}$ we have

[2] Since prices are fixed in the model it is perhaps better to refer to this as the full equilibrium rather than the long-run equilibrium. At the full equilibrium the goods market and the money market are in equilibrium, and $e = \widetilde{e}$.

$Y > \overline{Y}$, and when $e_t > \widetilde{e}$ we have $Y < \overline{Y}$. Hence, in the short run the relationship between the exchange rate and income that keeps the money market in equilibrium, the MM curve, is negatively sloped.

Using expression (8) we can also see how the slope of the MM curve depends on the speed of adjustment, θ. The smaller is θ, the longer it will take to reach the new equilibrium (by definition). If θ is low it will also take a larger increase in e to offset a rise in the money stock at impact. To see why, notice that the instant the money stock rises Y has not yet changed (the full equilibrium value of the exchange rate – $\widetilde{e}$ – rises of course). So the left-hand side of (8) is unchanged. To keep the right-hand side unchanged e must rise to offset the higher money stock. Notice that the larger is θ the smaller the required increase in e. If the adjustment speed is very low, on the other hand, it will take a larger increase in the spot exchange rate to offset any rise in the money stock. Since the full equilibrium value of e ($\widetilde{e}$) is independent of θ – because at full equilibrium $\delta = 0$ – then this makes MM steeper.

4.2.1. Dynamics: The Overshooting Model

We know use the apparatus we have developed. The full equilibrium is determined by the intersection of the YY curve and the LL curve. But in the short-run, when output is not at its full equilibrium level the economy moves to the new equilibrium along the MM curve. This is the key assumption of the overshooting model: asset markets clear continuously, so asset prices jump to equate asset supply and asset demand.

To see how this works, we examine an unanticipated money shock. Suppose the economy is at full equilibrium (e_0, Y_0). Now the money stock is increased. This causes the LL curve to shift to the right. We know that the new long-run equilibrium is at (e^*, Y^*). But income cannot rise immediately. Slow adjustment of the goods market means that Y increases gradually. Hence, the exchange rate must jump at the moment of impact all the way to e_1 in figure 1. As income increases the exchange rate depreciates as $e \longrightarrow \widetilde{e}$. Notice that the exchange rate overshoots it full adjustment: e rises from e_0 to e_1 at impact, which is greater than the full adjustment of the exchange rate, since $e^* < e_1$.

Why does the exchange rate overshoot? This follows, once again, from the assumptions about adjustment speed. Notice that a monetary expansion means that at unchanged income there is an excess supply of money. Consider equation (8). At impact $\Delta Y = 0$. To satisfy the expression – i.e., to maintain money market equilibrium – the RHS of the expression must be unchanged. Something must offset the rise in the money stock. The only variable free to move is e_t and it obviously must increase. The intuition is straightforward: to restore money market equilibrium the opportunity cost of holding domestic money must fall so that money demand can increase. But domestic interest rates cannot change because of perfect capital mobility. The only thing that can change is the exchange rate. If the dollar is expected to rise in value the cost of holding it obviously falls. But how can people expect the dollar to rise in value when they know that a monetary expansion is causing the exchange rate to rise from e_0 to e^*? The only way is for the dollar to depreciate so far at impact such that after that it is expected to appreciate. That happens when e_t jumps to e_1. The cost of holding dollars must fall, and the only way this can happen is if agents expect that $\delta < 0$ so that $i^* + \delta$ can fall. But the only way that agents can rationally expect the exchange rate to depreciate is if the exchange rate immediately jumps above the new full equilibrium value.

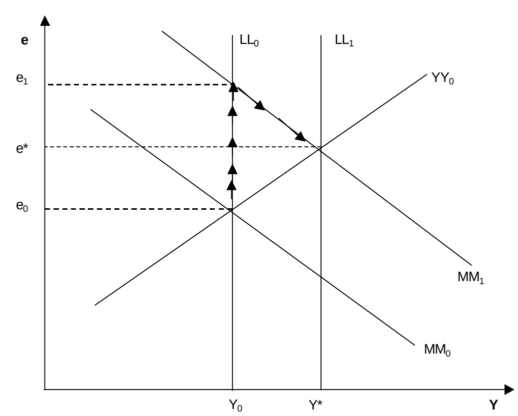

Figure 1: Adjustment of the Exchange Rate to an Unanticipated Monetary Shock

Another way to think about overshooting is to think about the adjustment in income. At impact income is unchanged but over time income will rise to Y^*. That means that money demand will increase as $Y \longrightarrow Y^*$. Because we are considering a one-time change in the money stock, and because that occurs before Y rises, this would create an excess demand for money. To keep the money market in equilibrium as Y rises the increase in money demand must be offset. Hence, the interest rate must be rising along the adjustment path to the new equilibrium. How can this happen if interest rates are tied to world interest rates? Only if people expect the dollar to rise in value. But how can the dollar rise in value when we know it is going to depreciate as we go from e_0 to e_1? The only way this can happen is the dollar falls so much today that it has to rise in the future.

We can see that arbitrage opportunities would arise if e did not overshoot. In the full equilibrium we know that $\delta = 0$ and that $i = i^*$. Because $e^* > e_0$, no overshooting would imply that the exchange rate would appreciate – and the currency depreciate – on the path to the new equilibrium. But if the currency depreciates in value and domestic interest rates equal foreign interest rates why would anyone hold domestic currency? They will dump dollars and buy foreign currency. This will make the exchange rate increase. When will the dumping of domestic currency end? Until agents expect sufficient currency appreciation to make them once again willing to hold domestic currency.

Does this imply that arbitrage profits can be made? On the contrary, it is only when the exchange rate overshoots to e_1 today that there are no arbitrage profits.

The overshooting model thus offers an explanation of why asset prices respond rapidly to new information.

Of course in practice the economy is subject to many shocks, so asset prices fluctuate in the kind of saw-tooth pattern that is characteristic of these markets.

4.2.2. Flexible Price Version

So far overshooting only arises in the fixed-price model. Is overshooting just an artifact of that? Is it only true in Keynesian-type models?

We can easily see that overshooting is independent of the fix-price assumption. To see this, let us assume that PPP holds. We simply assume that output is constant and that prices adjust more slowly than exchange rates. And we use the fact that in the long run exchange rates are proportional to prices.

We begin, as before, with the money market equilibrium condition, expression, $\frac{M}{P} = l(i, y)$. Now from the uncovered interest parity condition we know that

$$i = i^* + \frac{\widehat{e}_{t+1} - e_t}{e_t} \equiv i^* + \delta \tag{9}$$

where $\widehat{e}_{t+1}$ is the expected exchange rate next period. Now we can use the UIPC to substitute for i in the money market equilibrium condition:

$$\frac{M}{P} = l(i^* + \delta, y) \tag{10}$$

Notice that in long-run equilibrium $\delta = 0$, because exchange rates are no longer expected to change. But in the short run, when $\delta \neq 0$, this will enable us to see a relationship between P and e. Moreover, for the US we can treat i^* as an exogenous variable: it should be relatively unaffected by our policies.

We need one more assumption to complete the analysis – rational expectations. We assume that agents understand how the economy works, so that there forecasts of future exchange rates coincide with what the model predicts. Hence, if I let $\overline{e}$ be the equilibrium exchange rate, we can assume that $\widehat{e}_{t+1} = \overline{e}$. This gives us an idea of where the economy is headed.

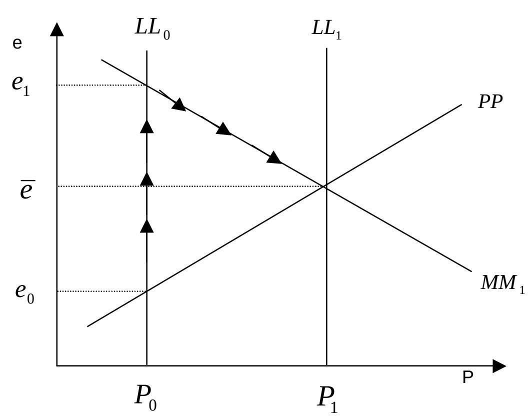

Figure 2: Overshooting

Now consider the relationship between P and e that satisfy expression (10). In the long-run $\delta = 0$, so we have $\frac{M}{P} = l(i^*, y)$; hence, any value of e is consistent with money market equilibrium. We have the LL curve in figure 2. That is what money market equilibrium tells us, but we also know from purchasing power parity condition that the exchange rate is proportional to the price level.[3] We label this relationship PP in figure 2. The intersection of these two curves gives us the long-run equilibrium exchange rate.

What about the short run when $\delta \neq 0$? Notice that if $\delta > 0$ ($e_t < \overline{e}$) this means that money demand decreases. At a given money supply the price level must rise to maintain money market equilibrium. If $\delta < 0$ ($e_t > \overline{e}$) then money demand is higher than in equilibrium so the price level must be lower. Hence, we observe a negative relationship between the spot exchange rate and the price level that maintains money market equilibrium. Of course we could have just as clearly spoken of P not being at its long-run equilibrium value and ask what must happen to δ. We label the combinations of e_t and P that satisfy (10) in the short run, MM. It should be obvious that in long-run equilibrium LL, MM, and PP intersect at the same combination of e and P.

Now put the parts together. We start at the initial price level and exchange rate (e_o, P_0). Now suppose that the money supply is increased. In the long-run prices will rise proportionately, to P_1. The LL schedule shifts to LL_1. Given purchasing power parity the exchange rate in the new equilibrium will be higher – the dollar depreciates due to the monetary expansion. The new long-run equilibrium exchange rate is given by $\overline{e}$. But prices do not, in fact, adjust instantaneously. When the money supply increases prices are given. The only way to satisfy money market clearing is with decreased money demand. Given that output is fixed this can only occur if people expect exchange rate depreciation ($\delta < 0$). But $e_0 < \overline{e}$, so this is clearly not satisfied. The exchange rate must rise immediately, in fact it must overshoot the long-run equilibrium increase so that $\delta < 0$. This is evident from the MM schedule. The exchange rate appreciated immediately to e_1, and then as prices increase it depreciates to the long run

[3] Recall that PPP is the assumption that the real exchange rate is constant, so that movements in spot exchange rate reflect movements in relative price levels. Hence, if P^* is the price in euroland, then $e = \frac{P}{P^*}$. Thus with foreign prices taken as given, e is proportional to P.

value. We get the familiar (by now) overshooting shape.

Why does the exchange rate overshoot? This follows, once again, from the assumptions about adjustment speed. Notice that a monetary expansion means that at unchanged prices there is an excess supply of money. To restore money market equilibrium the opportunity cost of holding domestic money must fall so that money demand can increase. The only way this can happen is if agents expect that $\delta < 0$ so that $i^* + \delta$ can fall. But the only way that agents can rationally expect the exchange rate to depreciate is if the exchange rate immediately jumps above the new full equilibrium value.

Another way to think about overshooting is to think about the adjustment in prices. At impact the price level is unchanged but over time the price level will rise to P_1. That means that real money demand will decrease as $P \longrightarrow P_1$. Because we are considering a one-time change in the money stock, and because that occurs before P rises, this would create an excess demand for money along the adjustment path. To keep the money market in equilibrium as P rises the decrease in money demand must be offset. Hence, the interest rate must be falling along the adjustment path to the new equilibrium. But the money stock is now larger. The only way to get to full equilibrium is if the interest rate first rises sufficiently at impact so that agents will expect depreciation.

We can see that arbitrage opportunities would arise if e did not overshoot. In the full equilibrium we know that $\delta = 0$ and that $i = i^*$. Because $\overline{e} > e_0$, no overshooting would imply that the exchange rate would appreciate – and the currency depreciate – on the path to the new equilibrium. But if the currency depreciates in value and domestic interest rates equal foreign interest rates why would anyone hold domestic currency? They will dump dollars and buy foreign currency. This will make the exchange rate increase. When will the dumping of domestic currency end? Until agents expect sufficient currency appreciation to make them once again willing to hold domestic currency.

The overshooting model thus offers an explanation of why asset prices respond rapidly to new information.

Of course in practice the economy is subject to many shocks, so asset prices fluctuate in the kind of saw-tooth pattern that is characteristic of these markets.

4.3. Anticipated Policies

An interesting feature of the overshooting model is that **anticipated** policies have immediate effects. Consider an announcement that the money stock will be increased next period. This will cause an appreciation of the exchange rate and a rise in income in the new full equilibrium. At impact, however, output has not yet risen. So asset prices feel the full brunt of the change in anticipations. Notice that the expected exchange rate increases as in the case of an unexpected increase in the money stock. So the MM curve shifts up, and the current exchange rate overshoots the full equilibrium adjustment.

What is interesting about this case is that the exchange rate increases **before** the money supply rises. The market **anticipates** the effect. Notice further that with the exchange rate appreciated income starts to rise even before the money supply increases. This makes sense because agents anticipate the effect. In practice, investment would increase in anticipation of the rise in income, though in our model investment depends only on the interest rate. The reason why income rises in our model is the real exchange rate appreciation which makes the economy more competitive. When the money stock does finally increase there is no discontinuous effect on the exchange rate, because that has already been **absorbed** in the price.

Of course in practice anticipated policies are not fully believed. We may expect the money supply to rise, but only probabilistically. A still relatively simple case would be a 50-50 bet that the money supply will increase. Let π be the probability that it rises, so that the exchange rate would be $\widetilde{e}_1$. Then with probability $1-\pi$ the exchange rate would stay at $\widetilde{e}_0$. In that case the expected exchange rate will be $E(\widetilde{e}) = \pi\widetilde{e}_1 + (1-\pi)\widetilde{e}_2$. Hence, the MM curve would shift up only half way. Then once the uncertainty is resolved (the Fed raises the money stock or does not), the MM curve either shifts up again or down.

The key point is that asset prices move when there is news, or new information. Not on old information.

4.3.1. Speculative Bubbles

The role of expectations makes it apparent how a bubble can arise in asset markets. A bubble is a situation where asset prices move because they are expected to move. That is not the same thing as anticipated policies (discussed in section 4.3.). In that case the asset price is following fundamentals; the fact that the change has not yet occurred yet does not mean that expectations are not based on fundamentals. In a bubble, on the other hand, the price moves away from fundamentals based solely on expectations of further movements. Expectations become **self-confirming**. You may not think this is possible, but stock market analysts think this way all the time. They argue about market momentum and technical analysis. This is the argument that prices move independent of fundamentals, or expectations thereof.

Can bubbles occur? Our discussion of attitudes towards uncertainty suggests how they can. People over-react to news. But it is a leap from saying that they can happen to the statement that observed episodes were bubbles. It is worth some consideration here.

Economists have discussed several episodes of speculative bubbles: Tulipmania,[4] South Sea Bubble, the dollar in 1985. Now we all talk about the telecoms bubble. Consider, for example, figure 3 which shows the US price-earnings ratio relative to profits. One can clearly see that prices rose relative to profits dramatically in the 1990's, totally out of line with previous experience.[5]

Despite the apparent evidence, Peter Garber has argued that many so-called bubble episodes have not been properly interpreted. In Tulipmania, for example, a Semper August bulb sold for 2000 guilders in 1625, an amount of gold worth \$16,000 at \$400/oz.[6] In 1636 prices rose speculation ensued and then prices collapsed. So goes the story. According

[4] Though Garber has argued that Tulipmania was not in fact a speculative bubble.

[5] This is taken to be evidence of a bubble. But it could reflect a structural change. Perhaps a change in tax treatment, or a shift in the regulatory regime that reduces future downturns. Or the new economy.

[6] The price of one special, rare type of tulip bulb called Semper Augustus was 1000 guilders in 1623, 1200 guilders in 1624, 2000 guilders in 1625, and 5500 guilders in 1637 (equal to current (1990) US\$ 50.000 in gold). Another bulb was sold in February 1637 for 6700 guilders. On these price levels one single tulip bulb could cost as much as a house on Amsterdam's smartest canal, including coach and garden. The average annual income at the time was only 150 guilders. After the "crash" prices are said to have fallen to less than 10 percent of their peak values and by 1739 prices had fallen to 1/200 of the peak price. Clearly, such price movements are in line with a bubble hypothesis: start low, reach high, end low.

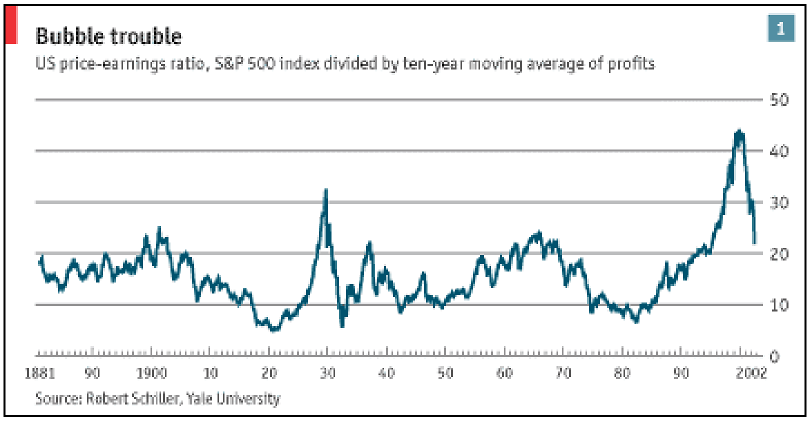

Figure 3: Price Earnings Ratio

to the chronicles, in 1637 prices collapsed and bulbs could not be sold for more than 10% of their value. Stories of sailors eating a $10,000 bulb is used as evidence of the mania, or that of four oxen and 1000 pounds of cheese being exchanged for one bulb. Explaining the tulip price puzzle actually requires that 3 entirely different components be dealt with.

1. High Prices Paid For Some "Rare" Tulips Bulbs

2. Price Patterns For "Rare" Bulbs (e.g. Semper Augustus, 1623-1739)

3. Price Patterns For "Common" Bulbs (i.e. January-February 1637)

As to the rare bulbs, these are luxury items. Newly introduced their prices may be very high. The "luxury good" explanation of tulip prices is based on tulips being scarce, on there being only limited quantities of a very much desired good/product. Garber (1990) points out that at the time, tulips were subject to a mosaic virus whose effect ("breaking") was to produce remarkable patterns on the flower (today this tulip mosaic virus no longer exists). Tulips can propagate either through seeds or through outgrowths or buds on the mother bulb. The valued mosaic pattern, however, cannot be reproduced through the much more easy seed propagation, but can only be reproduced by cultivating the buds from the original bulb. The size of the original bulb determines the number of outgrowths and therefore its value. The outgrowths are not ready to flower themselves until after a period of approximately 3 years.

Every common bulb could "break" at some unknown time and with unknown patterns. Tulips changed from one season to another.

As for the second point here, it must be noted that the prices quoted for were futures contracts on bulbs. These contracts were not legal – the government would not enforce them – but if the trades were profitable nobody cared. There were no margin requirements and no marking to market. So little wealth was needed to speculate here. But when prices really exploded they could be bought out for 10%. So if the price fell by 10%, say from 100 to 90, by paying 10 you could buy out of the contract. This is not a 90% fall in the price, but a 10% fall.

Notice, in fact, that this is really not a futures contract at all, but an option. The strike price is 100 you pay 10 for it. Suppose the expected price is 50. If there is some chance that the price may rise – volatility – you may purchase this option. A price of 10 may not be too high for this bet. But if this is an option, then 100 surely is not the actual price people were paying, or even expecting. It was the strike price of an out of the money option.

Most of the stories about expensive tulips turn out to be false,[7]. As for the common bulbs Garber offers a plausible explanation: From 1635-1637 a bubonic plague epidemic ravaged the Netherlands, killing 10-30 percent of the population in cities such as Amsterdam, Leiden, Haarlem. It appears reasonable that common people regarded tulip speculation in the same way as they do today a million-dollar lottery: an opportunity to become rich instantly and gain the opportunity to escape the drudgery of daily live (i.e. death from the bubonic plague). A "rational gambling" theory suggests that even uncertain projects with negative expected monetary values can be positively priced when one positive outcome is sufficiently extreme to be on an entirely different utility curve (effectively creating a quasi-convex utility function). The lottery was made possible by the market system: no margin requirement, no marking to market.

The basic argument here is that one should be very careful about the history. It seems

[7] Rhetorical arguments in pamphlets became facts in subsequent re-tellings. There was no such sailor. After all, what type of merchant would leave a $10,000 tulip sitting on a table?

quite logical that a tulip as expensive as a house must be the sign of hysteria. What else could it be? But there may be a fundamental explanation.

A modern manifestation of Tulipmania could be derived from a report on the Economist (January 22, 2000, p.57), which reported that a resident of Cuba paid $4,300 for a 25-year-old American car. The car was in deplorable condition, had windows that would not close and doors that wouldn't open in a normal fashion. In the USA such a car would be worth less than its weight in scrap metal. The average wage in Cuba equals around $10 a month. It seems that Cubans are quite happy to spend many years' salary on an obviously worthless commodity. Perhaps in twenty years time some clever historian will report that Cubans of the 1990's must be considered to have been quite mad and irrational. Obviously, there is a clear fundamental explanation that has a lot to do with the shortage of autos.

Garber also argues that fundamentals may have driven the prices.[8] He notes that even to this day new, rare bulbs fetch high prices, and then they decline over time. Similarly Garber argues that the South Sea Bubble and the Mississippi Company of John Law may also have been driven by fundamentals. Both of the latter companies sold equity to buy up low-grade government debt. They then invested in the colonies of the state and in various government granted monopoly activities. They were state-related finance companies and government officials were closely tied to them. Perhaps there were expected returns to such colonial investments that justified the high prices. The collapses, it seems arose from fundamental shocks too: the King sold his shares in the Mississippi company, for example. With government support missing expectations ought to change.[9]

What Garber does is argue that there are potential fundamental explanations that would justify high valuations. If earnings projections turned out correct prices would be justified and there is no bubble. But if expectations are rational why don't we ever observe periods

[8] In fact, he found evidence of a fundamental shock: In France, it became fashionable for women to wear quantities of fresh tulips at the top of their gowns, and men competed to present the most exotic flowers. In fact, there is evidence that a single flower of a particular broken tulip was sold for 1000 guilders in Paris – but this was final demand, it was purchased as a consumption good.

[9] A fad explanation also suffers from the fact that the explosion in the South Sea company's shares from £350 to £750 occurs just as the Mississippi Company's shares are collapsing by 50%.

when above book value prices are followed by huge earning growth? Why are investors **always** unlucky?

Supposing that there is evidence of a bubble in asset prices we want to ask how can such self-confirming equilibria occur? One answer, of course, is given in the terminology often used: **mania, fad, panic**, etc. And perhaps we should just take a psychological view. But given that these are financial markets and people have a lot of money invested here we want a bit more. It turns out that we can explain a **rational bubble.**

Think of an asset price, e_t, and suppose that fundamentals suggest that the exchange rate should be e^* for all t. At some time t_0 the exchange rate jumps to e_0 as in figure 4. Now suppose further that agents expect that the value of the dollar will increase at the rate $1+r$ in each period. For example, suppose $b_t = b_0(1+r)^t$ for arbitrary b_0. In other words, the price of domestic currency is increasing exponentially. Why are agents willing to pay increasing prices for the dollar? The price is growing each period due to expectations of future price growth. The expected capital gains are self-fulfilling – this is a rational bubble. The price of the asset bears no relation to fundamentals. It is the anticipation of never-ending appreciation of the price of the asset that keeps the bubble from bursting. The anticipation of ever-increasing prices is self-fulfilling and it satisfies the arbitrage condition: the capital gain on holding dollars compensates for the alternative returns. Of course, for this to occur the price will have to grow forever. If everyone knew that at period $T+j$ that the bubble would burst ($e \to e^*$ or $b_t \to 0$) then no one would pay the bubble price at $T+j-1$. The bubble unravels.

People are not idiots. They know that the price cannot literally increase forever. Bubbles can still arise, however, as long as expected price growth compensates for the capital loss that occurs when the bubble bursts. Suppose then that in each period agents believe that the probability that the bubble will not burst is q. Then we have:

$$b_{t+1} = \begin{cases} \frac{(1+r)b_t}{q} + \varepsilon_{t+1} & \text{with probability } q \\ \varepsilon_{t+1} & \text{with probability } 1-q \end{cases} \qquad (11)$$

where ε_{t+1} is a white noise error, with mean 0. If the bubble follows this path it is rational.

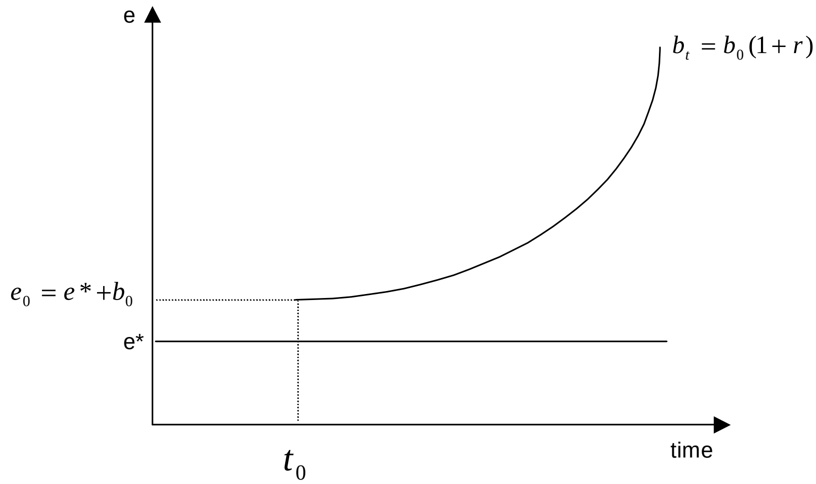

Figure 4: A bubble in the exchange rate

The reason is that the expected value of the bubble in period $T+1$ is exactly b_{t+1}. To see this, note that $E_t[b_{t+1}] = q\frac{(1+r)b_t}{q} + (1-q)(0) = (1+r)b_t$, which is our initial expression for the bubble path. The bubble continues with probability q, and it bursts with probability $1-q$. If it bursts, it returns in expected value to zero. Notice that this means that the bubble must grow faster (since $q < 1$) than it would in the previous example, because investors must be compensated for the risk of the bubble bursting. It is precisely this sort of reasoning that people used to think about the value of the dollar prior to the Plaza meeting of 1985.

Indeed, if the bubble is rational you can back out the market's expectation of it bursting. At any t you know the actual price and the interest rate. If you know the fundamental price (e.g., e_0) then you can use the fact that if the bubble has not burst $b_{t+1} = \frac{(1+r)b_t}{q}$ so that

$$q = \frac{(1+r)b_t}{b_{t+1}}.$$

This notion of a rational bubble is used frequently in analysis of asset markets. The path of the dollar, in particular, was thought by many to be on a bubble path in the mid- 80's. The reason was that fundamentals such as the balance of trade, interest differentials, and other determinants of exchange rates did not seem to explain the movements of the dollar. It seemed higher than could be explained by fundamentals.

4.3.2. Why this is important

Understanding bubbles is important for many reasons, but for our purposes the most important one is that many financial crises seem to be associated with bubbles in asset prices. These seem to follow financial liberalization, and is especially critical in emerging markets.

One explanation of these phenomena points to the fact that much investment in asset prices is financed by debt. If the ultimate source of funds cannot observe the riskiness of the investment then there is a classic risk-shifting situation. The borrower has an incentive to take excessive risks, as limited liability limits the downside risk (moral hazard). The agent captures most of the gain of successful investments but losses are limited. This causes the bubble. When credit is cheap the financing of the bubble is greater.