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Interlinkages*

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Asset Price Bubbles and Stock Market Interlinkages¹

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Abstract

The effect of stock market interlinkages on asset price bubbles are considered. Bubbles can occur when there is an agency problem between banks and the people they lend money to because the banks cannot observe how the funds are invested. This causes a risk shifting problem and asset prices are bid up above their fundamental. The greater is uncertainty about asset returns or about the amount of aggregate credit the greater is the bubble. Stock market interlinkages can moderate or exacerbate asset price bubbles.

1 Introduction

Stock market interlinkages have played an important role in the formation and collapse of bubbles from early times. For example, Carswell (1960) describes the links between the 1719 bubble in the stock of the Mississippi Company in Paris and the 1720 bubble in the stock of the South Sea Company in London. There were significant flows between the financial centers as these bubbles inflated and burst. Similarly, there were also flows between London and Paris and other financial centers in Europe such as Amsterdam and asset price movements were interdependent.

In more recent times stock market interlinkages also appear to play an important role in asset price bubbles. Higgins and Osler (1997) consider 18 OECD countries and document a significant simultaneous rise in real estate and stock prices during the period 1984-89. These prices subsequently fell during the period 1989-1993. Regression results indicate a 10 percent increase in real residential real estate prices above the OECD average in 1984-1989 was associated with an 8 percent steeper fall than average in 1989-1993. Similarly, for equities a 10 percent increase above the average in the earlier period is associated with a 5 percent steeper fall in the later period. Higgins and Osler interpret this as suggestive of the existence of bubbles. Investment and real activity were also sharply curtailed during the latter period. The fact that the rises and falls occurred during the same period suggests interlinkages may play a significant role.

The purpose of this paper is to investigate the effect of stock market interlinkages on asset price bubbles. The theory of bubbles the analysis is based on was developed in Allen and Gale (2000, 2002). Standard theories of asset pricing assume that investors purchase assets with their own wealth. In most financial systems, this is not the whole story. Intermediation is important. Many of the agents buying real estate, stocks, and other assets do so with other people's money. The purchase of real estate is usually debt financed. If the investment is successful, the borrower repays the loan and retains the difference between the value of the asset and the principal and interest. If the investment is unsuccessful, the borrower has limited liability and the lender bears the shortfall. Similarly, a large proportion of stocks are held by mutual funds, pension funds, and insurance companies. Money managers also have incentives to take risk. If their investment strategy is successful, they may be rewarded by a share of the returns, but most importantly they will attract new investors in the future. Because they

receive management fees in proportion to the assets under their control, they will be significantly better off as a result of their good performance. If the investment strategy is unsuccessful, there is a limit to the downside risk that the manager bears. In the worst case, she will be fired but in any case her liability is limited. Thus, when intermediaries make investment decisions, the incentive scheme they face has convex payoffs.

The agency problem of excessive risk taking associated with limited liability is crucial for the analysis presented below. If the penalties for default on debt or the reputational loss from being fired from an intermediary are sufficiently high then there will not be an incentive to take risks. Hence the theory can be thought of as applying to cases where these factors are insufficient to prevent risk taking.

If there is an agency problem of the type described the people making the investment decisions will have an incentive to take on risky projects. The fact that lenders are unable to observe the characteristics of a project means the borrowers can shift risk to the lenders and increase the payoff to themselves. This causes investors to bid up the prices of risky assets above their fundamental values and there is a bubble. The more risky the asset the greater is the amount that can be shifted and the larger the bubble. This risk can come from two sources. The first is asset return risk. The second is financial risk. This is the risk associated with future financial conditions such as the amount of credit that will be available.

It is shown that stock market interlinkages can play an important role in the evolution of these bubbles. The effect depends on the source of the risk that underlies the bubble. Suppose two countries with differing amounts of financial risk are linked together. The impact of the interlinkage is to reduce the bubble in the country with the larger degree of uncertainty and the higher asset prices. In the country with less uncertainty and lower asset prices the effect is to increase the bubble. The effect of the stock market interlinkages is thus to reduce the dispersion of asset prices. However, when the difference is due to riskiness in asset payoffs the effect of introducing the interlinkage is the opposite. In this case the high asset price is increased further and the low asset price is reduced. Thus links can ameliorate or exacerbate the extent of asset price bubbles.

2 Bubbles and Agency Problems

In many recent cases where asset prices have risen and then collapsed dramatically an expansion in credit following financial liberalization appears to have been an important factor. Perhaps the best known example of this type of phenomenon is the dramatic rise in real estate and stock prices that occurred in Japan in the late 1980's and their subsequent collapse in 1990. Financial liberalization throughout the 1980's and the desire to support the United States dollar in the latter part of the decade led to an expansion in credit. During most of the 1980's asset prices rose steadily, eventually reaching very high levels. For example, the Nikkei 225 index was around 10,000 in 1985. On December 19, 1989 it reached a peak of 38,916. A new Governor of the Bank of Japan, less concerned with supporting the US dollar and more concerned with fighting inflation, tightened monetary policy and this led to a sharp increase in interest rates in early 1990 (see Frankel, 1993; Tschoegl, 1993). The bubble burst. The Nikkei 225 fell sharply during the first part of the year and by October 1, 1990 it had sunk to 20,222. Real estate prices followed a similar pattern. The next few years were marked by defaults and retrenchment in the financial system. The real economy was adversely affected by the aftermath of the bubble and growth rates during the 1990's have mostly been slightly positive or negative, in contrast to most of the post war period when they were much higher.

Similar events occurred in Norway, Finland and Sweden in the 1980's (see Heiskanen (1993) and Drees and Pazarbasioglu (1995)). In Norway the ratio of bank loans to nominal GDP went from 40 percent in 1984 to 68 percent in 1988. Asset prices soared while investment and consumption also increased significantly. The collapse in oil prices helped burst the bubble and caused the most severe banking crisis and recession since the war. In Finland an expansionary budget in 1987 resulted in massive credit expansion. The ratio of bank loans to nominal GDP increased from 55 percent in 1984 to 90 percent in 1990. Housing prices rose by a total of 68 percent in 1987 and 1988. In 1989 the central bank increased interest rates and imposed reserve requirements to moderate credit expansion. In 1990 and 1991 the economic situation was exacerbated by a fall in trade with the Soviet Union. Asset prices collapsed, banks had to be supported by the government and GDP shrank by 7 percent. In Sweden a steady credit expansion through the late 1980's led to a property boom. In the fall of 1990 credit was tightened and interest rates rose. In 1991 a number of banks had severe difficulties because

of lending based on inflated asset values. The government had to intervene and a severe recession followed.

Mexico provides a dramatic illustration of an emerging economy affected by this type of problem. In the early 1990's the banks were privatized and a financial liberalization occurred. Perhaps most significantly, reserve requirements were eliminated. Mishkin (1997) documents how bank credit to private nonfinancial enterprises went from a level of around 10 percent of GDP in the late 1980's to 40 percent of GDP in 1994. The stock market rose significantly during the early 1990's. In 1994 the Colosio assassination and the uprising in Chiapas triggered the collapse of the bubble. The prices of stocks and other assets fell and banking and foreign exchange crises occurred. These were followed by a severe recession.

How can bubbles and ensuing crashes such as those in Japan, Scandinavia and Mexico be understood? The typical sequence of events in such crises is as follows.

There is initially a financial liberalization of some sort and this leads to a significant expansion in credit. Bank lending increases by a significant amount. Some of this lending finances new investment but much of it is used to buy assets in fixed supply such as real estate and stocks. Since the supply of these assets is fixed the prices rise above their "fundamentals". Practical problems in short selling such assets prevents the prices from being bid down as standard theory suggests. The process continues until there is some real event that means payoffs on the assets will be low in the future. Another possibility is that the central bank is forced to restrict credit because of fears of "overheating" and inflation. The result of one or both of these events is that the prices of real estate and stocks collapse. A banking crisis results because assets valued at "bubble" prices were used as collateral. There may be a foreign exchange crisis as investors pull out their funds and the central bank chooses between trying to ease the banking crisis or protect the exchange rate. The crises spill over to the real economy and there is a recession.

In the popular press and academic papers, these bubbles and crises are often related to the particular features of the country involved. However, the fact that a similar sequence of events can occur in such widely differing countries as Japan, Norway, Finland, Sweden and Mexico suggest such bubbles and crashes are a general phenomenon.

How can this phenomenon be understood? The crucial issues we will focus on below are:

- (i) What initiates a bubble?
- (ii) What is the role of the banking system?
- (iii) What causes a bubble to burst?

3 The Risk Shifting Problem

A simple example is developed to illustrate the model in Allen and Gale (2000).¹ They develop a theory based on rational behavior to try and provide some insight into these issues. Standard models of asset pricing assume people invest with their own money. We identify the price of an asset in this benchmark case as the “fundamental”. A bubble is said to occur when the price of an asset rises above this benchmark.² If the people making investment decisions borrow money then because of default they are only interested in the upper part of the distribution of payoffs of the risky asset. As a result there is a risk shifting problem and the price of the risky asset is bid up above the benchmark so there is a bubble.

In the example the people who make investment decisions do so with borrowed money. If they default there is limited liability. Lenders cannot observe the riskiness of the projects invested in so there is an agency problem. For the case of real estate this representation of the agency problem is directly applicable. For the case of stocks there are margin limits that prevent people directly borrowing and investing in the asset. However, a more appropriate interpretation in this case is that it is institutional investors making the investment decisions. This group constitutes a large part of the market in many countries. The agency problem that occurs is similar to that with a debt contract. First, the people that supply the funds have little control over how they are invested. Second, the reward structure is similar to what happens with a debt contract. If the assets the fund managers invest in do well, the managers attract more funds in the future and receive higher payments as a result. If the assets do badly there is a limit to the penalty that is imposed on the managers. The worse that can happen is that they are fired. This is analogous to limited liability (see Allen and Gorton (1993)).

Initially there are two dates $t = 1, 2$. There are two assets in the example.

¹For ease of exposition the example is slightly different from the model presented in the paper.

²See Allen, Morris and Postlewaite (1993) for a discussion of the definition of fundamental and bubble.

The first is a safe asset in variable supply. For each 1 unit invested in this asset at date 1 the output is 1.5 at date 2. The second is a risky asset in fixed supply that can be thought of as real estate or stocks. There is 1 unit of this risky asset. For each unit purchased at price P at date 1 the output is 6 with prob. 0.25 and 1 with prob. 0.75 at date 2 so the expected payoff is 2.25. The details of the two assets are given in the table below.

Table 1			
Asset	Supply	Investment at date 1	Payoff at date 2
Safe	Variable	1	1.5
Risky	1	P	$R = \begin{cases} 6 & \text{with prob. } 0.25 \\ 1 & \text{with prob. } 0.75 \end{cases}$ $ER = 2.25$

All agents in the model are assumed to be risk neutral.

3.1 The Fundamental

Suppose each investor has wealth 1 initially and invests her own wealth directly. Since everybody is risk neutral the marginal returns on the two assets must be equated.

$$\frac{2.25}{P_F} = \frac{1.5}{1}$$

or

$$P_F = \frac{2.25}{1.5} = 1.5.$$

The value of the asset is simply the discounted present value of the payoff where the discount rate is the opportunity cost of the investor. This is the classic definition of the fundamental. The benchmark value of the asset is thus 1.5 and any price above this is termed a bubble.

3.2 Intermediated Case

Suppose next that investors have no wealth of their own. They can borrow to buy assets at a rate of $33\frac{1}{3}$ percent. The most they can borrow is 1. If they borrow 1 they repay 1.33 if they are able to. If they are unable to pay this

much the lender can claim whatever they have. As explained above lenders can't observe how loans are invested and this leads to an agency problem.

The first issue is can $P = 1.5$ be the equilibrium price?

Consider what happens if an investor borrows 1 and invests in the safe asset.

$$\begin{aligned}\text{Marginal return safe asset} &= 1.5 - 1.33 \\ &= 0.17\end{aligned}$$

Suppose instead that she borrows 1 and invests in the risky asset. She purchases $1/1.5$ units. When the payoff is 6 she repays the principal and interest of 1.33 and keeps what remains. When it is 1 she defaults and the entire payoff goes to the lender so she receives 0.

$$\begin{aligned}\text{Marginal return risky asset} &= 0.25 \left(\frac{1}{1.5} \times 6 - 1.33 \right) + 0.75 \times 0 \\ &= 0.25(4 - 1.33) \\ &= 0.67\end{aligned}$$

The risky asset is clearly preferred when $P = 1.5$ since $0.67 > 0.17$. The expected payoff of 1.5 on the investment in 1 unit of the safe asset is the same as on the investment of $1/1.5$ units of the risky asset. The risky asset is more attractive to the borrower though. With the safe asset the borrower obtains 0.17 and the lender obtains 1.33. With the risky asset the borrower obtains 0.67 while the lender obtains $0.25 \times 1.33 + 0.75 \times 1 \times (1/1.5) = 1.5 - 0.67 = 0.83$. The risk of default allows 0.5 in expected value to be shifted from the lender to the borrower. This is the risk shifting problem. If the lender could prevent the borrower from investing in the risky asset he would do so but he cannot since this is unobservable.

What is the equilibrium price of the risky asset given this agency problem?

In an equilibrium where the safe asset is used, the price of the risky asset, P , will be bid up since it is in fixed supply, until the expected profit of borrowers is the same for both the risky and the safe asset:

$$0.25 \left(\frac{1}{P} \times 6 - 1.33 \right) + 0.75 \times 0 = 1.5 - 1.33$$

so

$$P = 3.$$

There is a bubble with the price of the risky asset above the benchmark of 1.5.

The idea that there is a risk shifting problem when the lender is unable to observe how the borrower invests the funds is not new (see, e.g., Jensen and Meckling (1976) and Stiglitz and Weiss (1981)). However, it has not been widely applied in the asset pricing literature. Instead of the standard result in corporate finance textbooks that debt-financed firms are willing to accept negative net present value investments, the manifestation of the agency problem here is that the debt-financed investors are willing to invest in assets priced above their fundamental.

The amount of risk that is shifted depends on how risky the asset is. The greater the risk the greater the potential to shift risk and hence the higher the price will be. To illustrate this consider the previous example but suppose the payoff on the risky asset is a mean-preserving spread of the original payoffs.

Table 2

Asset	Supply	Investment at date 1	Payoff at date 2
Risky	1	P	$R = \begin{cases} 9 & \text{with prob. } 0.25 \\ 0 & \text{with prob. } 0.75 \end{cases}$ $ER = 2.25$

Now the price of the risky asset is given by

$$0.25 \left(\frac{1}{P} \times 9 - 1.33 \right) + 0.75 \times 0 = 1.5 - 1.33$$

so

$$P = 4.5.$$

More risk is shifted and as a result the price of the risky asset is bid up to an even higher level.

It is interesting to note that in both the stock market boom of the 1920's and the one in the 1990's the stocks that did best were "high-tech" stocks. In the 1920's it was radio stocks and utilities that were the star performers

(see White (1990)). In the 1990's it was telecommunications, media and entertainment and technology stocks that did the best. It is precisely these stocks which have the most uncertain payoffs because of the nature of the business they are in.

One of the crucial issues is why the banks are willing to lend to the investors given the chance of default. To see this consider again the case where the payoffs on the risky asset are those in Table 1 and $P = 3$. In this case the quantity of the risky asset purchased when somebody borrows 1 is $1/P = 1/3$. In the equilibria considered above the investors are indifferent between investing in the safe and risky asset. Suppose for the sake of illustration the fixed supply of the risky asset is $4/3$. The amount of funds depositors have is 10 and the number of borrowers is 10. In the equilibrium where $P = 3$, 4 of the borrowers invest in the risky asset and 6 in the safe in order for the fixed supply of $4/3$ units of the risky asset to be taken up. In this case 40 percent of borrowers are in risky assets and 60 percent are in safe assets. A bank's expected payoff from lending one unit is then given by the following expression.

$$\begin{aligned} \text{Bank's Expected Payoff} &= 0.4[0.25 \times 1.33 + 0.75 \times (1/3) \times 1] + 0.6[1.33] \\ &= 1.03. \end{aligned}$$

The first term is the payoff to the bank from the 40 percent of investors in the risky asset. If the payoff is 6, which occurs with probability 0.25, the loan and interest is repaid in full. If the payoff is 1 which occurs with probability 0.75, the borrower defaults and the bank receives the entire proceeds from the $1/3$ unit owned by the borrower. The payoff is thus $(1/3) \times 1$. The 60 percent of investors in the safe asset are able to pay off their loan and interest of 1.33 in full.

If the banking sector is competitive the receipts from lending, 1.03, will be paid out to depositors. In this case it is the depositors that bear the cost of the agency problem. In order for this allocation to be feasible markets must be *segmented*. The depositors and the banks must not have access to the assets that the investors who borrow invest in. Clearly if they did they would be better off to just invest in the safe asset rather than put their money in the bank or lend to the investors.

4 Credit and Interest Rate Determination

The quantity of credit and the interest rate have so far been taken as exogenous. These factors are incorporated in the example next to illustrate the relationship between the amount of credit and the level of interest rates. We start with the simplest case where the central bank determines the aggregate amount of credit B available to banks. It does this by setting reserve requirements and determining the amount of assets available for use as reserves. For ease of exposition we do not fully model this process and simply assume the central bank sets B . The banking sector is competitive. The number of banks is normalized at 1 and the number of investors is also normalized to 1. Each investor will therefore be able to borrow B from each bank.

The safe asset pays a fixed return r to the investor: if x is invested in the safe asset at date 1 the return is rx at date 2. The safe asset can be interpreted in a number of ways. One possibility is that it is debt issued by the corporate sector. Another possibility is that it is capital goods which are leased to the corporate sector. The investors treat the rate of return as fixed because they are small relative to the size of the corporate sector. In equilibrium, competition will ensure that the rate of return on the bonds or the capital goods leased to the corporate sector is equal to the marginal product of capital.

The return on the safe asset is determined by the marginal product of capital in the economy. This in turn depends on the amount of the consumption good x that is invested at date 1 in the economy's productive technology to produce $f(x)$ units at date 2. The total amount that can be invested is B and the amount that is invested at date 1 in the risky asset since there is 1 unit is P . Hence the date 1 budget constraint implies that

$$x = B - P.$$

It is assumed

$$f(x) = 3(B - P)^{0.5}. \quad (1)$$

Provided the market for loans is competitive the interest rate r will be bid up by investors until

$$r = f'(B - P) = 1.5(B - P)^{-0.5}. \quad (2)$$

At this level the safe asset will not yield any profits for investors. If it was lower than this there would be an infinite demand for the safe asset and if it was higher than this there would be zero demand.

The amount the investors will be prepared to pay for the risky asset assuming its payoffs are as in Table 1 is then given by

$$0.25 \left(\frac{1}{P} \times 6 - r \right) + 0.75 \times 0 = 0.$$

Using (2) in this,

$$P = 4(B - P)^{0.5}.$$

Solving for P gives

$$P = 8(-1 + \sqrt{1 + 0.25B}). \quad (3)$$

When $B = 5$ then $P = 4$ and $r = 1.5$. The relationship between P and B is shown by the solid line in Figure 1. By controlling the amount of credit the central bank controls the level of interest rates and the level of asset prices. Note that this relationship is different from that in the standard asset pricing model when the price of the risky asset is the discounted expected payoff.

$$P_F = \frac{2.25}{r}.$$

This case is illustrated by the dotted line in Figure 1. A comparison of the two cases shows that the fundamental is relatively insensitive to the amount of credit compared to the case where there is an agency problem. Changes in aggregate credit can cause relatively large changes in asset prices when there is an agency problem.

5 Financial Risk

The previous section assumed that the central bank could determine the amount of credit B . In practice the central bank has limited ability to control the amount of credit and this means B is random. In addition there may be changes of policy preferences, changes of administration, and changes in the external environment which create further uncertainty about the level of B . This uncertainty is particularly great in countries undergoing financial liberalization. In order to investigate the effect of this uncertainty an extra period is added to the model. Between dates 1 and 2 everything is the same as before. Between dates 0 and 1 the only uncertainty that is resolved is about the level of B at date 1. Thus between dates 0 and 1 there is *financial uncertainty*. The uncertainty about aggregate credit B at date 1 causes

uncertainty about prices at date 1. Given that investors are borrowing from banks at date 0 in the same way as before this price uncertainty again leads to an agency problem and risk shifting. The price of the risky asset at date 0 will reflect this price uncertainty and can lead the asset price to be even higher than at date 1.

Suppose that there is a 0.5 probability that $B = 5$ and a 0.5 probability that $B = 7$ at date 1. Then using (2) and (3) the prices and interest rates are as shown in Table 3.

Table 3

Probability	B	P	r
0.5	5	4	1.5
0.5	7	5.27	1.14

The pricing equation at date 0 is

$$0.5 \left(\frac{1}{P_0} \times 5.27 - r_0 \right) + 0.5 \times 0 = 0,$$

where r_0 , the date 0 interest rate, is given by (2) with B and P replaced by B_0 and P_0 . Substituting for r_0 and simplifying

$$P_0 = \frac{5.27}{1.5} (B_0 - P_0)^{0.5}.$$

Taking $B_0 = 6$ and solving for r_0 and P_0 gives

$$\begin{aligned} r_0 &= 1.19 \\ P_0 &= 4.42. \end{aligned}$$

As when the uncertainty is due to variations in asset payoffs, the greater the financial uncertainty the greater is P_0 . Consider a mean preserving spread on the financial uncertainty so that Table 3 is replaced by Table 4.

Table 4

Probability	B	P	r
0.5	4	3.14	1.81
0.5	8	5.86	1.03

In this case it can be shown

$$\begin{aligned}r_0 &= 1.27 \\ P_0 &= 4.61.\end{aligned}$$

The risk shifting effect operates for financial risk in the same way as it does for asset payoff risk. Although the expected payoff at date 2 is only 2.25 the price of the risky asset at date 1 in the last case is 4.61. The possibility of credit expansion over a period of years may create a great deal of uncertainty about how high the bubble may go and when it may collapse. This is particularly true when economies are undergoing financial liberalization. As more periods are added it is possible for the bubble to become very large. The market price can be much greater than the fundamental.

These examples illustrate that what is important in determining the risky asset's price at date 0 is expectations about aggregate credit at date 1. If aggregate credit goes up then asset prices will be high and default will be avoided. However, if aggregate credit goes down then asset prices will be low and default will occur. The issue here is what is the dynamic path of aggregate credit. The point is that the expectation of credit expansion is already taken into account in the investors' decisions about how much to borrow and how much to pay for the risky asset. If credit expansion is less than expected, or perhaps simply falls short of the highest anticipated levels, the investors may not be able to repay their loans and default occurs. In Allen and Gale (2000) it is shown that even if credit is always expanded then there may still be default. In fact it is shown that there are situations where the amount of credit will be arbitrarily close to the upper bound of what is anticipated and widespread default is almost inevitable.

6 Stock Market Interlinkages

So far we have considered what happens in single countries. We next turn to the case where there are multiple stock markets and interlinkages between them. Initially, we start by investigating the effect of interlinkages between countries with different levels of financial risk and then go on to the case where the countries have different variability in asset payoffs. It turns out that the interlinkages have quite different effects in the two situations.

6.1 Different Levels of Financial Risk

The case considered is where the interest rate is endogenously determined as in Section 5 and there is financial risk due to uncertain levels of credit.

Suppose there are two countries, X and Y. Countries X and Y have the same parameters as those analyzed in Tables 3 and 4, respectively. Country X has a 0.5 probability that $B = 5$ and a 0.5 probability $B = 7$. Country Y has a 0.5 probability that $B = 4$ and a 0.5 probability $B = 8$. Country X thus has lower financial risk than Country Y. The realizations of the amounts of credit in each country are assumed to be independent. The interest rates and prices when the countries are autarchic are as in Section 5. At date 0, they are $r_{X0} = 1.19$ and $P_{X0} = 4.42$ in Country X, and $r_{Y0} = 1.27$ and $P_{Y0} = 4.61$ in Country Y. The low risk country has lower interest rates and prices than the high risk country.

If the two countries have links between the stock markets so they are effectively like one market then interest rates must be equalized. Since both risky assets have the same distribution of payoffs at date 2 they will have the same price as well. The total credit available will be split equally between the countries. Table 5 shows the four possible outcomes at date 1 for prices and interest rates.

Probability	B_X	B_Y	$(B_X + B_Y)$	$(B_X + B_Y)/2$	P	r
0.25	5	4	9	4.5	3.66	1.64
0.25	7	4	11	5.5	4.33	1.39
0.25	5	8	13	6.5	4.96	1.21
0.25	7	8	15	7.5	5.57	1.08

It can be shown in the usual way that if $B_0 = 6$ in each country then

$$\begin{aligned} r_0 &= 1.23 \\ P_0 &= 4.52. \end{aligned}$$

The effect of the interlinkages here is that Country X experiences higher asset prices and interest rates and Country Y lower asset prices and interest rates than before. The effect of interlinkages is to moderate the bubbles. Asset prices lie between those that would occur without the interlinkages. This is due to the fact that the variations in credit across countries are smoothed.

6.2 Differences in Asset Payoffs

Next suppose that Country X is as before. Country Y has the same credit distribution as Country X. Both have a 0.5 probability that $B = 5$ and a 0.5 probability that $B = 7$. The realizations of the level of credit in each country at date 1 are independent. The difference between the countries is now that the payoffs at date 2 on the risky asset in Country Y are now given by Table 2 rather than Table 1. The payoffs on Country Y's assets are more risky than the payoffs Country X's assets.

When Country Y is autarchic it can be shown in the usual way that the price distribution at date 1 is

Table 6			
Probability	B	P	r
0.5	5	4.45	2.02
0.5	7	6	1.5

and at date 0

$$r_{Y0} = 1.29$$

$$P_{Y0} = 4.64.$$

This contrasts with Country X where $r_{X0} = 1.19$ and $P_{X0} = 4.42$. Since the payoffs in Country Y are more variable than in Country X the price of the risky asset is higher. Given $r = f'(B - P)$ if the price is higher the interest rate is also higher since $f'' < 0$.

When stock market interlinkages are introduced the effect is rather different in this case than in the previous example. It can be shown as before that at date 1

Table 7						
Probability	B_X	B_Y	$(B_X + B_Y)/2$	P_X	P_Y	r
0.25	5	5	5	3.42	5.12	1.76
0.25	5	7	6	4	6	1.5
0.25	7	5	6	4	6	1.5
0.25	7	7	7	4.56	6.84	1.31

and at date 0

$$\begin{aligned}r_0 &= 1.25 \\P_{X0} &= 3.65 \\P_{Y0} &= 5.47\end{aligned}$$

Here the effect of introducing stock market interlinkages is to exacerbate the bubble in the country with the high autarchic asset price and reduce it in the other country. At date 1, the higher price in Country Y drives up the interest rate relative to Country X's autarchic allocation and this drives down the price of the risky asset in Country X. Relative to Country Y's autarchic case the interest rate is lower and this drives up the price of the risky asset for Country Y. At date 0 interest rates are again higher for Country X and lower for Country Y and this reinforces the fall in the price of Country X's risky asset and the increase in the price of Country Y's risky asset. In contrast to the case with differing levels of credit risk the bubble in the country with the highest risky asset price is increased.

7 Concluding Remarks

This paper has suggested that one basic reason for the existence of positive bubbles is an agency problem. Many investors in real estate and stock markets obtain their investment funds from external sources. If the ultimate providers of funds are unable to observe the characteristics of the investment, there is a classic *risk shifting* problem. Risk shifting increases the return to investment in risky assets and causes investors to bid up prices above their fundamental values. A crucial determinant of asset prices is thus the amount of credit that is provided for speculative investment. Financial liberalization, by expanding the volume of credit for speculative investments and creating uncertainty about the future path of credit expansion, can interact with the agency problem and lead to a bubble in asset prices. In addition it was shown that stock market interlinkages can have a significant effect on asset price bubbles that arise from agency problems. Depending on the form of risk that leads to risk shifting introducing interlinkages can either reduce or increase the extent of bubbles.

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Figure 1
Credit and Asset Prices

