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THE LENDER OF LAST RESORT AND THE RUN ON THE SAVINGS AND LOANS

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ABSTRACT

Speculative runs on asset price fixing schemes are most often attributed either to an inexplicable mass hysteria or to a sudden, unpredictable random disturbance. Such attribution places runs and panics outside of the realm of scientific inquiry. Alternatively, in this paper I define the notion of a run as a discontinuous shift in portfolio asset holdings brought about by a belief in the end of the price fixing regime. I also argue that runs are foreseeable events and employ the current difficulties of S & L's to serve as an extended example which emphasizes such predictability.

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As a result of the current high long-term interest rates, savings institutions have reached the point of substantial insolvency, evaluating their assets at market prices. While it is well-known that these institutions are in severe financial difficulty, their depositors have not yet attempted to transfer substantial funds to the close substitutes provided by the commercial banks. Such a failure to take this reasonable precaution must stem from depositors' confidence that, to prevent an impairment, the government, in the form of the FSLIC, the FHLB, the Treasury and the Federal Reserve, will make good at least those losses already incurred. Given that this confidence is founded on the anticipated actions of a hierarchical regulatory maze, the extent of whose resource commitment to the savings institutions is murky, it is uncertain how much more capital loss can be sustained before the depositors respond. Although depositors apparently believe that the government's resource commitment has not yet been reached, further large capital losses may impel them to attempt to remove massive amounts of deposits if they believe that the government is not prepared to provide further support.

In this paper, I will study the nature and timing of a predictable run by the depositors of S&L's in an environment of accelerating inflation. Since, as they are currently managed, the S&L's are creatures that can survive only in a stable price environment, a run by depositors is inevitable unless the government guarantees the S&L's entire mortgage portfolio. The run will cause the S&L's either to disappear or to convert themselves into institutions like commercial banks or money market funds. As long as the government, as a lender of last resort, is willing

to restore the S&L's asset losses contingent upon a run, the run need not imply a financial collapse of the S&L's; the S&L's are merely intermediaries which transfer the collapse to the government.

In this paper the government wears two hats. On the one hand it generates an accelerating inflation as a manifestation of its entire array of policy decisions. On the other hand, it guarantees to a limited extent the assets of S&L's in performing its duty as lender of last resort. Since the inflation generated by government policies triggers the run and forces a large transfer of real resources away from the government, this transfer can be interpreted as a penalty paid by the government for having created the accelerating inflation. The existence of the S&L institution, which incurs growing capital losses under accelerating inflation, together with a government deposit guarantee serves as a restraint on inflationary government policies. If the government raises the rate of inflation too much, the additional benefits gained from the inflation are offset to some extent by its losses as lender of last resort. Therefore, if the government raises inflation rates sufficiently to cause a run on S&L's, then a possible inference is that the government is willing to incur this one time loss in order to gain the greater benefits associated with yet higher inflation rates. In this case the S&L institution continues to exist only as an ephemeral manifestation of a transitional process; the S&L's as long-term lenders are anachronisms from a stable price regime which will predictably disappear after a switch to an accelerating inflation.

The paper is divided into four sections. In section I, I present a general discussion of the notion of a run on a financial institution and define the difference among bubbles, runs, panics, and collapses. In addition, I discuss the idea of a forseeable run on S&L's which will be fleshed out formally later in the paper. In section II, I display evidence relating to the current state of S&L's and to the restrictions on their behavior which have produced their current difficulties. In section III, I construct a formal example to demonstrate how to determine the predictable time of an S&L run and to explore some other predictable phenomena, such as downward shifts in rates of inflation, which materialize when the run occurs. Section IV contains some concluding comments.

I. Predictable Runs and Collapses

The notion of a run always evokes images of a panic or mass hysteria that destroys a financial institution which, in the absence of such crowd action, would be perfectly sound.[1] In this context a run must be a sudden, unanticipated event which catches by surprise both the institution and the financial markets upon which it is forced to dump its assets. However, recent developments of the rational expectations concept have led to a conclusion that a run may be not only perfectly rational but also perfectly predictable. In this section I will discuss informally the general set of ideas that underly the possibility of a predictable run, tracing its development in the literature. I will also distinguish among various terms associated with economic crises such as "panic", "bubble", and "collapse".

Finally, I will present a verbal discussion of the model which serves later to illustrate a run on the Savings and Loans.

(a) Differentiating among Runs, Collapses, Panics, and Bubbles

All of these concepts traditionally have been treated as manifestations of the same basic phenomenon: the outburst of an inexplicable mass hysteria among economic agents of strength sufficient exactly to realize that catastrophe that agents fear. Since they are inexplicable, they have been interpreted as random disturbances to an economic system's institutions, which are quite stable in their absence.

However, since runs and collapses can now be treated, at least technically, as forseeable events, they can be distinguished from purely unpredictable expectational exhilarations. To begin this distinction, a run is defined as a speculative attack on an asset price fixing scheme which causes a discontinuous asset shift in private agents' portfolios. The run occurs because of agents' belief that the nature of the price fixing regime will change, thereby causing a discontinuous shift in asset rates of return. Examples of runs are speculative attacks on a gold standard or a bank run. Note that the definition does not require that the actual fixing of asset prices ends with the run but only that the rules delineating the behavior of the price fixing institution are expected to change. Indeed, in this paper's S&L example a run will not terminate the fixed price between deposits and currency; it will only extinguish further obligations of the lender of last resort. In a model without perfect foresight, such a belief in institutional change,

depending on mistaken perceptions of how the price fixing institution will respond, may be unjustified; so the fixed price regime may remain unaltered after a run. In a model with perfect foresight, the belief will be correct.

Agents' rational expectations of future events always may contain an arbitrary, self-generating element in addition to anticipated future movements of market fundamentals.[2] If such arbitrary expectational components enter asset price solutions, then asset prices are driven in part by a "bubble". A run may be based purely on market fundamentals, on agents' perception that the nature of the forcing variables driving the economic system precludes the permanent existence of the current price fixing regime. However, it may also occur because an arbitrary expectation of price movement drives asset prices sufficiently also to preclude the permanent existence of the price fixing regime.[3] Thus, an expectational bubble may generate a run, but a run can be caused by a more general class of phenomena.

In a stochastic model, the moment of the run will not be perfectly foreseen; in this case there may be discontinuous shifts in asset prices and unanticipated capital losses or gains on some assets. Since a loss can be avoided and a gain realized by agents' being the last to trade at the old fixed price, the run will be characterized by an unplanned rush or "panic" in which each agent leaps into a disorderly queue to trade at the old price. The word "panic" can then be used to characterize a run whose timing was not perfectly foreseen. If the end of the old fixed price institution is perfectly foreseen, then there will be no

unruly mob associated with the discontinuous portfolio shift. The asset exchange will be carefully arranged in an orderly manner far in advance of the event. For example, a run on a banking system insured by a central bank as lender of last resort will be a completely choreographed pas de deux, with the central bank and the typical depositor performing their assigned roles with perfect timing, terminating in the orderly though sudden acquisition of the banks' assets by the central bank. Again, the notion of a run is general; its chief characteristic is a discontinuous asset shift which may occur either with a disorderly panic or with the most decorous ceremony.

Finally, runs are often associated with a collapse of the institution subjected to speculative attack. The collapse may assume the form of a sudden shift in reserves from the price fixing institution to the public, as would occur in a run on a gold standard or fixed exchange rate. The institution's reserves can be said to collapse; however, this is offset by the public's expansion of its reserves. On the other hand, the run may cause a reduction of some of the economy's assets. For example, a run on an uninsured banking system may force a destruction of deposits and of the money stock. In each case, however, the run produces a discontinuous decline in the asset holdings of the institution directly under attack.

If the price fixing institution is insured by another agent, then the run is indirectly an attack on the agent providing the insurance. The attacked institution becomes an agent of the speculators and merely transmits the attack to the insurer. The insurer, not the insured institution, suffers the collapse in its assets.

(b) Runs as Predictable Regime Switches

Models of predictable runs form a subclass of the set of models of predictable regime switches which are now well-known in the rational expectations literature. The first explicit model of a future regime switch is that of Sargent and Wallace (1973) in which a forward-looking solution determines the price level in a Cagan-type money market. Since the model is based on a continuous-time, perfect-foresight environment, a future anticipated discontinuity in the money stock will not cause any discontinuities in the anticipated (and actual) price level path. In Sargent and Wallace, the regime switch consists of a future jump in money at an exogenously given time and magnitude.

While models of the timing of predictable runs and collapses heavily exploit the forward solution and the implied continuity of the anticipated price path, they drop the exogeneity of the regime change's timing and magnitude. The time of the run is the time of the regime change, and the run produces exactly that discontinuity in private asset holding which makes feasible a change in regime while maintaining market equilibrium and price continuity. Alternatively stated, a regime switch occurs only in the contingency of a run; without a run the old regime would remain in effect.

Salant and Henderson (1978) developed the prototype run model in studying a predictable speculative attack on a government scheme to fix the relative gold price. The fixed price system shatters, conditional on a run on the government's gold stocks, into a new regime which allows gold's price to float. The run causes a discontinuity

in the government's and private sector's gold holdings without price discontinuity. Because real capital gains to hoarding gold are suddenly available in the new regime, agents rationally demand this discontinuous increase in their holdings. Krugman (1979), studying a run-induced switch from a fixed to a flexible exchange rate system, employed a similar methodology. Again, a discontinuous shift in reserve holdings is exactly the requirement to preserve exchange rate continuity at the transition time between the two regimes. In exploring the collapse of a gold standard, Flood and Garber (1981a) extended this methodology to a two-asset model in which gold has monetary uses.

Endogenous runs need not occur only in the context of a government price fixing scheme. A bank which attempts to fix the currency value of its deposits may also be run by its depositors. In Flood and Garber (1981b), a banking system suffering nominal capital losses in a deflationary situation eventually refuses to maintain sufficient assets to meet its nominal liabilities. At this point the depositors, faced with incipient capital losses, run the banking system and force a collapse in the money supply. However, the time of the bank run is independent of some reserve pool, unlike the gold and exchange fixing schemes. Rather, the movement of the nominal interest rate through a floor, signalling that bank owners are unwilling to maintain properly the banks' nominal asset value, triggers the run.

In summary, all models of foreseeable runs contain a set of common features. They are continuous-time, rational expectations models, so the anticipated paths of asset prices are continuous. They involve a

scheme to fix the relative price of at least a pair of assets, and the run occurs simultaneously with the end of the old price fixing scheme. At the time of the run there is a discontinuous shift in the amount of various assets held in the public's portfolio. Some assets either are destroyed as in an uninsured bank run or are increased discontinuously as in a run on an institution insured by a lender of last resort. At the time of the run there is a discontinuous shift in some assets' rates of return, which produces the shift in portfolio holdings. Also contemporaneously with the run, a shift in the policy or institutional regime occurs which changes the dynamic laws of motion of the economic system, thereby producing the discontinuity of asset returns; the switch in regime is always contingent upon the occurence of the run.

(c) The Run on Savings and Loans

I will now present a verbal outline of a model exemplifying a run on S&L's, which, due both to direct restrictions and to tax advantages, hold the bulk of their assets in long-term, fixed-interest mortgages. In a stable price era, most of these assets will earn approximately the same coupon rate of interest, reflecting an historic belief in low and steady future nominal interest rates. However, if a permanent regime of accelerating inflation unexpectedly replaces the stable price regime, the market value of S&L's assets at the time of the change will decline sharply, perhaps enough to produce a negative market net worth.

Without government deposit guarantees, the depositors would immediately run the S&L's, attempting to avoid the capital loss implied

by negative net worth. Unable to meet depositors' demands, the S&L's would be closed by their regulatory authority, ultimately to pay out the market value of the remaining assets. Also, share values in the non-mutual S&L's would collapse to zero.

However, if the government guarantees deposits, there will be no run because depositors incur no capital loss and the rate of return on deposits remains attractive. Since no run occurs and since the book value accounting violates no regulatory restrictions, the S&L's can remain in operation.[4] They may even earn accounting profits on their operation to be paid out as dividends, thereby allowing their share prices to remain positive.[5]

To provide a sufficient condition for a run on S&L's, however, I will assume that the government limits the amount which it will pay out to rescue S&L depositors. I will also assume that the accelerating inflation eventually drives S&L market capital losses high enough so that this limit is attained in finite time. The limit may be simply a given nominal amount. More likely, it may be a proportion of the nominal deposits.[6] Finally, it may be some given real amount. In this paper I will select the proportion of deposits as the limit purely because it allows some easy manipulations in the formal example presented below.

Once the maximum government support level is reached, any new capital loss will accrue to the S&L depositors. Before this time, the rates of return on S&L deposits, by regulation always slightly higher than those paid on commercial bank time deposits and somewhat in line with interest paid on money market funds, are sufficient

to prevent a deposit outflow to these institutions. However, when S&L depositors suddenly must add their capital loss to their interest receipts, there is a discontinuous fall in the rate of return on S&L deposits. This produces an attempt to shift deposits to other institutions, which, holding short term assets, do not face these capital losses. The sudden attempt to shift deposits precipitates the run, forcing the government to make good the S&L's capital losses.

After the run the S&L's may disappear, their depositors transferring their funds to commercial banks. Alternatively, they may continue to exist, providing that they are permitted to shift their portfolio exclusively to short term assets or, equivalently, to turn over continuously their entire portfolio of long term assets.[7] I will assume that the latter change in S&L behavior occurs with the run so that I can avoid analyzing the effect of deposit shifts on high-powered money demand.

The government has a number of means to finance this rescue. The central bank, acting as the lender of last resort, may buy the S&L assets at book value less book net worth, sell them at market value, and absorb the difference through a creation of high-powered money which monetizes the entire government obligation. Since agents would foresee the discontinuous increase in high-powered money at the time of the run, this policy would cause prices and nominal interest rates to rise at an exponentially increasing rate prior to the run with the inflation rate dropping discontinuously when the run occurs, as in Sargent and Wallace (1973). In turn, this policy would affect the time of the run. Alternatively, the government may present the S&L's with Treasury

securities equal in value to the difference between the book and market value of S&L assets, less net worth. If this additional government debt is not monetized in the future, the price path prior to the run is driven only by the original underlying inflationary policy; and there will be no discontinuity in short term inflation rates when the run materializes. To the extent that the central bank gradually monetizes this debt, there will be a foreseeable shift to a yet more inflationary monetary process when the run occurs, again causing a simultaneous, discontinuous fall in the inflation rate.

I will assume in this paper that the lender of last resort is the central bank; when a run materializes, the central bank will bail out depositors by discontinuously increasing the high-powered money stock. This assumption stems from my belief that a run by depositors is exactly that sort of event which galvanizes the central bank to fulfill its responsibility as lender of last resort. In the most recent U.S. example, the Federal Reserve delayed categorizing the bank failures of the early 1930's as a systematic crisis, preferring to consider the failing banks as unsoundly managed and therefore deserving of failure. The latitude for such discretion severly narrowed with the banking collapse of 1933. The Federal Reserve, demoralized by the universal acceptance of the Friedman-Schwartz (1963) censure of its actions in the 1930's, will be the institution most likely to leap to the rescue of S&L depositors in order to minimize the possibility of future censure. Of course, if the rescue originates from this monetary source the run will occur much earlier and the discontinuous shift in inflation rates will be much greater than if the Treasury finances the rescue. However, the Federal Reserve could force the Treasury to bear the costs of the bail-out by sterilizing it with open-market sales of Treasury securities; such a possibility will be contained in the formal model.[8]

II. The Current Situation of the Savings Institutions

In this section I shall present data indicating the current state of the Savings and Loans, comparing it to those of the commercial and mutual banks. In addition I shall discuss the nature of the insurance and regulatory scheme constraining the S&L's, focusing on the state of the Federal Home Loan Bank and the Federal Savings and Loan Insurance Corporation balance sheets. Finally, I will provide a discussion of some possible schemes for protecting S&L deposits and maintaining the existence of S&L's. These serve as alternatives to the pure money creation scheme which I study in Section III's dynamic model.

(a) Balance Sheets of Depository Institutions

Table I contains data on the evolution of S&L and mutual savings bank balance sheets since 1978, measured at book value. About 80% of S&L assets consist of long-term, fixed interest mortgages while mutuals hold 60% of assets in mortgages.[9] Part of the remaining S&L assets are more liquid, comprised of cash, demand deposits, short term government securities, time deposits in commercial banks, and banker's acceptances. S&L's are required by the FHLB to hold a minimum percentage of these assets against deposits of maturity less than one year. Other assets consist of real estate holdings, stock in the FHLB, and reserves at the FSLIC. Savings capital is the term for deposits in the S&L's. The other important liability categories are borrowings from the FHLB and Net Worth. Note that FHLB advances increased by 200% between December, 1978 and August 1981, the bulk of the increase occuring in

Table 1

1.37 SAVINGS INSTITUTIONS Selected Assets and Liabilities

Millions of dollars, end of period

Account	1978	1979	1980		1981							
			Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.[p]
Savings and loan associations												
1 **Assets**	**523,542**	**578,962**	**623,939**	**629,829**	**631,228**	**634,405**	**636,859**	**639,827**	**644,603**	**646,704**	**648,793**	**651,799**
2 Mortgages	432,808	475,688	499,973	502,812	504,068	505,309	507,152	509,525	511,754	514,803	516,527	517,581
3 Cash and investment securities[1]	44,884	46,341	57,302	57,572	57,460	58,401	58,461	56,886	59,045	57,616	57,453	58,534
4 Other	45,850	56,933	66,664	69,445	69,700	70,695	71,246	72,416	73,804	74,285	74,813	75,684
5 **Liabilities and net worth**	**523,542**	**578,962**	**623,939**	**629,829**	**631,228**	**634,405**	**636,859**	**639,827**	**644,603**	**646,704**	**648,793**	**651,799**
6 Savings capital	430,953	470,004	503,365	510,959	512,946	515,250	518,990	516,071	517,628	517,632	514,103	512,768
7 Borrowed money	42,907	55,232	62,067	64,491	62,938	62,270	64,197	67,704	70,025	74,756	79,554	83,145
8 FHLBB	31,990	40,441	45,505	47,045	46,629	46,360	47,310	49,607	51,064	53,836	57,188	60,050
9 Other	10,917	14,791	17,446	16,309	15,910	16,887	18,097	18,097	18,961	20,920	22,366	23,095
10 Loans in process	10,721	9,582	8,783	8,120	7,833	7,756	7,840	7,840	7,997	8,008	7,766	7,373
11 Other	9,904	11,506	16,433	12,227	14,104	16,071	13,271	14,946	17,089	14,756	16,365	17,995
12 Net worth[2]	29,057	32,638	33,221	33,319	33,120	32,981	32,645	32,266	31,864	31,552	31,005	17,224
13 MEMO: Mortgage loan commitments outstanding[3]	18,911	16,007	17,979	16,102	15,972	16,279	17,374	18,552	18,740	18,020	17,224	16,819
Mutual savings banks[4]												
14 **Assets**	**158,174**	**163,405**	**171,126**	**171,564**	**171,891**	**172,349**	**173,232**	**172,837**	**173,776**	**174,387**	**174,637**	
Loans												
15 Mortgage	95,157	98,908	99,677	99,865	99,816	99,739	99,719	99,798	99,790	99,993	100,072	
16 Other	7,195	9,253	11,477	11,733	12,199	12,598	13,248	12,756	13,375	14,403	14,378	
Securities												
17 U.S. government[5]	4,959	7,658	8,715	8,949	9,000	9,032	9,203	9,262	9,296	9,230	9,363	
18 State and local government	3,333	2,930	2,736	2,390	2,378	2,376	2,359	2,314	2,328	2,337	2,297	
19 Corporate and other[6]	39,732	37,086	39,888	39,282	39,256	39,223	39,236	39,247	39,111	38,418	38,425	
20 Cash	3,665	3,156	3,717	4,334	4,133	4,205	4,238	4,172	4,513	4,473	4,654	
21 Other assets	4,131	4,412	4,916	5,011	5,107	5,177	5,231	5,288	5,364	5,534	5,449	n.a.
22 **Liabilities**	**158,174**	**163,405**	**171,126**	**171,564**	**171,891**	**172,349**	**173,232**	**172,837**	**173,776**	**174,387**	**174,637**	
23 Deposits	142,701	146,006	152,133	153,501	153,143	153,332	154,805	153,692	153,891	154,926	153,797	
24 Regular[7]	141,170	144,070	150,109	151,416	151,051	151,346	152,630	151,429	151,658	152,603	151,450	
25 Ordinary savings	71,816	61,123	56,256	53,971	52,737	52,035	53,049	52,331	51,212	51,594	50,647	
26 Time and other	69,354	82,947	93,853	97,445	98,314	99,311	99,581	99,098	100,447	101,009	100,803	
27 Other	1,531	1,936	2,042	2,086	2,092	1,986	2,174	2,264	2,232	2,323	2,347	
28 Other liabilities	4,565	5,873	7,644	6,695	7,426	7,753	7,265	8,103	8,922	8,634	10,179	
29 General reserve accounts	10,907	11,525	11,349	11,368	12,957	13,412	11,163	11,042	10,923	10,827	10,661	
30 MEMO: Mortgage loan commitments outstanding[8]	4,400	3,182	1,682	1,476	1,316	1,331	1,379	1,614	1,709	1,577	1,401	
Life insurance companies												
31 **Assets**	**389,924**	**432,282**	**476,294**	**479,210**	**482,009**	**485,033**	**490,149**	**493,185**	**497,276**	**500,316**	**503,994**	
Securities												
32 Government	20,009	0,338	21,275	21,871	22,246	22,669	22,775	22,603	22,948	23,415	29,69[r]	
33 United States[9]	4,822	4,888	5,351	5,838	6,429	6,774	6,807	6,502	6,787	7,119	7,359	
34 State and local	6,402	6,428	6,571	6,701	6,571	6,145	6,199	6,809	6,815	6,876	6,865	
35 Foreign[10]	8,785	9,022	9,353	9,332	9,246	9,250	9,269	9,292	9,346	9,420	9,467	
36 Business	198,105	222,332	239,537	238,059	240,959	241,675	243,996	245,841	247,437	248,737	250,186	n.a.
37 Bonds	162,587	178,371	191,722	190,693	194,777	195,251	196,514	198,397	199,818	201,402	203,016	
38 Stocks	35,518	39,757	47,815	47,366	46,182	46,424	47,482	47,444	47,619	47,335	41,170	
39 Mortgages	106,167	118,421	129,813	131,080	131,710	132,567	133,230	133,896	134,492	135,318	135,928	
40 Real estate	11,764	13,007	14,919	15,033	15,657	15,869	16,244	16,464	16,738	16,966	17,429	
41 Policy loans	30,146	34,825	40,813	41,411	41,988	42,574	43,231	43,772	44,292	44,970	45,591	
42 Other assets	23,733	27,563	29,937	31,702	29,449	29,679	30,673	30,609	31,369	30,910	31,169	
Credit unions												
43 **Total assets/liabilities and capital**	**62,348**	**65,854**	**71,335**	**71,709**	**70,754**	**71,446**	**73,214**	**72,783**	**73,565**	**74,041**	**73,616**	**73,240**
44 Federal	34,760	35,934	39,428	39,801	39,142	39,636	40,624	40,207	40,648	40,948	40,510	40,233
45 State	27,588	29,920	31,907	31,908	31,612	31,810	32,590	32,576	32,917	33,093	33,106	33,007
46 Loans outstanding	50,269	53,125	47,299	47,774	47,309	47,451	47,815	47,994	48,499	49,064	49,507	49,976
47 Federal	27,687	28,698	25,273	25,627	25,272	25,376	25,618	25,707	26,038	26,422	26,661	26,974
48 State	22,582	24,426	22,026	22,147	22,037	22,075	22,197	22,287	22,461	22,642	22,846	23,002
49 Savings	53,517	56,232	64,304	64,399	63,874	64,357	65,744	65,495	65,988	66,472	65,854	65,138
50 Federal (shares)	29,802	35,530	36,183	36,348	35,915	36,236	36,898	36,684	36,967	37,260	36,819	36,373
51 State (shares and deposits)	23,715	25,702	28,121	28,051	27,959	28,121	28,846	28,811	29,021	29,212	29,035	28,765

For notes see bottom of page A30.

Source: Board of Governors of the Federal Reserve, Federal Reserve Bulletin, Oct., 1981, p. A29.

Figure 1

PRINCIPAL EARNING ASSETS AND LIABILITIES OF SAVINGS AND LOAN ASSOCIATIONS

AMOUNT OUTSTANDING, END OF QUARTER

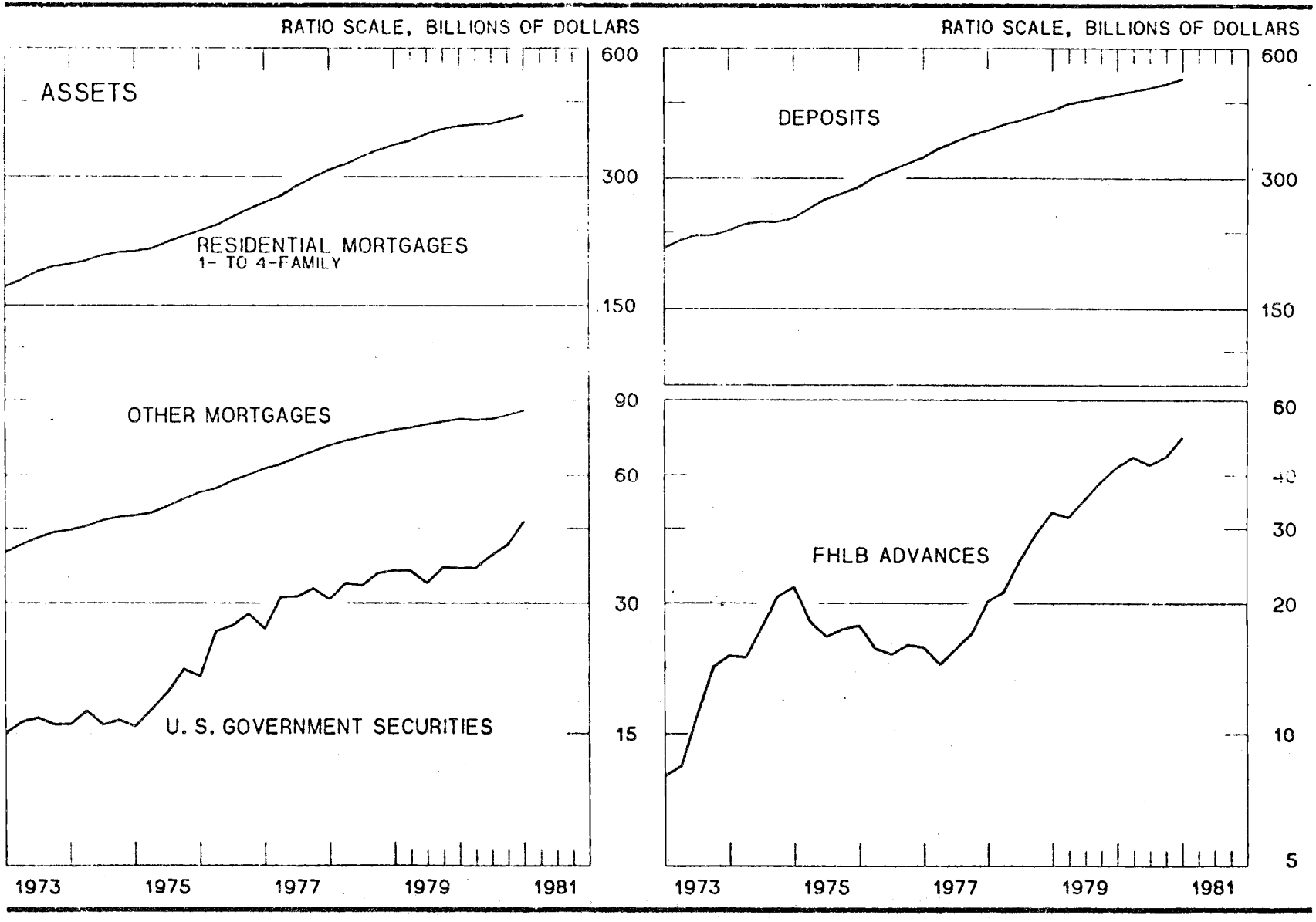
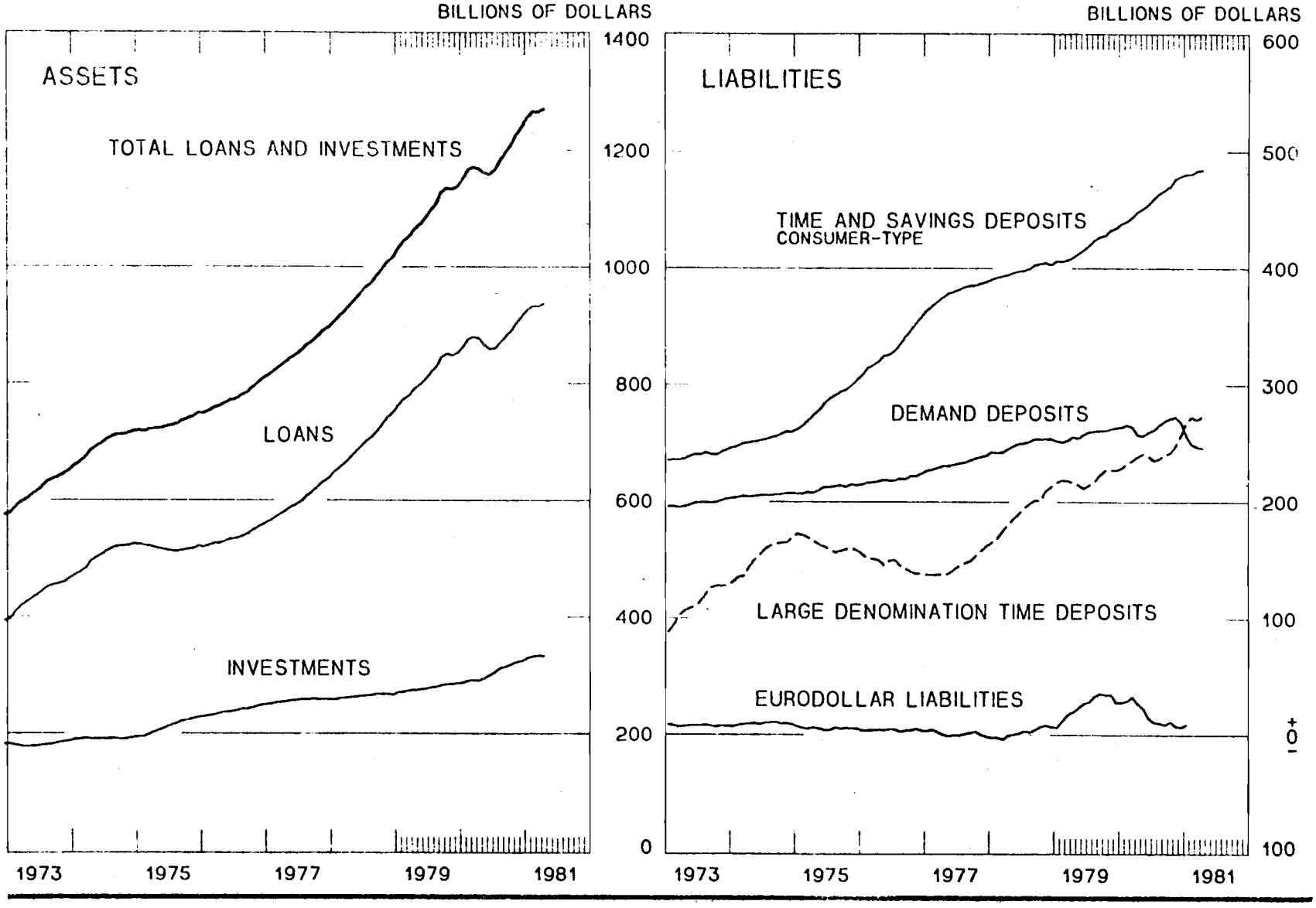


Figure II

PRINCIPAL ASSETS AND LIABILITIES OF ALL COMMERCIAL BANKS

SEASONALLY ADJUSTED, MONTHLY AVERAGES



1979 and 1981. Net worth includes undivided profits, general reserves, and the par value of shares in the stock associations.[10] General reserves, which are the bulk of net worth, are funds set aside to protect depositors against asset side losses.[11]

Figures I and II depict the evolution of the assets and liabilities of the S&L's and the commercial banks. The ratios of S&L deposits and monetary base to commercial bank deposits for December, 1977 through March, 1981 were approximately constant, as shown in Table II.

Table II

Monetary Base and Deposits in S&L's and Commercial Banks
(Billions of Dollars)

End of Period	S&L Deposits	Commercial Bank Deposits	Monetary Base (seasonally adjusted)	Ratio of S&L to Commercial Bank Deposits	Ratio of Monetary Base to Commercial Bank Deposits
1977	387	939	127.8	.412	.136
1978	431	1049	142.2	.411	.136
1979	470	1076	153.7	.437	.143
1980	511	1240	159.8	.412	.129
March, 1981	518	1190	161.3	.435	.136

Source: Board of Governors of the Federal Reserve: Federal Reserve Bulletin

Table III indicates the market value of S&L residential mortgage holdings by coupon at the end of 1980 when the book value of all S&L assets was $630 billion. Of course, the market value depends on the discount rate chosen; and since the maximum discount rate in the table is 16%, the market value may be overstated at current long term rates.

Table III

S&L Residential Mortgage Distribution, by Coupon, at 12/31/80

	Coupon								
	<6.00%	6.00-6.99%	7.00-7.99%	8.00-8.99%	9.00-9.99%	10.00-10.99%	11.00-11.99%	>12.00%	Total
Percent mortgages outstanding	1.25	3.41	9.67	23.17	29.83	14.54	8.39	9.74	100.00
Residential mortgages ($ million)	5605	15291	43361	103896	133760	65199	37621	43675	448408
Assumed coupon (%)	5.50	6.50	7.50	8.50	9.50	10.50	11.50	12.50	9.55%
Original maturity (years)	22	24	24	25	26	27	27	27	
Remaining life (years)	5	11	16	20	24	26	26	26	
MV @10% ($MM)	5039	12976	37139	93434	128717	67794	39728	52567	437394
MV @12% ($MM)	4812	11877	33093	81891	111355	58340	34013	45239	380620
MV @14% ($MM)	4602	10912	29702	72509	97631	50953	29706	39508	335523
MV @16% ($MM)	4402	10063	26840	64810	86610	45079	26278	34953	299035
Discount from BV @10% ($MM)	566	2315	6222	10462	5043	(2595)	(2107)	(8892)	11014
Discount from BV @12% ($MM)	793	3414	10268	22005	22405	6859	3608	(1564)	67788
Discount from BV @14% ($MM)	1003	4379	13659	31387	36129	14246	7915	4167	112885
Discount from BV @16% ($MM)	1203	5228	16521	39086	47150	20120	11343	8722	149373

Source: Report of the Task Force on Savings and Loan Portfolio Profitability, p. 7a.

Table IV

• Savings Deposits at Insured Associations, by Type of Account
(Millions of Dollars)

Type of Account	September 30, 1979		April to September Net Change	
	Amount	Percentage	1978	1979
Passbook	$126,324	27.9%	$— 4,191	$— 3,876
90-day Notice	4,863	1.1	— 809	— 817
MMC (2½ yrs.)	101,911	22.5	19,337	28,697
Four-year Market Rate Certificate	1,292	0.3	—	1,292
Other Certificates of less than $100,000:				
7.5% or less	131,647	29.0	— 8,654	—19,026
More than 7.5%	64,137	14.1	12,468	2,147
Subtotal	$430,174	94.9%	$ 18,151	$ 8,417
$100,000-minimum Certificate	23,123	5.1	2,817	7,063
Total Savings	$453,297	100.0%	$ 20,968	$ 15,480

Note: Data are based on reports from associations holding substantially all FSLIC-insured savings.
Source: Federal Home Loan Bank Board.

Source: U.S. League of Savings Associations, Table 47.

Nevertheless, at a 16% discount rate the book value of these mortgages exceeds the market value by $149 billion. The book value of S&L liabilities also overstates their market value because some deposits are made for a number of years at fixed rates. However, since the liabilities are of much shorter duration than the assets (see Table IV), the market value of the liabilities must exceed that of assets by an order of magnitude given by the $149 billion figure at current long term rates. In addition to the market value of financial assets and liabilities, there is also a market value associated with the S&L's as going concerns which should be added to the other assets in determining the degree of S&L insolvency at market prices. One may place either a fairly high or fairly low value on this component of S&L assets, depending on what remains of the S&L's monopoly position in the new regulatory environment. Regardless of the going concern value, however, it is difficult to escape the conclusion that the $33 billion S&L book net worth in 1980 overstates the market net worth by upwards of $100 billion, and long term interest rates have since risen above 16%.

(b) The FHLB and the FSLIC

The Federal Home Loan Bank and the Federal Savings and Loan Insurance Corporation regulate the S&L's. The balance sheets of these two institutions are reported in Tables V and VI.

The FHLB is a central supplier of credit to the S&L's. It is a federal agency whose purpose is to supply liquidity to S&L's experiencing

Table V

Federal Home Loan Banks

—Federal Home Loan Banks: Combined Statement of Condition
(In millions of dollars)

End of period	Assets				Total assets: total liabilities and capital accounts[2]	Liabilities			Capital accounts		
	Cash	Investments	Advances	Other		Deposits and borrowings	Consolidated obligations[1]	Other	Capital stock	Retained earnings	
1975	108	4,376	17,845	383	22,712	2,700	16,383	334	2,705	590	
1976	164	6,079	15,862	376	22,481	4,024	14,620	313	2,889	635	
1977	134	3,749	20,173	510	24,566	4,286	16,009	296	3,295	680	
1978	201	3,414	32,670	482	36,767	6,243	25,109	459	4,120	836	
1979	251	3,693	41,838	646	46,428	9,368	30,372	596	5,149	943	
1979											
Dec	251	3,693	41,838	646	46,428	9,368	30,372	596	5,149	943	
1980											
Jan	145	3,665	41,733	708	46,251	9,244	30,352	775	4,887	993	
Feb	160	2,961	41,802	659	45,582	9,358	29,925	440	4,826	1,033	
Mar	193	3,222	44,122	723	48,260	9,831	31,882	660	4,827	1,060	
Apr	173	4,399	44,660	725	49,957	10,049	33,095	864	4,849	1,100	
May	194	6,293	43,366	629	50,482	9,808	34,129	529	4,865	1,151	
June	250	7,108	42,364	639	50,361	10,163	33,466	800	4,975	957	
July	147	7,059	41,473	673	49,352	9,609	32,891	899	4,964	989	
Aug	146	5,294	42,605	658	48,703	9,875	32,221	626	4,969	1,012	
Sept	136	4,351	44,161	663	49,311	9,569	33,053	721	5,035	933	
Oct	105	4,357	46,115	710	51,287	9,531	34,917	858	5,031	950	
Nov	142	3,877	47,322	693	52,034	9,912	35,475	631	5,053	963	

[1] Represents Banks' participation exclusive of passthroughs to the Federal Home Loan Mortgage Corporation.
[2] Figures may vary from other published data on the Banks due to rounding and other reclassification of accounts.

NOTE: FHLBB data.

Dec	217	4,328	48,965	751	54,339	10,141	37,268	401	5160	869
1981										
Jan	155	5,099	48,581	800	54,635	9536	37,311	1057	5276	845
Feb	124	5,624	48,206	799	54,654	9348	34,293	786	5341	930
Mar	170	5,475	49,175	755	55,575	9744	38,710	814	5348	959
Apr	159	3,944	51,536	800	56,433	8932	40,145	960	5394	982
May	178	5,358	53,148	793	59,477	9347	42,816	792	5462	1,010

Source: FHLB Board Journal.

Table VI

Federal Savings and Loan Insurance Corporation

—FSLIC: Comparative Statement of Condition

Assets, liabilities, and reserves	March 31, 1981	March 31, 1980	Change
ASSETS			
Cash with U.S. Treasury	$1,283,645	$283,430	$1,000,215
Accounts receivable	13,325,151	18,013,991	(4,688,840)
Investments[1] (U.S. securities)	4,887,464,741	5,610,750,529	(723,285,788)
Accrued interest on investments	84,104,887	108,266,421	(24,161,534)
Assets acquired from insured institutions (book value of assets acquired to prevent default after allowance for losses)	1,397,190,410	254,238,292	1,142,952,118
Loans (loans to insured institutions and accrued interest)	356,167,523	90,635,819	265,531,704
Deferred charges and other assets	102,247	258,898	(156,651)
Total assets	6,739,638,604	6,082,447,380	657,191,224
LIABILITIES AND RESERVES			
Miscellaneous accrued liabilities and accounts payable	81,132,660	[illegible]74,112	72,458,548
Allowance for estimated losses—contribution agreements	59,249,935	36,694,882	22,555,053
Deferred Credits	6,882,816	6,012,468	870,348
Primary reserve (cumulative net income)	5,811,893,680	5,082,344,931	729,548,749
Secondary reserve (additional premiums in the nature of prepayments with respect to future premiums)	780,479,513	948,720,987	(168,241,474)
Total liabilities and reserves	6,739,638,604	6,082,447,380	657,191,224

[1] Market value of investments as of March 31, 1981 amounted to $4,074,870,602.65.

Table S.7.2.—FSLIC: Comparative Statement of Income and Expense

Income and expenses	12 months ended March 31, 1981	12 months ended March 31, 1981	Net change
Income:			
Fees from examinations of savings and loan institutions	$3,567,322	$9,275,237	$(707,915)
Insurance premiums and admission fees	405,179,026	374,056,464	31,122,562
Interest on U.S. and Federal agency securities	420,506,941	443,071,665	(22,564,724)
Interest on loans to insured institutions	16,359,490	3,700,474	12,659,016
Income on assets acquired from insured institutions	87,561,629	2,251,234	85,310,395
Miscellaneous	28,441,847	6,255,267	22,186,580
Total	966,616,255	838,610,341	128,005,914
Expenses:			
Administrative:			
Personnel compensation	561,894	467,082	94,812
Personnel benefits	52,399	41,112	11,287
Travel and transportation of persons	32,321	28,358	3,963
Transportation of things	2,901	516	2,385
Rent, communication, and utilities	160,130	156,967	3,163
Printing and reproduction	990	1,682	(692)
Other services	60,815	94,707	(33,892)
Supplies and materials	1,157	2,306	(1,149)
Equipment (noncapitalized)			
Subtotal—Administrative Department of Insurance	872,607	792,730	79,877
Department of Examination—Home Office	630,071	537,518	92,553
Department of Examination—Field	15,991,646	15,291,647	699,999
Subtotal—Administrative	17,494,324	16,621,895	872,429
Services rendered by Federal Home Loan Bank Board	21,893,448	16,765,934	5,127,514
Liquidation and other miscellaneous expenses	38,455,338	4,703,670	33,751,668
Subtotal	60,348,786	21,469,604	38,879,182
Return on premium prepayments	64,816,743	76,222,081	(11,405,338)
Net insurance losses and provisions for losses	195,433,187	38,693,647	156,739,540
Total	338,093,040	153,007,227	185,085,813
Net income	628,523,215	685,603,114	(57,079,899)

Source: FHLBB Journal.

heavy savings withdrawals. Therefore, the assets of the FHLB consist almost entirely of advances to S&L's, a category which has substantially increased in the last few years.[12] The primary liabilities which finance the advances are the consolidated obligations of the Federal Home Loan Bank Board, which are FHLBB debt instruments sold to private agents at market rates. In emergencies, the U.S. Treasury is empowered to purchase $4 billion of FHLBB obligations. In addition, the Federal Open Market Committee of the Federal Reserve is empowered to purchase and sell the debt issue of federal agencies such as the FHLBB. Thus, indirectly through the FHLB, the Federal Reserve is the only immediate lender of last resort to the S&L's.[13] The Federal Reserve can also lend directly to S&L's.[14]

The FSLIC completely insures S&L deposits against loss up to $100,000. When an S&L becomes insolvent (in book value terms) the FSLIC manages the liquidation, merger, or recovery of the S&L, perhaps infusing it with some of its assets to assure no loss to depositors. As of March, 1981, its assets equalled $6.7 billion, the bulk held in U.S. government securities. The FSLIC can borrow up to $750 million from the Treasury, assess premiums against its members, and require deposits from its members of 1% of their savings deposits.

There are some restrictions on S&L behavior which are of immediate relevance to the model in the next section. The FSLIC classifies an S&L as a problem institution if it is insolvent or projected soon to be insolvent in book value terms, not in market value terms. Thus, an S&L which is obviously insolvent in market terms is permitted to continue unhindered operations as long as its book net worth does not

fall too low. In addition, not accounting for current capital losses, it may earn large book profits and therefore pay dividends to its shareholders even though its market net worth is negative. This provides an incentive for a stock S&L which is insolvent at market value to lock itself in to its portfolio of long-term mortgages, never turning them over, lest it impair its book net worth.[15] To the extent that the managements of the mutual S&L's claim the residual book profits, they would behave the same as the owners of stock S&L's.

Only the FSLIC is obligated to protect the deposits of S&L's. As an insurance company it can readily meet this obligation if a single S&L becomes insolvent. However, in the case of the current systematic insolvency, the FSLIC, whose resources are obviously insufficient, cannot be the institution sustaining the S&L's. There must be a belief of S&L depositors that the next higher level of regulators, the Federal Reserve and the Treasury, will guarantee S&L deposits. Though no such explicit guarantee exists, there are at least legal channels through which primarily the Federal Reserve can provide substantial support to the S&L's in a crisis.

(c) Alternate Means of Protecting S&L Deposits

A basic assumption behind the next section's model of an S&L run is that the Federal Reserve will create a limited amount of high-powered money to protect S&L depositors when the run occurs. Of course, a wide variety of alternate methods may materialize, some of which appear to preclude a run entirely. In this section I will discuses a few such

alternatives and determine whether they will avoid a run, given the definition of Section II.

I will assume throughout that the Federal Reserve maintains the underlying policy of accelerating inflation which causes the insolvency in the first place. If the Federal Reserve were suddenly to replace the policy with one aimed at price stability, then the market value of S&L assets would jump upward to remove the insolvency problem. Any cash flow problems which may remain through sluggish adjustment of the public's expectations can be covered by temporary FHLB advances.

I will also assume in this section that the government explicitly guarantees all of the S&L deposits, thereby removing the depositors' incentive to shift out of S&L's. Since there will never arise a need for the government to infuse massive amounts of its liabilities into the asset side of the S&L's balance sheets, it appears that there cannot be a run.

Even if the government guarantees all deposits, the S&L's must eventually experience continual flow losses as the revenues generated by their assets fall short of the interest payments to depositors. If the government does not subsidize this shortfall, the depositors will withdraw their funds, precipitating a run according to the definition of Section II. The explicit guarantee is not sufficient to preclude a run. The guarantee is not free; it imposes an obligation of a continual and growing transfer from the government to depositors. Hence, a sudden, explicit guarantee of all deposits is equivalent to a sudden transfer of government securities to the S&L's. The only question is the manner by which these securities are to be financed.

One method of finance which is possible under current legal arrangements consists of the Federal Reserve's purchasing FHLBB obligations. The FHLBB then will make advances to the S&L's which are used to pay the interest to the depositors. If advances were counted as liabilities of the S&L's, then this operation would appear to an outsider as a Ponzi scheme since there would be no way to repay the FHLB advances. In reality, these advances would not be S&L liabilities but simply a measurement of the cumulated interest payments from the government's security transfer implicit in the deposit guarantee. Under this method of finance, agents can foresee that the Federal Reserve will shift from its underlying money generation policy to a yet more inflationary policy when the S&L's cash flow problem materializes. This expectation will influence the time paths of inflation and short term interest rates, thereby affecting the timing of the cash flow problem and of the regime shift.

Alternatively, interest payments to S&L depositors can be financed by the Treasury. As long as this Treasury expenditure is not ultimately financed by money creation, the paths of the inflation and short term interest rates will be driven only by the underlying money creation policy. However, the nature of the revenue raising method is important in preventing a run. The tax levied to finance this extra expenditure cannot be placed entirely on S&L depositors. For example, financing the interest payments through general revenues will not alter the return on S&L deposits relative to those in commercial banks. Similarly, a tax on all deposits and on money market funds also would not alter the return on S&L deposits relative to close substitutes.[16]

Since the government must somehow generate resources to guarantee S&L deposits, all of these mechanisms are quite similar. They prevent a run by maintaining the return on S&L deposits relative to those on other liquid assets. Either the Federal Reserve or the Treasury must generate the resources for this activity; and the source of these funds will influence the time path of the inflation rate. In the next section I present a formal model for determining the paths of the inflation and short-term interest rates and the timing of a run under the regulatory response which seems most likely, a limited bailout by the Federal Reserve.

III. An Example of a Run on the S&L's

This section contains a formal example to illustrate the foreseeable S&L run concept discussed in previous sections. The model developed here will be purely monetary; since all events are predictable, monetary changes will not affect real variables. Although a more general model might include monetary-real interactions, the paper's emphasis centers on the nominal affects of anticipated S&L runs, abstracting away from real affects. This assumed separation of monetary from real phenomena will not affect qualitative results on the timing and nature of an anticipated run.

While I have assumed that agents have perfect foresight to analyze this problem, a possible alternative is to assume that random, unanticipated monetary regime changes may occasionally occur. For instance the world may begin with a stable-price monetary regime in which S&L's have a non-negative net worth. An unanticipated shift to an accelerating monetary growth policy will then cause a discontinuous fall in long-term bond prices, making the

S&L's insolvent. This locks S&L's into holding their mortgage portfolio and produces an eventual run, barring a shift to a less inflationary monetary regime. In this light, the following analysis can be interpreted as a study of the events in the money and S&L deposit markets after an unanticipated switch to an accelerating inflation and conditional on no further basic monetary policy changes.

The basic model of the monetary sector used here is similar to that in Flood and Garber (1981b). I will assume that the money supply M consists of currency in circulation C and commerical bank deposits D* so that $M = C + D^*$. The demand for money is a function of the instantaneous nominal interest rate and real income or wealth. Real variables will be assumed constant to simplify the analysis; so the demand for money can be written as $m^d - p = \beta - \alpha\dot{p}$, $\alpha > 0$, where m^d and p are the logarithms of money demand and the price level, respectively, and $\dot{p}$ is the time derivative of p. β is composed in part of the constant real income and real rate of interest while α is a semi-elasticity of demand. Defining $m \equiv \log M$, the money market equilibrium condition is

$$(1) \qquad m - p = \beta - \alpha\dot{p}.$$

The money supply depends on the supply of monetary base and on agents' portfolio decisions to hold cash and demand deposits. Since a simple money multiplier model will serve present purposes, I will assume that commercial bank reserves R and currency holdings are a constant fraction of commercial bank deposits, i.e., $R = \Omega D^*$ and $C = \phi D^*$. Then letting H represent the

quantity of base money, $D^* = H/(\phi+\Omega)$ and $M = \Gamma H$ where $\Gamma \equiv (1+\phi)/(\phi+\Omega)$. Throughout the analysis I will assume that the money multiplier remains constant.[17]

S&L deposits are substitutes for deposits in commercial banks and for short term loans. The demand for S&L deposits D will be proportional to commercial bank deposits i.e., $D = \theta D^*$. The ratio θ should be dependent on the difference in the returns to S&L deposits, i_{SL}, and to bank deposits, i^*. Without deposit capital losses, these rates are approximately equal so θ should be constant.[18] However, if S&L depositors suddenly face capital losses on deposits, then there will be an incipient downward shift in θ. The incipient change in θ will prove crucial in generating an incipient run on S&L deposits.

The asset side of commercial bank balance sheets consists of reserves and short term nominal assets; the liabilities are deposits only.[19] S&L's will hold as assets only consols, each of which pays \$1 per period; liabilities consist only of deposits.[20] Both commercial bank and S&L income will be expended on payments to depositors, operation costs, and payments to owners. The interest forgone on reserve holdings and expended on operation costs will reflect the services of these institutions as financial intermediaries.

The supply of monetary base depends on the actions of the central bank. For whatever policy reasons, the central bank chooses a particular underlying process for generating base money. To provide a sufficient condition to trigger an S&L run, the analysis will begin at a time at which the central bank has already selected a path such that base money grows at an ever-accelerating rate. Defining $h \equiv \log H$, the monetary base evolves according to

$$(2) \qquad h(t) = h(0) + \delta(\exp\{\lambda t\} - 1)$$

where δ, $\lambda > 0$ and $\alpha\lambda < 1$. At $t = 0$, base money is $h(0)$; and for any t, it grows at a percentage rate $\lambda\delta\exp\{\lambda t\}$. This money growth process is deterministic and perfectly anticipated.

In addition to a central bank, there is a lender of last resort whose function is to prevent the collapse of the banking system. This institution may be either the central bank, the government, or a combination of the two. To prevent collapses, the lender of last resort must ultimately be prepared to guarantee banking institution deposits against loss, conditional on a systematic bank run. I will assume that while the lender of last resort is willing to sustain unlimited losses in protecting the commercial banks, it refuses to restore S&L losses beyond a certain proportion of the monetary base, a^*H.[21] While the quantity a^*H is the amount transferred from the lender of last resort to S&L depositors when the run occurs, not all of a^*H will materialize as new base money. A proportion μ of this asset transfer will be new monetary base; the remainder will assume the form of government debt financed by future taxes.

Therefore, the base money supply process consists of two components, the discontinuous jump, μa^*H, resulting from the activity of the lender of last resort and the underlying process in (2) resulting from whatever other motives which may influence the central bank's decisions. Defining $a \equiv \log(1+\mu a^*)$ and z as the time of a run on S&L's, the combined process generating the monetary base is

$$(3) \qquad h(\tau) = \begin{cases} h(0) - \delta + \delta\exp\{\lambda\tau\} & \tau \leq z \\ h(0) - \delta + \delta\exp\{\lambda\tau\} + a & \tau > z \end{cases}$$

The nominal market-valued capital loss on S&L assets attains a*H(z) at time z. Before z, depositors do not net current capital losses out of their current interest returns because the lender of last resort incurs the loss. After z depositors must subtract the new portfolio capital losses from their returns, so there is a sudden, discontinuous decline in S&L net returns relative to substitutes and a consequent desire to shift discontinuously out of S&L deposits. The incipient shift forces the lender of last resort to make good the cumulated losses, thereby shifting the high powered money stock upward at time z.[22] Given the time z of the run, the intuition of the model is then quite similar to that arising in Sargent and Wallace (1973) where there is a forseeable future money supply jump. Prior to z, the price level grows at ever-accelerating rates, even beyond those dictated by the currently observable money growth process. When the money discontinuity occurs, a discontinuous decline in the inflation rate also materializes with no price level discontinuity.

The central problem is to find conditions which determine the time of the run. If the S&L's operate long enough, they will eventually reach a point when the income generated by their assets is insufficient to pay the near-market rates demanded by their depositors. Since it is possible that this shortfall emerges prior to the asset capital losses' reaching the limit set by the lender of last resort, I will later discuss a means of determining z with this complication. However, I will first analyze the time of the run for the situation in which the system first reaches the capital loss limit.

The procedure for finding z consists first of solving the money market for the path of the instaneous inflation rate as a function of z.

From the inflation rates and the assumed constancy of the real rate, the path of the instantaneous nominal interest rate is readily available through the Fisher equation. By use of the instantaneous interest rates to discount the future stream of consol coupon payments, the current market price $P_B(t)$ of consols can be found as a function of z. Together with the knowledge of how S&L deposits and consol holdings evolve, $P_B(t)$ can be used to determine the total cumulated S&L capital loss as a function of z. z can then be solved as the time that this cumulated loss equals the limit set by the lender of last resort. Because of the nonlinearities involved, z will emerge as a zero of a fairly complicated non-linear equation.

Equation (1) is a first-order differential equation in p. After some calculation (see appendix), the forward solution, using the base money generation process (3), can be determined as

$$(4) \qquad p(t) = \begin{cases} g - \frac{\delta}{\alpha\lambda - 1} \exp(\lambda t) + a\exp\{-\frac{1}{\alpha}(z-t)\} & t \leq z \\ g + a - \frac{\delta}{\alpha\lambda - 1} \exp\{\lambda t\} & t > z \end{cases}$$

where $g \equiv \log(\Gamma) + h(0) - \delta - \beta$. The price level is continuous even though at time z there is a discontinuous shift in both base money and portfolio holdings.

The instantaneous inflation rate as a function of z is the left-hand derivative of (4):

$$(5) \qquad \dot{p}(t) = \begin{cases} \frac{-\delta\lambda}{\alpha\lambda - 1} \exp\{\lambda t\} + \frac{a}{\alpha} \exp\{-\frac{1}{\alpha}(z-t)\} & t \leq z \\ \frac{-\delta\lambda}{\alpha\lambda - 1} \exp\{\lambda t\} & t > z \end{cases}$$

Note that after z, $\dot{p}(t)$ depends only on the basic money supply process. Prior to z it is determined by the basic process and an exponentially

growing term dependent upon the magnitude of base money creation at z. At time $t = z$, $\dot{p}(t)$ falls discontinuously. The instantaneous nominal rate of return is $i(t) = r + \dot{p}(t)$ where r is the constant real rate.

At any time the market value of a consol is

$$(6) \qquad P_B(t) = \int_t^{\infty} \exp\{-\int_t^{\tau} i(\varepsilon)d\varepsilon\}d\tau.$$

By substituting for $i(\varepsilon)$ from the Fisher equation and for $\dot{p}(\varepsilon)$ from (5), $P_B(t)$ can be written more explicitly; but sparing the reader the necessity of observing this Gorgon's head, I report it in the appendix.

S&L consol holdings at time t are the initial amount B(0) plus the cumulated amount since time zero, $\int_0^t \dot{B}(\tau)d\tau$, where $\dot{B}(\tau) = \dot{D}(\tau)/P_B(\tau)$. Since $\dot{D}(\tau) = \theta\dot{H}(\tau)/(\phi+\Omega)$,

$$(7) \qquad B(t) = B(0) + \int_0^t \psi[\dot{H}(\tau)/P_B(\tau)]d\tau$$

where $\psi \equiv \theta/(\phi+\Omega)$. The market value of the S&L's consols at anytime t is $P_B(t)\cdot B(t)$.

When the book value of S&L deposits D(z) less the market value of assets $P_B(z)\cdot B(z)$ equals the lender of last resort's payout limit, the run occurs. Therefore, z can be determined as the solution to $D(z) - P_B(z)\cdot B(z) \equiv a^*H(z)$. Since $D(z) = \psi H(z)$, the equation which determines z can be written using (7) as

$$(8) \qquad (\psi - a^*)H(z) \equiv P_B(z)[B(0) + \int_0^z \psi[\dot{H}(\tau)/P_B(\tau)]dt.$$

Equation (8) can be made more explicit by substituting for $P_B(\tau)$ from the appendix and by noting that $H(\tau) = \exp\{h(0) - \delta + \delta\exp(\lambda\tau)\}$ and $\dot{H}(\tau) = \lambda\delta\exp(\lambda\tau)H(\tau)$.

Evidently (8) is a single, very complicated equation in the unknown z. It is not clear that a run will occur prior to the S&L's being unable to generate income sufficient to pay depositors' interest. In particular, if the lender of last resort is willing to make an unlimited guarantee of depositor losses contingent on run, i.e., if $\psi \leq a^*$, then a run will never erupt; for the market value of S&L assets cannot shrink to zero in finite time.

Suppose now that the S&L's reach a point when income is insufficient to service interest on deposits and that their capital loss has not reached the maximum limit. If no other intervention occurs, then the interest rate paid on S&L deposits will decline relative to substitutes, generating an outflow of S&L deposits. The S&L's must sell off assets, causing a book loss to materialize, impairing book net worth, and forcing a regulatory intervention. As an alternative to prevent such disruptions and to avoid such drastic actions, the regulatory authorities may lend the S&L's the difference between their interest payments and incomes. Since the S&L's can never repay such loans they will continually grow through the addition of new loans and the refinancing of old ones.[23] Eventually, the cumulated loans plus the capital loss on S&L assets will reach the limit set by the lender of last resort. If the loan component of this sum is not monetized prior to the run then the solutions for p and P_B are the same as previously computed. The only alteration is that z solves the equation

$$(9) \qquad D(z) - P_B(z)\cdot B(z) = a^*H(z) - L(z)$$

where L(z) is the cumulative value of loans to the S&L's from the start of S+L cash flow problems to the time of the run. Here,

ignoring operating costs,

$$(10) \qquad L(z) = \int_{w}^{z} [B(\tau) - i_{SL}(\tau)D(\tau)] \exp \{\int_{\tau}^{z} i(\varepsilon)d\varepsilon\}d\tau$$

where w is the time at which the S&L cash flow problem begins.

If the loans are partly monetized prior to z, then the solutions for p and P_B will differ because the scheme for generating base money given in (3) will not apply. Starting at time $w < z$, the growth rate for h(t) will be greater than that given in (3). I will avoid this complication by ignoring it here.

IV. Conclusion

This paper is intended as a study of a forseeable run on a financial institution. The behavior of private agents and institutions has been severely restricted so that the derivation of basic results can be achieved using the simplest possible framework. In particular, real and monetary phenomena have been separated; various assets are privately held in constant proportions; S&L's are prohibited from holding short term assets; the regulatory authority imposes book value accounting; and the central bank implements a monetary policy guaranteed to generate attacks on the system.

Of these restrictions, the central bank's monetary policy seems most dubious in generating a run of the sort analyzed here, though current policy may yet prove as inflationary as I assume. Some of the other assumptions, such as constant asset proportions or S&L behavior, can be justified at least partly by appeal to data or by regulatory constraints. The separation

of real from monetary phenomena is consistent with the perfect foresight assumption, given most currently fashionable business cycle models.

The result which deserves the central emphasis is the possibility of perfectly anticipating a future run on a financial institution. To demonstrate the predictability of a run in the S&L context is not startling, considering current conditions. However, the notion of predictability is general; models of anticipated runs can be built for a wide spectrum of markets. Given such models it is possible to address the concept of a run employing the legitimate techniques at the economist's disposal rather than confessing the complete ignorance implicit in characterizing the phenomenon as a panic or mass hysteria.

Notes

[1]For example, this seems to be the justification for Friedman and Schwartz's (1963) approbation of the establishment of the FDIC as a device to protect the monetary system.

[2]Keynes' (1936) famous Chapter 12 discusses such arbitrary expectational elements.

[3]In Flood and Garber (1981b, c), runs caused both by market fundamentals and by bubbles are explored in the context of a bank run and of a run on a fixed exchange rate system.

[4]However, they will be locked into their current assets. It may be desirable to sell these assets at a loss so that their coupon payments are not accounted as taxable profits. Unfortunately, such an action may reduce book net worth below required levels, thereby forcing closure of the bank and ending the dividend stream paid to its owners.

[5]Ultimately, the S&L's may experience a cash flow problem, as the low coupon payments on old mortgages will prove insufficient to meet the rising short term rates demanded by depositors. At this point, the S&L's may receive loans from the government in the form of FHLB advances or tax breaks to new depositors. The former is a Ponzi scheme with the proceeds from the new liabilities being used to pay interest to old depositors. Both should also be counted as part of the finite rescue effort of the government. These schemes will be discussed more fully in Sections II and III.

[6]The funds available to the FSLIC for rescuing troubled S&L's are a given proportion of nominal deposits.

[7]The turnover of long-term assets is required so that S&L's can continuously realize their capital losses on their books. Without this possibility, since the long-term rate is temporarily higher than the short-term rate, there is an appearance of a taxable book profit.

Currently, the S&L industry is changing its assets to instruments with annually renegotiable interest rates. These are basically short-term loans with an automatic roll-over provision.

[8]The Federal Reserve has limited latitude in forcing the Treasury to finance the entire loss. The amount of Federal Reserve credit currently is somewhat less than estimated S&L capital losses.

[9]The S&L's hold the bulk of assets as mortgages due to a combination of regulatory restrictions and tax advantages. For a discussion of the tax treatment of S&L's, see Biederman and Tuccillo (1975) and Goodman (1980).

[10]The stock associations comprised 17% of the number of S&L's at the end of 1979 with 25% of the assets. See U.S. League of Savings Associations (1980, p. 51).

[11]The FSLIC requires reserves of 5% of total savings accounts. In March, 1980, the FHLB was permitted to change the requirement in a range of 3% to 6%.

[12]Regulations of the FHLB adopted in May, 1980 limit an S&L's borrowings from the FHLB to 50% of the S&L's assets. See U.S. League of Savings Associations, p. 101.

[13]Of course Congress could authorize the Treasury to take such a role with some amount of legislative delay.

[14]The Federal Reserve has recently begun making direct loans to thrift institutions undergoing "sustained liquidity pressures." See Federal Reserve Bulletin, September, 1981, pp. 709-711.

[15]See Guttentag and Herring (1981) for a case of an S&L which shifted its asset portfolio, improving its market net worth while reducing its book net worth, thereby forcing itself into a merger.

[16]However, demand would shift toward currency to some extent. Financing the protection of S&L depositors in this way could then cause a one-time, discontinuous decline in the money supply at the time of the S&L cash-flow problem. In this case the inflation and interest rates would grow less rapidly prior to the decline than in the case of general revenue financing.

[17]The constancy of Γ simplifies the nature of the differential equations governing the price level. More generally, ϕ should depend on the relative rates of return between currency and commercial bank deposits. However, since the data do not indicate much movement in Γ in the face of large interest rate movements, there seems little to gain from adding this complication.

[18]The direct interest payments are regulated, with S&L's allowed to pay slightly higher rates than commercial banks. Also, S&L rates on many deposits move with money-market short rates.

[19]Commerical bank net worth can be ignored since commercial banks will remain solvent throughout.

[20]S&L's also hold some short assets, borrow from the FHLB, and have some net worth. Since the bulk of S&L assets are long-term, fixed-rate mortgages, short assets will not be considered here. Also, I start the world in a state in which S&L's have negative net worth, so book net worth can be ignored. Finally, I will assume that the bail out takes the form of a post-run asset infusion and treat advances only in the case that the government subsidizes interest payments on S&L deposits.

[21]The form of this limit is chosen purely for analytical convenience.

[22]This discussion assumes that there is a change in the nature of S&L's after the run. If the S&L's continued to hold long-term assets, they would again eventually be unable to pay the appropriate short-term interest rates to depositors. Hence, they would disappear with the run; and the assets into which their former deposits were converted would affect the analysis of the price paths. If instead S&L's were allowed to hold only short-term assets, then they become similar to commercial banks or money-market funds. The arguments used in the text implicitly assume that S&L's transform themselves into money-market funds; then no new base money reserves are suddenly required against S&L deposits. On the other hand, if S&L's blend into commercial banks, then the money multiplier and the derived demand for base money shift after the run.

[23]Recall the rapid growth of FHLB advances to S&L's.

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Appendix

a) Price Level Solution

The forward solution to equation 1 is

$$(A1) \qquad p(t) = \frac{1}{\alpha} \exp\{\frac{1}{\alpha} t\} \int_t^{\infty} [m(\tau) - \beta] \exp\{-\frac{1}{\alpha} \tau\} d\tau.$$

Substituting $[\log\Gamma + h(\tau)]$ for $m(\tau)$ and for $h(\tau)$ from (3), in (A1)

$$(A2) \qquad p(t) = \frac{1}{\alpha} \exp\{\frac{1}{\alpha} t\} [\int_t^{\infty} [g + \delta \exp(\lambda\tau)] \exp\{-\frac{1}{\alpha}\tau\} d\tau$$

$$+ \int_z^{\infty} a \exp\{-\frac{1}{\alpha}\tau\} d\tau],$$

where $g = \log\Gamma + h(0) - \delta - \beta$. Equation (4) follows from grinding out the integrals in (A2).

b) Solution for Consol Price

The solution for $P_B(t)$ can be made more explicit by substituting $r + \dot{p}(\varepsilon)$ for $i(\varepsilon)$ in (6) and by replacing $\dot{p}(\varepsilon)$ from (5). After the easier integrals are computed, the result must still be reported as an integral:

$$(A3) \qquad P_B(t) = \int_t^z \exp\{-r(\tau-t) + \frac{\delta}{\alpha\lambda - 1} [\exp(\lambda\tau) - \exp(\lambda t)]$$

$$- a[\exp\{-\frac{1}{\alpha}(z-\tau)\} - \exp\{-\frac{1}{\alpha}(z-t)\}]\} d\tau$$

$$+ \int_z^{\infty} \exp\{-r(\tau-t) + \frac{\delta}{\alpha\lambda-1}[\exp(\lambda\tau) - \exp(\lambda t)]\} d\tau.$$