Economic Stability under Alternative Banking Systems: The Case for 100 Percent Reserve Banking

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Abstract

In this paper we show that in an economy where investors hold rational expectations, output is generated by a linear homogeneous production function, and real investment is allocated according to the CAPM, a fractional reserve banking system characterized by money creation and investing is not Pareto efficient and leads to excessive risky productive investment that in turn amplifies future business cycles. The regulatory process should go even further than the Volcker rule by restricting bank investments to currency and deposit accounts on the central bank. Nonbank financial institutions should then carry out the financial intermediation function now carried out by banks.

Key Words: Economic Stability, 100% reserve banking, CAPM, Business Cycles, Pareto Optimality

JEL classification: E32, E44, E52, G1, G18, G21
I. **INTRODUCTION**

The world-wide crisis of 2007-2012 raises a number of fundamental questions regarding the role of bank and non-bank financial institutions in the financial systems and the real economies of financially developed countries. Before the crisis most financial economists and policymakers favored deregulating banks in order to promote one-stop shopping for financial products and encourage competition and innovation in the financial services industry. The prevailing view then was to let the innovative human capital in lightly regulated financial institutions operating in relatively efficient financial markets guide the savings of society into productive real investment. The end result was supposed to be an efficient allocation of resources and optimal economic growth. Since the crisis this view of financial institutions and markets is now being questioned. It has been argued (eg., Stiglitz, 2011 and many others) that some financial products invented by this innovative human capital have contributed to the severity of the financial crisis in that they have proven to be opaque and difficult to assess their underlying risk. Moreover large financial service companies have proven to be too unwieldy to manage efficiently and some are now in the process of being dismantled. They along with other large financial institutions unleashed a significant moral hazard problem in that some financial supermarkets became too big and interconnected to fail. Repeal of parts of the Glass-Steagall Act (excluding interest rate ceilings on deposits) and the Investment Company Act that occurred in the Gramm-Leach-Bliley Act in 1999 is now viewed by many economists and even some former bankers as a regulatory mistake. In response to the crisis Europe and the U.S. are now in the process of re-regulating the markets and institutions of their financial systems.

One very fundamental regulatory reform that has surprisingly received relatively scant attention from policymakers during the most recent financial crisis is the following: Why should privately owned banks whose checking account liabilities constitute an important component of the medium of exchange be
allowed to accept and facilitate the creation of checking account money (backed-up by a government subsidized insurance scheme) and engage in risky financial intermediation in the first place? This paper is concerned with this fundamental question. In section II we begin the discussion by considering one influential economic argument favoring the combining of deposit-taking and lending in the form of loan commitments within a single financial institution. This analysis abstracts from the problems and issues of deposit insurance and focuses on the provision of liquidity services to depositors and borrowers. The conclusion of this analysis is that present day banks are the most efficient liquidity providers. In section III the question is examined from the perspective of efficient real investment allocation abstracting from liquidity considerations. In this section we pose a thought experiment for a hypothetical economy that is considering two types of banking systems: i) a 100 percent reserve banking system and ii) a fractional reserve banking system. We then compare the investment allocations for the two systems. We find that a fractional reserve banking system that combines deposit-creation with risky lending and investment misallocates real productive investment in the Pareto sense. We also find that a fractional reserve banking system amplifies the business cycle. Section IV concludes with a short summary.

II. THE CASE FOR A DEPOSIT-TAKING AND LENDING BANKING SYSTEM

Until recently the strongest argument for combining deposit-taking and risky lending/investing in banks is that it has always been so for many hundreds of years and over many different countries. The conventional text book view is that those goldsmiths and money-changers who provided safety deposit box and foreign exchange services to merchants eventually realized that only a fraction of the coins deposited with them for safe-keeping would be withdrawn at any one point in time. It would therefore be relatively safe and profitable to lend/invest a certain proportion of “other people’s money” although it probably took much skill and experience to determine what that proportion for a specific money-changer might safely be. This quest for profit of modern day banks is aptly summed up in an interview
with Professor Raghuram Rajan at the Minneapolis Federal Reserve Bank by Ron Feldman (2009, p.22) when it is asked: “…what business are the banks in? They’re not in the business of being plain-vanilla entities, because they can’t make any money that way.” While trying to avoid making money (literally as we will argue below) in a plain-vanilla way is the argument of the money-changer/banker as to why banking evolved in the way it did, economists also want to know whether the way banks make money is socially optimal.

Kashyap, Rajan, and Stein (2002) extending Diamond and Dybvig (1983) provide an important economic argument for the social usefulness of present day banking that combines deposit-taking and loan commitments to borrowers. Their argument is based on the notion that deposit-taking and loan commitments represent demands for liquidity by owners of demand deposits and borrowers. Both of these demands for liquidity require the providing institution to hold a stock of liquid assets themselves that in turn can be used to service these demands from both sides of the bank’s balance sheet as they occur through time. From this observation they conclude that if these two demands for liquidity are not perfectly correlated, it makes economic sense to combine deposit-taking and loan commitments in the same financial institution, namely, present day banks. The reason is that a smaller quantity of liquid assets can service both demands for liquidity when they are provided by the same financial intermediary compared to the case when they are provided by separate intermediaries as proposed by 100 percent reserve banking. Liquid assets (eg., cash, reserve accounts with the central bank, Treasury securities, high grade commercial paper, etc.) in their model represent “costly overhead” that is required to service the normal demands for liquidity by depositors and lending commitments to borrowers. They argue this overhead is costly for three reasons: i) cash and until recently reserve accounts yield a zero nominal return; ii) short-term riskless and near riskless securities yield a nominal return but this return is subject to double taxation since banks are required to use the corporate form of business organization; and iii) borrowing ideas from the corporate finance literature they argue that large stocks of liquid
assets create agency costs in that they can quickly be transformed into perks and empire building. For these reasons it is desirable that this costly overhead be reduced to a minimum which it will be if deposit-taking and lending are combined in the same institution and if the two demands for liquidity are not perfectly correlated. In other words present day banks are low cost producers of liquidity services precisely because they service both demands.

III. Investment and Business Cycles under Alternative Banking Systems

The argument of Kashyap et al. (2002) that a given stock of liquid assets can support a larger volume of normal liquidity needs when deposit-taking and lending are combined into a single entity is an interesting rationale for present day banking. It does however assume an absence of runs induced by pending bank failure which presumably would affect both sides of the balance sheet of banks at the same time and move the correlation coefficient between the two liquidity needs towards unity. But in any event is minimizing the stock of liquid assets relative to liquidity needs the only criteria for judging a social optimum for a banking system? It would seem that another and perhaps more important criterion is whether a financial system based on 100 percent reserve banking allocates savings to investment better (in the Pareto sense) than a fractional reserve universal banking system with government subsidized deposit insurance. By “better” I mean will the level of investments in the economy generate the risk/return trade-off that maximizes the expected utility of household savers who finance the investment. In this paper I argue that in a 100 percent reserve banking system it does, whereas it doesn’t in a fractional reserve banking system.

1 The case for 100 percent reserve banking is not particularly new. Early English writing proponents of 100 percent reserve banking include Simons (1934) and Fisher (1935); and later three Nobel Prize winners, namely, Friedman (1959), Tobin (1985), and Allais (1987) among others. Their arguments in favor of 100 percent reserve banking were different than ours and focused on preserving the safety of the banking system. These arguments include: i) that it will stabilize the banking system; ii) enable the central bank to more tightly control the M1 stock of money; and iii) when coupled with a fixed percentage money growth rule leads to more stable prices and real economic activity. For a review of the older traditional and non-traditional literature on fractional and 100 percent reserve
To see this we abstract from the liquidity considerations of Kashyap et al. and look for a model that generates a risk/return tradeoff in the capital market. The workhouse model in finance that does this is the well-known 2-parameter capital asset pricing model, CAPM. Suppose then a modified version of the CAPM allocates investment in a closed economy. As originally developed by Sharpe (1964) and Lintner (1965), the CAPM takes the total stock of capital as fixed and given. It then derives a set of relative market prices for the individual financial claims on the total capital to be held in an efficient market portfolio that is optimal in the sense that it maximize the excess expected return (over and above the riskless return) on that portfolio for a given amount of portfolio risk. In doing this the model generates the expected return/risk trade-off on the market portfolio. This paper derives a CAPM type model where the stock of capital is a choice variable and therefore subject to change. Towards this end we assume that the individual capital assets are components (or divisions) of a single representative firm. The managers of these individual divisions are allocated capital by the market portfolio manager in the above optimal way; i.e., maximizing excess expected return on the portfolio per unit of portfolio risk. The question is how much financial capital should that representative firm get from saver/investors to allocate to its separate divisions. We then ask the question whether the stock of this capital underlying the market portfolio is Pareto efficient in a financial system with fractional reserve banking versus 100 percent reserve banking.

Consider then the following thought experiment where a privately owned deposit-taking narrow bank is only allowed to invest in a risk-free reserve asset. We also fix the size of the balance sheet of the central bank. In this world there is no need for a deposit insuring agency or capital requirements or regulatory agencies since banks can only invest in currency and deposits on the central bank. Assume

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banking see de Sota (2009) especially chapter 9. Recent advocates and discussion include among others Benes and Kumhof (2012), Kotlikoff (2010), Lucas (2013), and the detailed review by Pennacchi (2012). For proposals on how to transition from a fractional reserve system to a 100 percent reserve system see Krainer (2013) and the above authors.
also that households can only hold risk-free deposit money (for cash-in-advance reasons) with a zero return and invest long in the representative firm/ market portfolio. The manager of the market portfolio accepts savings from the representative household. He/she then allocates the savings among the separate divisions to buy productive capital in the CAPM way that generates the highest expected return on the portfolio for a give level of portfolio risk measured as the standard deviation of the return on this portfolio. In this set-up there is complete separation between deposit banking and the financial intermediation carried out within the market portfolio.

The return generating process of the linear homogeneous production technology of the representative firm that describes the expansion path for the efficient market portfolio is known to the market portfolio manager and its general form is assumed to be the following\(^2\).

\[
E(Y) = f(K) \quad f'(K)>0 \quad f''(K)<0 \quad 1)
\]

and

\[
\sigma(Y) = g(K) \quad g'(K)>0 \quad g''(K)\geq 0 \quad 2)
\]

where

\(K\) = Physical productive capital and real money balances. Real money is in the production function of the representative firm since it reduces frictions in implementing the technology.

\(E(Y)\) = Expected income on the productive capital underlying the market portfolio.

\(\sigma(Y)\) = Standard deviation of income generated on the productive capital of the market portfolio.

Equation (1) just says that the expected income generated on the physical capital and money balances is subject to diminishing returns and is quite standard. Economic theory is silent on equation (2) which has risk going up as capital investment goes up at a constant or increasing rate. Nature is stingy in this

\(^2\) See Stiglitz (1972, p.39) for this set of assumptions on the production of risk and return in the CAPM. Stiglitz provided no economic rationale on why risk should be increasing in the level of real investments. Theoretical reasons and empirical evidence for this assumption can be found in Krainer (2009, pp. 6-7).
model economy both in terms of expected income and risk. Even though economic theory is silent on equation (2), there is empirical evidence that future earnings variability is an increasing function of current capital investment. Kothari et al. (2002) provide regression evidence that current investments in year t of Compustat industrial firms in plant and equipment, R&D, and advertising cause an increase in the standard deviation (calculated over the period t+1-t+5) of future corporate earnings. Further evidence comes from the financing of investment projects. It is well-documented that credit standards for bank lending vary countercyclically in that a deterioration in credit standards accompanies an increase in bank lending during a cyclical expansion that is subsequently followed by high loan losses (see Cunningham and Rose (1994), Weinburg 1995, and Keeton (1999) for the U.S., Hoggarth et al. 2002 for 47 developing and developed countries, and Caporale et al. 2013 for Italy). This well-known phenomenon in the bank loan market has led to a regulatory response in the form of imposing a countercyclical capital buffer as part of Basle III in 2010. This countercyclical buffer allows bank regulators to increase capital requirements when credit relative to some metric like GDP exceeds its long-term trend. Thus when banks reduce their credit standards and finance the increasingly risky investment projects of firms with loans during the expansion phase of the business cycle, Basle III allows country regulators to raise capital requirements to offset the increased expected losses on loans thereby partially mitigating systemic risk. Several economic arguments support these empirical results and our assumptions on the derivatives in equation (2). One argument is that when the capacity-increasing investment is allocated by the fund manager unevenly across the separate divisions within the

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3 At this point an agrarian example might be useful. Think of K as representing land owned by government that can be sold off for farming or used for recreational activities. The more productive land is sold off to the representative farm with many individual plots managed by tenant farmers. The less productive land that is not farmed remains owned by the government who allows it to be used for recreational purposes. This recreational land is potentially farmable, but like all land is subject to diminishing returns and increasing risk as in (1) and (2). For example the next most productive parcel of land not farmed may be a marsh where the average return is lower and the variability of return is greater than the previous plot of land that is farmed. If the weather is good (i.e., dry) the land will yield a large crop; if bad (i.e., rain causing flooding) a small crop. Land in this set-up is reversible in use in that farmed land can be sold back to the government for money and converted to recreational land.
representative firm/market portfolio in response to changes in taste and technology, relative prices of output will become more variable. In this case changes in tastes and technology are the source of the risk. Thus an increase in the variability of relative prices, according to one version of the New Classical theory (Lucas, 1973), makes it more difficult for managers of the individual divisions/firms to estimate profits and plan production thereby increasing the underlying operating risk of future production.\(^4\) A second argument is that with a fixed supply of experienced managers, an increase in capital investment will require the firm’s divisions to use inexperienced managers. How these relatively new and inexperienced managers will perform is uncertain, and this uncertainty contributes to the increased operating risk associated with the new investment. A third and related argument is that a rapid expansion in productive capacity that comes with increased real investment may make it more difficult to maintain the quality of the firm’s product thereby creating a new but lower quality product. Will the firm/division be able to profitably sell this new but lower quality product in the market place at a profitable price? A recent example of the problems associated with rapid capacity expansion and maintaining product quality is the automobile manufacturer Toyota. Perceived quality changes that could accompany a rapid expansion in real investment pose an additional risk confronting the representative firm. This evidence would be consistent with the assumptions on the derivatives in equation (2).

With these assumptions on the derivatives of (1) and (2) we can derive a CAPM return/risk frontier between \(E(Y)\) and \(\sigma(Y)\) based on their separate relationships to \(K\). In this connection note that as \(K\) varies \([\sigma(y), E(Y)]\) describes a locus of points with equations (1) and (2) constituting a parametric

\(^4\) One interesting and controversial piece of empirical evidence relating to this assumption is the evidence on the positive relationship between the rate of general inflation and the variability of relative prices. Parks (1978), Ball and Mankiw (1995), Parsley (1996), Anderson (1994), and Balke and Wynne (2000) among others provide evidence that the variability of relative prices is positively associated with the general inflation rate. To the extent high rates of real investment are positively correlated with rates of inflation, then there also is a positive association between real investment and variability of relative prices. Differential capacity changing real investment is one way this empirical relationship might occur.
representation of the locus. Eliminating K between equations (1) and (2) defines \( E(Y) \) implicitly in terms of \( \sigma(Y) \). On the assumption that \( f \) and \( g \) are at least twice continuously differentiable functions of \( K \) and there is excess capacity in the capital goods producing industry, we can then express the derivative of \( E(Y) \) wrt \( \sigma(Y) \). Begin by noting that the total differentials of (1) and (2) are:

\[
\begin{align*}
d[E(Y)] &= f'(K)dK \quad \text{and} \quad 3) \\
d[\sigma(Y)] &= g'(K)dK \quad 4)
\end{align*}
\]

Dividing (3) by (4) the derivative of \( E(Y) \) wrt \( \sigma(Y) \) is thus

\[
\frac{dE(Y)}{d\sigma(Y)} = \frac{f'(K)}{g'(K)} > 0 \quad 5)
\]

indicating that \( E(Y) \) is a positive function of \( \sigma(Y) \). To compute the second derivative to test for concavity we write:

\[
\frac{d^2 E(Y)}{d\sigma(Y)^2} = \frac{d}{d\sigma(Y)} * \frac{dE(Y)}{d\sigma(Y)} = \frac{dE(Y)'}{d\sigma(Y)} \quad 6a)
\]

where \( E(Y)' = \frac{dE(Y)}{d\sigma(Y)} \). Taking the total differential of \( E(Y) \) and \( \sigma(Y) \) and then dividing as above we get

\[
\frac{d}{d\sigma(Y)} * \frac{dE(Y)}{d\sigma(Y)} = \frac{d}{dK} * \frac{dE(Y)}{d\sigma(Y)} * \frac{dK}{d\sigma(Y)} \leq 0 \quad 6b)
\]

Equation 6b is negative since \( d/dK * dE(Y)/d\sigma(Y) \) contains \( f''(K) \) which according to diminishing returns is assumed to be negative in (1) above. \( E(Y) \) is therefore a concave function of \( \sigma(Y) \) implying that the marginal rate of transformation of expected income for risk on real capital investment is diminishing\(^5\).

\(^5\) An alternative derivation based on the Inverse Function Theorem is to write:

i) \( E(Y) = f(K) \)
The relationships between $E(Y)$, $\sigma(Y)$, and $K$ from equations (1)-(6) are described in Figure 1. Quadrants 2 and 3 in Figure 1 respectively describe the relationship between $E(Y)$ and $\sigma(Y)$ as functions of $K$. Capital investment generates both expected return and variability of return. In quadrant 2 the productive opportunity curve $PO$ describes $E(Y)$ as a concave function of capital investment $K$ indicating diminishing returns while in quadrant 3 the capital investment risk curve $KR$ describes $\sigma(Y)$ as a linear or convex function of $K$. Together they imply the CAPM’s concave risk-return transformation curve $TC$ in quadrant 1 which describes the efficient tradeoff between expected income $E(Y)$ and risk $\sigma(Y)$ generated on the capital of the representative firm in this economy.

(Put Figure 1 here)

Next we describe the representative saver/investor in this economy. Saver/investors are endowed in the beginning of some hypothetical time period $t=0$ with a given stock of wealth (claims on the market portfolio) along with money, the result of providing factor services to the representative firm in the previous period. With this money they pay for the pre-ordered consumption goods in $t=-1$ to be consumed in the current period, and reinvest the remainder in the market portfolio at the beginning of the current period. Cash-in-advance and money-in-the-production function are the motivations for

\[ ii) \quad \sigma(Y) = g(K) \rightarrow K = g^{-1}([\sigma(Y)]) \]
That is, the inverse function $g^{-1}(\sigma(Y))$ exists on any interval where $g$ is monotonic with either $g'(\sigma(Y)) > 0$ or $g'(\sigma(Y)) < 0$.
Since $g'(K) > 0$, $g^{-1}(\sigma(Y))$ exists, and
It is then the case that:

\[ iii) \quad E(Y) = f(K) = f[g^{-1}(\sigma(Y))] \] and

\[ iv) \quad \frac{dE(Y)}{d\sigma(Y)} = f''[g^{-1}(\sigma(Y))] \cdot \frac{d}{d\sigma(Y)} g^{-1}(\sigma(Y)) \quad \text{or} \]
\[ v) \quad f''[g^{-1}(\sigma(Y))] \cdot \frac{1}{g'(K)} > 0 \]
\[ vi) \quad \text{Using the quotient rule the second derivative is} \]
\[ \frac{d^2E(Y)}{d\sigma(Y)^2} = f'''[g^{-1}(\sigma(Y))] \cdot \frac{1}{[g'(K)]^2} + f'[g^{-1}(\sigma(Y))] \cdot \frac{-1}{[g'(K)]^2} \cdot g''(K) < 0 \]
Since both terms on the rhs are negative, $vi)$ is negative. Thus the relationship between $E(Y)$ and $\sigma(Y)$ is concave just as it is in the CAPM. My thanks to Katherine Kovarik and Donald Schuette for pointing out this inverse function proof of concavity.
households and the representative firm for holding money in this economy. The manager of the representative firm/market portfolio will then use the money obtained from households to invest in tangible capital and money balances across the separate divisions within the market portfolio where it will become part of the capital stock in the next period.\(^6\) Our focus will be on the representative agent’s savings decision in the market portfolio and set aside their consumption decision. The assumption that consumption goods are pre-ordered closes the consumption goods factory and store as they are in the standard CAPM. Tangible and money capital are free to vary implying that the investment goods factory (with excess capacity) is open.\(^7\) To complete the model it is necessary to describe the preferences of the representative saver/investor in terms of expected income, \(E(Y)\), and risk, \(\sigma(Y)\), on their savings.

In this connection the standard expected utility function for the representative risk averse saver/investor (assuming non-satiation) is given by:

\[
E(U) = U[ E(Y), \sigma(Y) ] \\
U'[E(Y)] > 0 \quad U''[E(Y)] \leq 0 \quad U'[\sigma(Y)] < 0 \quad U''[\sigma(Y)] \leq 0 \tag{7}
\]

Taking the total differential of expected utility in (7) and setting it equal to zero yields an indifference curve in terms of \(E(Y)\) and \(\sigma(Y)\); namely,

\(^6\) To continue with the agrarian example in footnote 3, think of households as receiving money from the representative farm in \(t=0\) for factor services provided over the period \(t=-1\). At \(t=0\) they use this money to pay for the consumption goods pre-ordered at the beginning of \(t=-1\) that will be consumed during \(t=1\). They also pre-order consumption goods to be produced in \(t=1\) but consumed in period \(t=2\). The remaining money (if any) in \(t=0\) will be invested in the market portfolio for possible land purchases from the government. Money is held by households (cash-in-advance motive) at the beginning and end of a period, and by the representative firm and government (money-in-the-production function) during the period.

\(^7\) These assumptions are made to facilitate a comparison of a 100 percent reserve banking system and a fractional reserve banking system on the allocation of productive investment without the added complications of inflation. We want to show that even without full-employment and inflation, money creation results in a suboptimal allocation of investment. With consumption predetermined and the investment goods factory (with excess capacity) open, we eliminate any inflation associated with a transition to a fractional reserve banking system and restrict the analysis to emphasizing the increased volatility in future output that is set in motion when banks facilitate the financing of risky investment with newly created money. This point is graphically illustrated in Figures 2 and 4 below. If the investment goods factory were closed (i.e., full employment) then money creation by banks would obviously result in inflation in the store selling investment goods. This would obviously result in a redistribution of the ownership shares on the market portfolio towards banks and away from household saver/investors reducing the latter’s expected utility even further.
\[ dE(U) = U'E(Y)*dE(Y) + U'\sigma(Y)d\sigma(Y) = 0 \quad (8) \]

The slope of this indifference is positive since

\[ \frac{dE(Y)}{d\sigma(Y)} = -\frac{U'\sigma(Y)}{U'E(Y)} > 0 \quad (9) \]

It is traditional to assume that indifference curves in \( \sigma(Y), E(Y) \) space are convex as displayed by IC in quadrant 1 of Figure 1. Convexity implies that savers/investors require ever higher expected income in compensation for incremental increases in risk in order to keep their expected utility constant.  

With these assumptions on tastes and technology consider first in this thought experiment a financial system where banks are initially required to maintain 100 percent reserves against their deposit obligations and households alone through their saving/investment in the market portfolio provide the financing for the risky capital investment in the economy. With the return generating process of firms given by (5) and (6) and household preferences given by (9), the initial allocation of real investment, the production of expected income, and the production of risk are given by \( K_0', E(Y)_0', \sigma(Y)_0' \) for the beginning of the period \( t=0 \) in Figure 1. This equilibrium stock of private risky capital \( K_0' \) of firms is seen in the figure to be Pareto optimal in the sense that the marginal rate of transformation (given by the slope of TC) of risk for expected income generated by the real investments of the representative

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8 An intuitive demonstration of convexity of indifference curves is the following. Consider a point A on an upward sloping indifference curve involving relatively small amounts of \( \sigma(Y) \) and \( E(Y) \). Since \( E(U) \) is assumed to be a negative function of \( \sigma(Y) \) with a negative second derivative while \( E(U) \) is a positive function of \( E(Y) \) with a negative second derivative, the derivative \( dE(Y)/d\sigma(Y) \) at point A follows - \( U'\sigma(Y)/U'E(Y) \) - “small”/“large” ~ “small". In other words, \( dE(Y)/d\sigma(Y) \) is relatively small at point A and the indifference curve while upward sloping is relatively flat. Next consider a point B further up the positive sloped indifference curve involving large amounts of \( \sigma(Y) \) and \( E(Y) \). Again we have \( dE(Y)/d\sigma(Y) = -U'\sigma(Y)/U'E(Y) \) but now -\( U'\sigma(Y)/U'E(Y) \) ~ “large”/“small” ~“large” and the indifference curve is relatively steep. Thus as we move along an upward-sloping indifference curve from A to B in a northeast direction the value of \( d(EY)/d\sigma(Y) \) increases indicating that investors require ever increasing amounts of \( E(Y) \) for every unit increase in \( \sigma(Y) \) to keep their expected utility constant.
firm in the market portfolio is equal to the marginal rate of substitution (given by the slope of IC) of risk for expected income in the indifference curve of the representative saver/investor at \( M' \).

Does this version of the CAPM have anything to say about future business cycles? To answer this question observe that the beginning of the period capital stock \( K'_0 \) generates a probability distribution (assumed for convenience to be normal) with mean \( E\{Y\}_0 \) and standard deviation \( \sigma\{Y\}_0 \). On the assumption of rational expectations, it will be from this probability distribution that the actual end of period income \( Y'_1 \) to saver/investors will be drawn. The spread of this probability distribution describes both the utility maximizing potential future fluctuations of saver/investor income \( Y'_1 \), and future total output \( Q'_1 \) when \( Q \) is generated by a linear homogeneous production function with constant factor shares. In this model saver/investors freely choose the volatility of future business cycles when they choose the level of current savings to finance the capital investment \( K_0 \) in maximizing their expected utility. This is graphically described in Figure 2. In part A of the figure we reproduce quadrant 1 from Figure 1 with the normal distribution drawn in at the initial equilibrium of \( M' \) generating \( E\{Y\}_0 \) and \( \sigma\{Y\}_0 \) in period \( t=0 \). In part B we plot the possible realized \( Y'_1 \) as a linear function against the realized total output \( Q_1 \) generated by a Cobb-Douglas production function \( Q_1 = A[K'_0 N_0^{1-\alpha}] \) where \( N \) is fixed for the beginning of the period \( t=0 \) and \( A>0 \) represents total factor productivity. When \( A=1.0, Y_1 = E\{Y\}_0 \). The slope of the line translating \( Y_1 \) into \( Q_1 \) is \( \alpha \), or, capital’s share in total output. The horizontal dashed lines represent \( k\sigma\{Y\} \) standard deviations on both sides of the mean of \( Y_1 \) which when reflected back to \( Q_1 \) via the construction line with slope \( \alpha \) represents the magnitude of future fluctuations in total output \( Q_1 \). Thus the distance between \( Q'_1 \) and \( 'Q'_1 \) represents the varying degrees of future recession outcomes associated with \( K'_0 \) while the distance between \( Q'_1 \) and \( "Q'_1 \) represents the future cyclical expansions within the \( k\sigma\{Y\} \) bands. A clockwise (or counterclockwise) rotation of the saver/investor indifference curve reflecting changes in risk aversion in this static model will change these bands and the associated distributions describing business cycles.
From this initial Pareto efficient equilibrium now consider in this thought experiment an economy where the privately owned banks are only subject to a fractional reserve requirement; e.g., 10 percent of deposit obligations. We still assume the size of the central bank’s balance sheet is fixed. The banks now have money in the form of excess reserves which they can use to invest in the CAPM market portfolio provided the expanded market portfolio with new productive capital generates the expected return/risk ratio required by the private bankers. At the same time the government creates a costly and subsidized deposit insuring agency and regulatory agency that imposes capital and liquidity requirements in order to safeguard deposit money. The banks now have an even greater and well-known incentive to invest in the risky market portfolio because of the put option embedded in the deposit insurance which serves to lower the required rate of return of depositors. Banks will now fund the diminishing expected return and increasing risk real investment underlying the market portfolio with newly issued deposit money which is no different than the deposit money already held by individual household savers. With a lower cost of capital the representative firm in quadrant 2 of Figure 1 will now increase their capital investment from $K'_0$ to something like $K'_0 + \Delta K = K'_*$. Total capital investment of the representative firm underlying the market portfolio will now be financed by the income saved by the representative household at the beginning of the period plus the new deposit creation of banks. The effect on the financial system of this additional financing that allows risky capital accumulation to grow to $K'_*$ is described in Figure 3. There it can be seen in quadrants 2 and 3 of the figure that the additional productive investment generates an increase in expected income to $E(Y)_0$ and an even greater increase in risk to $\sigma(Y)_0$. Since the additional risky investment generates more expected income and even more risk, the economy moves further along the concave expansion path/ transformation curve TC to some point like $M^*$ in quadrant 1. At point $M^*$ the indifference curve of the representative saver/investor is no longer tangent to the transformation curve and lies everywhere below the
indifference curve that is tangent to TC at point M’. In other words, when investment is \( K_0 \) the representative firm is generating too little expected income per unit of risk in their productive investment decisions than saver/investors require in their personal trade-off between expected income and risk as reflected in their indifference curve.

(Put Figure 3 here)

Could the representative saver/investor undo this excessive risky capital investment financed by new deposit money at M* by simply reducing their personal investment in the market portfolio and get back to their expected utility maximum at M’? If they owned and controlled the money creating banks they could get back to M’ and substitute bank investments in the market portfolio for their own personal investment in the market portfolio. However if this were the case why become fractional reserve banks in the first place and then incur the expenses associated with deposit insurance and government regulation? Nor could the reason be that deposit insurance makes their investment in the market portfolio through banks safer than their direct investment in the market portfolio since they will ultimately bear any real investment losses on the part of banks as taxpayers. On the other hand if banks were privately owned (which they originally were and to a certain extent continue to be) or more likely management controlled due to agency problems associated with the separation of ownership and control, then private owners and/or managers would have an incentive to work towards legislation allowing fractional reserve banking.\(^9\) Any investment these banks would make in the market portfolio would then move the production of risk and expected return further away from M’ along the transformation curve TC to a point like M* > M’. At the new market portfolio M*household savers and

\(^9\) Management control that included the granting of excessive compensation agreements linked to risky investments has been well-documented in the Great Crisis literature; see Stiglitz (2011) and Prager (2012). Bonus plans in some banks take up as much as one-half the after-tax profits of the bank making manager’s implicitly large equity holders. Moreover in their mortgage business bankers were compensated in terms of the number and dollar amounts of mortgage deals they arranged with little regard for the quality of the credit extended.
bankers would share the E(Y) and \( \sigma(Y) \) in the same proportion as their relative share of investment in the market portfolio. To illustrate this let \( \gamma \) (for \( 0 < \gamma \leq 1.0 \)) be the proportionate share of investment in the market portfolio put up by household savers and \( (1-\gamma) \) be the share put up by the privately owned banks. On the assumption that risk increases linearly with investment (i.e., \( g''(K)=0 \) in equation (2) above), this sharing would be represented by a point somewhere along a ray emanating from the origin of quadrant 1 of Figure 3 to the new \( M^* > M' \) on curve TC. This sharing of \( \text{E}(Y) \) and \( \sigma(Y) \) can be illustrated in Figure 3A. Points on the ray OA in the figure lying closer to the origin would represent a relatively smaller share of investment in the market portfolio owned by the representative saver/investor while points closer to \( M^* \) would represent a relatively larger share. In the figure \( \gamma \text{E}(Y) \) and \( \gamma \sigma(Y) \) would then be the shares of expected income and risk belonging to the representative household saver/investor with indifference curve IC* when total investment in the market portfolio is \( M^* \). The indifference curve IC* touching or going through the sharing point lying on ray OA is now everywhere below the curve IC’.

(Put Figure 3A here)

In any event the larger amount of capital investment \( K_0^* \) while increasing the expected income of firms in the economy also increases the amplitude of future business cycles even more. This can be seen in parts A and B of Figure 4. In part A of the figure the probability distribution at point \( M^* \) associated with \( K_0^* \) capital investment is now more spread out than the distribution at point \( M' \) associated with the \( K_0' \) level of investment. Through the Cobb-Douglas production function this greater variability in expected income on capital of household saver/investors and banks is reflected in greater variability of realized output \( Q_1 \) at the end of the period. This can be seen in part B of the figure where the distance between \( ^1Q^* \_1 \) or \( ^nQ^* \_1 \) and \( Q_1' \) associated with \( K_0^* \) is greater in magnitude than the fluctuations associated with the Pareto efficient capital investment of \( K'_0 \) described in Figure 2.
This non-optimal and excessive level of capital investment by firms in t=0 is not the result of capital regulations, or changes in the risk perceptions and risk aversion of the banks, or changes in the value of collateral and/or net worth by borrowing firms, or changes in bank stock valuations, or mark to market accounting; arguments in the literature that link present day bank lending to increased amplitude of the business cycle. The problem in a financial system with fractional reserve banking is more fundamental. The ability of the banks (along with an accommodating central bank) to finance productive investment in the market portfolio with new deposit money acts as a negative externality for the saving/investing households. In this CAPM world saver/investors draw up an investment plan in t=0 that maximizes their expected utility. Embedded in that plan is a probability distribution from which under rational expectations future investor income and aggregate output is drawn in period t=1. In this sense the future fluctuations in income and output are the natural result of saving and investment in a risky economic environment where productive investment is allocated according to the 2-parameter CAPM. In other words, business cycles are a freely chosen and natural outcome of a private utility maximizing saving/investment decision when the risky capital investments of firms are financed with the saving of households. When financing is provided by the savings of households and the money creation of banks, the real capital investment underlying the market portfolio creates a probability distribution around future expected income and output that has a greater variability than the utility maximizing one chosen by saving/investing households when banks are subject to 100 percent reserves. In this sense fractional reserve banks financing risky productive investments create excessive risk in the form of business cycles with greater amplitude.

Banks in a fractional reserve system are not the only vehicles for excessive risk creation and volatile fluctuations in an open economy. Countries with large trade surpluses (the so-called global savings glut)
that in turn invest their surpluses in the risky sector of deficit countries can create the same externality for domestic saver/investors in the deficit countries. In a way these foreign saver/investors of surplus countries bear part of the cost of exporting business fluctuations to the deficit countries due to the repercussion effect of the greater volatility of their future exports and GDP. The U.S. has been somewhat lucky in this regard in that many Asian countries with substantial trade surpluses in the past have chosen to invest their surpluses in the risk-free sector\(^\text{10}\).

\section*{IV. Summary and Conclusions}

To conclude, it has long been known that the maturity transformation that is the business of present day fractional reserve banks exposes the system to financial instability and amplifies business fluctuation. In good times banks fund too many marginal projects at low costs of capital, and in bad times their flight to safety raises the cost of capital and precludes the funding of projects that in more normal times they would fund. Many economists attribute this amplification to a number of factors including herding, procyclical changes in monetary policy, countercyclical changes in risk perceptions and risk aversion, procyclical changes in the value of collateral and borrower net worth, procyclicality in lending induced by various Basle Accord capital requirements, and procyclical changes in bank share valuations that change the composition of bank portfolios. These factors can and do amplify business fluctuations. However, our criticism of the present day fractional reserve banking system with government subsidized deposit insurance and expensive regulation is more fundamental. In this paper we use the CAPM framework to show in a thought experiment how changes in the institutional

\footnote{\textsuperscript{10} There were some indirect effects of Asian and OPEC trade surpluses that contributed to the recent U.S. crisis even though these countries primarily invested their surpluses in Treasury securities. There is evidence that Asian and OPEC surpluses were invested in European bank deposits. These deposits provided the financing for European investments (particularly in asset backed securities) in the U.S. in the run-up to the crisis. A second indirect effect was that the massive inflows of capital into Treasury securities by Asian and OPEC countries lowered interest rates which in turn spread throughout the U.S. economy stimulating investment in housing. For an excellent review and discussion of the role capital imports from various groups of countries played in the run-up to the U.S. crisis see Bertaut et al. (2011).}
arrangements of going from a 100 percent reserve banking system to a fractional reserve banking system with government deposit insurance will increase the available funding for increasingly risky productive investments. These investments will increase growth. However, they will also amplify the business cycle.\textsuperscript{11} To the best of our knowledge this is the first time a CAPM type model with rational expectation and a linear homogeneous production function has been brought together to describe an expected utility maximizing business cycle. We argue that when capital investment is determined within a CAPM type model, the resulting allocation of productive investment is not Pareto efficient under a fractional reserve banking system even in the absence of inflation and full employment. The banking system facilitates the creation of money that can and does reduce the cost of capital to firms resulting in an increase in positive NPV investment projects. The end result is that productive investment is carried beyond the socially optimal point. This excessive productive investment associated with fractional reserve banking generates a lower return to risk ratio than the ratio associated with the maximum expected utility reflected in the indifference curves of saver/investors at the optimal level of investment when banks are subject to 100 percent reserves. More importantly excessive productive investment today will sow the seeds of greater variability in income and output tomorrow.

Of course moving to 100 percent reserve banking would not eliminate the financial amplification of the business cycle, a point emphasized by Simons back in the 1930’s. Non-bank financial institutions and individual savers investing in speculative asset markets are subject to the same swings in risk

\textsuperscript{11} There is some evidence that both economists and non-economists in the U.S. are prepared to give up cyclical expansions in order to eliminate recessions. In this connection a survey study of economists and non-economists by Shiller (1996, pp.22-23) found that 83 percent of non-economist endorsed a counter-cyclical policy that would eliminate recessions but also eliminate expansions. For professional economists 84 percent favored a counter-cyclical policy that equally eliminated recessions and expansions. This is a high degree of agreement for both groups and one of the few questions in the survey where economists and non-economists were in very close agreement. What is also interesting is that the survey was not taken in a recessionary period with high unemployment rates as we have had in the crisis of 2007-2012; but instead taken in a period of good times when the U.S. economy was experiencing better than average real GDP growth of 3.7 percent, an unemployment rate of 5.4 percent and falling, and a labor participation rate of 66.9 percent and rising (all data taken from the Economic Report of the President).
perceptions and risk aversion as banks. In our model this is represented by a clockwise or counter-clockwise change in the indifference curves of investors. The only difference is that with 100 percent reserve banking, household savers choose with their portfolio decisions based on their taste for risk and expected return the volatility in future real economic activity that maximizes their expected utility. The goal of 100 percent reserve banking presented in this paper is the same as it was in the original “Chicago Plan”; namely, to safeguard deposit money at a relatively less expensive price than current regulation, and, and more importantly, moderate the amplifying effect of the banking system on the real economy. However whether or not the policy of dampening expansions as well as recessions by separating deposit banking from financial intermediation is one that will be supported by the legislative branches of government subject to outside political pressures remains to be seen.

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**REFERENCE**


Figure 1

Pareto Efficient Investment in a CAPM Model
Figure 2

Business Cycles in a CAPM Model

\[ Q_1 = A \left[ K_0^\alpha N_0^{1-\alpha} \right] \]
Figure 3

Pareto Efficiency under Alternative Banking Systems in a CAPM Model
Figure 3A

Pareto Efficiency under a Fractional Reserve Banking System
Figure 4

Business Cycles under Alternative Banking Systems in a CAPM Model

\[ Q_1 = A \left[ K_0^\alpha N_0^{1-\alpha} \right] \]