Financial Crisis and Economic Depression: 'Post Hoc Ego Propter Hoc'? Implications for Financial Asset Valuation and Financial Regulation.

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Abstract:

It was more than four decades ago when James Tobin stressed the fallacy underlying the Latin motto "Post Hoc ergo Propter Hoc". His point was that a causal relation, back then between money and income, must rely on something more than time precedence. However, this fact has not received proper attention, contemporary literature explains the current depression from the financial crisis which preceded it and its' resolution depends on proper rules of financial regulation. This paper argues different, the current depression resulted from weak growth reflecting weak profitability. We show that under this reasoning financial crisis episodes are highly probable, serving as the trigger of depressions. The latter implies that financial assets valuation depends on a highly variable required rate of return, contrary to the postulations of modern investment theory. Highly volatile asset returns places financial markets in a world of true uncertainty as opposed to calculable risk. This shred of realism gives different meaning and limitations to financial regulation. Any regulatory policy monitoring liquidity or solvency ratios can prove insufficient as zero or weak growth turns unstable, an event usually preceded by increased amounts of speculative investments. Therefore, financial regulation should focus on what kind of assets financial intermediaries can sell and what kind of assets banks, pension funds, corporations and the broad public can hold to protect taxpayers from future bailout costs at least in part.

Keywords: Crisis, Financial Crisis, Asset Valuation, Rate of Profit, Rate of Profit of Enterprise, Financialization.

JEL classification: E11, E32, G12

Introduction:

Following the dramatic times of subprime market failure in the U.S. extensive debates are taking place on how we can avoid similar events in the future. The postulation underlying these discussions is that financial crisis emerged from the structure of the post Bretton-Woods financial system and the depression which followed was actually caused by financial crisis itself. This type of reasoning appeared both in mainstream and heterodox economics. Mainstream economists are elaborating on the idea of "moral hazard" (Farhi & Tirole 2009) and heterodox economists on the "lethal mix of consumer credit with investment banking" (Lapavitsas 2009).

Reasonably the discussion turned to financial system regulation policies. Suggestions on: separation of credit from investment banking, implementation of a new Bretton Woods treaty ensuring and regulating capital flows from surplus to deficit countries and regulation on bank executive bonuses are some of the ideas appearing in literature. Following the academic research legislators and policy makers are undertaking financial regulatory measures aiming to remove the causes of the crisis, thereby establishing the prerequisites for sustainable growth.

In the meantime, however, the crisis is taking its' own course. Despite trillions spent to avoid meltdown in global financial markets, stagnation prevails in major economies, whereas sovereign debt crisis haunts peripheral countries in the EU south and Latin America, recently threatening also BRIC countries like India and Brazil. The duration and severity of the crisis has led economists like Paul Krugman (Krugman 2012), Bradford de Long and Lawrence Summers (De Long & Summers 2012) to acknowledge that we are facing a depression.

Contrary to the majority opinion in the profession, this paper argues that major financial crisis episodes are manifestations of deteriorating conditions in production

and growth, and not the opposite. This causal link can explain the subprime market failure and asses the likelihood of major financial crisis episodes in the current phase.

Following the subprime market collapse banks were given vast state funds through capital injection and asset purchases, while enjoying unlimited central bank accommodation usually against low-grade collateral. The greatest part of these funds, however, were either held as "safety cushion" against further deterioration of bank asset side and depository base, or to finance corporate and sovereign bond issues (because it is acceptable collateral for central banks), or otherwise to support short-term investments in equities and derivatives. Only a small part extended corporate and consumer lending. This is not surprising, since in a depression corporations are looking for means of payment to stay in business so they lack proper collateral, whereas households also lack creditworthiness at low levels of wages and employment. In light of the above, we analytically investigate major financial crisis episodes in the mix of fragile, zero or weak, growth trends with bank exposure to loans, bonds, equities and derivatives. In this context the ongoing gradual relinquishment of central bank accommodation policies may play an important part.

Generalizing, this paper analytically explores financial crisis as reflection of weak growth which in turn implies weak profitability. In short financial panics are the trigger and not the cause of depressions. Important implications on crisis theory, economic policy, finance and financial regulation arise from this reasoning. Financialization, in this context, develops from the inherent contradictions of profit motivated growth as elaborated in Marx (Stravelakis 2012). Furthermore, the idea that in normal accumulation financial crises are shallow and rare has important implications for finance theory, asset pricing and financial regulation. In this regard we will theorize on empirical evidence initially elaborated by Robert Shiller (Shiller 1980) who showed that volatility in dividends cannot explain volatility in stock

prices. If however equity prices directly reflect corporate sector fundamentals as elaborated here a more realistic view of equity markets appears. This reasoning encompasses also derivatives and asset backed securities valuation as elaborated bellow. Finally in a world of true uncertainty as opposed to calculable risk financial regulation assumes different meaning and limitations. The focus moves from monitoring liquidity and solvency ratios to regulating what kind of assets financial intermediaries can sell and what kind of assets banks, pension funds, corporations and the broad public can hold.

The paper structure is as follows: The first section (I) presents a simple framework which imitates the growth pattern in the period following the great stagflation of 70 s' and its' contradictions. The second section (II) explores financial crisis episodes with regard to equities, derivatives and asset backed securities. The third (III) section comments on the analytical findings focusing on financial regulation and the last section summarizes.

I. The Aftermath of the Great Stagflation, Financialization and Growth:

Persistently declining profit rates characterized post war capitalism. This led to a depression in the 1970 s' referred in literature as the "great stagflation". Severe labor market deregulation and wage suppression was the response to the crisis. State policies demolished the post war welfare state and in turn reduced the wage share.

However, no vast destruction of capital took place and so profit rates stabilized but never increased to growth sustainable levels. In order to restore growth interest rates declined to historical lows, supported by low central bank intervention rates and severe deregulation of the financial sector. The aim was to boost the rate of profit of enterprise[1] and enhance corporate investment. Mild growth returned, but increased leverage ratios triggered an unprecedented growth of the financial sector. Banks

[1] The rate of profit of enterprise is equal to the rate of profit minus the rate of interest.

extended their balance sheets to exceptional levels based on moderate corporate deposits, while undertaking new forms of debt and supporting new assets, markets and non-bank financial intermediaries. Finance fused in all aspects of life and economists named the phenomenon: financialization of capital.

The model which follows imitates the growth pattern in the years following the great stagflation. However, contrary to a good part of financialization literature, in our context, the increased weight of finance is triggered by low profitability and is also limited from it. In other words when financial expansion exceeds a certain limit imposed by the rate of profit the system collapses. This understanding of financialization removes the focus from the variety of assets and debt recipients and places it in the underlying conditions of production and growth.

Some introductory remarks are appropriate at this point. Our model rests on the contention that profitability is the driver of growth. This implies of course that investment depends on profitability[2]. Because capitalism is an inherently dynamic system, where balance is reached through the succession of boom and crisis periods, the model is formulated in ratios and rates of growth rather than variable levels (Goodwin 1967[3]). In this regard the basic assumption is that the rate of growth of capital advanced (investment over total capital advanced) depends on the net

[2] Although this reasoning may seem obvious it is not, at least for economists. A good part of heterodox literature argues that corporate investment slowdown, following the depression of the 1970 s', is independent of profitability. In this regard they explain financialization and the current crisis by applying monopoly theory in relation either to under-consumption arguments, or to the incentives of a rentier strata emerging from monopoly dominance. Below I make express reference to this literature a complete survey, however, is included in Tome 2011.

[3] The sited paper is a path-breaking dynamic formulation of an economic model in terms of ratios and growth rates. Equilibrium is reached through the equalization of growth rates rather than variable levels.

(corporate) rate of profit, the rate of savings and the rate of effective demand. The latter relies on the share of corporate profit out of total gross profit and the "leverage ratio" as shown below (Eq. I.4'). Furthermore, we make two additional introductory assumptions: 1) production takes time capital is advanced at the beginning of the production period whereas profits are realized at the end of the period and 2) corporate retained earnings are equal to total social savings. The second assumption (2) suggests that total wage, dividend and interest incomes are fully consumed. Notation and definitions appear in brief following model equations in the main text and are fully laid out in appendix 1 for easy reference.

Since profitability is the driver of investment a modified Cambridge equation[4] (Pasinetti 1963, Marx 1893) is suitable to picture growth. The equation reads as follows:

$$\frac{(K_t - K_{(t-1)})}{K_{(t-1)}} = s \cdot r \cdot \frac{y_t}{y_{\max}} \quad Eq.(I.1)$$

Equation (I.1) tells us that the rate of growth of capital advanced (K) depends on the rate of savings (s), the gross rate of profit (r) and the ratio of the share of corporate profits (NP) to total gross profits (Pr) divided by its' maximum value. The latter measures denoted by: (y=NP/Pr) for the share of corporate profit and (y max) for the maximum value. The first two elements (s, r) on the right hand side constitute the typical Cambridge equation. Peculiarity of (I.1) comes from the ratio (y/y max), which implies that growth depends on the net (corporate) rate of profit: $nrop_t = \frac{NP_t}{K_{t-1}} = r \cdot y_t$ rather than the gross measure: $r = \frac{\mathrm{Pr}_t}{K_{t-1}}$. Furthermore no

[4] The Cambridge equation is attributed to Pasinetti 1963, however here it is used in the sense presented in Capital VII i.e. the reinvestment of surplus value in expanded reproduction.

assumption equalizing investment with savings is made, instead a positive leverage ratio equal to ($1/y_{max}$=a/r, a>r) appears. Proof of this last point follows.

Assuming constant profit (r) and interest (i) rates implies that the leverage ratio (capital over equity) is constant as well. For y max=r/a<1, s=i/r[5] constant and assuming further that variations in equity (EQ) are equal to retained earnings: $EQ_t - EQ_{t-1} = s \cdot NP_t$, equation (I.1) reads as follows:

$$\frac{(K_t - K_{(t-1)})}{K_{(t-1)}} = \left(\frac{s}{y_{\max}}\right) \cdot \left(\frac{(NP_t)}{K_{(t-1)}}\right) \Rightarrow K_t - K_{(t-1)} = \left(\frac{a}{r}\right) \cdot (EQ_t - EQ_{(t-1)})$$

Consequently it holds:

$$K = \left(\frac{a}{r}\right) \cdot EQ \Rightarrow \frac{K}{(EQ)} = \frac{a}{r} \, (Eq.\, I.2)$$

Equation (I.2) indicates also that parameter (a=Pr/EQ) is the gross return on equity. If (a=r) this implies that capital advanced equals equity or in other words that total debt is zero, which at this level of aggregation means that total investment always equals total savings (see initial assumption 2 above and equation I.4 below). For a>r, which is equivalent to a positive rate of interest (see equation I.8 below), excess demand appears in the event of corporate profits and excess supply for corporate losses[6]. This last result is made evident in equation (I.4') below.

[5] The definition of the rate of savings suggests that corporations adjust retained earnings to the rate of interest. High interest rates imply a high retention ratio and the opposite.

[6] I have shown elsewhere (Stravelakis 2012) that for a sufficiently high rate of profit and variable interest rates, the latter determined by borrower lender competition, secular or chaotic growth prevails. In this context periods of excess demand are followed by excess supply the two motions dynamically cancelling each other. The model elaborated here implies deficit financed growth because of the constant, suppressed interest rate assumption, which in turn implies low profit rates.

Motivation behind this growth pattern becomes clear from further modification in equation (I.1) in light of (I.2). Since the product ($r \cdot y_t$) is the net corporate rate of profit (I.1) takes the following form:

$$\frac{(K_t - K_{(t-1)})}{K_{(t-1)}} = s \cdot \left(\frac{a}{r}\right) \cdot \left(\frac{(NP_t)}{K_{(t-1)}}\right) = ROE_t (Eq.\ I.3)$$

Where, ROE is net return on equity ($ROE_t = \frac{s \cdot NP_t}{EQ_{t-1}}$). In a world of roughly constant gross profit rates, like the times following the great stagflation, corporations, unable to influence the rate of profit, turned to a strategy aimed to increase returns on their own capital. Banks on the other hand came before two options: to raise lending rates near profit rates keeping borrowing roughly constant, or to suppress interest rates and extend their asset side. I have argued elsewhere (Stravelakis 2012) that if interest rates are left to borrower-lender competition in a low profit rate environment then they will rise to rate of profit levels turning the rate of profit of enterprise to zero. Banks picked the most profitable option, offering lower interest rates and lending grew from 1980 onwards.

One final assumption suggesting that change in total debt is equal to total investment minus total savings closes the model. In our notation this reads as follows:

$$L_{(t+1)} - L_t = K_t - K_{(t-1)} - s \cdot NP_t (Eq.\ I.4)$$

Where (L) denotes aggregate borrowing[7]. If debt increases ($\Delta L>0$) this implies excess demand, if it declines ($\Delta L<0$) excess supply. Dividing both sides of (I.4) with (K_{t-1}) we can rewrite the relation in terms of ratios:

$$\frac{(L_{(t+1)} - L_t)}{K_{(t-1)}} = \left(\frac{a}{r} - 1\right) \cdot s \cdot \frac{(NP_t)}{K_{(t-1)}} = \left(\frac{a}{r} - 1\right) \cdot s \cdot r \cdot y_t (Eq.\ I.4')$$

[7] The time subscript (t+1) in (I.4) means that mobilization in excess of savings is reflected in next years' debt. In other words corporations spend their own capital before drawing down new debt facilities.

Equation (I.4'), mentioned in passing in various occasions above, indicates the deficit financed growth pattern underlying our model which approximates the actual growth pattern experienced during the last thirty years. Because (a) is assumed greater than (r), the corporate profit rate triggers excess demand, which accelerates investment but also debt growth. The opposite holds in the event of corporate losses. In order to assess the sustainability of this growth pattern we move to model solution.

Equations I.1-I.4 together with the definition ($y_t = (NP_t)/[Pr]_t = (1 - i \cdot L_t/[Pr]_t$)) (see appendix 1) solve the model as elaborated in appendix 2. The following non-linear difference map determines the time path of the share of corporate profit and thereby the rate of growth:

$$y_{(t+1)} = \left(1 - \frac{(a \cdot r)}{((1+r) \cdot r \cdot i + (r-i) \cdot a)} \cdot y_t\right) \cdot \frac{((1+r) \cdot r \cdot i + (r-i) \cdot a)}{(r^2 \cdot i)} \cdot y_t (Eq.\ I.5)$$

Equation (I.5) is a discrete time "logistic map" (May 1975) well-known and broadly used in biology to picture population dynamics. The following convenient forms (also derived in appendix 2) are helpful in analyzing the complex dynamics of (I.5):

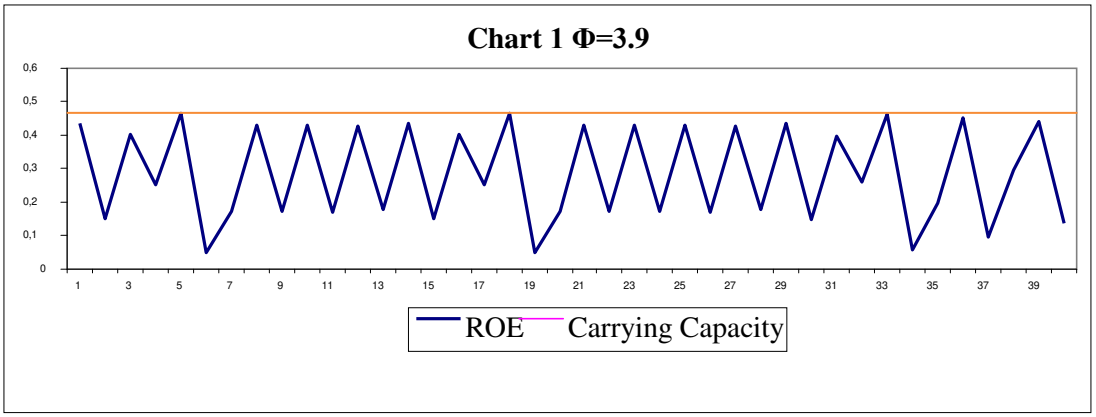
$$z_{(t+1)} = (1 - z_t) \cdot \varphi \cdot z_t (Eq.\ I.6)$$

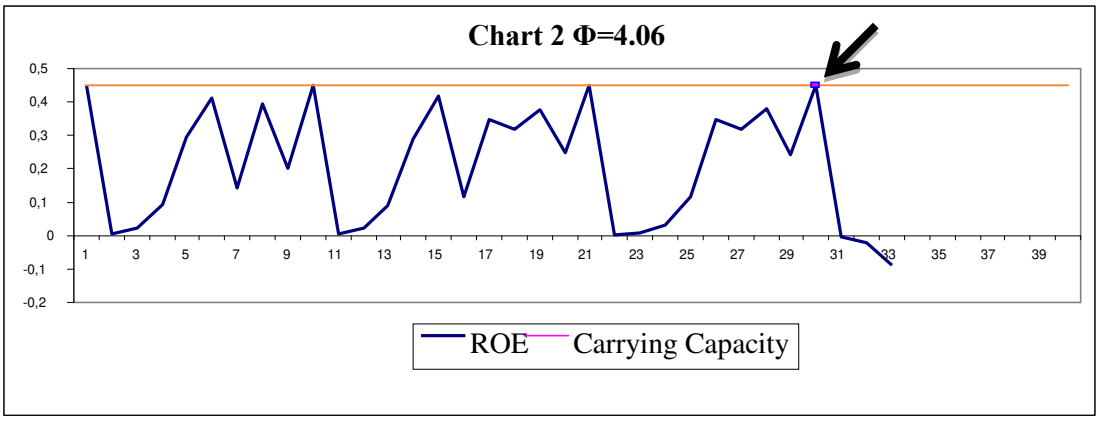
$$ROE_{(t+1)} = \left(1 - \left(\frac{1}{(i^2 \cdot \varphi)}\right) \cdot ROE_t\right) \cdot ROE_t (Eq.\ I.7)$$

$$\varphi = \frac{((1+r) \cdot r \cdot i + (r-i) \cdot a)}{(r^2 \cdot i)}, ROE_t = i^2 \cdot \varphi \cdot z_t$$

Equation (I.6) is the typical "logistic map" format where dynamics depend on the value of parameter (φ). But the most intuitive form is equation (I.7) where the term $i^2 \cdot \phi$ denotes the system "carrying capacity", in other words the maximum value ROE can take. For parameter values (φ<4) maximum ROE remains below carrying capacity and the system exhibits secular or chaotic growth. But for φ>4 ROE at some

point pierces the maximum value following which the system collapses. These two states appear in the simulation charts which follow:





In Chart 1 the value of φ is 3.9 and although the rate of growth follows a chaotic pattern involving milder or more severe fluctuations the value of ROE never exceeds "carrying capacity". In the second chart φ=4.06, although a chaotic pattern appears again after several fluctuations the value of ROE slightly exceeds "carrying capacity" (point marked on chart), following this the rate of growth collapses, return on equity receives negative values, indicating corporate losses, which keep coming period after period until meltdown.

What are the underlying economics explaining stable or semi-stable fluctuations and alternatively collapse? To understand the mechanics we will use a second property of the logistic equation that of competition. The main idea underlying the biological application of the equation is that limited resources constrain population

growth. In other words a population competes for survival until it exhausts subsistence means following which it declines. In our context this means a limit value beyond which ROE begins to drop. We can determine this value rewriting (I.7) as follows:

$$\frac{(ROE_{(t+1)} - ROE_t)}{(ROE_t)} = \left(\frac{1}{i^2}\right) \cdot ((\varphi - 1) \cdot i^2 - ROE_t) (Eq.I.7')$$

The greater the value of the parameter ($(\phi - 1) \cdot i^2$) the greater the value ROE can take before declining. Therefore it is reasonable for corporations and banks to seek a rate of interest that will maximize ($(\phi - 1) \cdot i^2$). The form has a maximum (derived in appendix 3) for:

$$i = \left(\frac{1}{2}\right) \cdot \frac{(r \cdot a)}{(a - r)} (Eq.I.8)$$

Equation (I.8) suggests that positive interest rates appear only for a>r justifying the assumption made so far. However, our reasoning supports further elaboration on parameter values. Since the strategy presented is meaningful for a positive rate of profit of enterprise, then there exists a minimum leverage ratio required for growth. The following expression specifies the minimum:

$$r - \left(\frac{1}{2}\right) \cdot \frac{(r \cdot a)}{(a - r)} > 0 \Rightarrow a > 2 \cdot r \Rightarrow from(Eq.I.2) \Rightarrow \frac{K}{(EQ)} > 2 (Eq.I.9)$$

From (I.9) it is clear that the strategy applies for leverage ratios greater than two (2), otherwise corporations will have no reason to undertake production risks.

Furthermore, the growth rate associated with a particular rate of profit of enterprise is sustainable for ($\phi \leq 4$). Substituting (I.8) into Eq. (I.7) (definition of φ) above the following sustainability condition appears:

$$\varphi = \frac{(1 + a - r)}{r} < 4 \Rightarrow a < 5 \cdot r - 1 \Rightarrow from(Eq.I.9) \Rightarrow r > \frac{1}{3} (Eq.I.10)$$

Equation I.10 tells us that sustainable growth prevails for profit rates greater than a certain minimum (in our case 1/3). Keeping in mind that the need to suppress interest rates comes from low profit rates in the first place, it follows that the growth path prevailing under this strategy is either unsustainable in the first place, or turns unsustainable following a slight decline in the rate of profit or the rate of interest. Moreover, dynamics pictured in Chart 2, where sudden collapse follows a long period of secular growth, demonstrate that instability can remain hidden for long making things look stable on the surface.

This superficial stability was the basis of mainstream contentions that unimpeded growth would persist for the foreseeable future. It was only a minority of heterodox economists who raised concerns on the sustainability of deficit financed growth (Godley 1999, Papadimitriou et.al 2004). However, mainstream approaches insisted that economic expansion was "structural" and unrelated to rising demand (Phelps 2000). As usual policy makers concurred with the mainstream (Greenspan 2000) and the deficit financed accumulation pattern continued unchecked until the outburst of the crisis in 2007.

But there is more to read out of this simple framework. From equations (I.4), (I.7) and the identity (y=NP/Pr) the following equation of debt growth appears (derivation in appendix 4):

$$\frac{(L_{(t+1)} - L_t)}{L_t} = \frac{((a-r)\cdot ROE_t)}{(2\cdot(a-r) - a^2\cdot ROE_t)} \quad (Eq.\ I.11)$$

Although credit expands, during the period which precedes collapse, capital and profits grow faster than debt in most cases[8]. This means that banks experience

[8] Since profits grow at a rate equal to the return on equity (ROE), it is not difficult to ascertain that if $ROE < \frac{a-r}{a^2}$ then profits will grow faster than debt. The reader can verify that the inequality holds for plausible parameter values.

increased liquidity which is not absorbed from corporate debt growth. It was this liquidity which made banks turn to consumer credit, speculative short term investments, new classes of assets and financial intermediaries. Good part of heterodox literature has focused on this side of financialization disregarding at the same time that it results from a pattern designed to restore growth in a low profit rate environment. Explanations on the rising weight of finance range from increased monopolization (Magdoff & Sweezy 1997, Lapavitsas 2011) to the prevalence of "rentiers" motivated by "perverse incentives" (Crotty 2009, Epstein 2005). We will critically assess these views in various occasions in the next section.

Returning to our main argument, it is clear from (I.11) that financial assets assume a substantial portion of corporate and bank asset side as deficit financed growth proceeds. The latter "sets the scenery" of financial crisis. To explain how it bursts we need to turn to finance theory and asset pricing.

II. Asset Pricing from the Fundamentals, Implications for Financial Crisis:

Alongside with the debt market, incorporated in our framework, we assume, there exists an equity market where trades on corporate and banking shares take place. Following the unanimously accepted principle that capital mobility tends to equalize risk free returns between sectors (Dybvig & Ross 1992), returns in our equity market remain in line with an underlying "required rate of return" (hereafter rror). However, contrary to mainstream wisdom (Campbell 1991)[9], but very much in line with empirical findings (Shiller 1980), this required rate of return is not assumed constant and equal to the lifetime rate of return of a particular investment. The reason is that fluctuations in demand produce secular growth patterns, as pictured in Charts 1, 2 above, which in turn alter the rate of return of the corporate sector creating arbitrage

[9]Actually in the sited paper Campbell acknowledges the limitations of constant required rates of return also suggested by the efficient market hypothesis.

positions in the equity market. Equity holdings are therefore inherently short-term reflecting short-term corporate sector returns. This in turn implies that equity market risk is roughly equal to that of the corporate sector (Shaikh 1997). A measure closely associated with the required rate of return is the short-term rate of profit:

$$rror_t = r \cdot u_t - irf_t (Eq.\ II.1)$$

Where (u) is capacity utilization. The measure ($r \cdot u_t$) pictured in (II.1) is a measure of short-term profitability of corporate investment, as opposed to lifetime rate of return which is equal, in our context, to the rate of profit (r). The latter prevails in full capacity utilization. When capacity is underutilized (capacity utilization is bellow unity) gross return on total capital outstanding falls below the basic gross rate of profit, the opposite holds when capacity is over- utilized. Furthermore, variable (irf), appearing in (II.1), measures the risk free interest rate in the current conditions of production and growth. The risk free interest rate is equal to the constant interest rate (i) minus yearly standard deviation of the rate of growth. It enters as negative factor in (II.1) since it represents returns foregone when equity investments are undertaken.

Assuming that capacity utilization (u) equals to the ratio of capital advanced to year-end corporate total capital (equity capital plus borrowed capital) we can denote the measure as follows:

$$u_t = \frac{K_t}{(L_{(t+1)} + EQ_t)} (Eq.\ II.2)$$

When capital advanced is less than year-end total capital this indicates under-utilization of existing capacity. In the event that capital advanced exceeds total capital, for example when customers advance funds against yet undelivered commodities, capacity is over utilized. From equation (I.2), the identity (y=NP/Pr)

and dividing the numerator and denominator with capital advanced (K), (II.2) takes the following form:

$$u_t = \frac{1}{\left(r \cdot \frac{\left(1 - y_{(t+1)}\right)}{i} + \frac{r}{a} \right)} = \frac{(i \cdot a)}{\left(r \cdot a \cdot \left(1 - y_{(t+1)}\right) + r \cdot i\right)} \quad (Eq.\ II.2')$$

Increased capacity utilization implies an increased share of corporate profits in the next period. In times of relatively low debt (compared to gross profit) corporations employ their excess capacity which leads to an increased share of corporate profits. As capacity utilization approaches or exceeds unity, corporations accumulate debt to extend productive capacity and the share of corporate profit declines because of increased interest payments. Corporations downsize production, reducing capacity utilization, to release liquidity and profit growth declines until the corporate debt/ gross profit ratio is sufficiently reduced. In normal accumulation the process roughly repeats itself, however when the economy reaches breakdown things change dramatically. Although production contracts, corporations remain illiquid, since any reduction in outstanding debt goes together with extended corporate losses.

At the bottom of the cycle banks and financial capital in general observe increasing capacity utilization and turn part of their liquidity to equity investments, in order to enjoy capital gains coming from increased corporate profitability. As result the price of both corporate and banking shares increases, discounting the expected increase in profitability. When loan demand accelerates banks liquidate most of their equity holdings realizing their gains and boosting their liquidity in light of increasing loan demand. Things again change when breakdown times arrive. Although banks dispose most of their equity holdings when debt accelerates and before the time growth exceeds systemic "carrying capacity", liquidity is not restored, because the depository base deteriorates from corporate losses. Banks dispose any remaining

equity holdings at a loss to increase their liquidity and corporations having exhausted their reserves soon turn to them seeking means to finance their losses.

A good part of past and contemporary economic literature interprets equity market breakdown as the cause of a depression because it precedes it. By extending our framework to encompass equity market arbitrage, stock market collapse again precedes the outburst of depressions without causing it.

Following Shiller (Shiller 1989) (in part) we assume that equity prices are given by the following formula:

$$P_t = (1 + rror_t) \cdot P_{(t-1)} (Eq.\ II.3)$$

Where (P) is the aggregate all shares equity index. Equation (II.3) indicates that the rate of growth of stock prices equals to the net required rate of return. When capacity utilization is high the "gross required rate of return" ($r \cdot u_t$) exceeds the "default free" interest rate and stock prices rise, the opposite holds in low capacity utilization. But increased capacity utilization reflects next year corporate profitability, as shown in equation (II.2'). It is for this reason that stock price reductions/ increases precede reductions/ increases in output and profitability. The simulation chart which follows pictures this result.

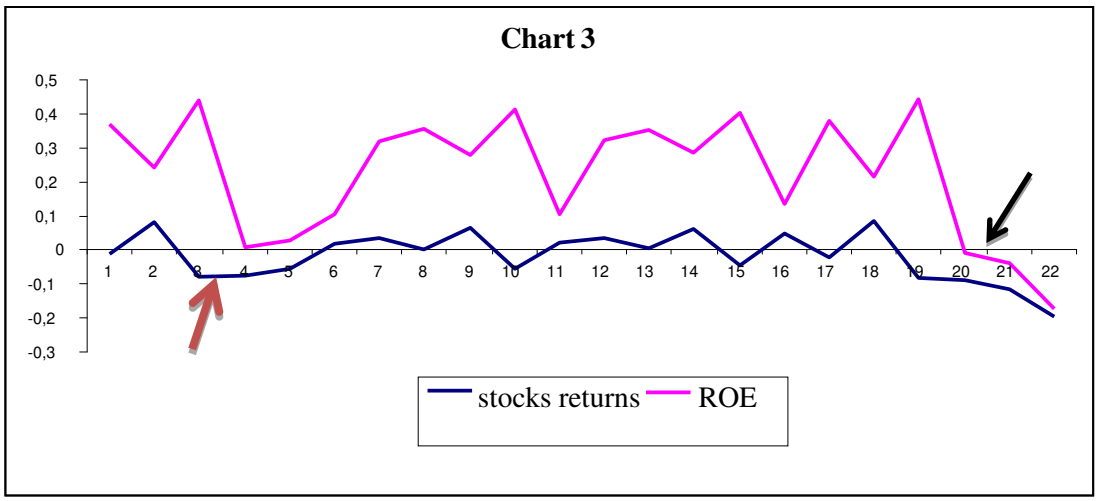


Chart 3 presents an unstable return on equity (ROE) path and the stock returns associated with it (blue line). Although sharp corrections and longer losing strings can

appear, as market on the chart (red arrow), stock returns remain overall positive as long as ROE remains positive and consequently corporate profits keep growing. But when ROE turns negative indicating a breakdown (black arrow) a sharp stock market correction precedes corporate profitability decline. It is the lead of stock market crash over actual depression episodes which creates the impression that the stock market crash is the cause, although causality runs the other way around.

We can take this reasoning further, assuming also that a derivative market is in operation. Mainstream economists suggest that trading of derivative contracts improves "efficiency" for the underlying asset market, by broadening the portfolio selection perspectives and reducing transaction costs (Pyle 1993). On this intellectual justification a 457 trillion dollar "notional amount outstanding" market stood in mid-2008 (Mai 2008). Of this notional amount only 16% trades in organized exchanges whereas the remainder involves "over the counter" (OTC) transactions. But the most astonishing fact is that despite financial crisis the OTC derivatives market grew further exceeding the world GDP and reaching the unbelievable amount of 693 trillion dollars in mid-2013 (Bank of International Settlements Statistical Bulletin Nov. 2013). Finally, recent studies (Avellaneda & Cont 2011) indicate that almost 90% of equity OTC derivative contracts take place between dealers and only 10% between dealers and "end users". The latter indicates that most of derivative transactions are of speculative nature.

Given the risks undertaken and the nature of transactions, one would expect that strong arguments supporting market efficiency underlie mainstream postulations. Regretfully, the whole argument rests on modern investment theory assumptions concerning underlying asset returns. Indicative in this regard is standard pricing of equity index forwards, used hereafter as an example derivative, where the risk free interest rate is the constant required rate of return. In other words "strike price"

determination comes from the application of a constant risk free rate (see equation (II.6) below). This same argument is extended further, by assuming normally distributed equity returns, to price "option contracts" under the celebrated Black-Scholes framework.

We can price an outright equity forward from our simple framework. Given the simulated data in hand, we can find a time path for index prices from (II.3), and the yearly standard deviation of growth from figures generated by (I.7). This data together with the constant rate of interest are sufficient to price the equity forward under the following standard formulas:

$$(ifr)_t = i - \sigma_{(ROEt-1)} (Eq.II.4)$$

$$(cifr)_t = \ln(1 + ifr_t) (Eq.II.5)$$

$$F_t = e^{(cifr_t)} \cdot P_{(t-1)} (Eq.II.6)$$

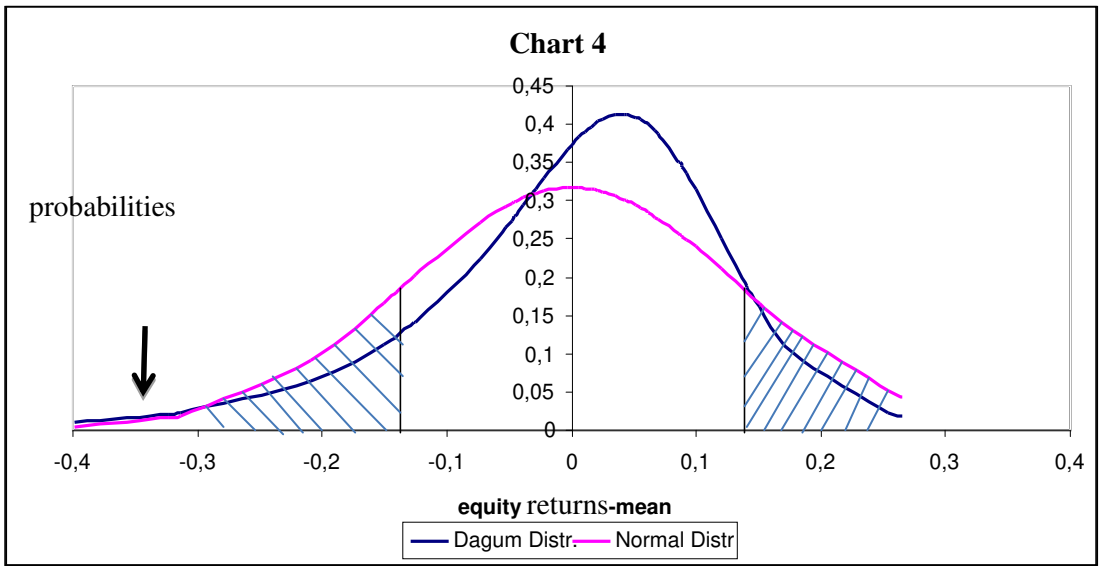
Where (cifr) is (ifr) in compound form and (F) stands for the yearly forward. Equation (II.4) determines the default free interest rate at the beginning of the period, (II.5) is the compound form of (II.4) and (II.6) the formula of the one year forward. Given our framework of stock returns, but also actual data, it is evident that derivatives are systematically miss-priced since their pricing rely on a theory which has no relevance with actual data. Many economists, professionals and mathematicians have acknowledged the fact (Mandelbrot & Hutson 2006).

The systematic pattern of derivative pricing against the underlying asset gave rise to a wide range of speculative financial intermediaries seeking higher returns by exploiting derivatives and these intermediaries are no other than the hedge funds. Banks supported hedge fund growth by granting them credit and derivative lines. Derivative lines support equity purchases without cash advances, limiting at the same time maximum contract value (notional amount outstanding). Each contract occupies

a part of the line determined by the product of underlying asset volatility and contract notional value. This practice, however, relies on the assumption that underlying asset returns follow the normal distribution. In other words that volatility remains roughly stable. If volatility varies and it does, the line may suddenly become insufficient and the borrower will either have to come up with cash or liquidate his positions. For positions "in the money" this is not a problem, actually the bank will extend the line to cover the customer, problems begin when derivatives are "out of the money". But again in a relatively stable growth environment banks will finance derivative losses (by turning the derivative line to a credit line or by rolling over the derivative position) it is again in times of breakdown that things turn dramatic.

By elaborating on the strategy of Macro Hedge Funds we will see how financial crisis becomes possible. Macro Hedge Funds speculate on big fluctuations in asset prices (in our context equity and derivative prices) assuming that it reflects a discrepancy between the market and the underlying fundamentals. By exploiting the discrepancy the hedge fund anticipates extraordinary profits. But this can imply that the normality assumption holds for equity returns as some hedge fund managers suggest (Nicholas 2008). More specifically, returns falling more than one standard deviation away from the mean reflect potential miss-pricing, since from the properties of the normal distribution 85% of asset returns should fall within one standard deviation from the mean. Furthermore, if asset returns are "normally distributed" this implies also that the underlying fundamentals are roughly stable as well. Therefore, any diversion will generate an opposite motion, since it comes from random occurrences.

The chart which follows (chart 4) compares the distribution optimally fitting equity returns generated from (II.1) (blue line), with a normal distribution calculated from the mean and standard deviation of the same data (purple line).



The distribution best fitting the data is a four parameter Dagum distribution (Dagum 1975). Returns on the horizontal axis are differences from the mean and probabilities appear on the vertical axis. The two shaded regions picture the areas of interest for macro hedge funds. For return values in the left hand side shaded area the hedge fund builds long forward positions. In the same fashion short forward positions are appropriate for returns in the shaded area on the right hand side[10]. However, the hedge fund miscalculates risk in both occasions. The most important miscalculation appears in the left hand side tail of the two distributions marked by the black arrow on Chart 4. Actual return distribution (blue line) has a long tail where finite probabilities appear for very low returns whereas in the assumed normal distribution (purple line) this probability is practically zero. Hedge funds assuming normally distributed returns took long derivative positions at this level of returns anticipating strong recovery. Instead they witnessed market collapse. Banks experiencing, during the same period, deterioration of their depository base were reluctant to finance these losses. This was the reason many macro hedge funds failed in the period of the financial crisis.

[10] This is by no means an exhaustion of potential hedge fund strategies but only a simplistic example. However, we can safely claim that almost every macro hedge fund strategy is vulnerable to extreme negative returns.

Economists and market professionals have used this finding to make a case for the causes of the current depression. The financial analyst Nicholas Taleb (Taleb 2009) argued that underestimation in the likelihood of extreme surprise events, "black swans" in his terminology, is responsible for the meltdown. Heterodox economists argue that "financialization" is the child of neo-liberal ideology (Fine 2011) which reached a climax in the theory of self – regulated markets, i.e. markets which could calculate risks correctly, thereby self-constraining any excesses. Under this reasoning, deregulated financial institutions undertook extensive derivative positions generating losses in excess of the underlying asset price reduction. This resulted to the depression caused from financial crisis spillover. What the argument misses is that excessive impairment of "fictitious capital", for example capital recorder in the "notional amount" of derivative contracts, reflects breakdown in the valorization of real capital as argued here.

Finally we will consider asset backed securities valuation, since the collapse of the mortgage-backed securities market triggered the current depression. Although these assets entered our everyday vocabulary following the subprime market collapse, they are by no means new. U.S. government owned or government-sponsored enterprises with a history going back to the years of the great depression have been issuing this type of securities for decades. For government agencies (Ginnie Mae) and government – sponsored agencies (Fannie Mae and Freddie Mac) securities rated triple A (AAA) were issued, since markets consider(ed) these assets backed by the U.S. government. This is the "prime" mortgage backed securities market. But as bank liquidity grew in the fashion pictured by our equation (I.11) and banks turned good part of this liquidity to consumer lending, lower quality mortgages were turned to "collateralized debt obligations" (CDOs). The latter is the "subprime" mortgage backed securities market which triggered the depression. As interest rates were

suppressed to historical lows from 1980 onwards mortgage backed securities gradually assumed the greatest part of bond markets. The reason is simple they offered a premium over corporate and sovereign bonds of the same rating, the premium representing compensation against the uncertainty of mortgage refinance. Consequently as interest rates declined and the likelihood of mortgage refinance was reduced these securities became more and more attractive. However, the market underplayed the risk that banks would be unable or reluctant to refinance bad mortgages, in other words the market underplayed the likelihood of a depression as elaborated below.

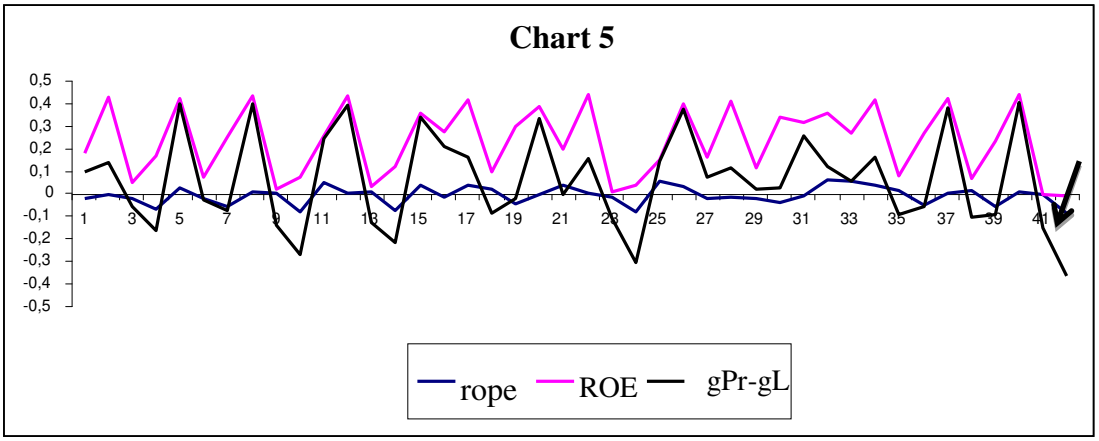
Although we can only consider securities "backed" by corporate loans in our context, the valuation method is valid for other types of asset backed securities. For reasons of simplicity we will assume that half of the bank loan portfolio comprises of productive corporations paying interest at a rate below the average (i), while the other half pays interest at a rate above average. We will assume further that banks pool their loans in two units (tranches) one involving productive low-interest corporate loans and the other unproductive high interest loans. They then issue one year securities on each unit which they sell through "special purpose vehicles". Returns, risks and excess returns for both units appear in the equations which follow:

$$(rtr)_{1_t} = \left(i - \left(\frac{1}{2}\right)\cdot\sigma_{(ROE)_t}\right) \Rightarrow (ertr)_{1_t} = (rtr)_{1_t} - (irf)_t = \left(\frac{1}{2}\right)\cdot\sigma_{(ROE)_t} \quad and \quad (rope)_{1_t} = r - \left(i - \left(\frac{1}{2}\right)\cdot\sigma_{(ROE)_t}\right) \quad (Eq.\,II.7)$$

$$(rtr)_{2_t} = \left(i + \left(\frac{1}{2}\right)\cdot\sigma_{(ROE)_t}\right) \Rightarrow (ertr)_{2_t} = (rtr)_{2_t} - (irf)_t = \left(\frac{3}{2}\right)\cdot\sigma_{(ROE)_t} \quad and \quad (rope)_{2_t} = r - \left(i + \left(\frac{1}{2}\right)\cdot\sigma_{(ROE)_t}\right) \quad (Eq.\,II.8)$$

Where (rtr) stands for return on tranches 1 and 2 and (rope) denotes the rate of profit of enterprise for the two corporate groups. Expected excess returns, denoted as (ertr), are equal to half the annual volatility of growth for group 1 and one and a half (1.5) times volatility of growth for group 2. Although the first unit will have a positive rate of profit of enterprise if r>i (II.7), the second unit may experience negative (rope)

even if the corporations included have an average rate of profit equal to the economy average (II.8). Therefore in highly volatile growth security holders rely on the willingness of banks to refinance these loans, which in turn rests on the conviction that growth will resume enabling the borrower to perform. This is of course the case when banks are liquid. But when bank liquidity deteriorates like the times close to breakdown things change. The simulation chart which follows pictures the risk associated with unit 2 securities in various states of the economy.



The blue line is the rate of profit of enterprise of unit 2 calculated as in (II.8). The purple line is the return on equity (gross profit growth) for the whole economy as before and the black line the rate of growth of profit less the rate of growth of debt. The latter is a measure of bank liquidity growth. Although the rate of profit of enterprise turns negative in many occasions, profits catch up quickly and banks refinance low-grade debt. At the eve of breakdown however (marked by the arrow on chart 5) as the rate of profit of enterprise of unit 2 turns negative banks experience a huge decline in liquidity, because the corporate sector as a whole experiences losses. As result low-grade loans do not get refinanced and asset backed security holders experience huge losses.

The scenario presented roughly imitates the collapse of the sub-prime market in the U.S. Securities issued on low-grade mortgages, the so-called "toxic" unit, were held on the assumption that the housing market will keep growing and collateral will

cover the loan. This in turn implied that banks would refinance mortgages when turned problematic protecting the security holders from capital losses. When this did not happen in 2007 the market collapsed.

A good deal of contemporary heterodox literature understood the sub-prime collapse as the cause of the crisis, in a "post hoc ergo propter hoc" (Tobin 1970) reasoning elucidated above and the level of wages as the cause of the sub-prime collapse. The wage incomes expropriation theory (Lapavitsas 2009) and the monopoly version of the under-consumption argument fall in this category. In the latter capitalism is stagnant by nature and growth resulted from consumer credit expansion (Magdoff & Sweezy 1987). Both versions arrive to an amazing conclusion: world capitalism entered a depression because wages were low limiting commercial credit expansion!

We have used a simple framework to show that an unstable growth path emerging from low profitability produces financial crisis episodes because corporate growth cannot absorb bank liquidity. In this context, financial crisis reflected in spiky reductions of returns on various asset categories (stocks, derivatives, asset backed securities) precede sharp reductions in output and employment. This result rests on the assumption that returns on financial assets reflect (short-term) underlying fundamentals. The latter follow patterns quite different from those anticipated by neoclassical theory and elaborated by "modern investment theory". This reasoning has important implications for economic policy and financial regulation demonstrated in the following section.

III. The World Economy in the Post Bear Sterns Era:

The failure of the investment bank Bear Sterns in 2007 marked the beginning of the current depression. At first regulators thought it was an isolated case which could be contained through traditional monetary policy tools. By mid-2008, however, the

subprime market failure made clear that the situation required extraordinary measures, since most of the U.S. banking system had collapsed. The main policy followed aimed to securitize banks through capital injection, troubled asset purchases and central bank accommodation against low-grade collateral. Governments supported this policy with state budgets. The state issued bonds to raise central bank capital and support the "socialization" of financial sector losses. In the U.S. alone public debt increased from about 8.7 trillion dollars in 2007 to 16.4 trillion dollars in the end of 2012.

These monies prevented meltdown mainly by enabling banks to revolve or turn corporate debt to equity, maintaining consumer credit as well. Most of economic activity remained in place instead of collapsing and world economy entered a period of stagnation and high unemployment. In our context this means that parameter (a) reduced to sustainable levels. But this involves also an increase in the effective interest rate (Eq.I.8) and a stagnant rate of profit of enterprise (Eq.I.9). The latter explains stagnation, high unemployment and impoverishment of big parts of the world population.

For contemporary mainstream literature crisis persistence is unanimously accepted nowadays. Explanations vary, ranging from high debt (mainly public debt) hampering growth (Reinhart & Rogoff 2013)[11], to blaming austerity policies applied to contain debt (actually to suppress wages). The latter approach stresses the limitations of monetary policy summarized in the so-called "zero interest limit" and promotes fiscal expansion (Krugman 2012). However, the first explanation disregards that low returns brought about the debt crisis in the first place, while the second ignores that in a depression corporations and banks sequester monies rather than

[11] I site the last paper of the two authors because in it they admit on one hand that the crisis persist over the last six years and second that austerity measures cannot turn debt sustainable as argued so far by austerity policy proponents.

invest them. Therefore, Keynesian "trickle down" policies justifying fiscal expansion have limited effect.

The reasoning detailed in this paper suggests alternative policies promoting direct state investments (Shaikh 2011). That is policies restoring economic activity and bank liquidity through increases in employment. As we have shown profit motivated growth breaks down in a depression, it is state investments following social goals that can offer employment to those who need it the most and have a “rise up” effect on businesses serving the increased demand.

Nevertheless, official policies support different trends. As public debts pile up and bank liquidity surges speculative financial investments are taking up substantial part of bank portfolios. Meantime stock exchanges have hit record prices, not supported by corporate fundamentals. All these are raising concerns that a new financial crisis is around the corner. As response central banks are downsizing accommodation policies and governments are issuing new bank regulation directives at the same time. The most clear policy outline is the "Volcker rule" passed on Dec 10th 2013 by the U.S. legislative bodies. A similar but slower process is taking place in the E.U. around the so-called "banking union".

Sticking to the "Volcker rule" because of concreteness we note that its' main aim is to prevent banks from assuming equity and derivative risk through hedge funds and other vehicles, but does not prevent them from running that risk directly in their balance sheet. The only factor discouraging assimilation of risk is increasing capital requirements. This is a policy relying on the assumption that financial assets carry a particular amount of relatively stable risk. If risk is stable banks can securitize depositors by assigning the appropriate amount of additional capital to back risky assets appropriations. But, as we have shown above, this does not hold especially when growth trends turn unstable, in such times capital requirements will prove

insufficient and the taxpayer will again lift the burden. The "Volcker rule" is the latest chapter in a long series of regulations going back to the "Peel act"[12] in mid-19th century England. Marx in Capital VIII (Marx 1959) mocked this early policy for being useless when the system was in normal accumulation and was withdrawn in the crisis of the 1850 s' to avoid bank failures.

The target of bank regulation is to protect the broad public, at least in part. Given uncertainty underlying financial markets, the rules applied must focus on what kind of assets pension funds, banks and the broad public can hold and to what proportions, in order to contain future damages. Depressions cannot be managed away through appropriate policies, because they emerge from the contradictions of profit motivated growth. This is why depressions appear every thirty to forty years the first on record dated as back as 1790. In this regard financial crises will always be a potential trigger of such events and regulation policies can only mediate losses by directly constraining risk. This means that institutions which take deposits or pension plan installments cannot hold just any kind of risky asset and the assets permitted cannot assume just any proportion of the asset side.

Returning to the present, the likelihood of a new major financial crisis depends on how stable is the roughly stagnant growth path prevailing. Stability seems to rely on the extraordinary liquidity measures primarily of the Fed, the Bank of Japan and secondarily of the ECB. These policies are keeping interest rates low. Capital impairment that would boost the rate of profit leading to gradual recovery seems to

[12] The Peel act of 1844 named after the British premier Sir Robert Peel on one hand prevented commercial banks from issuing their own banknotes and on the other placed restrictions on the bank of England in issuing banknotes. The idea was that with the restrictions in place inflation would remain stable and financial panics would seize to appear. Marx scorns the fact that the restrictions of the act were never needed /applied in normal accumulation and the act was abandoned altogether when the system entered a depression.

move in a slow and contradictory pace. Therefore when these policies are withdrawn financial panics and sharp corrections cannot be ruled out.

Overall the resolution of the present depression is proceeding at a very slow pace so far. Looking back to the history of crises it resembles the 1870-1890 depression, the longest on record. Therefore policy makers should be very cautious in declaring the end of the crisis and should focus on its' devastating consequences instead.

Summary:

We presented a simple framework analytically supporting the notion that profit driven growth turns unstable when the rate of profit is below a certain limit. Furthermore, if low profit rates are associated with suppressed interest rates finance assumes increasing weight like the period following the great stagflation of the 70 s'. The latter implies that major financial crisis episodes become likely triggering sharp reductions in output and employment. Model dynamics picture a path of secular growth followed by a sudden collapse imitating the growth pattern following the "great stagflation" and the subprime meltdown which triggered the current depression.

Besides implications on financial asset valuation this rationale indicates that financial regulation cannot rule out future crises, because crises emerge from the underlying contradictions of profit motivated growth. Regulatory policies can only temper future financial losses if implemented on the type and amounts of financial assets held by Banks, Pension funds and the broad public.

This approach differs from the reasoning underlying recent regulatory legislation like the "Volker rule". The latter relies on the contention that stable calculable risk is associated with every asset and in this regard appropriate capital requirements constrain risks undertaken by financial institutions. Regulation is

thereby limited to monitoring sound liquidity and solvency ratios by forcing banks to assume risk directly on their balance sheet. The latter indicates further, that regulators blame the "shadow" banking system (hedge funds, special vehicles etc.) for the current depression. We showed that if asset returns depend on corporate sector fundamentals financial asset risk is highly unstable and any solvency ratio will prove insufficient when the economy reaches breakdown point. Similar empirical results on financial asset risk are common knowledge in the economic profession following the path breaking work of Shiller (Shiller 1980).

The framework presented indicates further that depression will be over when sufficient capital is impaired on a world scale to support an increase in the rate of profit. In this regard crisis resolution lies ahead of us. Securitization of banking capital prevented economic meltdown, but, at the same time, initiated a contradictory process where capital is impaired at a very slow pace while stagnation prevails. If this stagnant growth path is dependent on central bank liquidity measures, in the sense that central bank policies keep effective interest rates low, then the relinquishment of these policies will mark the return of financial panics. In a panel, during the January 2014 conference of the American Economic Association, chief IMF economist Olivier de Blanchard arrived to a similar conclusion. He suggested that multiple equilibrium positions stand before world economy depending on the rate of interest prevailing after the abandonment of central bank extraordinary liquidity policies.

It is beyond doubt that recent mainstream literature (Reinhart & Rogoff 2013, Krugman 2012, De Long & Summers 2012) acknowledges that we are in the middle of a depression. However, economic reasoning underlying these arguments has important policy implications. Neoclassical economists reach the conclusion that high debt /GDP ratios are the cause of the crisis suggesting fiscal austerity as the resolution. Neo-Keynesians, on the other hand, consider austerity policies as the

cause, preaching in favor of fiscal expansion. Good part of heterodox literature has shown that wage suppression, standing behind austerity policies, is not sufficient for restoring the rate of profit. Moreover, Keynesian "trickle down" policies justifying fiscal expansion are not effective in depression times when profit rates are low.

Alternative policies relying on state direct investment in order to boost employment are appropriate now that profit motivated growth has broken down. Elaborating on the characteristics and limitations of such policy will be the focus of future work.

Appendix 1 Notation and Definitions

$Pr = Gross\ Profit$

$K = Capital\ Advanced$

$r = \frac{Pr_t}{K_{t-1}}$ *gross rate of profit*

$i = interest\ rate$

$s = \frac{i}{r}$ *rate of savings (corporate retained earnings)*

$L = aggregate\ corporate\ debt$

EQ = corporate equity and $EQ_t - EQ_{t-1} = s \cdot NP_t$

ROE_t = EQ NP net return on corporate equity

irf_t = i− ROE risk free interest rate, ROE the standard deviation of ROE

u_t = K1 EQ capacity utilization

$rror_t$ = r· u − irf net required rate of return for holding corporate equity

$P_t = (1 + rror_t) * P_{t-1}$ all shares equity index pricing formula

$F_t = e^{(cifr_t)} \cdot P_{t-1}$ *yearly all shares stock index forward*

$rtr_{1,2_t}$ = *return on asset backed securities tranches* 1,2 *respectivelly*

$rope_t$ = *rate of profit of enterprise*

Appendix 2 Model Solution

Letting: $\frac{L_t}{P_t} = l_t$ and using I.1-I.4

$$\frac{L_t}{P_t} = l_t \rightarrow l_t = \frac{1}{i} \cdot (1 - y_t) \rightarrow l_{t+1} - l_t = -\frac{1}{i} \cdot (y_{t+1} - y_t)$$

$$l_{t+1} - l_t = \frac{K_t - K_{t-1} - s \cdot NP_t}{\Pr_t} - \frac{\Pr_{t+1} - \Pr_t}{\Pr_t} \cdot l_t = (\frac{1}{r} - l_t) \cdot \frac{i \cdot a}{r} \cdot y_t - s \cdot y_t$$

$$l_{t+1} - l_t = (\frac{a}{r} - a \cdot l_t - 1) \cdot s \cdot y_t$$

$$-(y_{t+1} - y_t) = (\frac{a \cdot i}{r} - a \cdot (1 - y_t) - i) \cdot s \cdot y_t$$

$$y_{t+1} - y_t = (\frac{i \cdot r + a \cdot (r - i)}{r} - a \cdot y_t) \cdot s \cdot y_t$$

$$y_{t+1} = (\frac{(i^2 + 1) \cdot r + a \cdot i \cdot (r - i)}{r} - a \cdot i \cdot y_t) \cdot \frac{1}{r} \cdot y_t$$

$$y_{t+1} = (1 - \frac{a \cdot r}{(1 + r) \cdot r \cdot i + (r - i) \cdot a} \cdot y_t) \cdot \frac{(1 + r) \cdot r \cdot i + (r - i) \cdot a}{r^2 \cdot i} \cdot y_t$$

$$\phi = \frac{(1 + r) \cdot r \cdot i + (r - i) \cdot a}{r^2 \cdot i} = \frac{1 + r}{r} + \frac{(r - i)}{r \cdot i} \cdot a$$

$$z_t = \frac{a \cdot r}{(1 + r) \cdot r \cdot i + (r - i) \cdot a} \cdot y_t \rightarrow y_t = \frac{(1 + r) \cdot r \cdot i + (r - i) \cdot a}{a \cdot r} \cdot z_t$$

$$\rightarrow \frac{y_t}{\phi} = \frac{r \cdot i}{a} \cdot z_t \rightarrow y_t = \frac{r \cdot i}{a} \cdot \phi \cdot z_t \rightarrow ROE_t = i^2 \cdot \phi \cdot z_t$$

$$z_{t+1} = (1 - z_t) \cdot \phi \cdot z_t$$

$$ROE_{t+1} = (1 - \frac{1}{i^2 \cdot \phi} \cdot ROE_t) \cdot \phi \cdot ROE_t$$

Appendix 3: Carrying Capacity Maximization Interest Rate

$$\frac{d(\phi-1)\cdot i^2}{di}=(\frac{r\cdot i^2+(r-i)\cdot a\cdot i}{r^2})=\frac{2\cdot r\cdot i+r\cdot a-2\cdot i\cdot a}{r^2}=\frac{2\cdot i\cdot(r-a)+r\cdot a}{r^2}$$

$$2\cdot i\cdot(r-a)+r\cdot a=0\rightarrow i=-\frac{1}{2}\cdot\frac{r\cdot a}{(r-a)}$$

Appendix 4: Debt Growth

$$L_{t+1}-L_t=K_t-K_{t-1}-s\cdot NP_t\rightarrow L_{t+1}-L_t=\frac{1}{r}\cdot ROE_t\cdot \Pr_t-s\cdot y_t\cdot \Pr_t$$

$$L_{t+1}-L_t=\frac{1}{r}\cdot ROE_t\cdot \Pr_t-s\cdot y_t\cdot \Pr_t=(a-r)\cdot\frac{ROE_t}{2\cdot(a-r)-a^2\cdot ROE_t}\cdot L_t$$

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