Financial Deepening and Economic Growth

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Abstract

The core of Shapley-Shubik games and general equilibrium models with a Venn diagram is applied for a theory on the role of real finance in economic growth among advanced economies. Then the dynamic computable general equilibrium (DCGE) models for Germany, France, UK, Japan and USA are constructed to assess the validity of the over financing hypothesis that reappeared after the financial crisis of 2008. Actual financial deepening ratios observed in the non-consolidated balancesheet of the OECD exceeded by factors of 3.5, 2.4, 5.1, 11.6 and 4.8 to the optimal financial deepening ratios implied by DCGE models respectively in these countries because of excessive leveraging and bubbles up to 19 times of GDP which were responsible for this great recession. Containing such massive fluctuations for macroeconomic stability and growth in these economies is not possible in conventional fiscal and monetary policy models and requires a DCGE analysis like this along with adoption of separating equilibria strategy in line of Miller-Stiglitz-Roth mechanisms to avoid asymmetric information problems in process of financial intermediation so that the gap between actual and optimal ratios of financial deepening remain as small as possible.

JEL Classification: F41,O11,O33, O41

Keywords: financial deepening, growth

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1 An Introduction to Finance and Economic Growth

A good financial system channels savings into investment, allows intertemporal optimisation by individuals and firms, spreads risk among people and is a factor for an efficient dynamic economy. It causes economic crises when it is out of control as in 2008/09 that originated from distorted financial incentives. Reversing of housing market bubbles and the credit crises in the US spread around the globe. Recessions that it caused hit hard to the US, UK, EU, Japan and many other advanced countries and slowed down growths and other economic activities in them. Output, employment, investment, capital accumulation, exports and imports shrank causing alarming losses of income, deterioration in living standards of households and loss of business or profit prospects of small, medium and large scale firms. Governments of these countries attempted to stimulate the aggregate demand by expanding the public expenditure and cutting down the taxes despite growing risk of accumulation of public debts. Central banks reduced the basic interest rate to a record low rate since the beginning of central banking in order to expand the liquidity is the system; since January 2009 Federal fund rate has remained close to zero, Bank of England's basic rate is 0.5 percent and ECB's basic rate is now at 0.1 percent. Sources of credit levels of banks expanded under the quantitative easing. Why does a financial system collapse like this and how do they affect on long run growth are questions of great interest.

Five major theories have been advanced to explain the role of financial sector in the economy in the literature. The first theory has its origin in the classical school of competitive and efficient markets. The fact that the process of capital accumulation and growth in modern economies is enhanced substantially by the financial markets that channel resources of millions of risk adverse savers to millions of risk neutral borrowers is well recognised for long. Schumpeter (1911) argued for financial development for economic growth but Robinson (1952) viewed the financial development as

a by-product of economic growth process. Importance of risk minimisation and efficiency of portfolio allocation was noted by Markowitz (1959) and Merton (1973). Then Sidrauski (1967) and Tobin (1969) linked the balance sheet of the financial system to economic growth. The process of financial deepening and banking firms were discussed in Klein (1971) and Shaw (1973). These concepts were applied to developing economies by McKinnon (1973) and Fry (1978). King and Levine (1993) and Levin (1997) tested these propositions empirically across countries. Hills, Thomas and Dimsdale (2010) and Davies et al. (2010) studied recently the links of recessions to evolution of banking system in the context of the UK economy.

The second wave of literature in the financial deepening and growth emphasises the role of strategic modelling with Nash bargaining and signalling problems and coalition formation in line of Shapley (1953) and Shapley and Shubik (1969) and mechanism design of Rogerson (1985) and Roth (2008). Rasmusen (1987), Beaudry and Poitevin (1995), Cripps (1997), Dasgupta and Maskin (2000) and Roth (2008) further advanced strategic choices relating to investment. While the analysis of consequences of bank-runs are found in Diamond, Douglas and Dybvig (1983)), informal finance, stochastic factors and the financial structure and growth of economies are discussed in Townsend (1983), Boyd and Prescott (1986) and Bolnick(1987). Consequences of transaction cost in bilateral and multilateral negotiations (Balasko (2003), Kiyotaki and Moore (2006)) and financial deepening (Townsend and Ueda (2006)) were considered for developing models of coalition of intermediaries. Neoclassical and neo-Keynesian modeling paradigm of King, Sentana and Wadhwani (1994) and Covas and Den Haan (2012) have refined linking of financial sector to economic growth. Finanical markets should be thick, less congested and safe for its participants as should the Kidney exchange centres be for the potential donors and receivers of Kidneys (Roth (2008)).

Third set of literature on finance and growth focuses on risk management and highlights the

importance of the liquidity of the banking sector in theoretical or empirical settings in spirit of Epstein and Zin (1989), Fama (1980, 2014), Spencer(1984, 2008), Bank of England (1999), Raghuram and Zingales (1998), Roubini and Sala-i-Martin (1992), Radelet, Sachs, Cooper and Bosworth (1998), Cecchetti (2009), Brunnermeier (2009), Mendoza (2010) and Gai, Kapadia, Millard and Perez (2008). Beck, Levine and Loayza (2000), Carlin and Mayer (2003) and Allena, Vayanos and Vives (2014) survey the literature relating to the liberalisation of financial sector and associated problems including those of saving and loan associations in 1980 in the US, bank runs and failures of giant banks in Japan in 1990s or the collapse of credit and housing markets in the US and several EU economies recently including the credit crunch, bank failures, liquidity crises, stock market crash and bailouts in UK, EU and US after the crisis in October, 2008. Excellent intuition in these are found in Fama (2014) and Shiller (2014). New techniques on decomposing the impacts of shocks in the macroeconomy are developed further in Hansen (2012) and Brunnermeier and Sannikov (2014).

Fourthly the endogeniety and simultaneity between financial structure and economic growth is explained with general equilibrium and endogenous economic growth models by Greenwood, and Javanovic (1990), Robinson (1991), Roubini and Sala-i-Martin (1992), Mercenier and Srinivasan ed. (1994), Altig, Carlstrom and Lansing (1995), Bhattarai (1997) and Acemoglu and Zilibotti (1997). Recent resurgence of interest in analysing more complex nature of financial deepening and economics growth in international scale, particularly after the financial crises of 2008, is seen in Greenwood and Scharfstein (2013), Farmer (2013), Coeurdacier and Rey (2012) and Pilbeam and Olmo and Pouliot (2011).

Finally above propositions have been brought to empirical scrutiny as the data series on interest rates, deposits, stocks, bonds, foreign currency reserves and their prices becoming increasingly available in recent years (see Taylor (2010)). Propositions of King and Levine (1993) and Levin

(1997) have been tested for many economies in recent years (Allena, Vayanos and Vives (2014), Carlin and Mayer (2003), Arestis, Demitriades and Luintel (2001), Beck, Levine and Loayza (2000)). Various studies exist on the evaluation of impacts of financial sector in the economy (Bank of England (1999), Brunnermeier (2009) and Cecchetti (2009)). How the asymmetry of information on depositors and savers results in volatilities of unimaginable proportions in these markets and how it affects the choices of economic agents and prospects of economies is analysed testing theoretical models with empirical evidences. Financial markets often experience catastrophic failures whenever the expectations of lenders and borrowers do not match market realities.

Using four indicators of financial development for about 119 countries for 1960 to 1989 King and Levin (1993) had showed panel data analysis based empirical support for the Schumpeterian hypothesis that financial development leads to economic growth in contrast to the Robinsonian argument that growth rate of output had little connections to the financial development. The long run growth is a function of real physical capital not the financial leverages or derivatives that promotes the artificial financial deepening. Over-financing however is a phenomenon that has become more serious in the last two decades. The results from the DCGE computations reveals that there are little differences on the optimal financial deepening ratios across countries but there are large differences in actual financial ratios. Such gaps between these two measures are due to casino capitalism (Sinn (2010)) and asset bubbles or collective illusions as its consequence. It is pertinent here to consider Miller and Stiglitz (2010) analytical model that weaves the financial intermediation with incentive distortions and information frictions to show how economy reacts during the time of fiscal shocks and financial instability while assessing implications of these bubbles.

None of the earlier studies have sufficiently addressed the issue of discrepancy between the **optimal** and **actual** financial ratios required for growth as done in this paper. Section 2 motivates

the paper with a short discussion of the underlying actual financial deepening ratios from the OECD for five advanced economies. Section 3 presents concepts of an efficient competitive equilibrium mechanism theory contained in non-blocking core in Shapley-Shubik game and Pareto optimal core in a general equilibrium model that could be applied to think about efficient allocations both in goods and asset markets. It illustrates the Schumpetarian view qualitatively that growth of the financial sector is linked to the growth of the rest of the economy over time. Section 4 illustrates how fluctuations in growth rates are caused by shocks in the financial sector with a simple endogenous growth model with financial intermediation in contrast to the Ramsey model in Bhattarai (2005) or cash in advance or money in utility function models in Bhattarai (2014). Paper proceeds further in constructing multisectoral and multi-household DCGE models of Germany, France, UK, Japan and USA in section 5 to establish the efficient and optimal paths of capital output ratios implied by underlying equilibrium mechanism illustrated in Figures 4 and 5. This paper contributes to the literature by finding the degrees of the **excess** financial deepening ratios (FD-ratios) above the optimal ones required for smooth process of economic growth implied by the DCGE models of these economies. Conclusions, references and appendices supporting the study are in the final section.

2 Actual Financial Deepening Ratios: Statistical Facts

In general the size of the financial assets a country has is closely linked to its size of GDP as shown in Figures 1 and 2 for five advanced countries. Contrast GDP of 15.5 trillion to financial assets of 156.5 trillion dollars for the US economy with GDP of 1.5 trillion and FA of 29 trillion pounds for the UK. Data for the financial assets were obtained from the OECD's non-consolidated balance sheets in which the financial assets include currency and deposits, financial derivatives, securities, shares and equities for years 2007-2011. GDP figures were obtained from the OECD as well.

Figure 1: GDP of Five Advanced Countries ($trillion)

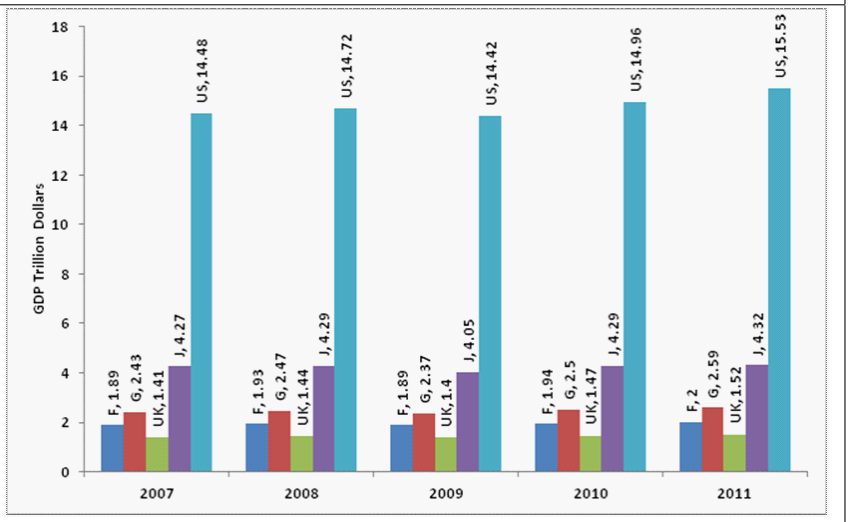
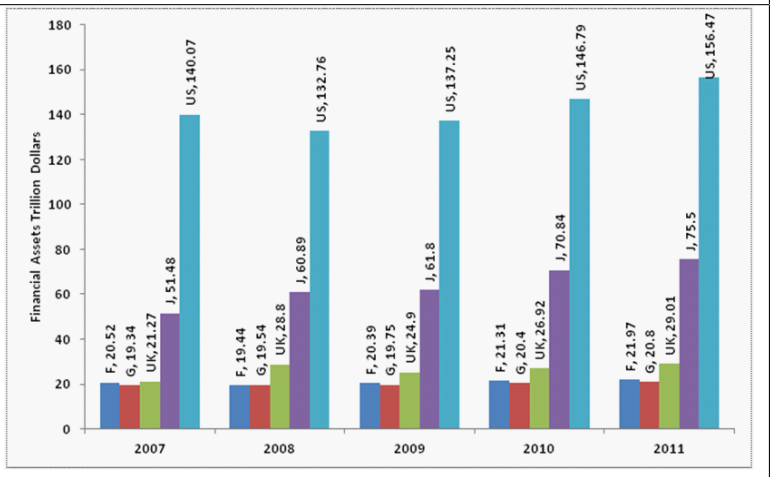


Figure 2: Financial Assets of Five Advanced Countries ($trillion)

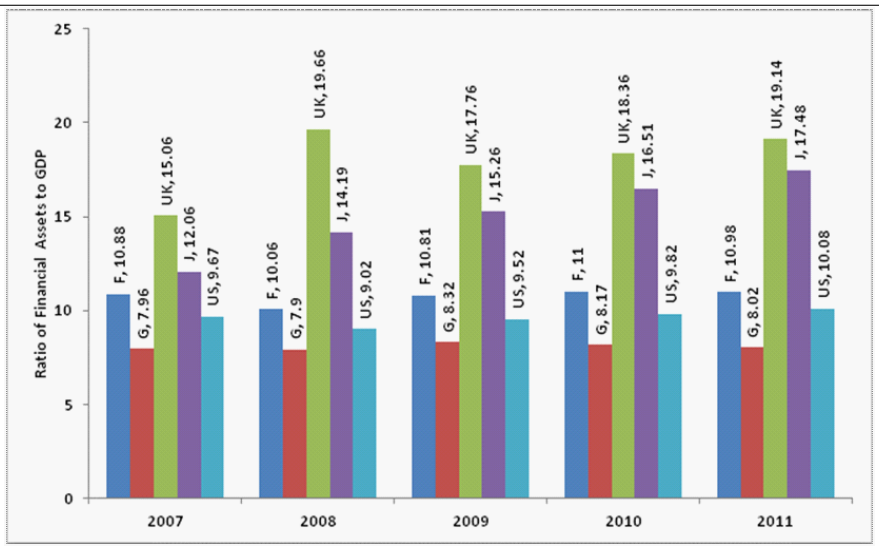


The actual financial deepening ratio (FA/GDP) is calculated by dividing the financial assets by GDP as shown in Figure 3. UK had the highest FD-ratios followed by Japan, France, USA and Germany. Thus UK financial system has more excess leveraging than other countries and more vulnerable to financial crisis like those of 2008. In fact all economies are vulnerable to good or bad financial sector policies, degree of over-financing and wide ranging inefficiencies, fluctuations

in growth of output and other economic activities whenever the actual financial deepening ratios deviate significantly from optimal ones.

Financial assets are counter parts of physical capital in a well balanced economy. Thus in the classical system with saving investment identity the rate of capital accumulation not only reflects rate of economic growth but also the accumulation of financial wealth in the economy. A higher degree of financial deepening through saving and investment activities promotes the level of income and raises the rates of economic growth. In real world level of economic advancement seems to have gone together with the level of financial deepening until the deregulation of financial markets in mid 1980s. However this tacit link seems to have broken in recent years.

Figure 3: Actual Financial Deepening Ratio in Five Advanced Countries



From the OECD data summarised more precisely in Table 1 it is clear that the financial deepening ratios are twice as large in the UK than those in Germany. While Japan is close to the UK but France and USA are closer to Germany in these ratios. Thus data makes it clear that UK and Japan are more vulnerable to financial sector turbulences than France, USA and Germany. It is important to show that financial and real sectors of the economy are mirror images of each other.

Table 1: Financial Deepening in Five Advanced Economies

	France			Germany			United Kingdom			Japan			USA		
	FA	GDP	FDratio	FA	GDP	FDratio	FA	GDP	FDratio	FA	GDP	FDratio	FA	GDP	FDratio
2007	20.52	1.89	10.88	19.34	2.43	7.96	21.27	1.41	15.06	51.48	4.27	12.06	140.07	14.48	9.67
2008	19.44	1.93	10.06	19.54	2.47	7.90	28.80	1.44	19.66	60.89	4.29	14.19	132.76	14.72	9.02
2009	20.39	1.89	10.81	19.75	2.37	8.32	24.90	1.40	17.76	61.80	4.05	15.26	137.25	14.42	9.52
2010	21.31	1.94	11.00	20.40	2.50	8.17	26.92	1.47	18.36	70.84	4.29	16.51	146.79	14.96	9.82
2011	21.97	2.00	10.98	20.80	2.59	8.02	29.01	1.52	19.14	75.50	4.32	17.48	156.47	15.53	10.08
Data Source: OECD (national accounts section). FA =Non-consolidated Financial Assets and Y=GDP both in Trillions ; FDratio = FA/GDP															
FA and GDP are in trillions of national currencies (Japan's in US $).															

Consider an asset (A_t) accumulation equation as:

$$A_t\left(1+\widehat{r}_t\right)+W_t-C_t=A_{t+1} \tag{1}$$

where C_t is consumption, A_t financial assets, W_t endowment, and $\widehat{r}_{t+1}$ return to asset net of tax and depreciation rate; $\widehat{r}_t=\left(1-\tau_k\right)\left(r-\delta\right)$ with r real interest rate, δ rate of depreciation and τ_k capital income tax. When $\tau_k=0$ equation (1) can be written as $A_t r_t+W_t-C_t-\left\{A_{t+1}-\left(1-\delta\right)A_t\right\}=0$. Now replacing A_t by capital stock (K_t) and using definition of income $Y_t=A_t r_t+W_t=C_t+I_t$, one gets the macro balance proving the equivalence between the financial assets and physical capital stocks in (2) as:

$$Y_t-C_t-\left(K_{t+1}-\left(1-\delta\right)K_t\right)=0;\quad\Longrightarrow Y_t=C_t+I_t \tag{2}$$

Thus the stocks of financial assets (A_t) must balance to the stocks of physical capital (K_t) in a smooth functioning economy with unrestricted borrowings and lending though their values remain sensitive to shocks in various market conditions as to be discussed in sections 4 and 5.

2.1 Optimal and Actual Financial Deepening Ratios

Optimal financial deepening ratio ($OFDR_t$) is the result of the growth process in the economy and varies across production sectors ($F_{i,t}$) according to variations in investment rates and levels of output among them. This happens as banks channel funds saved by households or enterprises for investment by firms at the real interest rate that matches cost and productivity of funds to the firms. Value of $OFDR_t$ is obtained by dividing the capital stocks by the GDP. Actual financial deepening ($AFDR_t$) is obtained dividing the total of financial assets from the non-consolidated balancesheet by the GDP.

$$OFDR_t = \frac{K_t}{Y_t} = \sum_{i=1}^{N} \frac{K_{i,t}}{Y_{i,t}};\ AFDR_t = \frac{FA_t}{Y_t} \tag{3}$$

$OFDR_t$ is the real measure of optimal financial deepening, resulting from the optimisation behavior of consumers and firms in the economy. It should equal to the ratio of financial assets to GDP in the financial market in an ideal world as shown in (4) as such intertemporal equilibria is guaranteed by the flexibility of prices, wages and interest rates in the economy. Imbalances either due to the rigid or inflexible prices cause market imperfections or crises in the real world giving a different value to the actual financial deepening ratio ($AFDR_t$). Gap between $OFDR_t$ and $AFDR_t$ is due to conditions in the financial markets. Good financial policies result in right set of accumulation process and higher growth rate of the economy over periods. Then these two measures are expected to be closer as I found in case of emerging economies illustrated in a related paper that I prepared for the Review of Development Economics. Wrong financial sector policies lead to mismatch between the volume borrowed and lent, that often manifests in terms of bail outs or subsidies or preferential treatment of one sector against another, which distorts the accumulation process ultimately reducing

the prospects of the economy in the long run. This causes a large gap between $OFDR_t$ and $AFDR_t$ as to be presented in section 5.

What is the optimal ratio for a bubble-less smooth functioning of these economies? For each period t, $OFDR_t$ is aggregated from from the sectoral optimal ratios, $OFDR_{i,t} = \frac{K_{i,t}}{Y_{i,t}}$ obtained from the solution of the DCGE model with many production sectors. This is discussed in section 5 after explaining the meaning of the core allocations and stochastic growth underlying those DCGE calculations in sections 3 and 4.

3 Classical Theory: Core of Finance, Growth and Efficiency

The dynamic economy implied by models mentioned in section 1 is better explained by diagrams in Figure 4 and 5. Figures 4 shows distinct possibilities of excess or shallow financing in comparison to the normal equilibrium path in the middle. Then the fluctuations around the steady state are shown in Figure 5 where the E-E is allocations representing the core equilibrium path; LL market valuations of lenders; BB the market valuation of borrowers. The gap between LL and BB reflects the subjective differences in the assessment of prospects of financial assets. The gap between these two is the reason for trades among lenders and borrowers. Wide fluctuations in these are not only the sources of cycles but also the sources of crises.

Figure 4: Financial Deepening and Economic Growth

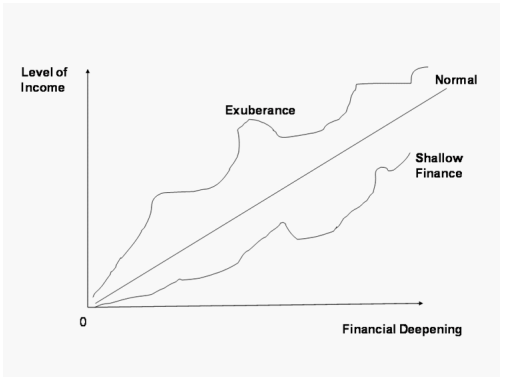
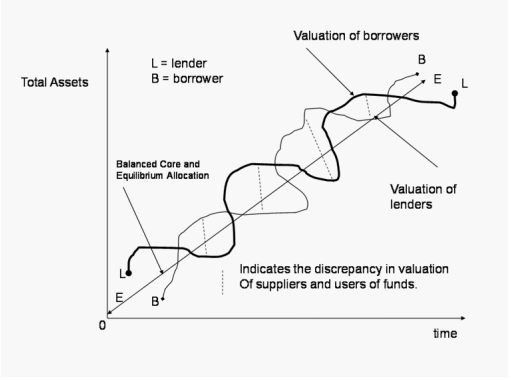


Figure 5: Equilibrium and Core in Asset Markets Over Time



Market equilibrium path E-E represents a no friction complete information world of lenders and borrowers. It ignores the asymmetry of information in financial markets, which is the underlying cause of deviation of asset accumulation path of borrowers (BB) and lenders (LL) of the equilibrium path (EE). The main intuitive points from classical theory of finance and growth thus are as follows:

1. Assets are results of consumption saving behavior resulting from the intertemporal optimisation of households or firms.
2. There is an equilibrium allocation EE for each time period of the economy that is at the core of the equilibrium.
3. Lenders and borrowers start with different amounts of endowments and bargain continuously in order to gain more from the transaction.
4. Underlying productivity and preferences cause differentiation in valuation by the buyers and sellers in the asset markets. Therefore the valuation can be generalised in n number of cases.
5. Corrective measures are taken by individuals or the policy makers when these valuations significantly deviate away from the underlying equilibrium destabilising the whole financial system.
6. The asset accumulation profile can contain overlapping generations and has infinite life in contrast to individual traders with finite life.
7. There are gains from trading in the financial markets. Whether the lenders or the borrowers get the larger shares of this gain depend on their bargaining power, which changes over time.

Miller-Stiglitz mechanism of bubbles and crashes is helpful in advancing above thoughts by designing incentive compatible contracts contained in Maskin and Tirole (1990) and Roth (2008) to

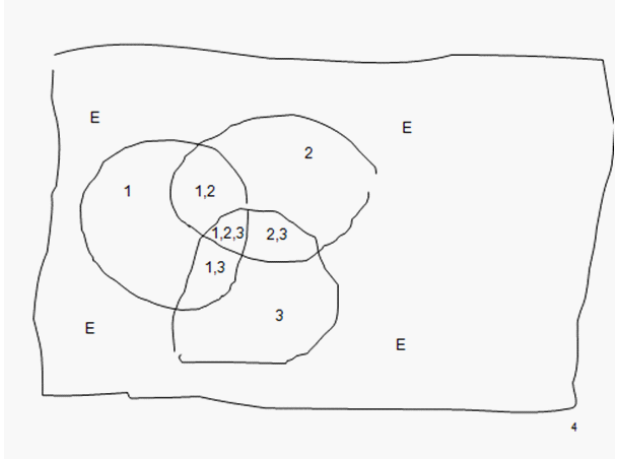
separate normal borrower and lenders from risky ones under asymmetric information to solve moral hazard or adverse selection problems required to ensure efficient equilibrium path EE by minimising gaps in their evaluation as shown above by LL and BB lines in Figure 5. Arbitrage in the financial market should be set in such a way that it guarantees the efficient and Pareto optimal core of the economy in coalition games and growth with dynamic general equilibrium in the economy.

3.1 Arbitrage and core in games and general equilibrium models

Arbitrage conditions set at the core of the economy lead to efficient decisions in the financial markets and promote growth. Game theory and general equilibrium models show how optimal choices are made by consumers and producers facing the resource constraint are efficient when these set of points belong to the core of an economy. Arriving to these unique set points in the core involves continuos bargaining over the gains from the intra and intertemporal trade on goods, services and financial assets. Technically the Shapley value of a bargaining game is given by the payoff from non-blocking coalition in a Shapley-Shubic game and it is a set of Pareto efficient points. Similarly core of a general equilibrium lies in the contract curve where it is difficult to make one economic agent better off without making another worse off. The core of the coalition in the game and that in a general equilibrium model represent basically the same efficient points and relative prices as proven in (4). These are consistent to the efficient arbitrage conditions in an efficient financial market. As the optimal allocation of resources to economic agents possible with given endowments confirm to the first and second theorems of welfare economics, solutions either of game or DCGE models characterise the optimal allocation of resources after more complex bid and offer interactions among economic agents. This also happens to be the key process in the financial markets. This set of efficient points is illustrated by the intersections of three circles at the centre in a Venn diagram

with three players as in Figure 6[1].

Figure 6: Shapley Shubik Core in a Venn Diagram



Economic agents in the financial markets tend to play a zero sum and non-cooperative game when they are outside this core set. The benefits of coalition and cooperation far exceed from non-cooperation (Gale (1986)). Even when agreements are made for cooperation there are questions on whether such coalitions are stable. There are always temptations at least for some players to cheat and break the cooperative agreements in anticipation of raising their own share from the total gains against other players. However, such process sets a motion of negative externality and retaliations resulting in mistrusts and eventually a low value of the game. No player can fool other players for long as they will discover the cheaters and penalise them more than what they could gain by

[1]Debreu and Scarf (1963) had proven the equivalence of a competitive equilibrium to the core of the game for economies with and without production by contradiction when preferences are non-satiable, strictly convex and continuous. Scarf (1967) theorem states that a balanced n person game has a non-empty core. Financial markets open each time, bid-offer process sets the prices of assets, exchange takes place in the core. This process continues forever. Thus the competitive equilibrium is equivalent to the allocation at the core, "An exchange economy with convex preferences always gives rise to a balanced n person game and such will always have a non-empty core (Scarf (1967))."

$$\sum_i x_i = \sum_i^n \sum_{\substack{T=\{S\} \\ S\supset\{i\}}} \delta_i x_i^S = \sum_{T=\{S\}} \delta_S \sum_{i\in S} x_i^S = \sum_{S\in T} \delta_S \sum_{i\in S} \omega_i = \sum_i^n \omega_i \sum_{\substack{T=\{S\} \\ S\supset\{i\}}} \delta_S = \sum_i \omega_i \tag{4}$$

cheating, thus giving the non-cooperative Nash outcome of the game.

A financial coalition among players should be consistent to the individual rationality, group rationality and coalition rationality because of the supper-additivity property. This implies that the value of the game in a coalition is greater than the sum of the value of the game of playing alone non-cooperatively by those individual members. In case of three players this means: $v(1 \cup 2 \cup 3) \geq v_1(1) + v(2) + v(3)$; financial coalitions (parties) playing together generate more value, $v(1 \cup 2 \cup 3)$ for each of its member than when they play alone with payoffs $v_1(1)$, $v(2)$,and $v(3)$. Cooperation and team spirit generates extra benefits. Considering three sets, 1,2, and 3, of possible allocations in a market, there is only a tiny set core equilibrium as illustrated by the intersection of 1,2, and 3 in the Venn diagram in Figure 6. Financial arbitrage made at this core are efficient and optimal and bring smooth growth in the economy. Thus efficient allocations in the economy are only a small subset of all possible allocations. Proliferations of financial assets as observed in the OECD data in section is the union of sets rather than their interactions at the core.

On the otherhand a general equilibrium is given by the relative prices that clears all markets in the economy. It is derived using a sequence of correspondence and optimising relations by which consumers and producers make prudent choices subject of resource or technology constraints and public policies. Consumers' optimal choice set are complete, transitive, continuos, monotonous and convex; $\{u : \mathbb{R}^n \longrightarrow \mathbb{R} | x \in X\}$. These contain quantities of n commodities ($\mathbf{x} = x_1, x_2, ...x_n$) in nonnegative orthant of $X \in \mathbb{R}^n$. These maximize utility $u(x)$ subject to budget constraints $p.x \leq y$. Given the input and output prices, $w \geq 0$ and $p \geq 0$ producers choose output levels $y \in \mathbb{R}^n_+$ to maximize their profits, $\pi(p, w) = p.y - w.x$; ; $\{y : \mathbb{R}^m \longrightarrow \mathbb{R} | y \in Y\}$. Here y is produced using labour and capital. The general equilibrium system results in the Pareto optimal allocation when it is not possible to improve the level of welfare of one person without lowering the level of

welfare of another person. Financial allocations emerging from this core given by the relative prices that guarantee equilibrium in the system lead to the most efficient outcome in terms of welfare and growth though these are often distorted by the tax, transfer, spending policies of government as well as tariffs and trade system in the global economy. The wide-ranging backward and forward linkage effects of the financial markets run on arbitrage principles are consistent to the feasibility and optimality of intertemporal plans of consumers and producers at the core. This optimal core itself is however subject to shocks of financial frictions and technologies of production from time to time and can cause significant fluctuations in economic growth. How it happens is briefly illustrated in the next section in an one sector growth model with financial intermediation to provide a background for the DCGE model in section 5.

4 Model of Financial Intermediation and Endogenous Growth

Let a dynamic economy be expressed with a simple stochastic technology $Y_t = z_t K_t$ where $z_t \sim N\left(0, \sigma^2\right)$. Capital stock accumulates form investment, $I_t = K_{t+1} - (1-\delta) K_t$. Amount of investment deviates from saving depending on the efficiency of financial markets $(0 < \phi < 1)$, $I_t = \phi S_t$ and $\frac{I}{Y} = \frac{\phi S}{Y}$as in (Bhattarai,2005). Assuming market clearing $Y_t = C_t + S_t$ and a steady growth rate of the economy $K_{t+1} = (1+g)K_t$ and the parameters z, ϕ, s and δ in Table 2 determine the growth rate of the economy as shown in (5)[2] and in Figure 3. Kiyotaki and Moore (2006) illustrate importance of the bilateral and multilateral commitment in maintaining the efficiency of the financial system (ϕ) like this[3].

[2] $\because I_t = \phi S_t = (1+g)K_t - (1-\delta) K_t = (g+\delta) K = (g+\delta) \frac{Y}{z}$

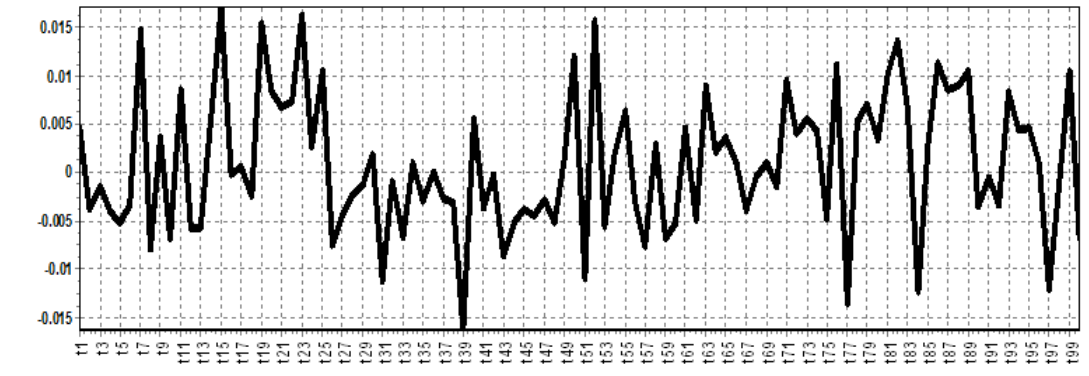
[3] Bhattarai (2014) numerically shows how financial crises of 2008 could be explained due to the shocks to these real sides of the financial system is illustrated with standard dynamics contained in simple cash in advance (CIA) in Sargent (1987), and money in utility (MIU) theories Sidrauski (1967) in small prototype models.

$$g = z\frac{I}{Y} - \delta = z\phi s - \delta \tag{5}$$

Table 2: Endogenous growth with financial efficiency

Parameters	δ	ϕ	y_0	z	s
CIA	0.02	0.95	1	$(0.15, 0.05)$	0.15

Figure 7: Fluctuations in growth rates due to stochastic financial frictions



Such excess volatility in economic growth causes further bubbles or crash in contagious fashion as shown by Miller and Stiglitz (2010) resulting in panic runs to the banks or exuberances as shown in Figures 4 and 5 above with a wide gaps between $OFDR_t$ and $AFDR_t$. Policy analyses and prescriptions that not based on the structural features of the economy and heterogeniety in consumption, production and trade can hardly come up with a concrete solutions required to resolve the problem. Despite a large body of theoretical and empirical literature on finance and growth mentioned in section 1 very little work has taken place in analysing the financial markets with a dynamic general equilibrium model. This lacuna in the literature motives us for this effort on constructing a dynamic CGE model to explain the implications of financial deepening on efficiency, growth and redistribution refining Bhattarai (1997). The main ingredients of these DCGE models are presented in the next section.

5 Finance in a Dynamic CGE Model

A dynamic CGE model quantifies how the size of financial sector relates and contributes to the economic growth at the core over time. There are mainly two different theories relevant to a DCGE. One is the classical approach which takes finance as a by product of investment saving activities among economic agents. The size of the financial sector basically is determined by the rate of saving and investment, marginal productivity of capital and size of the economy in it. This structure resembles to a competitive market economy with the neoclassical or Ramsey process of economic growth. In more recent theories, the sizes of financial sector and the economy are endogenously linked to each other and determined by the risk taking behavior or risk pooling arrangements of economic agents. Risky projects usually have higher rate of return but investors are willing to take risky projects only when risk is pooled among borrowers and lenders by an insurance mechanism. An economy with greater degree of risk-pulling will have higher rate of investment and growth and larger financial sector because of implementation of more productive investment plans in general. Higher level of income in turn allows more amounts to be saved and invested. Greater the degree of capital accumulation bigger are the coalitions of intermediaries and larger the size of the financial sector (Townsend (1983), Greenwood and Javanovic (1990) and Acemoglu and Zilibotti (1997), Balasko (2003), Brunnermeier and Sannikov (2014)). This theory is supportive of the deregulation and liberalisation of financial sector after 1980s. It is however irony that the risk taking behavior can reach out of proportions and create bubbles and lead to collapse of the financial system as it happened unprecedented in financial crisis of 2008 (and in several episodes of them that preceded it). Such devastating experience has made economists think about structural theories of bubbles originating in the financial sector that spreads adverse consequences not only on asset prices but also investment, growth, employment and welfare of the households in the economy.

The DCGE model proposed here takes main points of above theories and properly accounts for the intertemporal preferences of households between the current and future consumption (and saving), long run decision of investors in accumulating capital and the policies of government that often positive or negative affects on choices of these heterogenous firms and households. It is pertinent to present the generic structure of a dynamic general equilibrium model here and to apply it to the five advanced economies selected for this study with a focus on the optimal financial deepening ratios emerging from the optimising behavior of consumers and producers in these economies.

5.1 Consumers

Consumers are forward looking in the DCGE model. They are interested in smoothing out their life time consumption in order to guarantee a certain level of utility or standard of life for each period in their life, given subjective discount factors $0 < \beta^h < 1$. This requires intertemporal optimisation over the life time, maximising lifetime utility $\left(U_0^h\right)$ given the present value of the life-time income (8) and budget constraints (9).

$$U_0^h = \sum_{t=1}^{\infty} \beta^h U_t^h \tag{6}$$

$$U_t^h = U\left(C_{i,t}^h, L_t^h; \sigma_c\right) \tag{7}$$

Each consumer starting from initial endowment of physical capital $\left(K_0^h\right)$ and labour time $\left(L_0^h\right)$ makes decision to consume $\left(C_i^h\right)$ and work $\left(LS_t^h = \overline{L}_t^h - L_t^h\right)$ and save from its full income $\left(I_t^h\right)$ in each period leaving it to the banking system to channel those savings to the potential investors.

$$I_0^h = \left[\sum_{t=0}^{\infty} e^{-\rho t} \sum_{i=1}^{N} \left\{P_{i,t}\left(1+t_i\right) C_{i,t}^h\right\} + w_t^h\left(1-t_l\right) L_t^h\right] \tag{8}$$
$$= \sum_{t=0}^{\infty} e^{-\rho t} I_t^h = \left[\sum_{t=0}^{\infty} w_t^h\left(1-t_l\right)\overline{L}_t^h + r_t\left(1-t_k\right) K_t^h\right]$$

$$\sum_{t=0}^{T}\sum_{i=1}^{N} P_{i,t}\left(1+t_{ci}^h\right) C_{i,t}^h = \sum_{t=0}^{T}\left[r_t\left(1-t_k\right) K_t^h + R_t^h + w_t^h\left(1-t_l\right) LS_t^h\right] \tag{9}$$

Households supply factors of production, K_t^h and LS_t^h, to firms. They receive net of tax wage income in return to labour supply [$w_t^h\left(1-t_l\right)\overline{L}_t^h$] and capital income $\left[r_t\left(1-t_k\right) K_t^h\right]$ in return to their investment. They pay taxes on their capital and labour incomes and may receive transfer payments (R_t^h) from the government on the mean tested basis.

5.2 Firms

Firms are central to the supply of goods and services. Given the production technology, optimal choices of inputs are made to maximise profits in each period and over the model horizon. Entry and exit is allowed with regulations to maintain a competitive economy. Therefore in each period, firms compare prices of inputs and products $\left(r_{i,t}, w_t^h, p_{i,t}\right)$ and determine the optimum level of output that would maximise profits. Implicitly the level of output depends on relative prices of inputs and outputs as:

$$Y_{i,t} = F_i\left[K_{i,t}\left(r_{i,t}, w_t^h, p_{i,t}\right) p,\ L_i\left(w_t^h,\ p_{i,t}\right),\ A_i, \sigma_c\right] \tag{10}$$

$$\sum_{t=0}^{T} P_{i,t} Y_{i,t} = \sum_{t=0}^{T}\left[r_t\left(1+t_k\right) K_{i,t} + \sum_{h=i}^{H} w_t^h\left(1+t_l\right) L_{i,t}^h\right] \tag{11}$$

The structure of inputs and types of technology differs for firms operating in different sectors - agriculture, manufacturing, services. Some are capital intensive, others labour intensive, operating

on linear, Cobb-Douglas or CES technologies. All of them are interested to maximise total profit given the process of capital accumulation, $K_{i,t} = (1 - \delta_{i,t}) K_{i,t-1} + I_{i,t}$.

5.3 Trade

Economies modelled here are price takers in the global market except that they need to balance their trade over time. Adjustment in the real exchange rates brings such balance in the value of imports $[\sum_{t=0}^{T}\sum_{i=1}^{N} PM_{i,t}M_{i,t}]$ and exports $[\sum_{t=0}^{T}\sum_{i=1}^{N} PE_{i,t}E_{i,t}]$ and net flows of capital $[\pm\ FL_t]$.

$$\sum_{t=0}^{T}\sum_{i=1}^{N} PE_{i,t}E_{i,t} = \sum_{t=0}^{T}\sum_{i=1}^{N} PM_{i,t}M_{i,t} \tag{12}$$

$$\sum_{i=1}^{N} PE_{i,t}E_{i,t} - \sum_{i=1}^{N} PM_{i,t}M_{i,t} = \pm\ FL_t \tag{13}$$

Real exchange rate the ratio of weighted price indices of imports and exports and thus are determined by $PE_{i,t}$ and $PM_{i,t}$.

5.4 Government

Government provides public services like law and order, education and health, social security and pension and protection of environment to households and firms and adds to the public capital by investing in economic infrastructure, health and education. These expenditures enhance productivity and make these economies more competitive in the global market. In a dynamic economy the public spending should balance to the public revenue as shown in (14).

$$\sum_{t=0}^{\infty} e^{-\rho t} RV_t \lesseqgtr \sum_{t=0}^{\infty} e^{-\rho t} \left(G_t + R_t^h\right) \tag{14}$$

Government collects revenue through direct taxes on income of households and firms and indirect

taxes on their consumption. The optimal level of public expenditure and revenues is set when the benefits from the public spending equals the costs of public funds in equilibrium (see Mirrlee's et al. (2010)).

5.5 Markets

This dynamic economy is run efficiently by the market clearing relative price system. There a tatonement process in operation to eliminate the excess demand for each commodity in the model. Prices of commodities and services and factors of production continue to adjust until demands are balanced to supplies in each market. The optimal financial deepening ratio ($OFDR_t = \frac{K_t}{Y_t}$) measures the ratio of capital to output in aggregate. Corresponding measures across sectors are given by optimality conditions guiding the accumulation for these sectors, $OFDR_{i,t} = \frac{K_{i,t}}{Y_{i,t}}$. The real exchange rate links between the domestic and foreign sectors were results of the flow of imports and exports. Equilibrium allocations and arbitrage occur at the core of the economy and are Pareto optimal. In other words DCGE economy converges towards the competitive equilibrium over time and in each period and are optimal in the sense that all economic agents are doing the best given the amount of assets and time endowments they possess.

6 Parameters and Results of DCGE Model on Financial Deepening

The DCGE model constructed to assess the prospects of financial development in five economies consisted of eleven sectors of goods and services, capital assets differentiated by sectors and labour differentiated by skills. The micro-consistent datasets for these models were taken from the input output tables published by the OECD in 2006 for Germany, France, UK, Japan and USA. These

datasets provide information on the actual values for demand supply balances of firms, revenue and expenditure of the government, saving and investment balance for the private sector and the export-import balance for the economy. For instance the variation in the capital input tax rates (t_k) by sectors across model economies are as presented in Table 3. Other details on data and programme are skipped for space reasons and kept in the Appendix available upon request.

Table 3: Taxes in capital input by sectors across countries for the CGE Models

	Germany	France	UK	Japan	USA
Primary	-0.0724	0.0144	0.0103	0.0218	0.0054
Manufacturing	0.0241	0.0562	0.0627	0.1621	0.0242
Metal Manufacturing	0.0319	0.1012	0.0881	0.0557	0.0156
Machine Manufacturing	0.0457	0.1542	0.0851	0.0426	0.0119
Utilities	0.0378	0.0683	0.0683	0.0382	0.0732
Construction	0.0220	0.0876	0.0684	0.1093	0.0096
Tourism, Hotel and Restaurant	0.0580	0.0717	0.0543	0.0514	0.2200
Transport and communication	0.0264	0.0821	0.0921	0.0394	0.0500
Financial and Real Estate	0.0184	0.0313	0.0196	0.0135	0.0411
Business Services	0.0042	0.0495	0.0395	0.0356	0.0048
Professional Services	0.0213	0.0679	0.0647	0.0239	0.0351

Key parameters of dynamic model such as the elasticity of substitution between consumption and leisure $\left(\sigma_c^h\right)$, intertemporal subjective discount factor $\left(\beta^h\right)$, substitution between capital and labour in production (σ_y), elasticity of substituiton between domestic goods and imports (σ_m) are based on literature and sensitivity analysis (Robinson 1991). Acceptable values are assigned for the benchmark rate of growth, benchmark interest rate and generic rate of depreciation are given in Table 4.

Table 4: Key parameters for model simulations

Parameters	σ_c^h	$g_{i,t}$	r	β^h	$\delta_{i,t}$	σ_y	σ_k	σ_m
Values	1.5	0.02	0.05	0.98	0.1	2.0	1.5	1.0

A number of assumptions are made regarding the nature of the steady states among these economies. First, the bench mark rate of return on capital stock is chosen to be the natural rate of

interest (r) for each country. Information about the rate of deprecation of capital (δ_i) in each sector is obtained from the historical data and tested with sensitivity analyses. The steady state growth rates (g_i) are made consistent with the historical growth rates for each sector. The parametric values of r, δ_i and g_i define the reference path of the economy. Elasticities of substitution in consumption (σ_c) and production (σ_p) are based on the literature. In addition to capital input taxes as above, model contains taxes on consumption, wage income and transfers to households $\left\{t_c, t_w, R_t^h\right\}$ that are retained for all sectors except for the financial and real estate sectors in the counter factual analyses. Model is applied for policy analysis only after the calibration of the benchmark economies with the microconsisent dataset constructed for the 11 sector general equilibrium model from the input-output table obtained from the OECD. Fundamentals to all these rest on the optimising behavior of households regarding the division of labour between leisure $\left(L_t^h\right)$ and work and division of income between consumption $\left(C_t^h\right)$ and saving $\left(S_t^h\right)$. Accumulation capital drives the rate of economic growth.

6.1 Optimal and actual financial deepening

The general equilibrium theory provides a very clear framework for analysis of results obtained by solving equations with more than 14 thousands variables simultaneously for each of five model economies; France, Germany, UK, Japan and USA with a lifetime horizon of 86 years between 2006 and 1992. The optimal financial deepening ratios (OFDR) in the steady state are based on DCGE results ($OFDR_t = \frac{K_t}{Y_t}$), the ratios of actual financial deepening ratios are ratios of stock of assets from the OECD balance sheet to the GDP ($AFDR_t = \frac{FA_t}{Y_t}$) as expressed in (3) earlier. The results are relevant to the basic theme of this paper are summarised in Table 5[4].

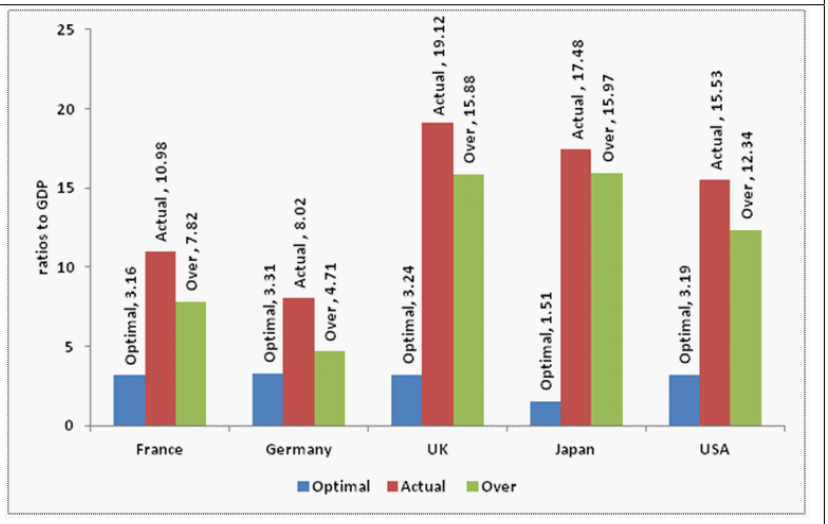
[4]Detailed solutions of these models are skipped here for space reasons and can be available upon request.

Table 5: Optimal, actual and excess financial deepening ratios (FDR) in Frnace, Germany, the UK, Janpan and the USA

Parameters	Optimal FDR	Actual FDR	Excess FDR
France	3.16	10.98	7.82
Germany	3.31	8.02	4.71
UK	3.24	19.12	15.88
Japan	1.51	17.48	15.97
USA	3.19	15.53	12.34

The overall optimal real financial deepening ratios from the general equilibrium models are consistent across countries; these are found to be around 3.16 in France, 3.31 in Germany, 3.24 for the UK, 1.51 in Japan and 3.19 in the USA. These are sensible results and consistent to the converging patterns of economic growth across these countries. The actual ratios of financial deepening reported in the OECD non-consolidated balance sheets of 10.98, 8.02, 19.1, 17.48 and 15.53 exceed by factor of 3.5, 2.4, 5.1, 11.6 and 4.8 than the optimal ratios computed from the solutions of the DCGE models of France, Germany, the UK, Japan and USA respectively as shown in Table 5. These are easier to compare and appraise in Figure 8.

Figure 8: Actual and optimal financial deepening in advanced countries



The discrepancy between the real and the nominal magnitudes of financial deepening gives credibility to the over-financing hypothesis that UK economy is more vulnerable to the financial crises as it has more assets originating from the financial derivatives and is more subject to the problems caused by asymmetric information. Japan is in a similar situation. Sectoral impacts of financial sector reforms are different for each of three countries. Despite this, economic growth rates in these models are driven by fundamentals of the financial markets based on the net present value calculations and portfolio selections satisfying the arbitrage across markets, risk-return analysis to minimise risks and maximise returns in anticipation of insurances to cover unforeseen contingencies. Supply of funds arises from inter-temporal utility maximising consumers and demand for funds for investment originates from profit maximising producers. Subjective discount factors of consumers and depreciation rates of capital of firms are balanced by the real interest rates so that funds are allocated according to the marginal utilities of households or productivities across various sectors leaving regulatory roles to the government for maintaining law and order to create fair opportunities for the participants from the private sector.

6.2 Policy implications

On-going financial sector reforms, including the mortgage to income ratios announced recently for the housing markets at 4.5 or tax free ISA in the UK, can be expected to make these economies more efficient so that the costs of funds decline in the counter factual experiments, where the taxes on the financial sectors are set to minimise distortions relative to the benchmark. Such measures will then result in the higher rate of growth of output, employment and capital stock in almost all sectors even with lower capital output ratios. By designing measures to counter inefficiencies due to the asymmetric information problem the financial liberalisation pays for itself, welfare of consumers improves with reforms rather than without it.

The proper reforms of financial markets not only improves the efficiency of financial intermediation but also brings speedier rate of economic growth by linking the lending and borrowing rates to the fundamentals of demand and supply of funds, removing controls on credits, by creating right structure of incentives for investors and depositors and by freeing up the foreign exchange market from arbitrary decisions making it subject to fundamentals of domestic and foreign asset markets. These mechanism remove repressionary regimes with non inflationary public finance for smooth processrd of capital accumulation, increased liquidity, technical advancement and economic growth, elimination of parallel markets and reducing the proportion of toxic non-performing assets. Liberalisation and reform mechanisms thus are instrumental in reversing repressionary and distortionaly financial regimes towards more classical free enterprise economy that would promote accumulation and growth in these model economies.

Monetary policy was not effective in containing the current crisis because of excess financial deepening ratio due to the excess leveraging and collateral debt obligations in the financial markets made possible by financial liberalisation and deregulations that led to proliferation of toxic assets

in these economies. Further analysis of these are found in seminal and most recent papers such as Fama (2014), Shiller (2014), Hansen (2012), Taylor (2010), Brunnermeier and and Sannikov (2014) and Nordhaus (1995). Bhattarai (2014) proves the neutrality of money both in cash in advance and money in utility models. This provides validity to the analysis of the real financial sector as presented in this paper.

Competitive financial markets are perfect in allocating assets only when all agents that have complete information and are efficient in processing such information. Financial markets are full of asymmetric information, activities of one set of players depend on actions taken by another set of players and the amount of information they have impacts on the likely choices of others. This requires state contingent incentive compatible mechanisms in the DCGE model and is an issue for further investigation.

7 Conclusion

The core of Shapley-Shubik games and general equilibrium models with a Venn diagram is applied for a theory on the role of real finance in economic growth among advanced economies. Then the dynamic computable general equilibrium (DCGE) models for Germany, France, UK, Japan and USA are constructed to assess the validity of the over financing hypothesis that reappeared after the financial crisis of 2008. Actual financial deepening ratios observed in the non-consolidated balancesheet of the OECD exceeded by factors of 3.5, 2.4, 5.1, 11.6 and 4.8 to the optimal financial deepening ratios implied by DCGE models respectively in these countries because of excessive leveraging and bubbles up to 19 times of GDP which were responsible for this great recession. Containing such massive fluctuations for macroeconomic stability and growth in these economies is not possible in conventional fiscal and monetary policy models and requires a DCGE analysis like

this along with adoption of separating equilibria strategy in line of Miller-Stiglitz-Roth mechanisms to avoid asymmetric information problems in process of financial intermediation so that the gap between actual and optimal ratios of financial deepening remain as small as possible.

The dynamic CGE model results used in measuring the gap between the actual and optimal financial deepening ratios is a unique contribution of this paper to the literature on financial deepening and economic growth. It takes account of wide-ranging interactions among a large number consumers and producers and mimics the real world situations in model economies[5].

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