MACRO-ECONOMIC IMPACT OF INVESTMENT SHOCK IN GLOBAL ANTICIPATIVE MARKET

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Abstract

From previously established framework to analyse abuses in the use of leveraging effect by European banks, it has been shown how very high level of risk has been reached. In present paper, the macroeconomic approach is improved by taking better account of (global) economic agent action in giving each of them its own predictive mechanism based on knowledge of all agent anticipations. Agents risk appetite and risk recession objectives are modified and, with access to estimation of other agent variables, each agent is able to take more accurate decisions. The impact in each agent balance sheet and profit and loss account can be evaluated. Application is made to the analysis of the impact of a strong shock reduction in investments on Chinese economy.

Keywords: Finance, China Economy, Agent based model, Macroeconomics, Cobb-Douglas, Hall & Taylor, Interest rate

I. Introduction

In present economic context, banks are maximizing their profits by leverage mechanism which consists in participation to financial operations with as large borrowing as possible to cover their deals [1,2,3]. In this context, the objective of all economic agents today is to optimize debt level to avoid a new global economic crisis like last US one in 2008. Because operation coverage is sometimes based on non-reliable enough assets, it is very important to have a realistic risk estimate, as over-leverage effect has been identified as principal cause of US ‘’subprime’’ crisis [4,5]. It can dangerously weaken banking system as a whole by domino effect consecutive to highly nonlinear amplification once the banking sector starts being vulnerable and inherently unstable after adverse shocks [6,7]. It is consequently of up-most importance to build up a reliable model of macroeconomic link between banks and leverage effect, in order to determine financial impact of this interaction, and have the elements for efficient control of banking sector. The role of excess leverage as a driving force for the instability in the financial-real linkage is studied in many DSGE models. Much of this work is based on [8] which exhibits some mean reverting behavior. In other theoretical works, more distant to DSGE model, a number of studies focus on how fragile bank balance sheets and the financial sector are likely to be destabilizing rather than mean reverting. The asset price channel through which the banking system instability is triggered has become essential and is strongly stressed in [9,10,11]. Other studies [12] focus on financial experts representing financial intermediaries. Here it is a shock to asset prices which creates a vicious cycle through the balance sheets of the banks, contagion effects and macro feedback effects (the volatility paradox). When volatility of asset prices is low, risk taking and borrowing occurs, but low volatility builds up instability. When prices of assets held by banks fall, and therefore their equity value and net worth fall, the margin requirements for borrowing on the money market rise, forcing financial intermediates to take haircuts and to further de-lever to remain liquid. This, in turn, can lead to a resale of assets, further depressing asset prices, decreasing net worth and thus triggering an endogenous jump in volatility and risk for all, generating a downward spiral.

To avoid excessive development of microeconomic addition to global classical models, and different from predictive methods [13,14,15,16] and control [17,18] type methods, it is here proposed to improve economic analysis at same macroeconomic level by giving the (global) agents in the model {government, financial authorities, banks, consumers, producers} access to all representative economic variables of the system for deciding a strategy. This presents the advantage of same simplicity of state space which remains at global level with same dimension, but still a real improvement by adding some adaptation at this global level in giving all global agents the access to prospective behaviour of each of them. Here, Government variable is government expenditure, Banks variable is interest rate, Consumer variable is consumption level. Producers adapt their production and adjust the level of richness produced in the country. Instead of relatively more advanced predictive learning [19], each agent in proposed model is given by adapted knowledge mechanism the possibility to estimate the variables of other agents for faster convergence toward equilibrium at each sampling period.

In present "agent" oriented macroeconomic model in contrast to classical IS-LM model approach [20], each agent proceeds in three steps during each time period corresponding respectively to action on its own variable, to estimation of other agents variables, and to resulting balance elaboration to decide next action. To test the reliability of proposed "intermediate" model in between pure classical macroeconomic and its "improved" version by addition of agent prospective responses, the example of strong but sensitive Chinese economy has been considered here, where it is subjected to an investment shock downward by a factor three for three trimesters in the row, which is a sufficient time period for testing the shock effect.

II. Model Description

The model comprises four blocks exchanging at discrete time steps elements corresponding to their specific function in the global economy, see Figure **1**. In the model, G is Government spending, Producers determine the GDP using a Cobb Douglas equation (Y = GDP, K = economic capital, L = labour), Banks determine the interest rate (r), Consumers determine the Consumption (C), B represents the money borrowed by Producers from Banks, L is the money borrowed by Consumers from Banks. Equations of the system are displayed on Table **I.** The study is developed on a two-year time period to avoid convergence problem, however sufficient to analyse shock effect on system dynamics.

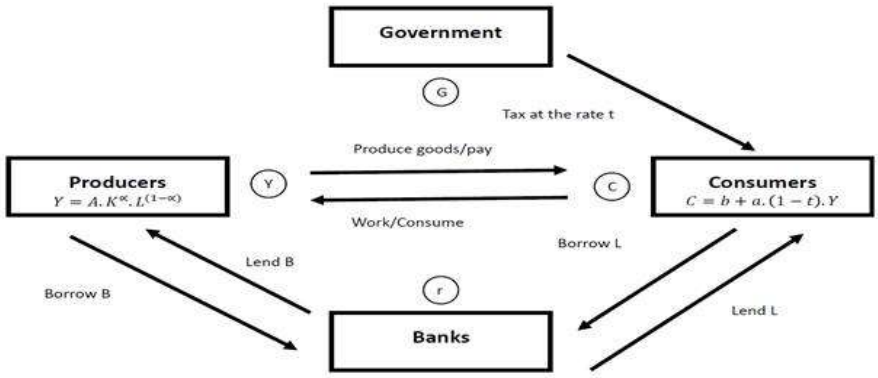

Figure **1**. Overall Model Architecture. Variable Y is Different for Producers and for Consumers. Similarly L Borrowed by Consumers from Banks is Different from L Involved in Producers Equation.

Equations	Variables meaning
$Y = C + I + G + (X - M)$ (1)	Production *Y* in terms of consumption *C*, investments *I*, government spending *G* and net exports (*X* □□*M*).
$Y^d = (1-t) * Y$ (2)	Remaining GDP (after tax) = Production – Government taxes.
$C = b + a * Y^d$ (3)	Households' consumption level.
$I = e - d * r$ (4)	Households' investments governed by interest rates.
r = *h*□1[*k*∗*Y* □ *M/P*] (5)	Interest rates function of GDP and price indices.
□*exp*□□□□□□□□1□□□□□□□□2 (6)	Expected inflation □exp from two terms extrapolation
□□□□□□exp + □*Y*□□□*Y*exp)/ *Y*exp (7)	Real inflation estimation
$P_t = P_{t-1} * (1 + \pi)$ (8)	Current price depending on inflation □ and previous period prices.
EP/P$_w$ = *q* + *v* + *r* (9)	Outer economic exchanges
X □ *M* = *g* □□*m*∗*Y* □□*n*∗*EP/P*$_w$ (10)	Export exchanges
$G_d = G - t * Y$ (11)	Remaining government spending = Government spending + Incomes from taxes.
U = *U*exp □□□□□□□□*Y*□□□*Y*exp)/ *Y*exp□□□□□	Unemployment *U* from GNP *Y*

Table **I.** Model Equations. Interaction between the Variables are Indicated in the Right Column.

III. Agent Balance Sheets

Running the model on historical data provides an estimate of each agent variable. From them the following balance sheets are established for each agent at each step:

ASSETS	LIABILITIES
Estimated households balance sheets	
Investments (= Household investments taken from the treasury account established by extrapolation.)	Saving (= Saving + net debt (by extrapolation) if debt net is > 0, if not, we simply consider saving)
	Loans (= Net debt taken from treasury account (by extrapolation) if > 0, if not, there are no loans)
Actual households balance sheet	
Investments (= Household investments given by Hall-Taylor model)	Saving (= Saving + net debt (from Hall-Taylor) if > 0, if not, only saving is considered)
	Loans (= Net debt from actual treasury account if > 0. If negative, loans value is set to zero).
Estimated banks balance sheet	
Book reserves = as from bank Excel worksheet (R)	Deposits = Deposits taken from bank Excel worksheet
Loans to households = households' loans	Results (D)
Bonds = Industry bonds	
Actual banks balance sheet	
Book reserves = as from the bank Excel worksheet (R)	Deposits = Deposits taken from bank Excel worksheet
Loans to households = households' loans	Results (D)
Bonds = Industry bonds	
Estimated industries balance sheet	
Investment (= Investment from industries' treasury account)	Capital (= Set at 12650M $)
Fixed assets and Furniture (= Set to 12650M $ for the first year; investments, fixed assets and furniture of the past period are added after)	Bonds (= 0 if bonds amount > 0, otherwise it is set at + the amount of company's bonds)
Liquid assets (= 0 if the amount of obligations (extrapolated) is > 0, otherwise it is set at – the amount of company's obligations)	Book reserves (= Accumulation of book reserves (extrapolated) and results of past period)
	Result (= Comes from industries' extrapolated profit and loss account)
Actual balance sheet	
Investments (=Variation in capital between two consecutive years using Cobb-Douglas' model)	Capital (= Set at 12650M $)
Fixed assets and Furniture (= Set at 12650M $ for the first year; investments, fixed assets and furniture of the past period are added after)	Bonds (= 0 if bonds amount > 0, otherwise it is set at + the amount of company's bonds)
Liquid assets (= 0 if the amount of bonds are positive, otherwise it is set at – the amount of company's bonds)	Book reserves (=Accumulation of book reserves and results of the past period)
	Result (= Comes from industries' real profit and loss account)

IV. Application to Chinese Economy

All parameters in macro-system describing economy dynamics in Table **I** have been first determined from past collected economic data, see Table **II**, and used to fix system evolution.

The model enables to determine Households consumption. Banks are modelled from CC-LM model in which equilibrium equation writes $R + L^s + B_b^D = D^s$ where R represents banks reserves, L^s the consumers loans, B_b^D the bonds bought by banks and D^s the deposits given by $D = (1 - t)^{-1}(L + B)$ with $t = R/D$ the

a	50%	e	653,378,641,749.72
t	15,00%	d	371,163,136,053.25
b	1.47669E+11	q	6.4
k	2.001172259	v	22.077
G	3.10E+10	g	3,446,964,722;668.13
M	81.5E+9	n	447,759,,096,210.51
m	.231598496	□	.8
h	1.58986E+14	□	.2
		□	302.0015277

Table **II**. Numerical Values of System Coefficients for Chinese Economy

treasury reserves ratio which can be obtained from banks data. To close the system of equations, banks profit given by

$$\text{Profit} = (r + s)*L + r*(B \square\square D\square \quad (13)$$

is added and the spread value *s* is researched to maximizes this output parameter, see Figure **2**.

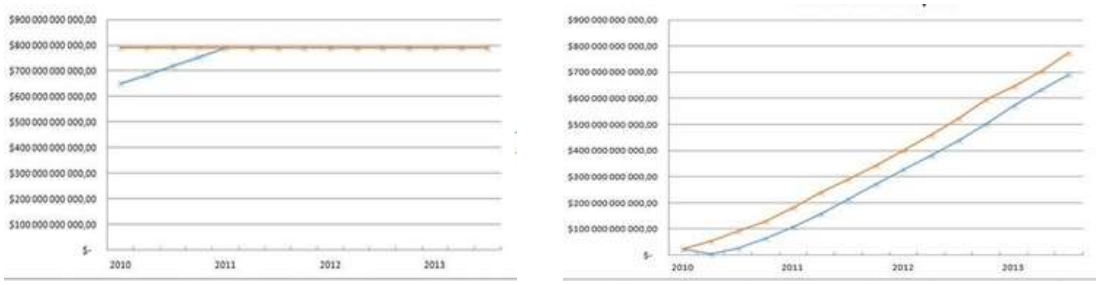

Figure **2**. Quarterly Households Consumption (Left) and Banks Profits (Right) (Blue Predicted; Yellow Present Model)

Production is calculated from Cobb-Douglas equation which provides quarterly GDP values:

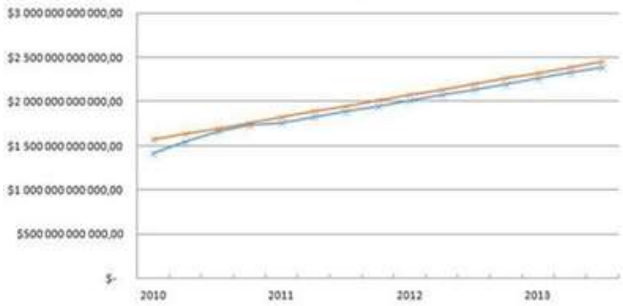

Figure **3.** Quarterly GDP (Blue Predicted; Yellow Present Model)

To study the effect of added predictive learning for preventing new economic crisis, an economic shock is applied on the model by dividing by three the investment for three trimesters (Trimester 4 of 2010, Trimester 1 of 2011 and Trimester 2 of 2011). Consequences on Chinese economy are displayed on Figures **5,6** respectively without and with shock.

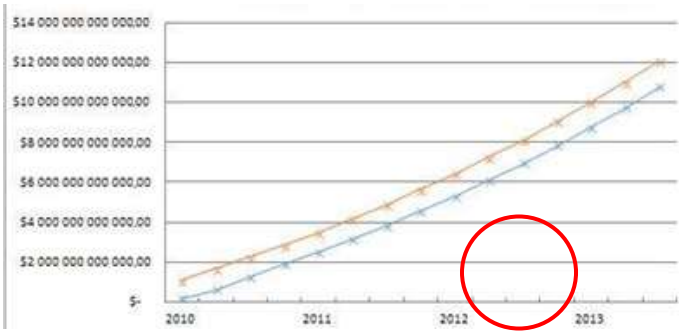

Figure **4.** Consumption (Top Left), Household's Result (Top Right) and Household's Debt before Investment Shock.

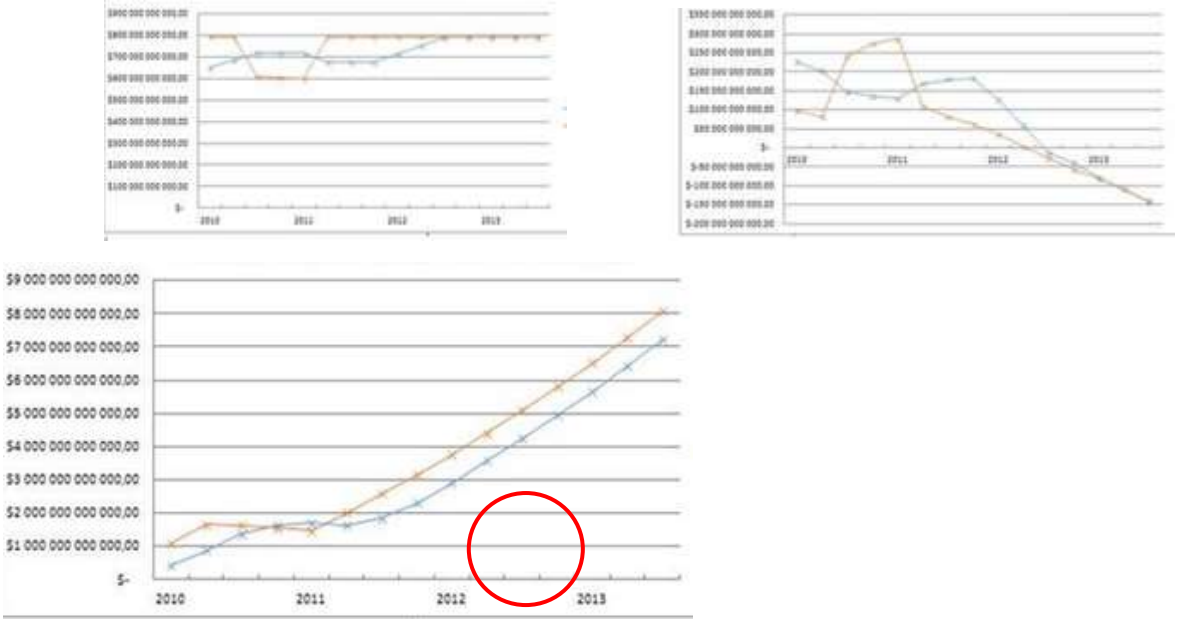

Figure **5.** Consumption (Top Left), Household's Result (Top Right) and Household's Debt after Investment Shock.

The important impact of investment shock on economy is visible from Figures **4,5**.. Response is much stiffer and more rapid than predicted. Paradoxically this is expectable as long as in present model each global agent is much faster aware of other agents behaviour than in classical system where information is just transiting at characteristic time response of various blocks. In particular, a large drop in Household Consumption is observed for the three trimesters of shock duration, followed by a rapid recovery of their result. Debt is just shifted of shock duration. This observation also reflects the "open loop" nature of present study in that government has only a strictly "liberal" attitude. Proposed analysis strongly indicates its weakness and suggests to complete the model by closing the loop with adapted government reaction to minimize shock impact.

V. Conclusion

Rather than simple usual dynamical evolution calculated from global macroeconomic models with adjustable parameters, proposed approach tries to emulate the complex alchemy between agents at this macroeconomic level by making them to interact adaptively when each one knows all their dynamical behaviours listed in their personal present and estimated balance sheets. Then they can better evaluate their "next step" and try to optimize their return from present and prospective system behaviour. To test the system, the effect of an investment shock has been analysed on Chinese economy which combines the strength of modern economy with still some weakness in banking system. Based on specificities of the country, the model has been used to simulate the impact of dividing investments by a large factor on the economy. The results show the interdependency between economic agents and could be an interesting way to measure its level in different countries. A way of improving present very "liberal" and open loop model would be to incorporate government behaviour to some degree and see corresponding system economic reaction. It is reasonably advisable to consider that in reality the State would react to such a shock by for instance increasing its spending or cutting taxes with consequences to be observed in this new adaptive global closed loop system.

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