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碩士論文

Rethinking on Liquidity Shock and Capital Requirement Strategies under European Debt Crisis

流動性危機與銀行資本適足率策略探討

以歐債危機為例

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摘要

銀行資本適足率為確保整個銀行與經濟體系穩定與完善的重要指標之一，而近年來隨著新巴塞爾協定之推行，經濟學家間掀起關於現行資本適足率的適切性的討論。本篇論文以流動性危機、道德風險建構模型，在此基礎下推導出最適資本適足率策略，模型主要論點為資本適足率需根據各國經濟情勢而有所調整，當一國的 GDP 與利率呈現正向關係時，意味資本適足於經濟成長時緊縮(提高)，而於經濟衰退時放寬(下降)；而當一國 GDP 與利率呈現負相關時，則資本適足率於經濟成長時放寬(下降)，而於經濟衰退時緊縮(提升)。

在此模型理論基礎下，本篇論文以歐元區十七國之資料來深入探討歐債危機之下資本適足率的策略。實證結果顯示，在 2005Q2 到 2011Q3 大部份的國家 GDP 與利率呈現正向關係，亦即資本適足率與所得之反向循環策略是較適當的，追蹤資料分析更指出貿易程度開放的國家需要相對較嚴格的資本適足率策略，而較傾向實行財政政策之國家需要更寬鬆的資本適足率策略。本篇論文亦對 2012 年各國應有的資本適足率策略做預測，結果證實歐洲各國應採行資本適足率與所得之正向循環策略，其中，希臘、義大利、西班牙、法國，在經濟衰退之時需要寬鬆的資本適足率策略，但寬鬆(下降)幅度必需有所限制。

關鍵字：資本適足率、歐債危機、巴賽爾協定、流動性危機

Abstract

Capital requirement serve as an important key for ensuring the stability and effectiveness of the overall economy. As the new Basel Accord has announced, debates over how capital requirement should be implemented, especially in the times of crisis, are heated among economist. In this paper, based on liquidity shock and moral hazard problem, we derive the optimal capital requirement strategies, which depend on general economic condition. We argue that counter-cyclical capital requirement, which adopts looser capital requirement when GDP decreases and increases capital requirement when GDP increases, should be adopted when GDP and interest rate is positively correlated while pro-cyclical capital requirement are appropriate when GDP and interest rate is negatively related.

To further characterize the problem under European Debt Crisis, we use 17 countries in Euro Zone to conduct empirical test and panel estimation. We conclude that most countries should adopt counter-cyclical capital requirement during 2005Q2 to 2011Q3. Besides, our panel estimation indicate that countries with more trade openness should adopt more flexible capital requirement policies, while countries who focus more on fiscal policy weight should have larger adjustment on their capital requirement. Finally, our forecast result suggests that in 2012, all the countries in Euro Zone should adopt counter-cyclical capital requirement policies. In particular, Greece, Italy, Spain, Portugal and France should have looser capital requirement compared to other countries.

Keywords: Capital Requirement, European Sovereign Debt Crisis, The Basel Accord, Liquidity shock

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回想兩年前毅然決然決定從外語學院踏入商學研究所，當時很不確定如此抉擇是否正確，如今看來完全沒有後悔的理由，這兩年在系上教授與政大其他系所優異的師資指導之下，我獲得與原本學習領域完全不同的思考方式，對我來說，是感動、是震撼，也是滿滿的感謝。怎麼也想不到自己能擁有如此充實的研究所生活，並且能在這段學習時光結束的尾聲，順利的完成我的碩士論文。

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1. Introduction

1.1 European Sovereign Debt Crisis

European sovereign debt crisis is an ongoing crisis. The causes can be roughly attributed to international trade imbalance, easy access to borrowing money, bailout spending in financial crisis in 2008, and the further economic recessions from 2008 to 2012. Relative to Germany, Greece, Ireland, Portugal, Italy and Spain has large amount of trade deficit. The trade imbalance has kept worsening, thus resulting series fiscal deficit. Besides, increase savings around globe during 2000 to 2007 made the money available for investment, as investors seeking for higher yields target than US treasury bonds. Increase investment in fixed income securities, together with the guarantee of Euro Zone, has made Greece and Ireland get easy access to borrow money. After the bubble burst and the asset price declined, the liability owned to global investors remains at full price, thus deepening government's debt burden. Finally, the bailout spending during financial crisis has been the last straw. The bailout package has transformed the debt from private sector, such as banks, to the government. With the high debt levels and low existing interest rate, the government is left with few policies to take over the burden.

In 2008, Greek government's bond yield rises from 25 basis point to 65 basis point, reflecting the starting point of investors demanding high interest rate from governments with higher debt and high deficit levels. These governments have a hard time financing its existing debt and deficit. The subsequent downgrading of credit risk in Greece, Ireland and Portugal, accompanied by the rising government debt exceeding its GDP ratio in these countries, has aroused tremendous fears among investors. In 2010, the worries are intensified when the market found out the Greek's

deficit is much worse than it claimed. To restore confidence of Europe as well as ensuring financial stability across Europe, EU creates a European Financial Stability Facility (EFSF)[1]. IMF and the Euro Zone agree to bailout Greece, following later Portugal and Ireland. The bailout is at the cost of the promise that the government will cut its spending budget and start debt reconstruction plan. Soon after, Greece starts to unveil a series of austerity measures[2] aim at cutting the deficit. However, the excessive spending cuts bring Greece into serious recession. In 2012, the subsequent bailout plan has been agreed by EU. However, the opposition voice against austerity measure has spread among Euro Zone. With debt borrowing kept rising in Spain and Italy, and the economic contraction has been reported across Europe, it seems the Europe sovereign debt is just at its beginning.

In this paper, we look at the capital requirement policy to examine the current response to European sovereign debt crisis. We use data in 17 countries in Euro Zone to find suitable capital requirement strategies. We also discuss whether current austerity measure, especially capital requirement policy, is capable of solving the crisis. But first, we will give a brief review on now-existing Basel Accord and capital requirement.

1.2 Basel Accord and Capital Requirement

The Basel Accord, conducted by the Basel Committee on Banking Supervision (BCBS) to set a standard of capital requirement in banks all over the world, has become an important regulation to prevent international risk and crisis. It is the most crucial banking supervision standard in the world. The goal of Basel Accord has been

[1] ESFS serve as special vehicle financed by members in Euro Zone to address European debt crisis, with the objective to provide financial support to Euro Zone states in economic difficulty. It was set on 9, May, 2010. The headquarters are in Luxemburg.

[2] Austerity Measure refers to policies that involved with cutting the spending to lower the deficit.

insuring stable management as well as fair competitiveness among banks.

Over the years, capital requirement policy has evolved substantially under the standards set by the Basel Committee on Banking Supervision (BCBS). In 1988, the Committee set a capital requirement standard that assets are grouped into five categories according to credit risk[3], which refers to as Basel I. As the goal of Basel I is simply to raise capital requirement in some countries regarded low capital requirement level, Basel I has been criticized for making very limited distinctions through risk weights between difference in credit risk.

Later in 2004, the Committee agreed on a new capital framework whose fundamental characteristic is to make minimum capital standards more risk-sensitive, which is refers to as Basel II. The capital charges of Basel II are based on asset quality rather than on asset type. It will permit banks to use its own internal rating system (IRB) to quantify the creditworthiness of their debtors. As in the old framework, total capital requirement are still 8 percent of risk-weighted asset. Besides, Basel II has strengthened the ability of supervisors to require higher capital targets above the minima based on an assessment of risk management. It also develops more transparency disclosure requirements to allow the market participants to judge the capital requirements of an institution. However, the common criticism for Basel II is the regulation often incur procyclicality problem[4]. Skeptics believe that requiring bank to hold more capital requirement when banks are exposed to greater risk will further induce economic downturn, or bankruptcy.

After the financial crisis in 2008, the Committee once again revises the capital requirement standard as Basel III. Besides strengthening risk coverage, new

[3] The five asset categories are risk weights of zero (mostly home sovereign debt), ten, twenty, fifty and one hundred percent (mostly corporate debt).

[4] Basel II Accord require bank to raise their capital requirement when they face more risk, so bank will lend less during recessions. The contraction will further make the economic condition worse. On the contrary, less capital requirement holding in the boom will is likely to create bubbles.

regulatory requirements on bank liquidity and bank leverage were introduced. A minimum of 3% leverage ratio is required, and bank should hold sufficient high-quality liquid asset. These changes are aim to enhance risk-management, reduce procyclicality as well as promoting countercyclicality, avoid moral hazard problem, and increase transparency. From Basel I to Basel III, the Committee has been dedicated on setting capital requirement that ensures bank be able to withstand crisis as well as maintain its stability. However, whether the new capital requirement will be appropriate for each country is still under debate.

In this paper, follow the framework of Len-Kuo Hu (2012), we considers a model in which deposit and equity capital level are only depends on the decision of a representative, who simultaneously plays three roles including a representative consumer, a depositor and the bank's equity holder. Our main argument is capital requirement should follow different strategies across different countries and times, according to its economic condition. More specifically, we suggest that when GDP is negatively related to the interest rate, the country's authorities should raise the required ratio in recession and lower it in the boom. On the contrary, the countries' authorities should raise capital requirement in boom and lower it in recession if the GDP is positively related to interest rate.

The rest of the paper is organized as follows. Related Literatures concerning European debt crisis, liquidity shock and capital requirement are reviewed in section 2. A summary of liquidity shock model will be presented in section 3 and 4. Section 5 and 6 performs descriptive analysis and panel estimation to find out the appropriate capital requirement strategies under European debt crisis. Section 7 concludes our main argument and results.

2. Literature Review

European sovereign debt crisis is an ongoing crisis, but the fundamentals of the crisis and the future impacts are still under debate. Arghyrou and Tsoulalas (2011) consider the European Sovereign debt crisis as a currency crisis. Using Obstfeld (1996) and currency model,[5] they conclude that Greek debt crisis will continue to escalate because market expectation for Greece has shifted from credible commitment with implicit guarantee from Germany, to non-credible commitment without any backed guarantee, making the cost of maintaining the currency peg higher than abandoning it. Thus, they only way out for Greece is to rely on IMF's emergency financing, or leave the EU eventually.

Vitek and Bayoumi (2011) estimated a structural macroeconomic model of the world economy to analyze possible future spillovers from real and financial shock mainly from Greece, Ireland and Portugal both within Euro area and to the rest of the world. The result suggests macroeconomics and financial market spillovers have been small to countries with high trade or financial exposures, but it will be of more concern if Italy and Spain are under large financial pressure. Besides, they also find that monetary policy response produce limited scope to reduce the spillovers. It requires fiscal and financial policy measures to both alleviate market concern and respond to future large adverse shock in Euro Area member countries.

One of the interesting findings by Reinhart and Rogoff (2010) are worthy of mentioning. They extended the debt data to a range of half a contrary, form 1980 to

[5] The government balances the credibility cost incurring by defaulting on the exchange-rate peg commitment against the macroeconomic cost arising from deviating from the peg-maintenance. In the first generation model, excessive deterioration in fundamentals will result in the peg's collapse since the cost of maintaining the peg exceeds defaulting. However, in the second generation model, which applies on Greek before the debt crisis, the peg's cost is endogenous to the private sector's expectations. Under credible commitment, overvaluation defending the peg is less costly.

2009. One of their results indicate banking crisis always precede or accompany sovereign debt crisis[6], which may explain the financial banking crisis in 2008 has indirectly b cause European sovereign debt cerise, and the debt crisis may further inducing another banking crisis. Due to the close relationship between debt crisis and banking crisis, we narrow down our research focus to the role banking regulation, specifically referring to capital requirement, during the time of debt crisis.

Numerous papers have concerned the issue of capital requirement, showing its crucial roles in banking regulation and supervision. One particularly issue raised is the procyclicality of Basel I and Basel II, which is the debate over whether the raising capital requirement during recession and loosing it during contraction will further cause economic fluctuations. If the capital requirement increases in recessions, given that raising capital is very costly, banks would have to reduce loans and the subsequent credit crunch would deepen the downturn.

Kashyep and Stein (2004) argue that under Basel II capital requirement, additional procyclicality impact is significant. Their theory suggests that capital requirement should come down when the economy is in downturn, i.e. economy-wide bank capital is scarce relative to lending opportunities. They also propose that capital requirement rule should base on aggregate business cycle indicators, such as creating to GDP threshold. Rabell, Jackson and Tsomoso (2005) find that more stable rating scheme over the cycle would not further induce the procyclicality of capital requirement, whereas ratings according to the current point of the cycle would significantly increase procyclicality. However, bank will not choose the more stable rating system, meaning the procyclicality problem is still big issue. Heid (2007) prove under Basel I

[6] They use VAR method to test the relationship. Both variables, banking crisis and debt crisis dummies, are treated as endogenous, which can be explained by its own lagged values and the lagged values of the second variables. Their results also indicates that systematic banking crisis in financial centers help explain domestic banking crisis, which is very intuitive.

and Basel II, procyclicality problem exist, but can be mitigated by capital buffer [7]decisions. In addition, they point out the procyclicality effect will vary among countries, depending on different macroeconomic fluctuations.

Conversely, Zhu (2007) proposed a completely different view, stating that Basel II does not necessarily cause procyclicality of capital regulation, which he uses capital buffer to measure instead of the change in regulatory capital. The capital requirement does not affect the volatility of the bank credit and economic output. Furthermore, higher volatility of capital rule does not necessarily result in big movements in bank's lending activity, since banks often choose loans that are different from that of the regulated capital constrains.

Finally, two empirical tests conducted in Europe, which is the main focus of this study, also have different results on the issue of procyclicality. Ayuso et al. (2004) indicates that instead of arguing the procyclicality of capital requirement, we should examine capital buffer's variation over business cycle. The reason is few banks hold just capital requirement, while most keep capital buffers. They perform empirically test using Spanish data from 1986 to 2000. They confirmed that an increase of one percentage in GDP growth reduces capital buffers by 17%, meaning that the test support procyclicality of Basel II. However, similar empirical testing on Germany, conducted by Stolz and Wedow (2011) on the contrary indicates procyclicality of Basel II is not clear. Their results demonstrate a fundamental concern of this paper: Should capital requirement implement a certain formula in every country, regardless of the variation of economic situation across each country?

As capital requirement can affect bank's liquidity decision, both in advance of

[7] Capital Buffer refers to the amount banks have to hold above minimum requirement, according the forecast of risk. There are two types of Capital buffer, capital conservation buffer and countercyclical buffer. The former focus on individual bank's financial condition while the latter's goal is more macro-prudential, which protects the banks form excessive credit growth.

credit extension as well as facing serious economic downturn, another issue we must address here is bank's liquidity. Diamond and Dybvig (1983) proposes that bank can transform illiquid asset into liquid demand deposits, but banks do not know the exact time of all depositors. If the liquidity needs of many depositors come at one time, or more seriously, the self-fulfilling runs[8] occur, it may force bank to liquidate the illiquid asset in a wrong time, further jeopardize bank's activity. Roche and Tirole (1996) also use their model to prove that in the optimal financial contract linking each bank and its lenders, the bank is subject to liquidity requirement, in proportional to its risky asset. To prevent systematic risk, government should implement the liquidity management by centralizing the payment system, the Fed funds markets, and other markets where banks are exposed to each other. This would ensure efficient liquidity allocation among banks. As suggested by Borio and Zhu (2011), weak liquidity constraint can support higher risk-taking, and effectively increase risk-tolerance. In turn, the greater risk-tolerance also relaxes external funding constraints. Whereas when liquidity condition tightens, risk-tolerance and risk-taking ability decrease.

Farhi and Tirole (2012) use a liquidity hoarding model to argue that when everyone take part in maturity mismatch[9], the optimal policy for the authority is simply to bailout, which creates a social cost. To further discuss the choice of bailout policy, they propose that interest rate policy, including any measure that will lower financial institutions borrowing cost, is always the optimal bailout unless the crisis affects a large fraction of the banks, in which case interest rate policy and direct transfers are both used in equilibrium. Direct transfer, referring to interventions boosting the net

[8] More specifically, if everyone expects that other depositors to withdraw their funds from the bank, then they will all rush to the bank to withdraw their deposit. The bank will soon out of money since it will not be able to pay all the depositors coming at the same time. Thus, bank's bankruptcy will take place.

[9] Maturity mismatch occurs when banks hold substantial long-term assets but short-term liabilities (such as deposit). When banks engage in serious maturity mismatch, it is susceptible that bank run will occur.

worth of financial institutions without lowering the their borrowing cost, thought better targets on strategic actors, it entails a greater waste of resources by supporting entities that have no need for due to an asymmetry of information. On the contrary, interest rate policies, though entailing an invisible subsidy from consumers to banks, help to screen out institutions with limited financing needs. In their point of view, interest rate policies are the market- driven solution, but needs to be attentive of the cost of maturity mismatch and authorities loss of credibility, which sowing the seed for the next crisis.

Our model summarizes the key point in that of Len-Kuo Hu (2012), which based on the framework model of Holmstrom and Tirole (2011). In the paper, they construct a moral hazard model, assuming that the entrepreneurs still has incentive to work hard given private benefit private that entrepreneurs will commit all of the firm's pledgeable income to the investors. Under the liquidity shock, when the cost of continuing a project falls between the pledgeable income and the total income, the project can continue only if the funding has arranged in advance, thus creating demand for liquidity. The firm faces the dilemma between sacrificing larger investment scale at the beginning but insured against future liquidity problem, or choosing lager investment scale but facing future solvency problem. Our model has very much similar setting with theirs, but we extend it to describe the property of capital requirement ratio and appropriate bankruptcy threshold, and further relate GDP and capital requirement. The details will be specified in section 3.2, 3.3 and Section 4.

3 The Model

3.1 The Set Up

We characterize the society through the activity of a representative individual who simultaneously represents the representative consumer, depositor as well as the banker, and equity holder of the bank. We assume that each role of the individual does not affect his others characters. In other words, his decisions are not affected by his other roles in each of the situations. The ultimate goal of the banker is to determine an optimal level of bank loan L to an investment project. In t=0, there's an opportunity and to make loan L, which should be financed by either the inside equity or the outside deposit of the bank. In t=1, there will be gross payments of either R if investment succeed, or 0 if the investment fails. The probability of success depends on the unobserved action of the banker of where to invest the funds I. If he chooses to invest in an efficient technology H, it will give him a probability of success P_H. If he choose the alternative option to invest in and inefficient technology L, it will grants him a lower probability of success P_L, in which $P_L < P_H$, but with a private benefit B.

As stated above, the loan L comes from two sources, both from inside capital injection K and outside deposit of the bank D, implying $L = K_0 + D_0$. The deposit D_0 should earn a risk-free return R_f at t=1, which is assured by the government. The bank equity holder, injecting capital K_0 to the bank at t=0, should earn a risky return R.

As with the model of Holmstrom and Tirole (2011) which we illustrate in the last section, there are two constraints that must be satisfied. First, the banker must has some incentive to work hard, indicating the condition that

$$P_H \cdot R_b + (1 - P_H) \cdot 0 \geq P_L \cdot R_b + (1 - P_L) \cdot 0 + B \cdot L$$

$$R_b \geq \frac{B \cdot L}{\Delta P} \tag{3.8}$$

Let $\Delta P = P_H - P_L$

Second, the pledgeable income ρ_0 is defined as the maximum expected amount that outside financier, i.e. the depositor of the bank, can be promised when the banker is paid R_b.

By the definition of pledgeable income we know

$$\rho_0 = P_H \cdot (R - \frac{B}{\Delta P}). \tag{3.9}$$

For each unit of investment, the firm can raise ρ_0 from outside investors, leaving $1 - \rho_0$ be covered by the firm's own fund. Thus, the second constraint illustrating repayment constraint is

$$(1 - \rho_0) \cdot L \leq K_0$$

Or

$$\rho_0 \cdot L \geq L - K_0 \tag{3.10}$$

3.2 Loan-Equity Ratio and Bankruptcy Threshold

At date 0 the bank chooses to invest the risky project I. The project will be subjected to a liquidity shock ρ before date 1, so the bank has to inject ρ to continue the project and realize any payoffs. Otherwise the whole project will be abandoned with zero return to equity holder and no compensation for the banker. If the assumption of $\rho > \rho_0$ holds, the bank cannot get outside funding to continue the project unless it has arranged for such funding in advance. Thus it creates the demand for liquidity.

Assume that bank will continue at full scale L when the liquidity shock is ρ. It requires a reinvestment ρL before date1, and at date 1 it yields pledgeable return $\rho_0 L$ and private return$(\rho_1 - \rho_0)L$ to the banker.

Let $F(\rho)$ be the distribution function and $f(\rho)$ be the density function of the liquidity shock ρ. The outside financier, i.e. the depositor, will choose to retain all of the pledgeable income $\rho_0 L$ while the banker holds $(\rho_1 - \rho_0)L$ to maximize his return on initial injection K. Thus, we get

$$\max \int_0^{\rho^*} (\rho_1 - \rho_0) \cdot L \cdot f(\rho) d\rho \qquad (3.11)$$

$$\text{s.t.} \int_0^{\rho^*} (\rho_0 - \rho) \cdot L \cdot f(\rho) d\rho \geq (L - K_0) R_f = D_1$$

The budget constraint illustrates that given the reinvestment needs ρL subtracted from investors date 1 return $\rho_0 L$, the expected pledgeable income must cover investors' date 0 contributions. The optimal cut-off point level is denoted as ρ^*, which satisfies $\rho_0 < \rho^* < \rho_1$. The project will continue with full scale L if $\rho \leq \rho^*$ and it is discontinued if $\rho > \rho^*$.

The optimal investment size L should be determined until the budget constraint is binding, which implies

$$L \cdot \left[F(\rho^*)\rho_0 - \int_0^{\rho^*} \rho f(\rho) d\rho\right] = (L - K_0) \cdot R_f \qquad (3.12)$$

Let k be the capital requirement ratio, so $L = \frac{K_0}{k}$. From (3.12), we can obtain

$$k = \frac{K_0}{L} = 1 + \frac{\int_0^{\rho^*} \rho f(\rho) d\rho - F(\rho^*)\rho^0}{R_f} \qquad (3.13)$$

The capital requirement ratio should be ranged between one and zero, thus (3.13) implies

$$-R_f < \int_0^{\rho^*} \rho \cdot f(\rho)\, d\rho - F(\rho_*)\rho_0 = (\rho^* - \rho_0)F(\rho^*) - \int_0^{\rho^*} F(\rho) d\rho < 0$$

Equation (3.13) and (3.14) indicates that low pledgeable income ρ_0 will require bank to hold higher equity loan ratio. From equation (3.9), we can also know that high private benefit as well as low expected investment returns $P_H R$ both result in higher equity loan ratio.

In addition, to find out the relationship between k and optimal bankruptcy threshold, we differentiate k respect to ρ_*

$$\frac{\partial k}{\partial \rho_*} = \frac{\rho^* f(\rho^*) - f(\rho^*)\rho_0}{R_f} > 0 \qquad (3.14)$$

This implies that the higher bankruptcy threshold is, the higher the capital requirement should be.

Lemma 1: *A low pledgeable income ρ_0, high private benefit B, low expected investment returns $P_H R$, and an increase in bankruptcy threshold ρ_* will all lead to an increase in bank's equity-loan ratio.*

Substituting $L = \frac{K_0}{K}$ into the in the banker's objective function (3.11), we rewrite the result as a function of expected unit cost of effective investment $C(\rho^*)$, which can be written as

$$\int_0^{\rho^*} (\rho_1 - \rho_0) \cdot L \cdot f(\rho) d\rho = (\rho_1 - \rho_0) \frac{K_0}{k} F(\rho^*) = \frac{(\rho_1 - \rho_0) \cdot R_f \cdot K_0}{c(\rho^*) - \rho_0}$$

Where $C(\rho^*) = \frac{R_f + \int_0^{\rho^*} \rho f(\rho) d\rho}{F(\rho^*)}$

To find the optimal cut-off point ρ^* from the entrepreneur's utility function, we minimize the expected unit cost of effective investment $c(\rho)$. The first order condition for minimizing $c(\rho^*)$ can be expressed as

$$\frac{\rho^* f(\rho^*) F(\rho^*) - f(\rho^*)\left[Rf + \int_0^{\rho^*} \rho f(\rho) d\rho\right]}{[F(\rho)]^2} = 0$$

Thus we can find the optimal cut-off point ρ^* given the distribution of ρ and R_f, expressed as

$$\int_0^{\rho^*} F(\rho) d\rho = R_f \tag{3.15}$$

We can infer from this equation that ρ^* and R_f are positively correlated. An increase in R_f will result in a higher bankruptcy threshold ρ^*.

Lemma 2: *An increase in risk-free rate will lead to an elevation of a bank's bankruptcy threshold* ρ^*.

3.3 Bankruptcy Threshold from Consumer's Approach

Now we consider the situation when the individual act as a representative consumer. Assume he put μ proportion of savings into the bank deposit and $1-\mu$ porportion into the equity shareholdings. His decisions would be

$$\text{Max } U(C_0) + \delta EU(C_1) = U(C_0) + \delta U(E((C_1) - \frac{\text{Var}(C_1)}{2t})$$

Where $C_0 = Y - D_0 - K_0$, $D_0 = (Y - C_0) \cdot \mu$, $K_0 = (Y - C_0) \cdot (1 - \mu)$

$$E(C_1) = D1 + \int_0^{\rho^*} (\rho_1 - \rho_0) \cdot L \cdot f(\rho) d\rho$$

$$= (Y - C_0) \cdot \mu R_f + (\rho_1 - \rho_0) F(\rho_0) d\rho \cdot \frac{K_0}{k}$$

$$= (Y - C_0) \cdot \mu R_f + (\rho_1 - \rho_0) F(\rho_0) d\rho \cdot \frac{(Y - C_0)(1 - \mu)}{k}$$

$$\mathrm{Var}(C_1) = \left(\frac{B}{\Delta P}\right)^2 [1 - P_H] P_H F(\rho^*) \cdot \frac{[(Y - C_0)(1-\mu)]^2}{k^2}$$

$$\text{Where } t = \frac{U'}{C \cdot U''}$$

By differentiating both equation, we obtain the first order condition for C_0 and μ

$$\frac{\partial U}{\partial C_0} = U'(C_0) + \delta U'\left(E(C_1) - \frac{\mathrm{Var}(C_1)}{2t}\right) \cdot (-R_f) = 0$$

$$\frac{\partial U}{\partial \mu} = R_f + \frac{1-\mu}{t} \cdot (Y - C_0) \cdot \left(\frac{B}{\Delta P}\right)^2 \frac{[1 - P_H F(\rho^*)]^2 P_H F(\rho^*)}{k^2} = \frac{\rho_1 - \rho_0}{k} \cdot F(\rho^*) = 0$$

Substituting the optimal consumption C^* and saving proportion μ^* into objective function, we can rewrite the objective function of representative individual as indirect form

$$V(C_0^*, \mu^*; \rho^*) = \mathrm{Max}\, U'(C^*) + \delta U'\left((Y - C_0^*)\left[\frac{R_f(1+\mu^*)}{2} - \frac{(\rho_1 - \rho_0)F(\rho_0)(1-\mu^*)}{2k}\right]\right)$$

So Far, the economic condition Y affects only the consumption level, but has no impact on capital adequacy ratio k and bankruptcy threshold ρ^*. Now we assume that bankruptcy threshold is decided by the government instead of banker. Since the government puts the representative individual's welfare as main concern, it will face the following problem:

$$V(C_0^*, \mu^*; \rho^*)$$

Using envelope theory, we derive the first order condition for optimal bankruptcy threshold ρ^*

$$\frac{\partial V}{\partial C_0^*} \cdot \frac{\partial C_0^*}{\partial \rho^*} + \frac{\partial V}{\partial \mu^*} \cdot \frac{\partial \mu^*}{\partial \rho^*} + \frac{\partial V}{\partial \rho^*} = 0$$

$$\frac{\partial V}{\partial \rho^*} = \delta U'\left((Y - C_0^*)\left[\frac{R_f(1+\mu^*)}{2} - \frac{(\rho_1 - \rho_0)F(\rho_0)(1-\mu^*)}{2k}\right]\right) \cdot [(Y - C_0^*)(-A)] = 0$$

Where A stands as

$$A = \frac{(\rho_1 - \rho_0)f(\rho^*)(1-\mu^*)\cdot 2k - 2\cdot(\rho_1-\rho_0)F(\rho_0)(1-\mu^*)\frac{\partial k}{\partial \rho^*}}{4k^2}$$

$$\frac{\partial k}{\partial \rho^*} = \frac{\rho^* f(\rho^*) - f(\rho^*)\rho_0}{R_f}$$

The first order condition can be given as

$$f(\rho^*)\cdot k - F(\rho^*)\cdot\frac{\partial k}{\partial \rho^*} = 0$$

$$\frac{f(\rho^*)R_f + f(\rho^*)\int_0^{\rho^*}\rho f(\rho)d\rho - f(\rho^*)F(\rho^*)\rho_0}{R_f} - \frac{\rho^* f(\rho^*)F(\rho^*) - f(\rho^*)F(\rho^*)\rho_0}{R_f} = 0$$

By simplifying the function, we obtain

$$f(\rho^*)R_f - f(\rho^*)\int_0^{\rho^*} F(\rho^*)\rho_0 d\rho = 0$$

Therefore,

$$\int_0^{\rho\cdot} F(\rho)d\rho = R_f$$

The result is the same as what we have derived when the bankruptcy threshold is chosen by the banker. We can conclude here that capital requirement ratio and optimal bankruptcy threshold still holds when the scenario change to the viewpoint of representative consumer.

4 Optimal Capital Requirement

4.1 GDP and Interest Rate

From the previous analysis, we conclude that

$$\frac{K_0}{D_0} = \frac{1-\mu^*}{\mu^*}\frac{k}{1-k} = \frac{R_f+\int_0^{\rho^*}\rho f(\rho)d\rho-F(\rho)}{F(\rho)\rho 0-\int_0^{\rho^*}\rho f(\rho)d\rho} \equiv g(\rho^*, R_f) \qquad (4.1)$$

It indicates that optimal requirement ratio is only determined by the distribution of liquidity shock and the risk-free interest rate. The optimal capital requirement has no relation with GDP level when GDP is irrelevant with risk-free interest rate.

Proposition 1: *The optimal capital requirement is only determined by the distribution liquidity shock* ρ**and the risk-free interest rate. It will be irrelevant of GDP if GDP is independent of interest rate.*

However, GDP movement can be highly correlated with the change in risk-free interest rate. We consider this relation in the following equation, assuming $Y = h(R_f)$

$$dY = h' \cdot dR_f$$

$$\text{Or } dR_f = \frac{1}{h'} \cdot dY \qquad (4.2)$$

Depending on the relationship between dR_f and dY, or, more specifically, the signal of $\frac{dR_f}{dY}$, h'could be both negative and positive.

To further discuss the relationship between GDP and capital requirement k, we start from equation (3.15), which implies

$$d\rho^* = \frac{1}{F(\rho*)}dR_f = \frac{1}{h\prime\cdot F(\rho^*)}dY. \qquad (4.3)$$

Recall that

$$k = \frac{K_0}{L} = 1 + \frac{\int_0^{\rho^*} \rho f(\rho) d\rho - F(\rho^*)\rho^0}{R_f} \tag{3.13}$$

By total differential equation (3.13), we can obtain

$$dk = \frac{[(\rho^* - \rho_0)f(\rho^*)R_f]d\rho^* - \left[(\rho^* - \rho_0)F(\rho^*) - \int_0^{\rho^*} F(\rho)d\rho\right]dR_f}{{R_f}^2}$$

Substituting equation (4.2) and (4.3), we obtain the following result:

$$dk = \frac{[(\rho^* - \rho_0)f(\rho^*)R_f] \cdot \frac{dY}{h' \cdot F(\rho^*)} - \left[(\rho^* - \rho_0)F(\rho *) - \int_0^{\rho^*} F(\rho)d\rho\right] \cdot \frac{dY}{h'}}{{R_f}^2}$$

$$= \left\{\frac{(\rho^* - \rho_0)f(\rho^*)}{R_f \times h' \cdot F(\rho^*)} - \frac{(\rho^* - \rho_0)F(\rho^*) - \int_0^{\rho^*} F(\rho)d\rho}{{R_f}^2 \cdot h'}\right\} \cdot dY \tag{4.4}$$

Since $0 < k = 1 + \frac{\int_0^{\rho^*} \rho f(\rho) d\rho - F(\rho^*)\rho^0}{R_f} < 1$, we can conclude that

$$(\rho^* - \rho_0)F(\rho^*) - \int_0^{\rho^*} F(\rho)d\rho < 0$$

Thus, whether dk is positively or negatively related to dY depends solely on h'. If $h' = \frac{dY}{dR_f} > 0$, then $\frac{dk}{dy} > 0$, implying that the capital requirement is pro-cyclical. On the contrary, if $h' = \frac{dY}{dR_f} < 0$, then $\frac{dk}{dy} < 0$, implying the capital requirement is counter-cyclical.

Proposition 2: *When considering that GDP is related to its interest rate, a country should follow counter-cyclical requirement when its GDP level is negatively related to its interest rate. On the contrary, it should pursue pro-cyclical capital requirement when its GDP is positively related to the interest rate.*

Therefore, capital requirement policy should be implemented on the country-base economic condition. Each country should increase or decrease capital requirement

depending on $h' = \frac{dY}{dR_f}$. In the following sections, we will focus on the empirical test to find out whether $h' = \frac{dY}{dR_f}$ is positive or negative, thus deciding different countries optimal capital requirement policy. But let us first begins with addressing the function of h'.

4.2 Keynesian Model and the Specific Form

We use Keynesian's macroeconomic IS-LM model to derive h'. The traditional IS-LM equation is as following:

$$IS: Y = C(Y - T) + I(R_f) + G_1 + X - M(Y)$$

/ ;

$$LM: \frac{M_2}{P} = L(Y, R_f) \qquad (4.5)$$

We denote Y as Gross Domestic Product, C as household consumption, I as domestic investment, G_1 as government consumption expenditure, X as export, M as import, M_2 as monetary supply M_2, P as price level and R_f as interest rate.

In order to elaborate on debt crisis, we add another constraint to the IS-LM model. Assuming government debt is all financed by the government bond, the constraint goes as

$$G_2 - T = B_s \qquad (4.5)$$

Where G_2 is government expenditure. We distinguish government expenditure G_2 from government consumption expenditure G_1 because the former includes the latter, and it will underestimate the government deficit if we regard the two as the same

items.[10] T is government total tax and Bs is the gross issue of bonds. Here, we do not consider the situation in which government debt is financed by creating money supply. The reason for this is that in most of the situation, instead of creating money supply, government lowers interest rate as a kind of interest bailout, as stated in Farhi and Tirole (2011). We illustrate the model which includes money supply as finance means in our appendix for more detail.

The endogenous variables in the equations are Y and $R_{f.}$ By total differential equation, we obtain

$$dy = Cyd \cdot (dy - dT) + Ir \cdot dr + dG + dX - My \cdot dy$$

$$dm - dp = Ly \cdot dy + Lr \cdot dr$$

$$dG_2 - dT = dB_s$$

Let $dM - dP = dm$

Substituting the constraint $dT = dG_2 - dB_s$ into equation, we obtain

$$dy = Cyd \cdot [dy - (dG_2 - dB_s)] + Ir \cdot dr + dG_1 + dX - My \cdot dy$$

By rearrange the equation,

$$(1 - Cyd + My) \cdot dy - Irdr = -Cyd \cdot (dG_2 - dB_s) + dG_1 + dX$$

$$Ly \cdot dy + Lr \cdot dr = dm$$

Solving the equation by matrix, we obtain h' as

$$h' = \frac{dy}{dr} = \frac{[-Cyd \cdot (dG_2 - dB_s) + dG_1 + dX] \cdot Lr + dm \cdot Ir}{(1 - Cyd + My) \cdot dm - Ly \cdot [-Cyd \cdot (dG_2 - dB_s) + dG_1 + dX]} \qquad (4.6)$$

[10] G_2 consists of current and capital expenditure, while G_1 consists of only current expenditure. The reason to separate G_1 from G_2 is that the definition of G in national account is not compatible with the definition of G in our constraint equation (4.5). For more detail of G_1 and G_2, refer to Appendix A.

We can refer from the function that it is not easy to specify whether h' is positive or negative. It depends on different macroeconomic situations of each country. The meaning of h' can be interpreted as how much unit of income (Y) will be affected by a unit change in interest rate (R_f). In the following paper, we denote h' as Interest- Rate-Change-to-Income Effect. With the specific form of Interest-Rate-Change-to-Income Effect, we are able to use empirical data to test the optimal capital requirement concerning its relationship with GDP. In the next section, we will perform the test using 17 countries from Euro Zone to identify capital requirement strategies under European debt crisis.

5 The Estimation and Result

5.1 The Data

Our main goal is to identify the optimal capital requirement strategies in each country under the theme of European debt crisis. Therefore, we focus our analysis on the 17 country in the Euro Zone, including Greek, Spain, Ireland, Portugal, Italy, Belgium, Germany, France, Finland, Netherlands, Austria, Cyprus, Slovak, Slovenia, Luxembourg, Malta, and Estonia. We use seasonally adjusted quarterly data obtained from European Central Bank (ECB) and DATASTREAM from 2005Q1 to 2011Q3. The data obtained from two databases uses different methodology to calculate the data, but in general the data is matched.

We define tax (T) as total tax of the government, which is the sum of direct, indirect tax, social contributions, government sales, and capital taxes. As for government total expenditure (G_2), it is the sum of current expenditure, which includes transfer, subsidy etc., and capital expenditure.[11]

When we observe missing data in taxes and other current account items, we do not calculate Interest- Rate-Change-to-Income Effect for the quarter. However, if the missing data are only observed in interest rate, which occurs in some country, we still calculate Interest- Rate-Change-to-Income Effect for the quarter. The total interest-rate-change-to-income effects calculated are 398.

5.2 Simple Regression

To calculate Interest- Rate-Change-to-Income Effect, we must first identify each value

[11] More detailed data definition will be described in Appendix A.

of marginal effect in equation (4.6).We use simple regression to obtain them. In the next section we discuss the common factors that influence Interest-Rate-Change-to-Income Effect by constructing panel data.

To calculate Interest- Rate-Change-to-Income Effect [12], we first calculate marginal propensity to consumption (Cyd), the effect on investment and money demand from a unit change in interest rate (Ir, Lr), and the effect on money demand and import result from a unit change in income (Ly, My).We use simple regression to obtain these values. We regress consumption on disposable income to obtain marginal propensity to consumption (Cyd); Gross fixed Capital Formation on interbank interest rate, which is the risk-free rate, to obtain effects on investment from a unit change in interest rate (Ir); Real money supply on GDP and interbank interest rate to obtain effect on money demand result from a unit change in income (Ly) as well as a unit change in interest rate (Lr); import on GDP to obtain the effect on import result from a unit change in income (My). According to macroeconomic theory, we expect marginal propensity to consumption (Cyd), the effect on money demand and import result from a unit change in income (Ly, My) to be positive. We expect he effect on investment and money demand from a unit change in interest rate (Ir, Lr) to be negative values. The result is presented in table 1.

There are few observations worthy of mention here. First of all, almost all sighs are compatible with what we have expected, except effects on investment from a unit change in interest rate (Ir). For all 17 countries effects on investment from a unit change in interest rate (Ir) are all positive, which means when the interest rate increases, the investment will increases. We contribute this result to the large flow of foreign investment in to Euro Zone countries. When interest rate increases, it will attract more foreign investment, thus making the effects on investment from a unit

[12] Refer to equation (4.6) to see how to calculate Interest-Rate-Change-to-Income Effect, or h'.

change in interest rate (Ir) to be positive. The values of the effects on investment from a unit change in interest rate (Ir) are especially large in Spain, Italy, France, Germany and Ireland, indicating that there are large flows of foreign investment injecting into these countries. Besides, My is especially large in Germany, Belgium, Netherlands, Luxemburg and Malta, indicating that these countries may have high trade flows with foreign countries. This is also consistent with what we have seen in the figures 4 and 5 in previous section. Third, marginal propensity to consumption (Cyd) is comparatively large in Greece, Cyprus, Estonia, Slovakia and Slovenia. It may show that these country exhibit strong consumption propensities once its GDP increases.

Table1 Simple Regressions Results on Cyd, Ir, Lr, Ly, and My

	Cyd	**Lr**	**Ly**	**Ir**	**My**
Greece	0.760621	-45.6756	0.060462	**910.745**	0.375369
P-VALUE	6.27E-05	0.000294	2.31E-12	1.26E-08	0.000186
Italy	0.045136	-357.08	0.044614	**2310.32**	0.677315
P-VALUE	0.56401	9.14E-10	4.02E-10	2.34E-11	5.1E-07
Spain	0.333202	-333.203	0.0712	**5590.04**	0.292788
P-VALUE	0.000228	1.04E-07	1.65E-14	1.41E-14	0.00452
Portugal	0.19139	-12.6566	0.03738	**292.673**	0.603843
P-VALUE	0.128069	0.12221	2.5E-05	4.77E-07	2.51E-05
Ireland	0.22941	-65.4263	0.033421	**1714.03**	0.287126
P-VALUE	0.020841	0.23356	0.195125	1.87E-06	0.017306
France	0.245478	-210.535	0.051349	**2007.71**	0.412321
P-VALUE	0.000319	4.32E-07	2.31E-18	0.013741	3.12E-07
Germany	0.326226	-366.776	0.038315	**1931.21**	**0.938013**
P-VALUE	0.00537	3.45E-05	1.4E-09	0.038941	8.25E-13
Belgium	0.111423	18.4409	0.020069	**192.652**	**1.148747**
P-VALUE	0.020284	0.086139	1.06E-06	0.239066	9.04E-08
Austria	-0.05439	-43.2671	0.078566	**295.36**	0.687598
P-VALUE	0.482612	0.031854	6.15E-06	0.003305	1.77E-06
Finland	0.514274	-38.7561	0.033283	**330.179**	0.574516
P-VALUE	0.002149	3.7E-08	5.78E-12	0.000202	3.36E-08

	Cyd	Lr	Ly	Ir	My
Netherlands	0.20708	-64.5517	0.063625	**654.99**	**1.293333**
P-VALUE	0.000742	0.02457	1.08E-10	0.011595	1.71E-11
Cyprus	0.760621	-45.6756	0.060462	**910.745**	0.375369
P-VALUE	4.93E-05	0.022857	2.91E-10	0.402154	3.91E-05
Estonia	0.756925	-0.36829	0.013667	**81.4458**	0.751692
P-VALUE	2.91E-11	0.58406	2.68E-05	0.011023	1.12E-05
Luxemburg	0.336994	139.983	0.005414	**71.3167**	**1.573355**
P-VALUE	1.87E-07	1.03E-11	0.55291	0.336454	2.56E-12
Melta	0.499736	0.51036	0.026615	**9.41366**	**1.087049**
P-VALUE	6.28E-05	0.332697	1.9E-05	0.030197	3.08E-08
Slovakia	0.773039	-8.90026	0.012423	**145.663**	0.880222
P-VALUE	4.48E-11	0.000101	4.23E-05	0.027833	1.11E-07
Slovenia	0.982028	-2.39844	0.009719	**135.124**	0.867106
P-VALUE	2.15E-05	7.57E-09	2.37E-14	0.000178	1.54E-07

5.3 The Result

In this section, we will give descriptive analysis of Interest- Rate-Change-to-Income Effect, identifying the trend and variation across the 17 countries. In the following section we will we discuss the common factors that influence Interest-Rate-Change-to-Income Effect by constructing panel data.

We first discuss the sign of Interest- Rate-Change-to-Income Effect. According to equation (4.6), if Interest- Rate-Change-to-Income Effect is positive, it means the pro-cyclical capital requirement is more appropriate while if the effect is negative, counter-cyclical capital requirement strategies would be more suitable.[13] There are few arguments we want to make here. First of all, during 2005Q1 to 2011Q3 Interest-Rate-Change-to-Income Effect exhibits both positive and negative value, though most countries are dominated by positive sign. This indicates that capital requirements should adjust according to each country's general economic situation at different point

[13] More detailed results are presented in Appendix.

of time. Second, dominated positive Interest- Rate-Change-to-Income Effect for most countries, except Belgium and Malta, means that pro-cyclical capital requirement policy should be adopted. When GDP increases, the government should tighten its capital regulation while in economic recessions, the government is supposed to loosen capital requirement. Third, we can see that all countries, except the small country such as Cyprus and Malta, in 2011Q3 have positive Interest- Rate-Change-to-Income Effect. It indicates that during the time of ongoing European debt crisis, the austerity policy might not be optimal in the times of economic downturn. Deeply in-debt countries, especially Greece, Spain, Ireland, which have all positive Interest-Rate-Change-to-Income Effect during our research period, need stimulus expansionary policy to help the economy recover.

Next we turn to the trend and variation of Interest- Rate-Change-to-Income Effect. Figure 1 and Figure 2 shows the trend and variation of interest rate change to income effect across 11 main Euro Zone countries. We focus on major countries and compare the movement. Among the major 11 Euro Zone countries, Italy, Portugal, France and Germany exhibit very large variation of Interest- Rate-Change-to-Income Effect. In some point, it may indicate a unit change in interest rate, which results from fiscal policy or monetary policy, will cause income to shift by a large amount in these countries. It also indicate that capital regulation policy in these countries should be more flexible, switching between pro-cyclical and counter-cyclical.

We also observe from the figures that in the time near 2008, most countries have larger positive value of Interest- Rate-Change-to-Income Effect relative to other period. When Interest- Rate-Change-to-Income Effect has higher values, it means effects on capital requirement from a unit change in income will be smaller.[14] In other

[14] We can refer this from equation (4.4). Since h' is in the denominator, $\frac{dk}{dy}$ will decrease.

words, if GDP decreases that quarter, which happens in 2008, the government should adopt loose capital regulation policies but has an upper limit.[15]

Overall, Interest- Rate-Change-to-Income Effect exhibits large variation within each country as well as across different countries.

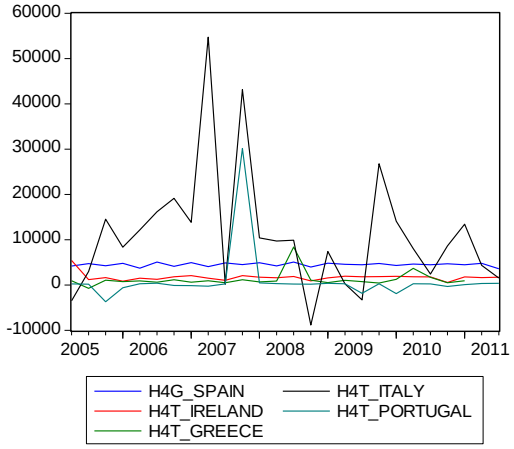

Figure1 Trend of Interest- Rate-Change-to-Income Effect for PIIGS

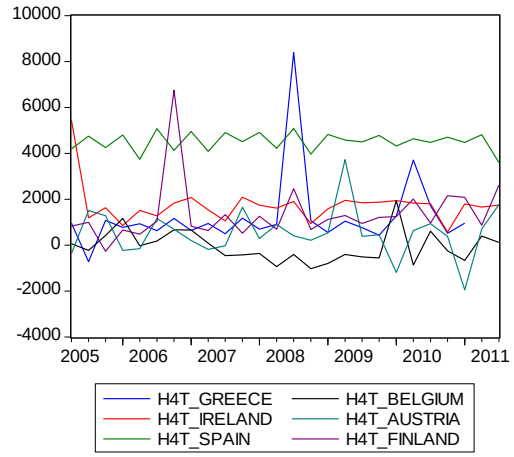

Figure2 Trend of Interest- Rate-Change-to-Income Effect for Relatively Small Variation

[15] Under the assumption of counter-cyclical capital requirement, different values of Interest-Rate-Change-to-Income-Effect will have opposite effects on the change of capital requirement. Assume GDP all change the same unit, as Interest-Rate-Change-to-Income-Effect increases, $\frac{dk}{dy}$ will decreases, and capital requirement will have lower adjustment compared with the situation when Interest-Rate-Change-to-Income-Effect decreases. In other words, as Interest-Rate-Change-to-Income-Effect increases, one unit increase in GDP requires lower decrease in capital requirement compared with the situation when Interest-Rate-Change-to-Income-Effect increases.

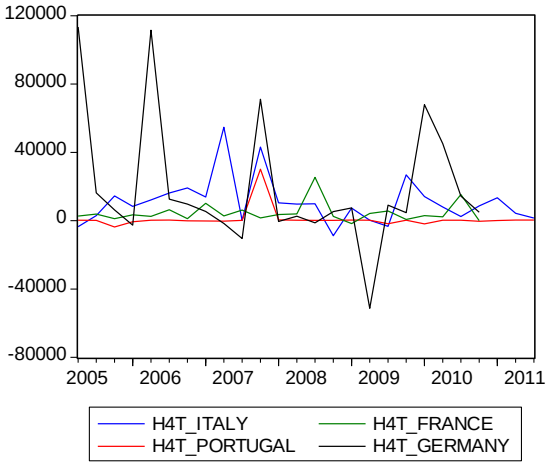

Figure3　Trend of Interest- Rate-Change-to-Income Effect for Relatively large Variation

6 Panel Data Estimation

6.1 The Unit Root Test

To find whether there are common factors in each countries influencing Interest-Rate-Change-to-Income Effect, we construct panel data estimation. The estimation equation goes as follows:

Interest- Rate-Change-to-Income Effect= Intercept+ Monetary Policy Effectiveness+ Fiscal Policy Effectiveness+ Trade Openness+ Fiscal Policy Weight + Debt Flow (6.1)

All the variables are stated before, except for debt flow. Instead of cumulative debt level, we use debt increase in every quarter as variable to see whether the debt increase level across countries have common influence on Interest-Rate-Change-to-Income Effect.

Before constructing the panel data, we should perform unit root test. Table 1 shows the statistic and p-value of Argumented Dickey Fuller test, Phillip-Pearson Test, and Breitung-T Test. The result shows that all variables, except monetary policy effectiveness and fiscal policy effectiveness, are stationary. After first differencing Monetary Policy Effectiveness and Fiscal Policy Effectiveness, the two variables become stationary. In the following sections, our result will be presented in both estimation before first differencing and estimation after first differencing.

Table2 Unit Root Test Result for variables in (6.1)

The Unit Root Test Sample: from 2005Q2 to 2011Q3	ADF		PP		Breitung t-stat	
	Statistic	P-Value	Statistic	P-Value	Statistic	P-Value
Interest-rate-change-to-income effect[16]	240.901	0.0000*	269.874	0.0000*	-5.18864	0.0000*
Monetary Policy Effectiveness[17]	22.6953	0.9303	12.7478	0.9997	-2.37752	0.0087*
Fiscal Policy Effectiveness[18]	24.2809	0.8909	12.764	0.9996	-2.62222	0.0044*
Trade openness[19]	65.3137	0.0010*	47.274	0.0647	-3.29405	0.0005*
Fiscal policy weight[20]	231.007	0.0000*	278.715	0.0000*	-8.23047	0.0000*
Debt flow[21]	212.311	0.0000*	278.154	0.0000*	-6.76618	0.0000*

6.2 Panel Data Analysis

Table 2 is the original panel data result of (6.1) before we take care of the unit root issues. Because we have identified Fiscal and Monetary Policy Effectiveness might not be stationary variables, we present first differencing result in table 3. Therefore, our interpretations below follow the first difference adjustment result in Table 3.

We construct our estimation by splitting countries into three groups. First, we pool all 17 countries together, with 398 samples. According to our previous results, most countries have positive Interest- Rate-Change-to-Income Effect. Under the

[16] As stated in (4.6), Interest-Rate-Change-to-Income Effect is defined as how much unit of income (Y) will be affected by a unit change in interest rate (R_f).

[17] Monetary policy effectiveness is the elasticity of IS, calculated as $\left|\frac{\frac{dy}{y}}{\frac{dr}{r}}=\frac{dy}{dr}\cdot\frac{r}{y}=\frac{1}{\frac{dr}{dy_{IS}}}\cdot\frac{r}{y}\right|$

[18] The elasticity of LM is $\left|\frac{\frac{dy}{y}}{\frac{dr}{r}}\right|=\left|\frac{dy}{dr}\cdot\frac{r}{y}\right|=\left|\frac{1}{\frac{dr}{dy_{LM}}}\cdot\frac{r}{y}\right|$.

[19] Trade openness is the proportion of the sum of import and export to GDP.

[20] Fiscal policy weight is calculated as $\frac{dG+dX}{(dG+dX)+(\frac{dm}{Ly})}$.

[21] Debt flow is the proportion of additional increase of debt in the calculated quarter to GDP.

assumption of procyclicality capital requirement, the significance of trade flow indicates that countries with high trade flow relative to its GDP are tend to require larger adjustment to its capital requirement rule. To think intuitively, high trade-flow countries have higher dependency on other countries, thus the economic situation is more relative to others, especially in crisis. In order to prevent the spillover effects, more flexible capital requirement is needed[22]. In the second column, we have excluded six small countries which we consider extreme values, including Cyprus, Estonia, Luxemburg, Malta, Slovakia, and Slovenia. The results are similar with the previous panel, indicating that extreme values in the 6 small countries do not affect the overall trend of our data. Finally, we pool only the 5 in-debt countries, including Greece, Ireland, Spain, Portugal and Italy. The significance of expansionary policy weight and effectiveness shows under pro-cyclical capital requirement, the more weight and more effective fiscal policy is, the less capital requirement adjustment needed. In some point, this can be linked to the fact that countries with more government expenditure should loosen capital requirements during recession but has an upper limit, i.e. the degree of loosen capital regulation should not be out of control, preventing these countries to go into further break down. Besides, though not obvious in other countries, debt flow is significant when we pool the 5 countries together. The result indicates the higher the debt level, the higher level of capital requirement adjustment is needed. Last but not the least, the trade openness is not significant in these 5 countries. We interpret it as though trade openness play a part in determining capital requirement policy, other indicators, such as debt increase level in PIIGS countries have dominated trade openness. Therefore, for PIIGS, the capital requirement policy should be adjusted depending on the fiscal policy weight and

[22] For more detailed explanation to the relation between Interest-Rate-Change-to-Income-Effect, see footnote 15.

effectiveness, debt increase level in each quarter.

Table3 Panel Estimation Result for Variables in (6.1) Before First differencing

Dependant Variable: Interest-Rate-Change-to-Income Effect Sample: from 2005Q2 to 2011Q3	All 17 countries		excluding 6 small countries		5 in-debt countries	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Monetary Policy Effectiveness	-235984.5	0.1572	-84754.8	0.0091*	-98499.8	0.0000*
Fiscal Policy Effectiveness	1902.619	0.0094*	90630.28	0.0060*	120275.7	0.0000*
Trade Openness	-52.16518	0.0001*	-61.3473	0.0028*	-51.743	0.0031*
Fiscal Policy Weight	-2637.831	0.2653	-2267.12	0.4789	5292.276	0.0353*
Debt Flow	-7194.699	0.2856	-7623.28	0.3542	-8538.43	0.1958
Samples	398		276		128	
R-square	0.046948		0.061236		0.253382	
Adjusted R-square	0.037293		0.043851		0.22271	
F-Statistic Probabilities	0.001281		0.004214		0.000001	

Table4 Panel Estimation Result for Variables in (6.1) After First differencing

Dependant Variable: Interest-Rate-Change-to-Income Effect Sample: from 2005Q2 to 2011Q3	All 17 countries		excluding 6 small countries		5 in-debt countries	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Monetary Policy Effectiveness	24143.14	0.6974	-154187.3	0.2980	-215478.2	0.0932

Dependant Variable: Interest-Rate-Change-to-Income Effect Sample: from 2005Q2 to 2011Q3	All 17 countries		excluding 6 small countries		5 in-debt countries	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Fiscal Policy Effectiveness	2458.784	0.4181	163814.3	0.1781	223308.8	0.0620*
Trade Openness	-18.2393	0.0550*	-43.06878	0.0129*	-17.19854	0.2970
Debt Flow	-6341.946	0.3060	-7000.504	0.3278	-15316.68	0.0308*
Samples	398		276		128	
R-square	0.046948		0.061236		0.126240	
Adjusted R-square	0.037293		0.043851		0.0889	
F-Statistic Probabilities	0.001281		0.004214		0.000001	

6.3 Forecasting and Future Policy Suggestion

In this section, we want to use the estimation result in previous section to forecast Interest- Rate-Change-to-Income Effect in 2012. We present the forecast result before first differencing in figure 4 and after first differencing in figure 5. Our result shows that most countries exhibit positive Interest- Rate-Change-to-Income Effect. After dealing with unit root by first differencing, Interest- Rate-Change-to-Income Effects in all the countries are positive. This indicates that in 2012, where the European Sovereign debt crisis deepens, counter-cyclical capital requirement should be adopted. Countries with decreasing GDP need loose capital requirement to inject revival to their economy. This is especially true in PIIGS countries. According to our previous analysis, the higher the value of Interest- Rate-Change-to-Income Effects, the less capital requirement adjustment needed to make. Observing from figure 4 and figure 5,

we find that among PIIGS, Greece, Italy, Spain and Portugal all have relative high value of Interest- Rate-Change-to-Income Effect. We conclude that instead of austerity measure, the authority should adopt counter-cyclical capital requirement. When recessions occur, the authority should loosen capital requirement but still holds an upper-limit to prevent further break down. This also applies to other major Euro Zone countries, such as Germany and France. However, for Ireland the result is different. It still shows Ireland need to loosen capital requirement in 2012 since it has encountered economic recession, and the lower value of Interest-Rate-to-Income Effect means Ireland should further decrease capital requirement since its GDP has declined in 2012.

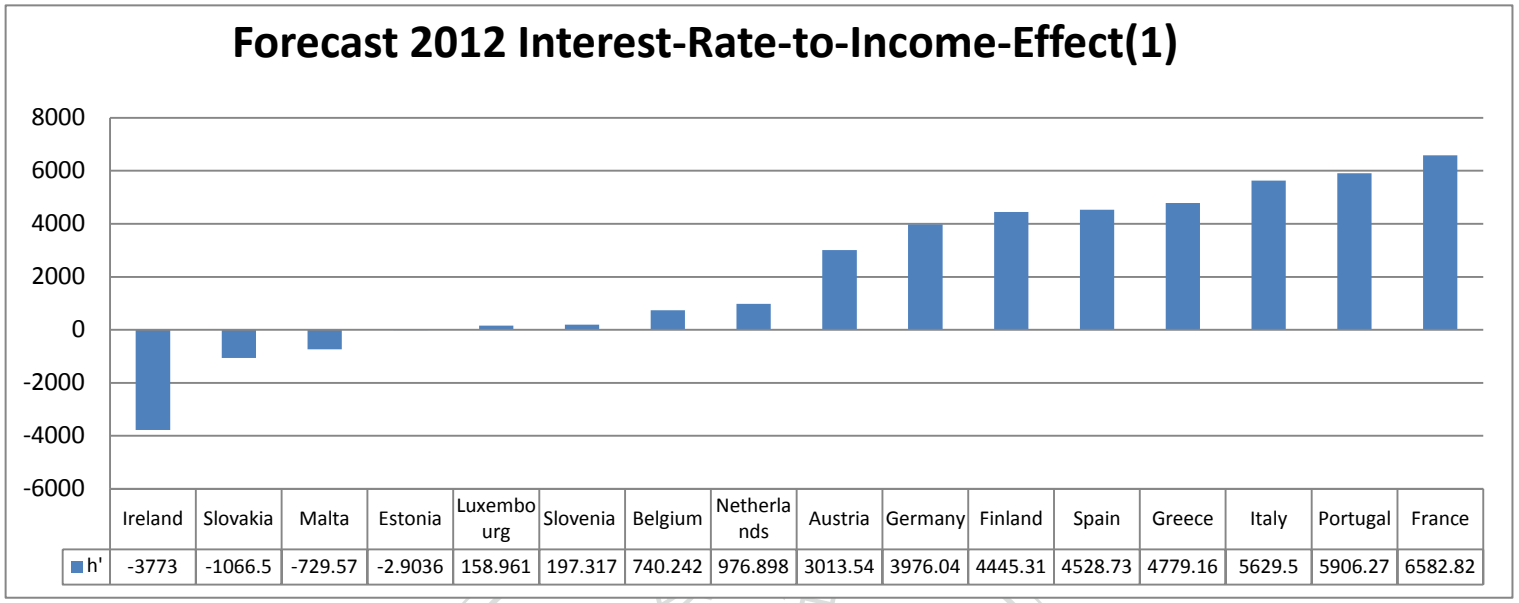

Figure4 Forecast of 2012 Interest-Rate-Change-to-Income-Effect Before First differencing

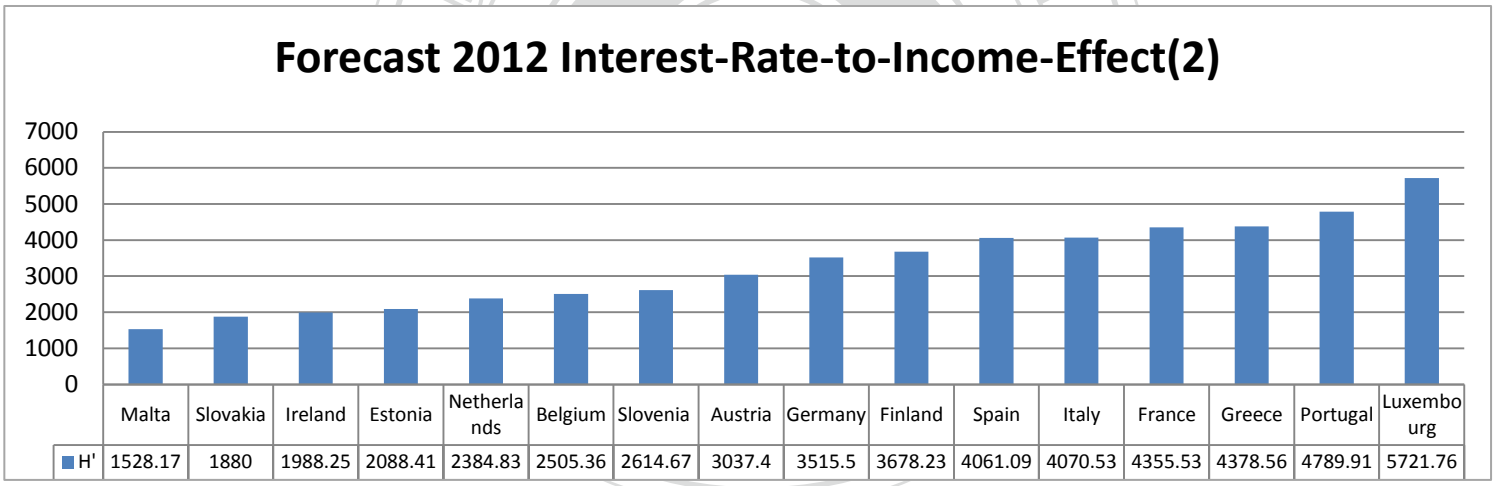

Figure5 Forecast of 2012 Interest-Rate-Change-to-Income-Effect After First differencing

7 Conclusion

In this paper, we followed the framework of Len-Kuo Hu (2012) to derive capital requirement strategies. Depending on interaction with liquidity shock, the loan's project's return, and the moral hazard problem, we derive the optimal capital requirement function, which determines on general economic condition in each country. Our model suggests that counter-cyclical capital requirement should be adopted when a country's GDP is negatively related with its interest rate. On the contrary, the government should implement a pro-cyclical capital requirement policy when a country's GDP is positively related with its interest rate. With Keynesian's IS-LM framework, we are able to further specify how to identify whether capital requirement should increase or decrease as GDP changes.

We use the result of our model to test the optimal capital requirement strategies under the theme of ongoing European debt crisis. Our results can be summarized as following. First, among the 17 countries across Euro Zone, most countries exhibit positive relation between GDP and interest rate during 2005Q2 to 2011Q3, indicating counter-cyclical capital requirement strategies should be adopted. Besides, in 2011, GDP in Greece, Ireland, Italy, Spain and Portugal are declining, meaning that these countries need loose capital requirement to foster its economic demands. The austerity measure will only worsen the already weak economic condition. Third, by constructing panel data, the result indicates that under the counter-cyclical capital requirement strategies, countries involved with higher trade are required to adopt more flexible capital requirement policy. When we only estimate PIIGS countries, the result shows that debt increase, fiscal policy weight and effectiveness dominate Interest- Rate-Change-to-Income Effects. Finally, when we use our data and equation

estimation result to forecast Interest- Rate-Change-to-Income Effects in 2012, we find all 17 Euro Zone countries should adopt counter-cyclical capital requirement policies. In addition, Greece, Italy, Portugal, France, and Spain are the countries needed to have an upper-limit when loosen capital requirement is adopted.

Appendix A: Detail Definition of Variables

Variables		Definition
C	Household final consumption expenditure	Consists of expenditure incurred by residents household on individual consumption of goods and services, household payment to the product provided by the government. It also includes various kinds of imputed expenditure of which the imputed rent for services of owner-occupied housing (imputed rents). Household final consumption includes household expenditure made on the domestic territory by residents and inbound tourists, but excludes residents' expenditure made abroad.
I	Gross Capital Formation (GFCF)	Gross Capital Formation consists of outlays on addition to the fixed assets of an economy and net changes in inventories. Fixed asset includes land improvements, plant, machinery, equipment purchase, construction of the roads, railways, schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales. Net acquisitions of valuables are also considered capital formation.
G_1	Government final consumption expenditure (GFCE)	Government expenditure on goods and services that are used for the direct satisfaction of individual needs (individual consumption) or collective needs of members of the community (collective consumption). It mainly consists of the current expenditure, which is the sum of service and goods purchased by government, social payments and compensation to government employees.
G_2	Total expenditure	The sum of current expenditure and capital expenditure. 1. Current expenditure The sum of compensation to government employees, the service and goods purchased by government, interests, social payments (social benefits and pensions paid in

		money, and service funded by government that are produced and delivered to household by market units), and subsidies. 2. Capital expenditure The sum of government investment which deals with the acquisition of fixed capital asset, capital transfers, acquisition of stocks, valuable lands less the disposal of such asset.
T	Tax	Sum of current revenue and capital revenue. 1. Current revenue The sum of direct taxes payable by household and cooperation, indirect taxes which received by EU institutions, social contributions of employers and employees, sales which includes output for own final use as well as actual receipts from the sale of goods and services by government units, receives of other current transfers. 2. Capital revenue The sum of capital taxes, investment grants and other capital transfers.
X	Exports of goods and service	Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees, investment income and transfer payments.
M	Imports of goods and service	Imports of goods consists the value of all goods and other market services received from the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees, investment income and transfer payments
M_2	Money Supply	M2 is defined as M1, which is the sum of currency in circulation and overnight deposit, plus deposits with an agreed maturity up to 2 years, and Deposits redeemable at a

		period of notice up to 3 months.
P	Harmonized Consumer Price Index(HICP)	Each country in European Union computes some 80 prescribed sub-indices, and their weighted average constitutes the national HICP. All countries uses 2005 as base period.
R_f	3-month Interbank rate	The rate of interest rate charged on 3-month loans between banks.

Appendix B: Value of Interest-Rate-to-Income Effect in 17 Euro Zone Country

	2005Q2	2005Q3	2005Q4	2006Q1	2006Q2	2006Q3	2006Q4	2007Q1	2007Q2	2007Q3	2007Q4	2008Q1	2008Q2
Sloveni	155	234	152	401	261	414	51	218	192	119	196	231	232
Slovaki	NA	NA	NA	NA	-1292	2453	-211	-5591	264	2094	-34368	431	1232
Melta	-10	-25	-6	-21	-8	-34	0	-6	-16	26	-8	12	-2
Luxem	-46703	1207	2829	823	-141	388	829	93165	-1936	271	-822	484	65
Estonia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15
Cyprus	-50	-27	-60	125	0	-18	-125	176	359	-22	-68	NA	NA
Netherl	7806	310	-831	-18743	5521	626	-103	162	983	512	721	617	-347
Finland	1737	1175	574	-10703	-167	1198	779	1453	-25205	981	-382	956	3947
Austia	-352	1506	1285	-226	-153	1164	693	203	-179	-25	1652	290	902
Belgiu	69	-176	411	732	47	178	811	655	92	-334	-336	-304	-887
Germa	113432	16285	6292	-2624	111535	12664	9702	5440	-1571	-10365	71062	-441	2635
France	2723	3889	1227	3438	2556	6425	1226	10189	2790	6257	1632	3589	4017
Ireland	5430	1196	1637	857	1517	1279	1833	2078	1540	1060	2094	1742	1614
Portuga	273	197	-3665	-602	310	422	-83	-118	-232	250	30162	472	338
Spain	4204	4753	4254	4803	3743	5081	4131	4953	4086	4906	4512	4917	4221
Italy	-3461	2993	14541	8375	12196	16199	19167	13855	54718	192	43149	10430	9732
Greece	958	-717	1077	774	938	632	1167	647	946	501	1181	701	910

2008Q3	2008Q4	2009Q1	2009Q2	2009Q3	2009Q4	2010Q1	2010Q2	2010Q3	2010Q4	2011Q1	2011Q2	2011Q3
167	212	219	320	3	220	244	170	415	239	226	221	-593
439	398	434	529	379	732	-951	801	709	2083	111	276	468
-17	-15	-27	-8	-15	-9	-13	-14	-14	-7	-17	-9	7
78	548	2154	2573	-810	4163	-95	-704	-1105	-803	203	16416	132
103	49	30	52	-20	55	32	23	65	21	71	27	-53
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
230	636	1305	-16	966	893	869	1724	629	936	275	4925	972
842	8254	1158	1037	1200	997	994	859	1247	837	854	1408	833
414	218	538	3730	387	457	-1182	636	938	386	-1947	716	1767
-313	-805	-660	-302	-448	-437	1531	-742	652	-235	-494	361	116
-1221	5299	7491	-51267	9127	4730	67982	45091	14442	4952	NA	NA	NA
25365	2517	-1646	4254	5717	738	3022	2245	15359	-13	NA	NA	NA
1908	941	1586	1956	1848	1877	1941	1836	1806	571	1797	1660	1746
242	185	397	300	-1804	296	-1888	288	265	-316	118	361	381
5083	3970	4824	4577	4495	4780	4321	4633	4482	4706	4481	4812	3605
9925	-8818	7432	269	-3264	26794	14112	8042	2426	8662	13442	4356	1546
8386	1069	559	1047	767	438	1276	3707	1718	519	962	NA	NA

Appendix C: Descriptive Analysis of Raw Data

In appendix C, we will have a brief look at the raw data, including GDP, cumulative level, trade openness, and policy weight and effectiveness to form big pictures of 17 countries.

C.1 GDP

Across all 17 countries, we observe that the biggest scale economy is Germany, following France, Italy, Spain, and Netherlands. Countries with medium-sized GDP are Belgium, Austria, Greece, Finland, Portugal and Ireland. The smallest-sized GDP countries are Slovakia, Luxemburg, Slovenia, Cyprus, Estonia, and Malta.[23] During 2005Q1 to 2011Q3, we observe that all the countries have experienced economic downturn during 2009, which leads to decrease in GDP. Almost all countries have returned to its previous GDP except Greece, Ireland. This observation indicates that the economic situation in these two countries is deteriorating. Besides, although the GDP once return to previous level, Italy, Spain, and Portugal are again experiencing recession with its GDP is falling in 2011.

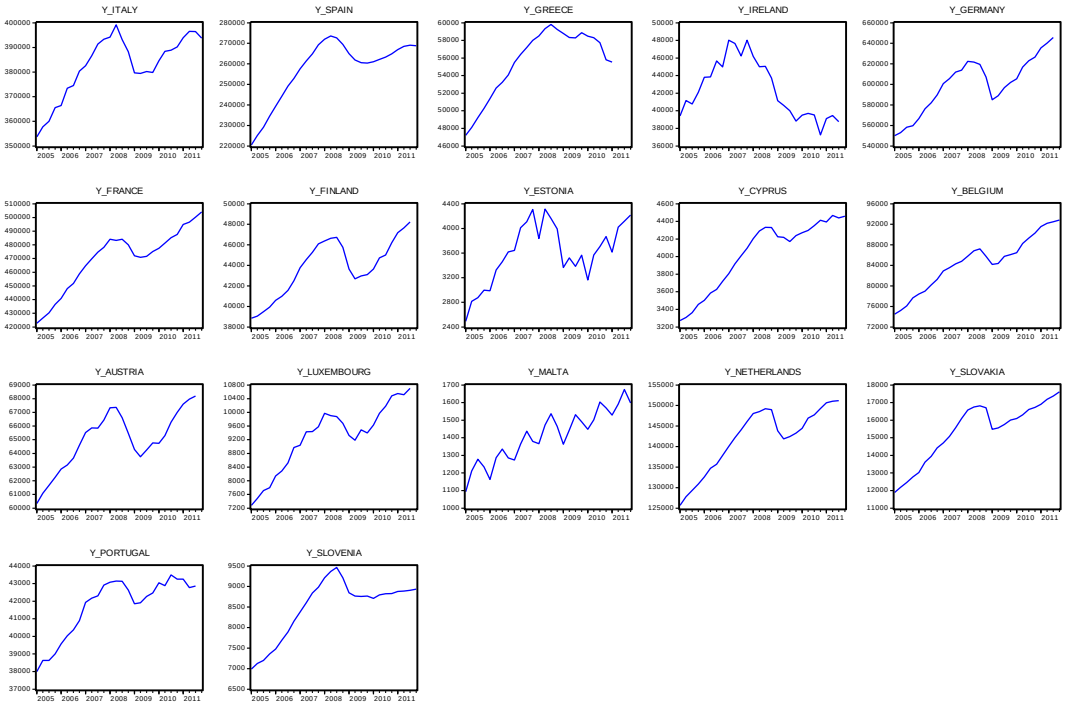

Figure6　GDP for Main 17 Euro Zone Countries (Unit: Millions of Euro)

C.2 Cumulative Debt[24] Level to GDP ratio

Before we discuss further about European Debt Crisis, we shall look at debt level across major Euro Zone countries. Figure 2 and 3 shows the cumulative debt level as proportion of GDP in each quarter across 11 countries. We can observe from the figures that debt in most countries began to elevate at a higher amount after 2008, especially for PIIGS. Debt in Greece, Ireland, and Portugal is increasing at a very fast

[24] The debt here refers to general government debt.

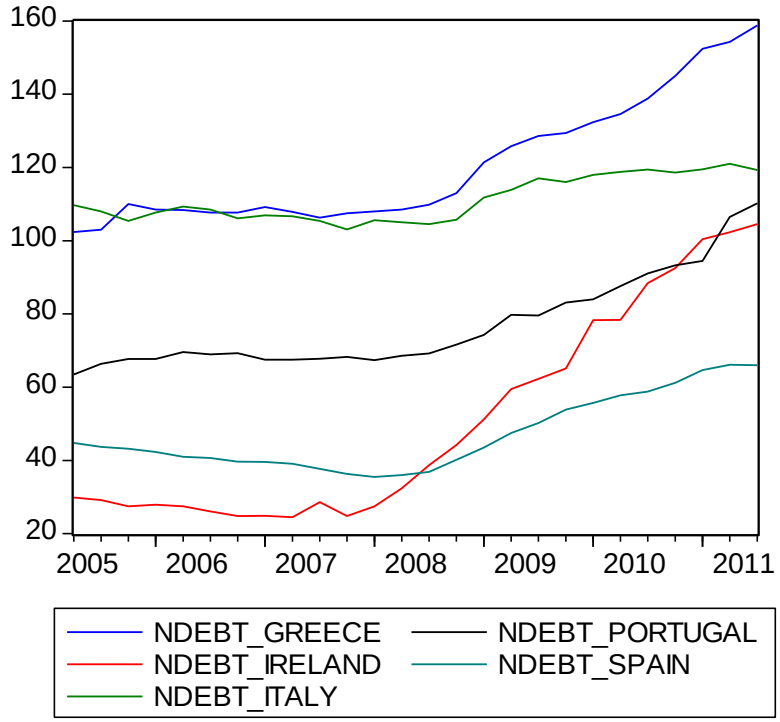

Figure7 Cumulative debt/GDP in Greece, Ireland, Spain, Italy and Portugal

(Unit: Percentage Rate %)

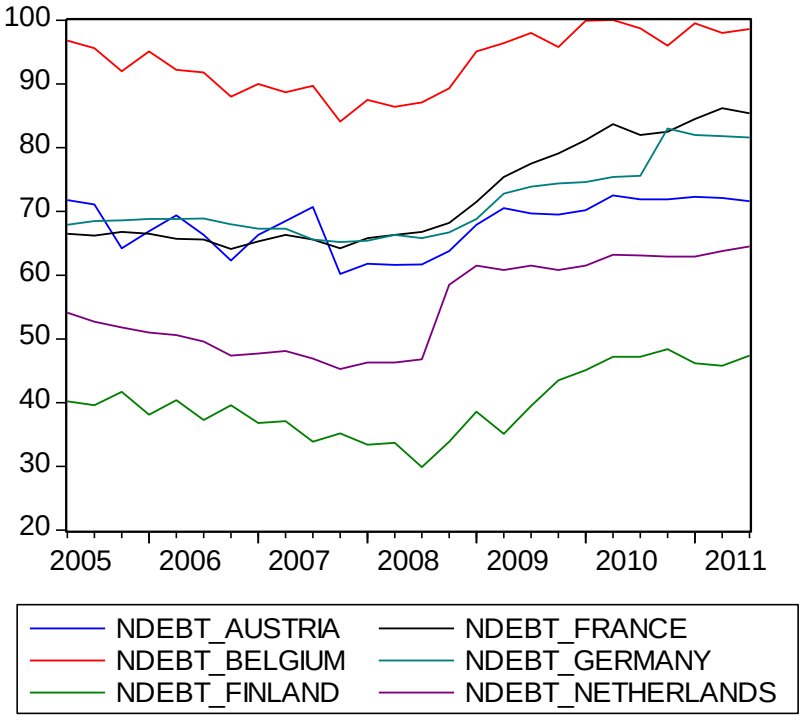

Figure8 Cumulative Debt/GDP in Other Major Euro Zone countries

(Unit: Percentage Rate %)

speed after 2008, exceeding 10% of their GDP every year. It confirms the argument that financial crisis in 2008 is one of the causes for European Sovereign debt crisis. Among PIIGS, the highest cumulative debt level country is Greece, following Italy, Portugal, Ireland and Spain.

Debt for other countries beside PIIGS[25] are worthy of taking a look. Although increasing at a much lower speed, cumulative debt level for Belgium, France and Germany are relatively high. It raises concern that the debt crisis my spread to core Euro Zone countries when the economic condition get worse in the future.

C.3 Trade Openness (Trade flow/GDP)

Next, we shall look at the trade volume relative to its GDP in each country to identify the openness and dependency on trade across Euro Zone. We define trade flow as the sum of export and import. The common trend observed from figure 4 shows most country have experienced enormous trade flow reduction during financial crisis in 2009. After a short period of recovery, the trade flow is again falling down in 2011. However, Germany and Ireland still enjoy a certain amount of trade growth relative to its GDP. Besides, few country have higher trade flow/GDP ratio relative to other countries, including Ireland, Germany, Belgium, Austria, Netherlands. These countries exhibit high economic interaction with others, and it may result either higher dependency on others thus high contagion effect in crisis, or, higher resilience to withstand the shock because of its openness. We will discuss its influence in the following section.

[25] PIIGS refers to Portugal, Italy, Ireland, Greece and Spain.

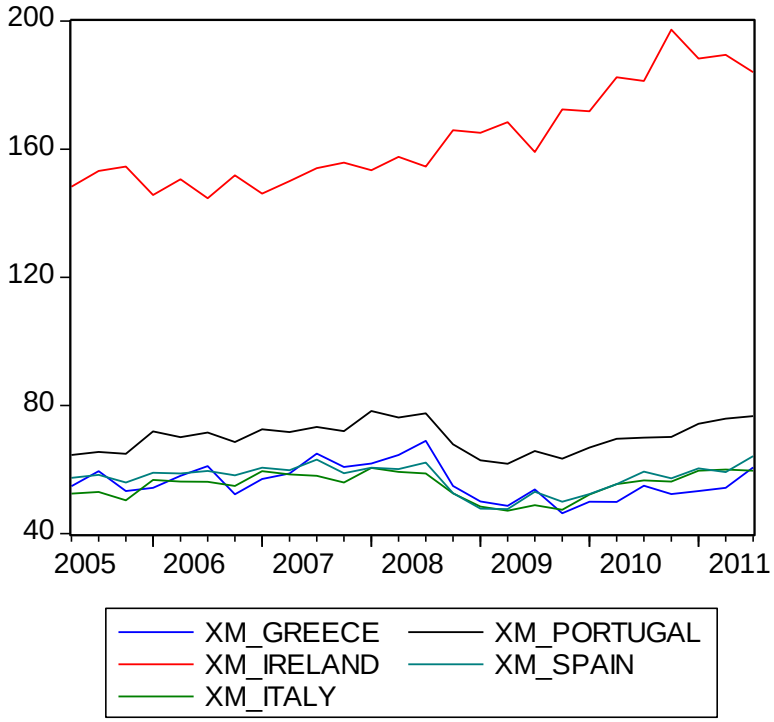

Figure9 Trade Openness in Greece, Ireland, Spain, Italy and Portugal

(Unit: Percentage Rate %)

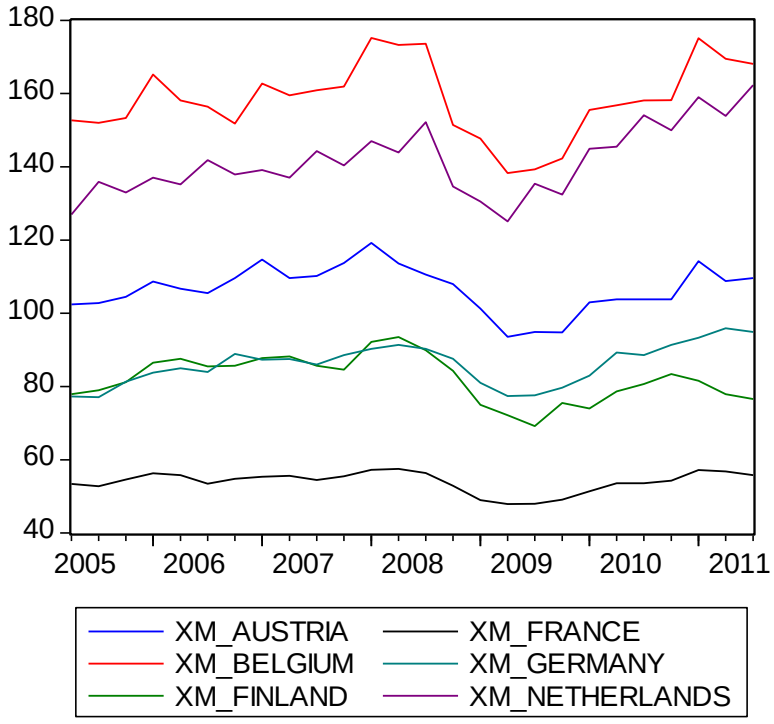

Figure10 Trade Openness in Other Major Euro Zone countries

(Unit: Percentage Rate %)

C.4 Monetary and Fiscal Policy: Weight and Effectiveness

Before we discuss the result of Interest- Rate-Change-to-Income Effect and provide policy suggestion, we shall look at current policy weight and effectiveness. We measure policy weight by calculating the proportion of fiscal policy to the sum of fiscal and monetary policy. We define fiscal policy as exogenous shock in IS curve which will have a change on income. According to Keynesian model the IS curve can be written as:

$$\text{IS: } Y = C(Y - T) + I(R_f) + G_1 + X - M(Y)$$

Consumption(C), investment (I) and import (M) are function of Y, i.e. they are endogenous variables in the function of income(Y). Only changes induced by exogenous variable G_1 and X would result in changes of income. Therefore, we define sum of government consumption expenditure change (dG_1) and export change (dX) as fiscal policy.

To denote monetary policy, we use the similar rezoning. In the LM equation, real money supply (dm) is the only exogenous variable. Therefore, we define real money supply divided by income effect (Ly) as monetary policy, as stated in equation (5.1).

$$LM = K(Y)$$

$$dY = \frac{dm}{K\prime} = \frac{dm}{Ly} \qquad (5.1)$$

The fiscal policy weight is the proportion of fiscal policy to the sum of both policies[26]. Here, since the sum of fiscal and monetary policy weight is one, we only calculate fiscal policy weight. Figure 5 shows PIIGS fiscal policy weight relative to

[26] Fiscal policy weight is calculated as $\frac{dG+dX}{(dG+dX)+(\frac{dm}{Ly})}$

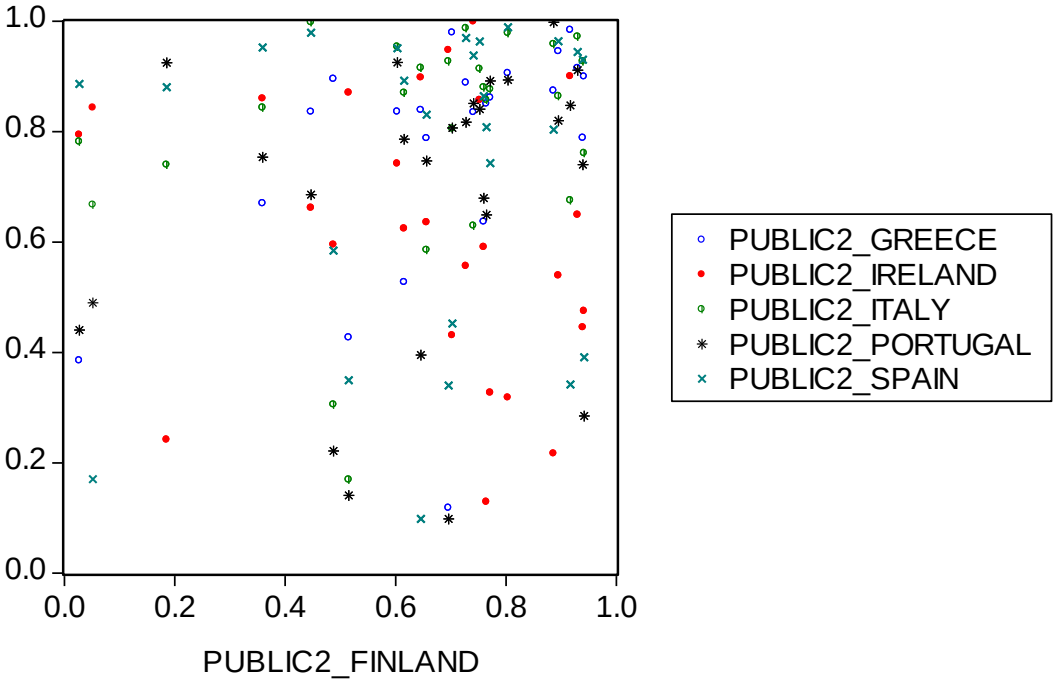

Figure11 Fiscal Policy Weight for PIIGS (Unit: Percentage Rate %)

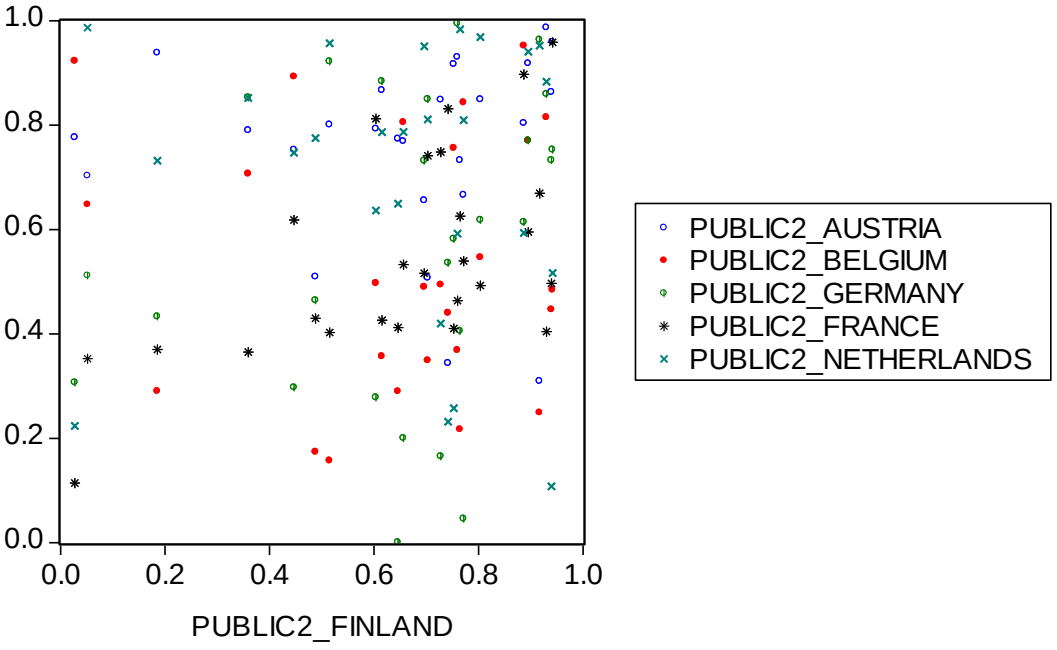

Figure12 Fiscal Policy Weight for Other Major Countries (Unit: Percentage Rate %)

base country Finland while figure 6 shows that of other major Euro Zone countries. Compare the two figures, we find PIIGS countries put more weight on fiscal policy than monetary policy compared to other countries. Greece, Portugal and Spain are among the highest. It somehow reflects the large amount of government expenditure in these deeply in debt countries. For other major Euro Zone countries, monetary and fiscal policies are scattered more equally

As for measuring policy effectiveness, we also use IS-LM curve to measure. By effectiveness we mean how much output would fluctuate due to the policy from transmission by interest rate. The elasticity of interest rate toward income, measured by inverse of IS curve, is an indicator to monetary policy effectiveness. The flatter the slope of IS curve, the more effective monetary policy will be.[27] The same applied to fiscal policy, which measured by the inverse of slope of LM curve[28]. Because our goal is to identify output fluctuation, we take the absolute value of elasticity.

From figure, we observe that both fiscal and monetary effectiveness is tremendously reduced after 2008, but is getting better in 2011. This may contribute to the economic depression after 2008 and a slow recovery in 2011. Among 11 countries, Ireland exhibits the greatest effectiveness of monetary as well as fiscal policy, but also the largest fluctuations. Finland, Italy, Spain also have higher fiscal policy effectiveness compared to other countries. For monetary policy effectiveness, Greece, Spain, and Portugal are relatively higher. But the differences of both policies effectiveness across 11 countries are becoming smaller after 2008. Comparing the two policies, though fiscal and monetary policies are both venerable to economic recessions this time, fiscal policy are still more effective to monetary policies, and this

[27] Monetary policy effectiveness is measured by $\left|\frac{\frac{dy}{y}}{\frac{dr}{r}}\right| = \left|\frac{dy}{dr}\cdot\frac{r}{y}\right| = \left|\frac{1}{\frac{dr}{dy}_{IS}}\cdot\frac{r}{y}\right|$

[28] Fiscal policy effectiveness is measured by $\left|\frac{\frac{dy}{y}}{\frac{dr}{r}}\right| = \left|\frac{dy}{dr}\cdot\frac{r}{y}\right| = \left|\frac{1}{\frac{dr}{dy}_{LM}}\cdot\frac{r}{y}\right|$

is more obvious for countries beside PIIGS.

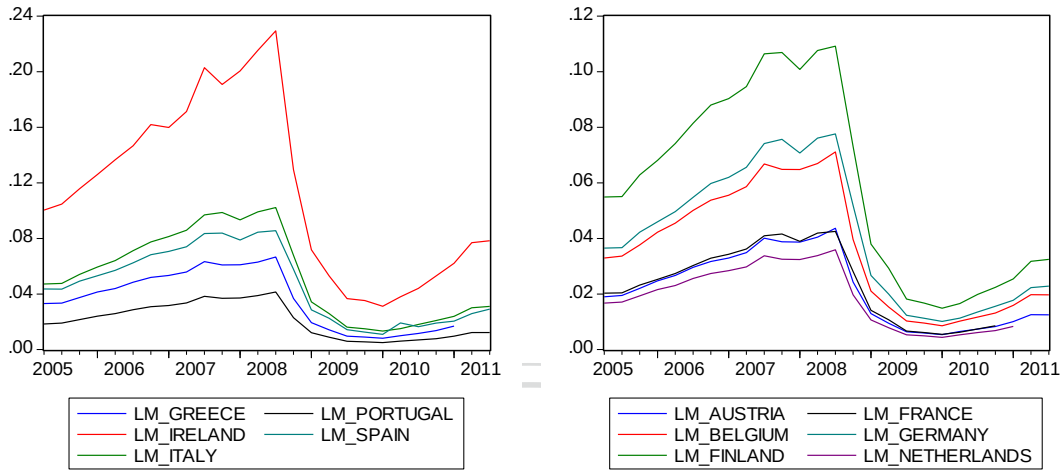

Figure13 Fiscal Policy Effectiveness for Major 11 Euro Zone Countries

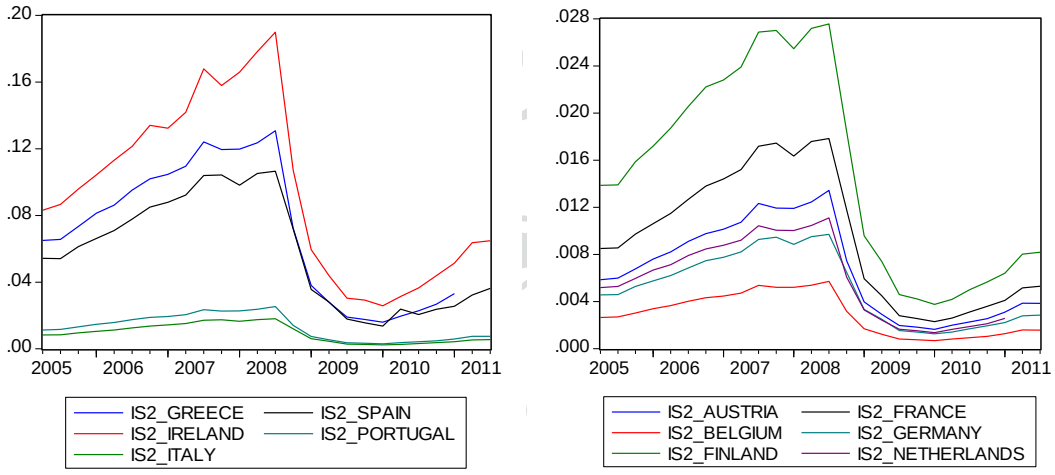

Figure14 Monetary Policy Effectiveness for Major 11 Euro Zone Countries

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