行政院國家科學委員會專題研究計畫 成果報告

從美國次級房貸風暴探討台灣住宅抵押貸款違約因素與不動產抵押債權證券化風險評估之研究
研究成果報告(精簡版)

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計 畫 編 號 ：NSC 97-2410-H-004-107-
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執 行 單 位 ：國立政治大學地政學系

計 畫 主 持 人：林左裕
共 同 主 持 人：楊顯爵、陳宗豪
計畫參與人員：碩士班研究生-兼任助理人員：侯蔚楚
碩士班研究生-兼任助理人員：程于芳

報 告 附 件 ：出席國際會議研究心得報告及發表論文

處 理 方 式 ：本計畫可公開查詢

中 華 民 國 98 年 09 月 21 日

行政院國家科學委員會補助專題研究計畫成果報告

從美國次級房貸風暴探討台灣住宅抵押貸款違約因素

與不動產抵押債權證券化風險評估之研究

計畫類別：■ 個別型計畫　　□ 整合型計畫
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計畫參與人員：陳宗豪

成果報告類型(依經費核定清單規定繳交)：■精簡報告　□完整報告

本成果報告包括以下應繳交之附件：
□赴國外出差或研習心得報告一份
□赴大陸地區出差或研習心得報告一份
■出席國際學術會議心得報告及發表之論文各一份
□國際合作研究計畫國外研究報告書一份

處理方式：除產學合作研究計畫、提升產業技術及人才培育研究計畫、列管計畫及下列情形者外，得立即公開查詢

執行單位：國立政治大學

中　華　民　國　九十八 年　七　月 三十一　日

從美國次級房貸風暴探討台灣住宅抵押貸款違約因素

與不動產抵押債權證券化風險評估之研究

前言

本研究已整理發表於三篇學術及實務期刊，如下所列：

1. **林左裕** (2009) ***再論美國次級房貸風暴對我國金融資產證券化、估價制度及投資者之啟示***， 土地問題研究季刊，31(8-3), pp. 18-34。
2. 楊顯爵、**林左裕**、陳宗豪(2008)***住宅抵押貸款違約之研究---影響因素之顯著性分析***, 台灣土地研究, 11(2), pp. 1-36 (NSC 97-2410-H-004-107 研究成果)（**TSSCI**）。
3. **林左裕**(2008) ***美國次級房貸風暴對台灣金融資產證券化及投資者之啟示***,住宅學報,17(1), pp. 111-123（**TSSCI**）。

以下內容僅列出上述第一篇成果之內容，另關於台灣房貸之部分，資料已蒐集完整，實證分析部分仍在進行中，將整理實證結果後再行發表。

摘 要

自 2006 年起美國發生次級房貸風暴後，終於在 2008 年蔓延至全世界，演變為全球之金融海嘯,全球各界也自不同面向探討次貸危機發生的原因及影響程度，各國也積極進行相關制度與法律規範之強化，以期能亡羊補牢及防範未然。本研究首先進行次貸危機發生原因之探討，乃美國於 2004 年起實施之「可負擔房屋計畫」(Affordable Housing Plan)之政策鼓勵能力不足之借款人申貸及提供保證所致,輔以證券化架構使得放款銀行或貸款創始機構得以藉證券化機制移轉放款風險，而無需審慎查核貸款所導致之「道德風險」。其次針對我國「金融資產證券化條例」之架構進行探討與建議，包括要求放款金融機構在進行資產證券化時，在風險分攤之原則下，應購回並持有部分具風險等級之證券，以避免道德風險之發生；放款銀行對抵押不動產之估價宜採具中立性之估價師報告；以及提供收益率（殖利率）曲線為未來發生金融風暴之先行指標等。所提建議對於未來推行金融資產證券化可有效防範類似風暴之發生,以及在金融風暴發生前可提供投資者決策之預警依據。

關鍵詞：次級房貸風暴(subprime mortgage crisis)、金融資產證券化(asset securitization)、收益率曲線(yield curve)、不動產抵押權擔保證券（ mortgage-backed security, MBS ）、債權抵押擔保債券(collateralized-debt obligation, CDO)、可負擔房屋計畫 (Affordable Housing Plan)

Abstract

The subprime mortgage crisis occurred in the U.S. in 2004 caused the worldwide financial markets turbulence. Subprime mortgages are risky mortgages with both high loan-to-value and debt payment-to-income ratio, and low credit scores. The U.S. has experienced a long-term period of low interest rates since 1980. Low interest rates encouraged homebuyers to acquire risky mortgages, and pushed up the prices of real estate and mortgage-related securities. To cope with the rising inflation in 2003, the U.S. government thus raised the interest rates drastically, consequently leading to the default peak of subprime mortgages and affecting the stability of global financial markets.

This study points out that the subprime mortgage crisis was caused by the structural weakness of the mortgage securitization --- originating mortgages without holding them, and thus losing the motivation of due diligence. The author finally proposed remedy for prevention of similar crisis, such as regulations requiring mortgage originators to hold some portions of risky securitized vehicles, and then keeping to the consistency of screening mortgage application. This study also found out that the change of the shape of “yield curve“ can serve as an effective warning signal for financial crisis. The suggestions proposed in this study may effectively improve the structure mechanism of asset securitization in Taiwan, and provide investors and overall financial markets worthy pre-caution indicators for financial crisis.

「土地問題研究季刊」
(2009),31(8-3), pp.18-34

再論美國次級房貸風暴對我國金融資產證券化、估價制度及投資者之啟示*

一、前言

自 2006 年起美國發生次級房貸風暴後，終於在 2008 年蔓延至全世界，演變爲全球之金融海嘯，全球各界也自不同面向探討次貸危機發生的原因及影響程度，各國也積極進行相關制度與法律規範之強化，以期能亡羊補牢及防範未然。本研究首先進行次貸危機發生原因之探討，乃美國於 2004 年起實施之「可負擔房屋計畫」(Affordable Housing Plan)之政策鼓勵能力不及之借款人申貸及提供保證所致，輔以證券化架構使得放款銀行或貸款創始機構得以藉證券化機制移轉放款風險，而無需審慎查核貸款所導致之「道德風險」。其次針對我國「金融資產證券化條例」之架構進行探討與建議，包括要求放款金融機構在進行資產證券化時，應購回並持有部分具風險等級之證券，以避免道德風險之發生；以及放款銀行對抵押不動產之估價宜具中立性；以及提供收益率曲線逆轉時爲未來發生金融風暴之先行指標等。所提建議對於未來推行金融資產證券化可有效防範類似風暴之發生，以及在金融風暴發生前可提供投資者決策之預警依據。

二、次級房貸緣起之簡介

* 本文爲國科會補助研究案 NSC 97-2410-H-004-107 部分成果，謹致謝忱。本文部份資料採自作者於 2008 年 6 月「住宅學報」第 17 卷第 1 期所發表之「美國次級房貸風暴對台灣金融資產證券化及投資者之啓示」、2008 年 11 月 11 日於「地政節」之講稿、以及 2009 年於「地政學訊」所發表之「都是房地產惹的禍嗎？」。

美國自 2006 年起逐漸發生的次級房貸(subprime mortgage)違約風暴，讓全球哀鴻遍野，據美國銀行統計全球股市下跌市值在 2008 年底高達 7.7 兆美金，也使得以往的財富管理原則深受質疑、華爾街的金融新貴們失業率激增、以及美國在世界的強權地位搖搖欲墜，這一切都源自 2007 年起陸續爆發的不動產抵押權相關證券的違約潮，也使得世人見識到美國華爾街金融戰的專精與不負責任，但到底是何因素使得美國不動產影響全世界？

多數文獻與報導多將次貸風暴之原因歸咎於銀行不負責任之放款及資產證券化之機制，然資產證券化架構自 1970 年起已在美國實施近 40 年，何以在 2007 年才出現問題？且銀行應不致毫無緣由地放款給無償還能力的借款人，因此其基本原因仍需深入探討。

綜合經濟與政治因素，可歸納出次貸發生的源頭，就是美國經濟不振下，想藉刺激所謂的「火車頭產業」---不動產，以達振興經濟的目的。小布希前一任總統柯林頓的運氣奇佳，其任期在 1990 年代，恰逢網路科技熱潮，當時只要各國的公司名稱掛上”網路科技公司(.com)”，不論獲利與否，股價至少可連續數天升值，當時全球產業與金融市場也陶醉在此波夢幻中，由於當時經濟成長高，卻伴隨低通膨與低失業率，有別於以往常見之「高成長、高通膨」，故被命名爲「新經濟」(new economy)，也使得柳案誹聞纏身的柯林頓輕易連任。

小布希於 2000 年上任後，網路科技泡沫隨即破滅，之後歷經 911 恐怖攻擊、以及以「搜索毀滅性武器」爲名而出兵攻打伊拉克之戰等事件，在在都是勞民傷財的事件，尤其是後者，背後的原因「據稱」是伊拉克總統海珊爲報復之前老布希當政時的攻擊，宣稱要向伊拉克購買原油的國家需使用歐元，此舉將使得美金需求及幣值劇跌，影響小布希連任之路，遂引起小布希的「毀滅性武器搜索」之戰，沒想到毀滅性武器之產地就在自家的後院---華爾街，所製造出來的就是諸多以次貸包裝的衍生性金融商品，如不動產抵押權證券(mortgage-backed security, MBS)、債權擔保債券(collateralized-debt obligation, CDO)及信用違約交換(credit-default swap, CDS)等，在不動用一兵一卒及軍火下，終究導致全球經濟的

衰退（林左裕，2009）。

在一連串浪費民膏民脂的事件過程中，貨幣政策是在刺激經濟景氣最容易發揮的了，因爲不必經國會同意，只要總統任命的聯準會主席配合即可，因此美國利率自 2001 年的 6%降至 2003 年的 1%，目的在刺激經濟景氣，沒想到產業沒回暖，卻造成了資產標的(含股市、不動產及相關證券)的飆漲。而 2004 連任之路在即，小布希政府遂想出以所謂的「火車頭工業」---房地產刺激經濟，其在選前提出「可負擔房屋計畫」(Affordable Housing Plan)，美其名爲提升低收入戶之購屋能力，實爲「知其不可而爲之」，一方面鼓勵低所得者或收入不穩定者向銀行借款購屋，另一方面政策性要求「二房」，即聯邦房貸協會(或稱「房利美」，Federal National Mortgage Association, FNMA)及聯邦住屋房貸公司(或稱「房地美」，Federal Home Loan Mortgage Corporation, FHLMC)，出面保證貸款，以利不動產抵押債權包裝成 MBS 後出售，此時銀行樂得不再審慎查核房貸之申請，因爲只要放款出去就可重新包裝再出售債權，賺取創始費及服務管理費。一時之間房地產熱潮持續不退，全球證券市場也瘋狂追求高收益率的次貸相關證券，後續的過程包括雷曼兄弟的再次包裝證券爲 CDO、信評公司(如惠譽)因二房保證而給予 CDO 高級評等、風險移轉機制下的保險公司(如美國國際集團 AIG 等)、以及扮演再保公司角色而購買信用違約交換(CDS)的投資者等。而在石油價格持續飆漲所導致的成本推動型通貨膨脹後，美國聯邦準備理事會(The Federal Reserve Board)只得提高利率以平抑物價，終究引發次貸戶的違約潮，上述的各角色都因標的源頭是「次貸」且過度「超值」包裝而紛紛中箭落馬，且源頭標的資產不良，應用各類的衍生性商品避險亦無濟於事！因此次貸風暴可歸納爲錯誤的政策所導致的金融海嘯!

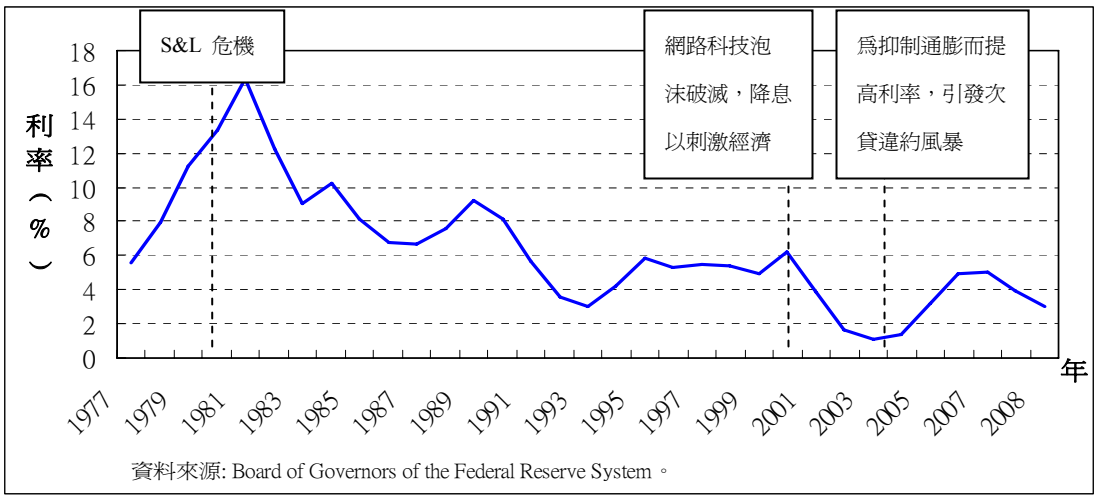
回顧美國上一次的金融風暴，也與不動產有關係，就是在 1980 年代初期的儲貸協會(saving and loan association, S&L)危機，當時的儲貸協會存款利率受法規限制具上限，如此可達到壓低民眾購屋貸款成本之目的，及達成協助民眾完成「美國夢」的任務，然在全球市場化之浪潮下利率持續高漲，最高達 16%，存款戶不堪權益受損，遂湧出提款潮直接投入市場，稱爲「逆仲介」，市場上約 5000 家的

儲貸協會也因不堪突如其來的擠兌而倒閉 1500 家，引發該次的金融風暴。

然何以這次美國境內的次貸金融風暴蔓延至全球，原因是證券化的機制使得世界各國、基金或個別投資者或多或少持有 CDO 或 CDS，在失去信心下，「去槓桿」(de-leveraging) 效應一洩如注，終於釀成世界性的金融海嘯。

在不動產榮景或低利率時期，借款人可按時繳款，房貸相關證券投資人可收取固定之本利償還收入；若無法承擔本利償額，則以轉售房屋之收益清償房貸。然在不動產市場景氣低迷或高利率時期所引發之房市下跌，借款人可能因就業或收入不穩定、或債務償額因利率上漲而攀升導致無法按時還款、甚至違約，尤其以收入不穩定的信用品質較差的借款人最容易違約，且房價的下跌也使借款人面臨房屋市價低於貸款餘額的「負權益」(negative equity)的窘境，因此借款人的違約之機率與利率、房價及總體經濟情況息息相關。

由圖一可看出，美國聯邦基準利率自1980年的15%，降至2003年6月的歷史最低點1%，在資金成本大爲降低、融資容易下，推動房地產市場的多頭行情，房價在2005年創21年新高，使得十年間美國人房屋自有率由65%上升至69%，但其中有一半的融資來源屬次級房貸。終於在2004年起石油價格暴漲，引發「成本推動型通貨膨漲」後，聯準會連續十七度調高利率，終於使得浮動利率貸款(adjustable-rate mortgage, ARM)的借款者（尤其是次貸戶）還款能力遽跌，引發次貸違約風暴。



資料來源: Board of Governors of the Federal Reserve System。

圖一

美國聯邦儲備銀行利率與相關金融事件 (1977-2008 年)

三、金融資產證券化之架構與相關商品之設計

金融資產證券化的目的原爲降低金融機構因放款及長期持有放款債權所引發的利率風險、流動性風險及提前清償風險等，然其前提爲包裝出售之資產標的應爲審慎查核下之優質(prime)貸款債權，美國自 1970 年代開始實施此機制後，著實達到此機制之原規劃目的，然當此機制遭誤用時，亦可能導致更嚴重之金融風暴。當政府一方面利用此機制鼓勵銀行放款給明顯無能力之借款人購屋以刺激經濟，另一方面政策性要求「二房」提供保證給次貸借款人以提高銀行之放款意願時，實已種下未來違約風暴之禍因。

而次貸亦因經「二房」之保證，使得信用評等公司給予高等級(如 AA 級)之評等，遂使得華爾街券商有極大的設計包裝空間，由圖二可看出在「二房」的保證及資產證券化「創造債權卻不長期持有」之特色下，金融機構得以基於管理信用風險及追求資產流動性的考量下，積極地創造債權及移轉風險，並從中賺取貸款創始費用(origination fee)、利差及管理費用。而券商亦因市場利率低迷、投資者因追求高報酬而失去風險意識下，得以不動產抵押債權或甚至在外流通證券，恣意包裝成一般投資者無相關專業能力評估之證券，如 CDO 再包(CDO squared)、CDO 三包(CDO cubed)、以及扮演再保險公司之信用違約交換(credit default swap, CDS)等，在不動產抵押債權未來現金流量提前被放款機構及證券發行機構等提領、甚至是次貸違約現金流量歸零之情況下，金融風暴的來臨是指日可待的。

四、台灣金融資產證券化之發展現況與規範

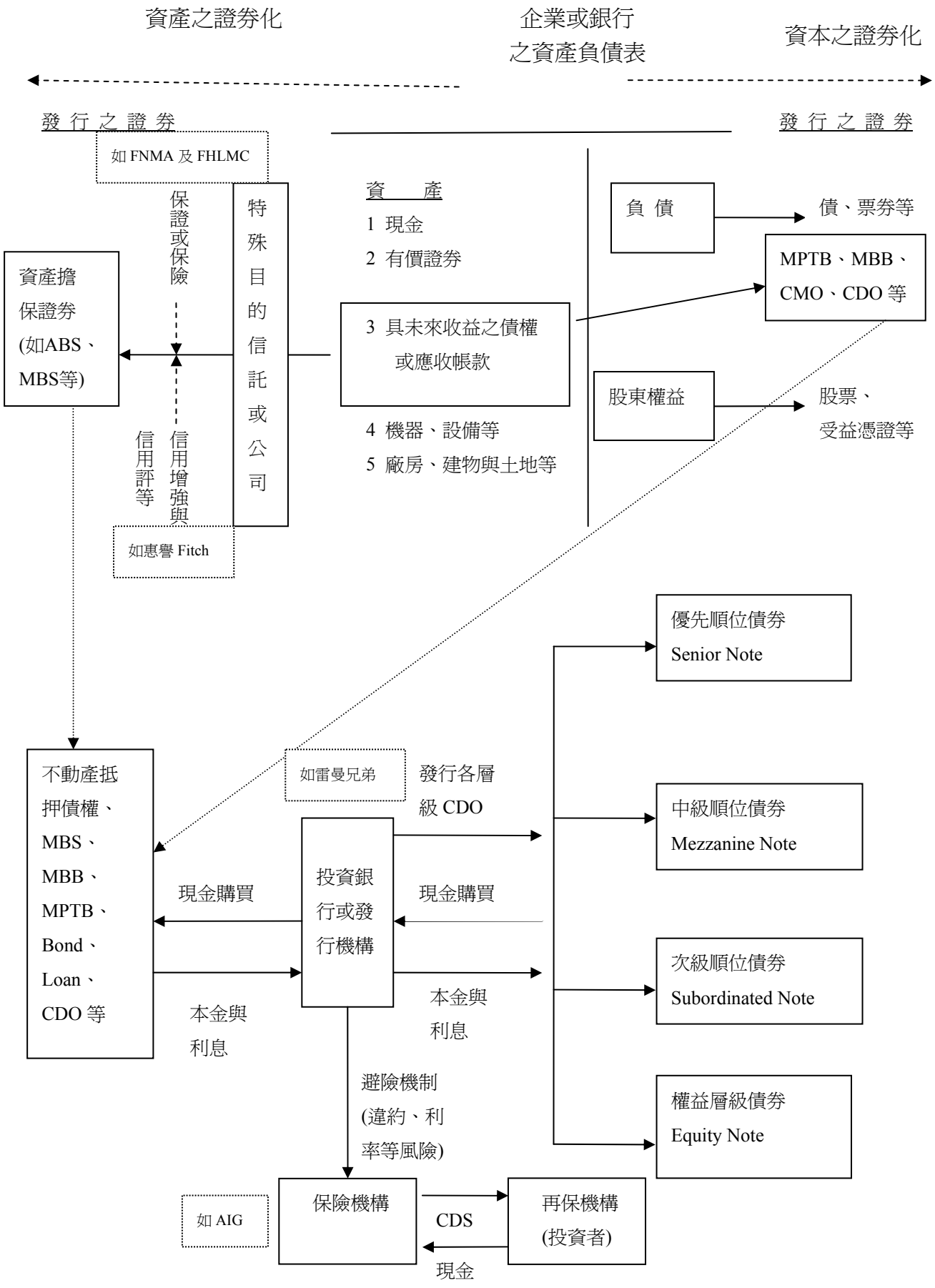
台灣在 2002 年通過「金融資產證券化條例」，至 2008 年已有多檔案件經金融資產證券化機制發行，發行總金額超過新台幣 1.3 兆元，惟受次貸風暴影響，在 2008 年僅一件核准通過，如表一所示。

表一
我國金融資產證券化案件統計

單位：新台幣億元

年度	核准件數	發行金額	發行餘額
2003	5	270	159
2004	8	422	478
2005	14	1419	1653
2006	17	4119	2829
2007	10	6170	3453
2008	1	1258	3335
合計	52	13657	

資料來源：金融管理委員會，2009。



資料來源：修改自林左裕(2007)、(2008)。

圖二

美國次級房貸與相關證券發行架構圖

在「金融資產證券化條例」第四條規範中之「資產」指汽車貸款債權、房屋貸款債權或其他動產擔保貸款債權及其擔保物權、租賃債權、信用卡債權、應收帳款債權或其他金錢債權等，在美國發生次級房貸風暴之際，對未來國內創始機構欲藉類似架構發行 MBS、CMO 或 CDO 等不動產抵押權相關證券以提高資產流動性或擴大融資管道的途徑，正具警示之意味。金融資產證券化之立意在提高不動產及金融資產投資者、放款者或應收帳款持有者之流動性，並降低利率、市場及違約等風險，但若證券化之結果免除了上述法人之風險，將相關風險「全數」移轉至金融市場及小額投資者承擔，導致前端創始機構之「道德風險」(moral hazard）進行高風險放款或投資，結果卻影響整體金融市場之秩序，則有必要檢討此過程中疏漏之處。

綜觀我國之「金融資產證券化條例」，規範之架構除了對商品之定義及組織設立及計畫與業務規範外，雖有信用評等及增強、監督及罰責等，但對創始機構規範僅限於創始機構與受託機構不得爲同一關係企業(金融資產證券化條例第九條)、提供給受託機構之資料不得有虛僞或隱匿之情事（同條例第一 0 九條)；對於特殊目的公司亦僅限於「董事應以善良管理人爲特殊目的管理公司處理事務，並負忠實義務」(同條例第六十四條)。對於信用評等機構之結果則照單全收（同條例第一 0 二條)，對其功能及職責卻無任何防止道德風險之措施；而對於創始機構進行高風險放款進而將債權證券化而移轉風險之防範則付諸闕如（林左裕，2008)。而在薪酬之規範上，僅在同條例第六十四條簡略規範「董事之報酬，應以章程明定之」帶過，對於董事與經理人之報酬金額標準與相對超領報酬時可能產生之「道德風險」則未能予以防範。

又創始金融機構在進行放款額度評估時，除了其收入及工作外評估，通常以不動產或相關抵押品爲擔保而以其估計價值之某一成數(即 loan to value ratio, LTV)，此時除了應參考 LTV 成數（如最高八成）之規範外，亦未見銀行不動產放款債權中具證照之中立不動產估價師之功能，導致銀行與存款戶間之代理問題

（principal-agent problem），也給予了放款金融機構（尤其在資金浮濫時）藉證券化架構將不良放款售出套現的機會（林左裕，2008）。且在發行證券價格的管理上，僅在第 75 條要求載明資產基礎證券之發行總金額，對於發行金額之合理性、與後續市場上流通價格之持續(on-going)監管上，並無明確規範。因此創始機構的放款查核疏失、不動產擔保標的之估價偏頗、信評機構的道德風險、相關人員的超額薪酬、以及證券發行價格的評定及流通價格的失控等漏洞的結合，就是引發次級房貸風暴之發生的根源，未來在規範上，即應儘量針對這些漏洞進行防弊規範，才能有效的防止下一波類似的風暴產生。

五、我國不動產抵押放款債權現況之探討

相關美國次級房貸違約之因素與影響，多篇文獻已陸續著墨，如 Capozza & Thomson (2006)、Danis & Pennington-Cross (2005)、Kiff & Mills (2007)及 Zimmerman (2007)等。楊顯爵等(2008)亦以國內資料實證得出影響不動產抵押貸款違約之因素爲「借款人個別因素」、「契約因素」及「總體因素」，其中又以「總體因素」變動下，最易引發違約行爲。在總體因素方面，又恰逢美國自 2004 年起爲了抑制通貨膨脹而引導利率上漲，終於導致經濟成長衰退、房地產市場之下跌、以及次級房貸借款人無力承擔因利率上漲而引發之違約潮（林左裕，2008）。

另一個影響美國不動產貸款違約的重要因素爲「追索權限」之限制，在美國，不動產貸款違約情況下，在某些州之最高追索權限只侷限於該不動產標的，並不擴及該借款人之其他所得，因此違約的「選擇權」(default option)對美國借款人較輕易執行，即部分借款人在低利率時期輕易購屋，著眼於房價之上漲空間；也在後續利率上漲、房價下跌後輕易違約。相對上，台灣之不動產貸款違約後，其追索權擴及個人所得，因此違約的「權利」在台灣通常不會輕易執行，除非到最後關頭。兩國違約追索制度的差異也會影響借款人之違約行爲，也因此可預期台灣的不動產貸款市場違約情形不會如美國般嚴重。

由表二可看出我國貸款起始年及相對違約率，在 1997 東南亞金融風暴發生後

至 2000 年，貸款違約率相對偏高，經過數年之金融改革與逾放整理後，也適逢總體經濟景氣在 2003 年攀升，違約率遂維持在 3%以下。

表二

我國貸款起始年與相對違約率

貸款起始年	總件數	違約件數	起始百分率(%)	違約率(%)
1996	64068	4472	9	6.98
1997	51944	3976	8	7.65
1998	50062	4220	7	8.43
1999	59758	4908	9	8.21
2000	49469	3441	7	6.96
2001	42243	1988	6	4.71
2002	50051	1333	7	2.66
2003	42152	980	6	2.32
2004	42237	924	6	2.19
2005	63222	1142	9	1.81
2006	47310	566	7	1.20
2007	74084	238	11	0.32
2008	48468	8	7	0.02

資料來源：金融聯合徵信中心(2009); Chang and Lin (2009)。

由表三我國不動產抵押貸款之貸款成數與相對違約率亦可看出，貸款成數愈高者，其違約率愈高，尤其是超過八成者，其違約率(8.29%)即明顯高於低成數者(2-3%)。因此未來銀行就違約的考量下，應避免高成數之放款。

表三

我國不動產抵押貸款之貸款成數與相對違約率

貸款成數 LTV	總數	違約數	佔總數百分比(%)	違約率(%)
0.6 及以下	160100	3802	23	2.37
0.6-0.7	228571	6921	33	3.03
0.7-0.8	111035	2882	16	2.60
0.8-0.9	162482	13467	24	8.29
0.9 以上	22860	1124	3	4.92

註：貸款成數超過 9 成以上者包含其他擔保品。

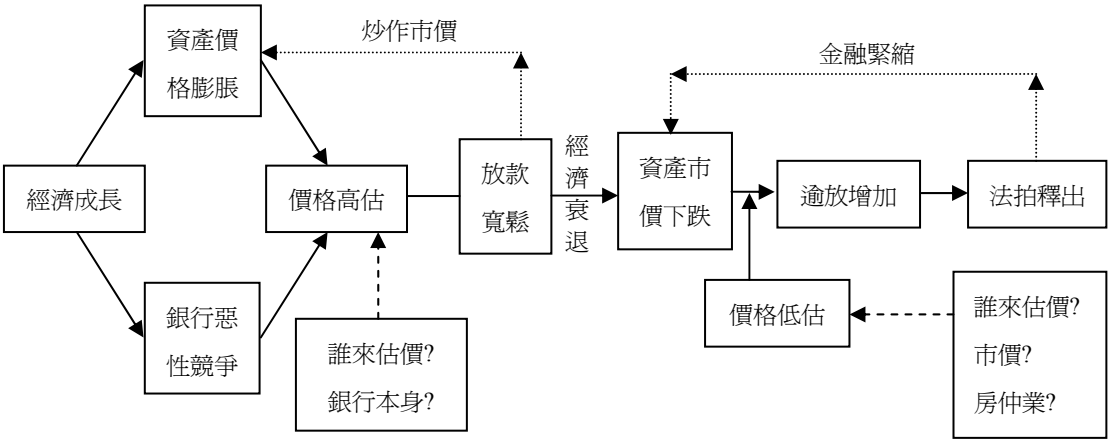
資料來源：金融聯合徵信中心(2009); Chang and Lin (2009)。

六、對我國金融資產證券化未來規範與發展及投資者之建議

由上述引發次貸風暴因素之探討，我國可積極因應相關規範以防範未然，以下即針對以上影響因素提出雛見以供主管機關、投資者及各界參考。

（一）抵押資產標的估價之相關問題

由於不動產抵押放款之違約率與貸款成數息息相關，而貸款成數之依據爲不動產估值，因此不動產估價之中立性及合理性對違約率、甚至後續之金融風暴有顯著之影響。在估價技術上若只用採用「比較法」，則容易在資產價格膨脹或泡沫時期導致「追漲」的估價結果。另一值得注意的估價制度漏洞爲銀行放款時，估價人員、估價結果及放款額度均由銀行全權決定，亦可能導致金融機構與存款戶間之「代理問題」。由圖三可看出，當景氣繁榮時，放款寬鬆後可能導致資產價格市價之膨脹。而在景氣無以爲繼，或受生產因素（如石油等）影響而衰退時，則可能逆轉爲另一惡性循環，使價格低估。因此不動產估價的中立性與合理性，值得與目前之相關規範進行探討。



資料來源：修改自林左裕(1999)。

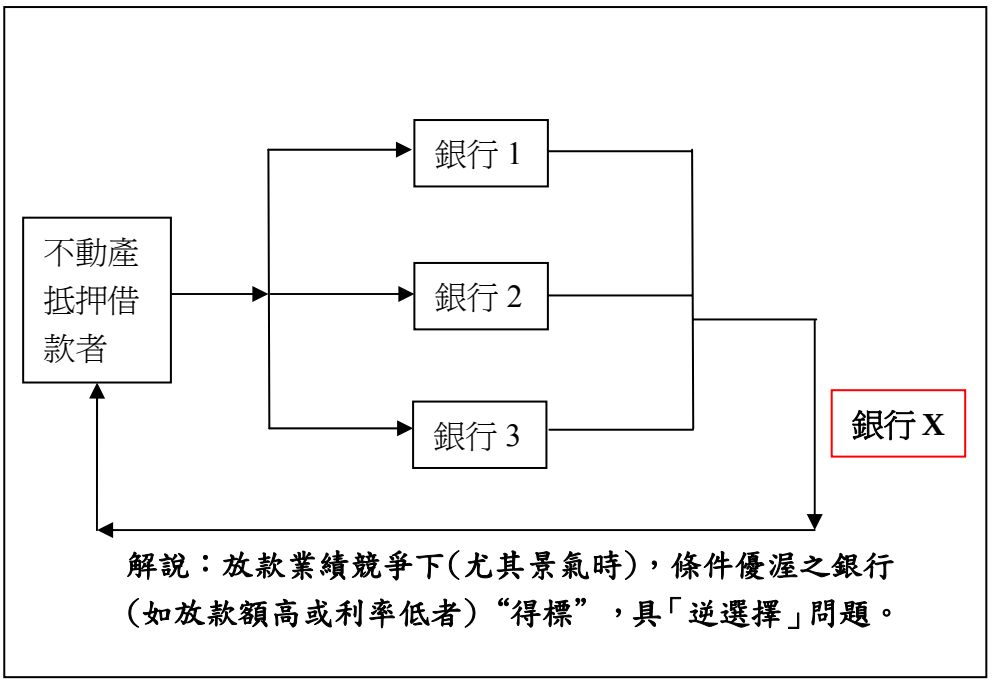
圖三

金融機構之估價在不同經濟景氣時之助漲助跌效應

我國自 2000 年及 2001 年頒訂「不動產估價師法」及「不動產估價技術規則」後，即開始實施不動產估價師制度，然銀行不動產放款之估價，則仍由銀行內聘(in-house)之估價人員進行估價。就銀行內聘人員估價之特性而論，在有業務壓力或上級壓力，或景氣低迷時規避風險之壓力時，易對圖四中所示之金融市場造成「助漲助跌」之效應。而當採取房仲業之資訊估價時，雖然市場交易資訊可能較充分，但可能在飆漲或泡沫時期高估價格；或在不景氣或金融風暴時期低估價格。因此若能採中立估價師進行估價，可兼採市價比較法與收益還原法，所得之估值將較爲穩定。

在目前國內銀行供過於求之情況下，購置不動產之貸款申請對銀行而言，有如銀行「標購」不動產抵押債權，條件愈優渥者（如利率愈低、貸款成數愈高、或貸款額度愈多）即可得標，由圖四即可看出，此類「競標」即使銀行面臨「逆選擇」(adverse selection)問題，「得標」銀行在進行高成數或高估值所致之高額度放款後，即持續面臨借款人之違約風險，尤其是在不動產景氣走低之情況下。若能經中立之不動產估價師依市價、未來收益性及經濟情況進行合理之估價後，應可降低違約風險及「逆選擇」問題，以及減少只依不動產市價進行估價所導致之

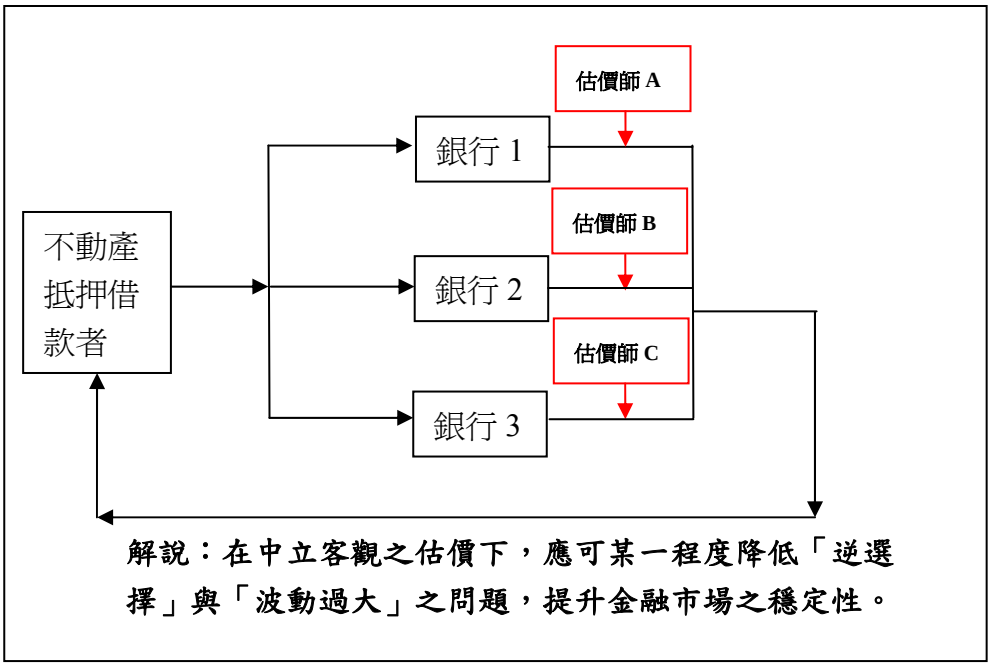
波動風險（如圖五所示）。



資料來源：本研究整理

圖四

銀行在業務壓力下進行不動產抵押放款之「逆選擇」問題



資料來源：本研究整理

圖五

經中立估價師估價後，可降低銀行不動產抵押放款之「逆選擇」問題

而美國在發生次貸風暴後，爲確保不動產估價之正確性(accuracy)與獨立性(independence)，即積極推動「房屋評價保護新準則」(New Home Valuation Protection Code) ，其相關規範如下：

1. 未來銀行不得使用內部人員估價(in-house appraisal)，亦不得使用該行所擁有或有關係之估價公司報告書。
2. 自 2009 年 1/1 起，「二房」只能保證與購買經「中立估價師」所估價之房貸。
3. 銀行或仲介者不得在估值上指使估價師，或給予目前或未來之業務壓力。
4. 未來放款銀行必須即時提供借款人一份估價報告書。
5. 對估價師之估價結果進行「品質管制測試」(Quality Control Test) ，以 10%之顯著水準測試其偏離程度(如以自動估價系統或大宗資料爲基準) 。
6. 設立「獨立估價保護機構」(Independent Valuation Protection Institute) 。

--- 如設立「估價申訴熱線」(appraisal complaint hotlines) ，供消費者或估價師申訴估價過程中之不公問題。

以上「房屋評價保護新準則」規範中，如資產證券化過程中經保證之不動產抵押債權需爲中立估價師之估價結果，可降低銀行內部估價人員之業務及上層壓力；而相對上對於估價師之估價品質進行「品質管制測試」，則可有效估價師之道德風險。此類之規範，頗值我未來進行金融資產證券化機制及維持金融秩序之穩定性時之有效參考，故建議我國金融管理當局可再針對銀行之不動產放款估價問題（如估價人員之資格與權限等）進行漏洞之改革，並定期對估價師進行類似之「品質管制測試」，以防範未來金融市場因不動產估價而導致類似的失序問題。

（二）資產相關證券之發行及流通價格上限探討

依金融資產證券化架構所發行之商品屬固定收益證券，其價格行爲類似債券，與市場利率成反向變動，在利率低迷時期，商品價格將因折現效應而上漲，但因折現因子最小值爲 1（當利率爲零時），因此其價格之上限爲所有利息與面額之和[1]，當發行價格或流通價格超過此上限時，即已觸發違約風險。根據估計在 2006 年約有 1,000 億美元次級房貸包裝進總額 3,750 億美元的 CDO 在美國市場銷售（許振明與陳沛柔，2007），可見次貸風暴中金融資產證券化等固定收益性商品超值銷售所引發違約情事的嚴重性。

（三）創始銀行或投資機構經理人薪籌制度之探討

由於金融資產證券化相關證券爲固定收益，雖然價格與利率呈反向變動，如上所述，其價格上漲仍有其限制，因此創始銀行或投資機構相關人員之薪酬，即不應無限制地成長，若其薪酬愈多，即表未來證券投資者之現金流量愈少，即愈可能引發償還能力問題或違約風險。根據統計指出，在 2006 年間美國五家主要投資銀行之 1300 億美元收入中，有 600 億元爲薪資，有 360 億是紅利及獎金，也由於此不符合比例之高額報酬吸引財金及數理精英投入華爾街之商品設計及銷售中（辛喬利與孫兆東，2009），後續引發次貸風暴也不足爲奇。因此關於薪酬制度之訂定，主觀機關可適度予以規範，甚或在證券存續期間持續擁有調查權利，以降低證券在期滿前之違約風險。

（四）貸款創始機構之風險分攤原則

在以不動產及相關（債權）資產爲擔保且包裝、切割爲不同風險等級之證券售出時，管理當局得視情況要求創始機構、特殊目的公司(special purpose corporation, SPC)、發行券商或投資銀行(investment banker)購入並持有某一比例之

[1] 舉例而言，當某公司發行之債券面額 1000 元，票面利率 6%，十年期，每年還息，期末還本，則在市場利率爲零時，此債券發行價格最高爲 1600（=60x10+1000）元，當發行價格超過此上限、或未來流通價格超過後續付息及還本之總和時，即已觸發違約風險。

風險等級較高之證券，在違約情事發生時，可先由其先行吸收，藉此機制要求創始機構審慎查核其放款。亦即未來依金融資產證券化所發行之證券需明確劃分等級，且風險須由創始機構及發行機構等共同承擔，否則在道德風險無法規避之前提下，不宜以此途徑進行證券化（林左裕，2008）。

有鑑於此，歐盟於 2009 年初立法通過，未來之金融資產證券化若發生損失情事，5%需由創始機構承擔，即著眼於承擔損失之相對責任。一般雖認爲此損失承擔之要求比率過低，但此規範已顯示出主管機關認定部分之放款審核責任應歸屬於創始機構，對未來銀行之審慎查核責任有更強化之要求與激勵。

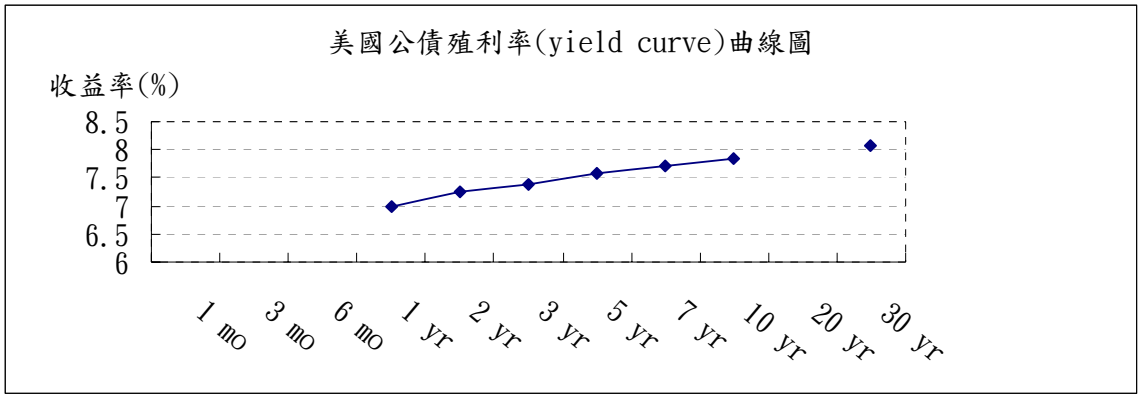
（五）證券「每日結算」(mark-to-market)機制所衍生的問題

每日結算機制原爲降低期貨、選擇權等衍生性金融商品之違約風險所制定的制度，然當市價在恐慌性事件或不理性因素下，可能形成資產證券化相關證券惡性循環的跌勢，尤其在目前流通世界甚廣的「結構型商品」(structured products)，常以固定收益證券與選擇權包裝成一商品發售，又在國際型投資機構有定期公佈淨值的壓力下，每日結算制度對證券、衍生性金融商品、金融資產證券之相關商品價格、甚至金融市場之穩定性，有助長其波動性之影響。此波的次貸風暴即因每日結算機制導致多數證券及基金受益憑證之市場價格明顯超跌而影響其流動性，因此國際間亦正對此機制之副作用進行探討。

（六）金融機構及投資者宜培養高度之專業預測能力

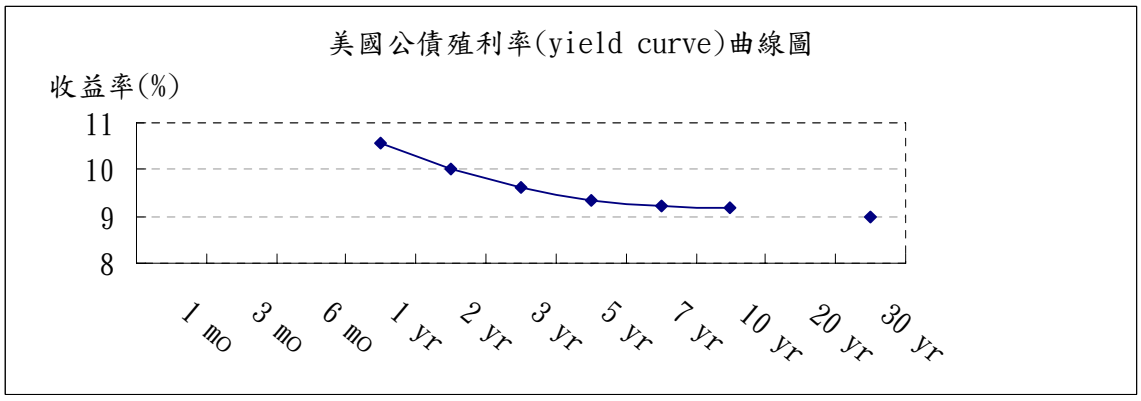
對放款銀行及投資者而言，除了個別標的之產業及個別公司風險外，最需要注意引發金融風暴或股市遽跌的系統風險。除了經濟成長率之預測外，對於資金的供需，收益率曲線(yield curve)之形狀即扮演著即有效的預警指標。在正常情形下，因長期放款比起短期放款多出了「期限風險溢酬」(liquidity risk premium)，因此收益率曲線爲正斜率之曲線。然當景氣逆轉時，金融市場上短期資金之需求將遽增，使收益率曲線之斜率轉爲負斜率，此時資金需求者除了自銀行提領現金

外，亦將自證券市場出售證券以求現，故可能導致股市遽跌或銀行擠兌危機，因此當收益率曲線由正斜率轉爲零或負斜率時，可爲金融市場預警之有效指標。由圖六及圖七可看出，1978 年美國之收益率曲線仍爲正斜率，在 1979 年即轉爲負斜率，之後在 1980 年即發生儲貸協會危機。而圖八及圖九中之收益率曲線自 1998 年之正斜率轉爲 1999 年之零斜率，也在之後的 2000 年發生網路科技泡沫破滅事件。在 2005 年至 2007 年之收益率曲線斜率逆轉（如圖十至十二），也有效預測了此波次貸風暴。因此未來金融機構及投資者可長期觀察收益率曲線的走勢，以作爲全面性的股市遽跌或金融風暴的先行指標，並據以因應放款或投資決策。



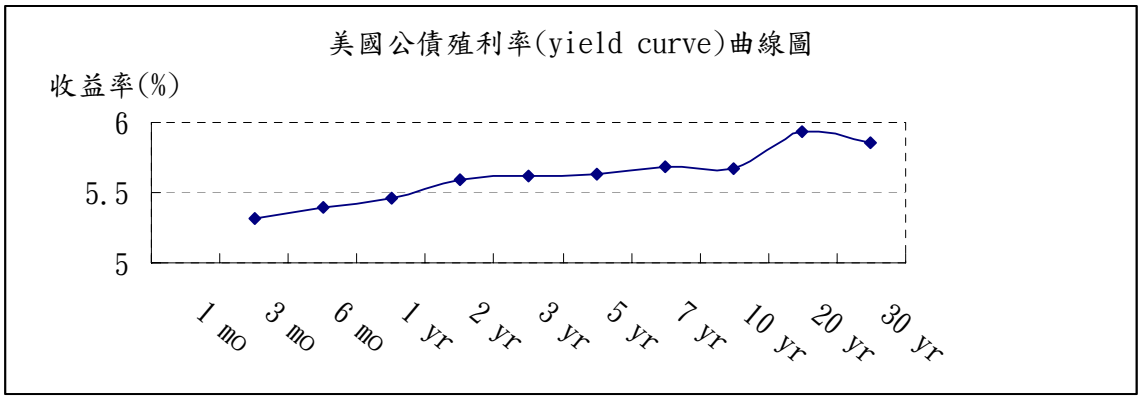
圖六

美國公債殖利率曲線圖（1978/1/3）



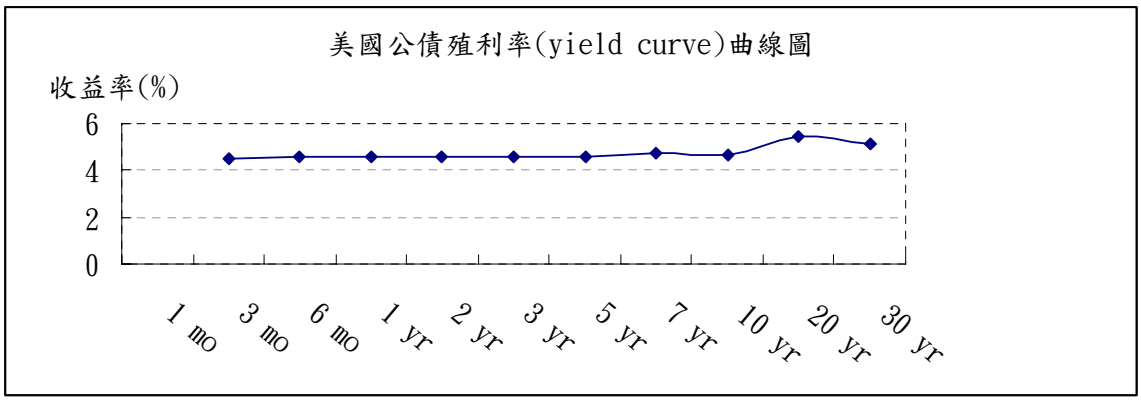
圖七

美國公債殖利率曲線圖（1979/1/2）



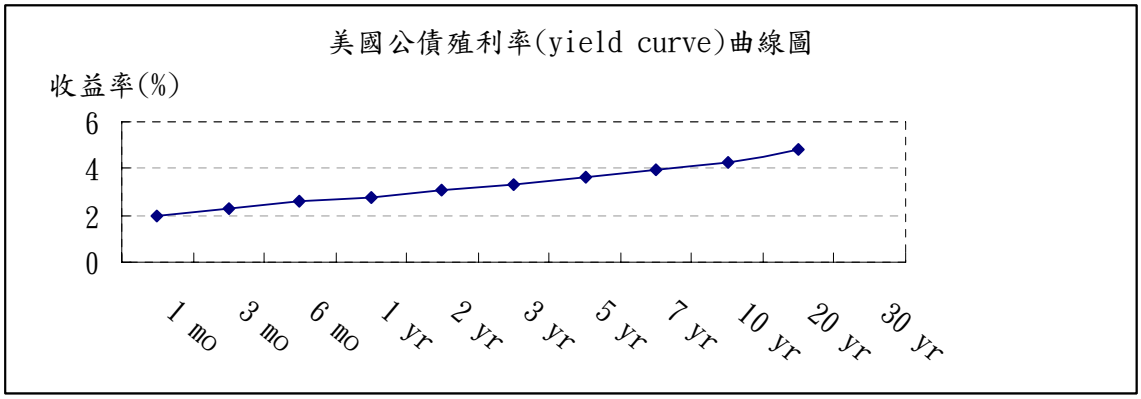
圖八

美國公債殖利率曲線圖（1998/1/2）



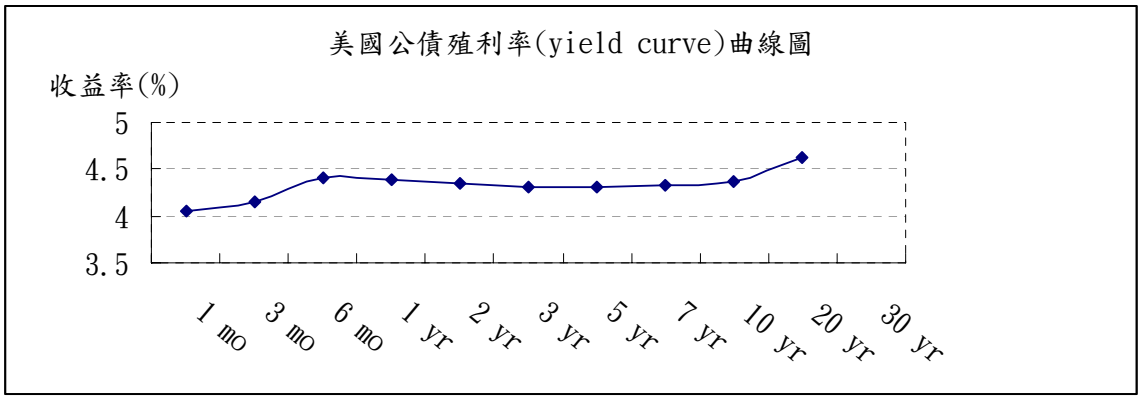
圖九

美國公債殖利率曲線圖（1999/1/2）



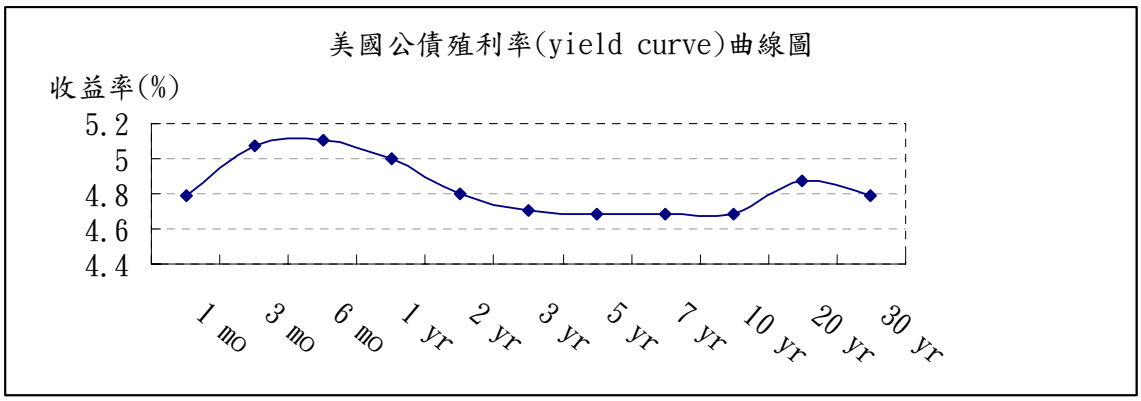
圖十

美國公債殖利率曲線圖（2005/1/3）



圖十一

美國公債殖利率曲線圖（2006/1/3）



圖十二

美國公債殖利率曲線圖（2007/1/2）

七、結論與建議

金融資產證券化之設計目的原爲降低放款銀行或企業持有具收益之債權或相關資產之風險，並提升其資產流動性，可有效降低金融機構之經營風險，並減少政府出面擔保發生危機之金融機構的情形，然前提是將優質(prime)且違約率低的債權售出。若因政府或民間機構爲提高資產型證券之市場性或其他政策因素而對劣質或次等(subprime)的標的提供保證，再將其出售至證券市場、甚至國際上，則可謂「倒行逆施」，將未來違約的禍害隱藏在當前的流動性中。在各國金融資產證券化機制逐漸發展且邁向成熟之際，強化投資者與金融市場之風險管理機制刻不容緩，因此在各步驟中的縝密規範，將可防止未來類似風暴的發生。

本研究針對金融資產證券化過程中可能的疏漏之處提出補正之芻議，如放款銀行宜採用中立估價師的報告，以避免過度依賴市價爲依據放款而導致對市價有助漲助跌的效應；對資產相關證券之發行及流通價格應依其現金流量設定上限，並長期追蹤觀察；對創始銀行或投資機構經理人及資產證券化過程中之從業人員，宜設立客觀之薪籌制度標準，以避免固定現金流量下因薪籌溢領而提升違約的機率；基於風險分攤原則，創始機構若出售貸款，應在貸款違約時分攤一比例之損失，以有效降低放款機構之「道德風險」。又在證券「每日結算」的機制下，若在市場失靈時可能引發惡性循環及影響證券市場流動性，則有必要研擬一套準則在波動程度過大時適用。除此之外，金融機構及投資者宜培養對趨勢波動的敏銳觀察力及專業性，以在股市遽跌、甚至金融風暴來臨前及時因應，而收益率曲線之變動可視爲一有效之預警指標。只要在嚴謹的規範下，將各步驟之風險及可能弊端機率降至最低，金融資產證券化機制仍是提供放款金融機構及企業資產流動性之極佳途徑。

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The Feasibility Study of the Application of the Reverse Mortgage in Taiwan[#]

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Abstract

With the continuously declining fertility rates and the increasing life expectancy, Taiwan has become one of the aging societies in the world. To release the financial strain of the government, a great number of literature has suggested an alternative option, Reverse Mortgage (RM), to improve the retiring life quality of the elders. However, little attention has been given specifically to the feasibility of the application of RM and the pricing model in individual countries. This study thus conducted the questionnaire and collected the data in Taiwan for analysis in order to show the implementation feasibility of RM in aging society for both the aspects of both lenders and borrowers.

First of all, to find out the factors affecting the willingness in applying for RM and the characteristic of the middle-aged homeowners, we designed a survey and a quantitative analysis of the questionnaire through Logistic Regression Analysis.

Second, under a break-even hypothesis, we analyzed the ratio of Loan to Value (LTV) a reverse mortgage lender would offer through the simulation model. Furthermore, the housing data from different metropolises of Taiwan is integrated into the study in order to determine whether if the Income Replacement Ratio of RM (IRR_{-RM}) could meet the basic needs of Taiwanese.

Results found in this paper suggest that RM could satisfy the general need of people in Taiwan. Procedures conducted in this study may also provide precious insight for other aging countries. This paper suggests that reverse mortgage could not only solve the society issues, but also secure the retiring lives of the elders and preserve their living qualities.

Keywords: Reverse Mortgage, Logistic Regression, Simulation Analysis,
Loan to Value, Income Replacement Ratio (IRR)

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1. Introduction

According to the Social Indicator announced by the Ministry of Interior in 2007, Taiwan is one of the rapidly aging societies[1] in the world due to the continuously declining fertility rate and the increasing life expectancy. As shown in Figure 1, the percentage of population for ages younger than 15 will decrease from 18% to 8%, and the elders of over 65 will rapidly increase from 10% to 35% in coming forty years. Besides, the aging index[2] has gone up to 58% in 2007, which is 1.5 times than the global average. Moreover, it is expected to increase dramatically to 182% in 2029, the next coming two decades; and the old-age dependency ratio[3] will increase up to 35%. It implies that every three adults at least should take care of one elder; the aging society would become a serious problem in the near future.

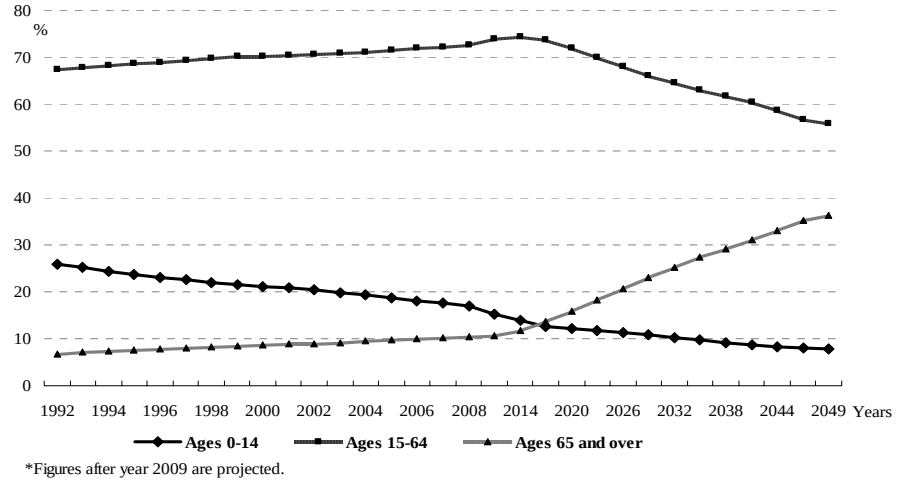


Figure 1

Percentage of population by ages in Taiwan

The serious aging population has been attracting considerable attention from the government. In October 2008, Taiwan government enforced the "National Annuity" system by building the "National Annuity Law." According to the National Annuity Law, people in Taiwan who participate in the pension insurance program and pay the insurance monthly could obtain a life annuity when they reach 65 years old. The amount of the annuity they can get depends on how long they participate in the program.

Although the pension insurance system is in a way expected to cope with the aging problem, high dependency ratio will still drag down the government's financial system and the economic development of Taiwan (Jung, 2007). Fortunately, more and more financial innovative products have been developed to assist the elders by planning their

[1] In Taiwan, the people aged 65 and older account for 7% of the general population in 1993, which is the criterion of an aging society. In 2006, it was 10% in Taiwan, compared with other country in Asia, Japan is 20%, Hong Kong is 12%, Korean is 10%, and China is 8% in 2006.

[2] According to the definition of the indicators of aging population from the U.N., the aging index is calculated as the number of persons 60 years old or above per hundred persons under aged 15.

[3] The old-age dependency ratio is the number of persons 65 years and above per one hundred persons 15 to 64 years old.

income after retirement, such as Life Annuities, Long-term Care Benefits, Longevity Insurance and Reverse Mortgage (RM). However, in the case of RM, it could be the most feasible scenario due to it has long been developed in Europe and the United States (Mitchell, Piggott, Sherris & Yow, 2006). Reverse mortgage is a mortgage to help the elders convert their home equity into cash. They can receive a payment by using their house as collateral. And as long as they stay alive, they do not need to repay the mortgage and can still withhold ownership and residence of the house. This approach is somewhat like a home-based annuity (Cocheo, 1993).

On the basis of the Life-cycle Hypothesis, people will use their life-time accumulated assets during their retirement years (Ando & Modigliani, 1963; Artle & Varaiya, 1978; Shefrin & Thaler, 1988). That could be the reason why the elders will finance their residence even though the financial planners have recommended that mortgages should be paid off after they retired so that they will have more funds available for other expenses and reduce the risk of not being able to afford the mortgage payments. (Karen, Melinda & Doseong, 2006; Michael, 1999), or choose to draw down their home into smaller ones or with less value (Amanda, 2007; VanderHart, 1994).

The following evidence also demonstrated the feasibility of the application of RM in Taiwan. For the elders in Taiwan, there is a tendency of their major source of the income—coming from themselves or their children—to decrease, yet the income source from the government has a reverse trend (Ministry of Interior, 2005). Besides, among the households by tenure of dwelling, the self-homeownership ratio for people aged more than 65 has reached the standard of 80% (Statistical Bureau, 2006). It shows that the Chinese traditional value, the concept of "raising children to prepare for getting old", has gradually become outmoded. Nevertheless, considering that the income source from the government and oneself take on a large proportion and with the high self-homeownership ratio, it can be pointed out that more and more elders do not have enough income to cover their daily expense, yet they own expensive houses. In other words, they may become "living poor but dying rich" people.

Therefore, the current study suggests that reverse mortgage can be an alternative financial option for elderly people who own the home equity but limited income. Homeowners in retired life are able to consume their home equity through RM with no need to move out. Meanwhile, RM could be a way to pay for services and support seniors "aging in place" (Redfoot, 1993; Stucki, 2005).

As mentioned above, in more recent years, we have seen mounting evidence of the feasibility of the application of the reverse mortgage in aging countries. Although many researchers also consider RM as a way to enhance the economic security preparation for elders, few attempts have been made to discuss the feasibility of RM in these countries from both the RM borrowers' and the RM lenders' consideration. That is, for the research in the feasibility of the reverse mortgage in aging societies, little attention has been given to both the aspect of the supply and the demand.

Hence, this study aims to offer a complete analysis by considering both these two aspects. From the viewpoints of borrowers, this study attempts to find out the positive and negative factors which affect the intention of the middle-aged homeowners and see the basic need of RM for people in Taiwan if it is available in the future.

On the aspect of the lenders, this study tends to compute the Loan to Value (LTV) through the simulation analysis to explore how much the disbursement that RM lender

could offer. Furthermore, the study examines the Income Replacement Ratio (IRR_{-RM} [4]) by comparing the pre-retirement earning and the income from RM. And then we discuss whether the application of RM could meet the basic need for the people in Taiwan or not.

2. The Concept of the Reverse Mortgages

Reverse Mortgage is a mortgage which allows older homeowners (aged 62 or older in the U.S.) to convert their lifetime home equity savings into cash. It is aptly named because the payment stream is "reversed." Instead of making monthly payments to a lender, as in a regular mortgage, the borrower receives payment from lenders against the value of their property. Under the concept of payment pattern, the RM is basically designed to enable elderly homeowners to unlock non-liquid assets tied up to their housing equity in order to generate income (Ong, 2008). Because the elderly person is conventionally classified on the economic circumstance as "asset-rich but income-poor" group (Hancock, 1998; Rowlingson, 2006), the RM can be an alternative option for those elderly homeowners to enhance the liquidity of their poverty and improve their current consumption.

Figure 1 shows the relationship between home equity and RM throughout the life span. In stage 1, the debtor may apply for a mortgage from the bank in order to purchase a house. Then, with the accumulating repayment for the loan balance, the home equity increases over the time. Then after the debtors pay off the mortgages, they finally own the house without any debt (stage 2). But this is often achieved while the debtors reach middle age or in the latter years of their working life. If they do not have retirement plans or income sources, then it will become a serious challenge for them to face their life after retirement. Under this condition, they only own their houses earned during their life time but lack any other source of income. This dilemma may lead hem to make the difficult decision to sell their house and move to another place or reduce the daily expenses dramatically; otherwise, they can only rely on the government's support.

[4] $\text{Income Replacement Ratio of RM} = \dfrac{\text{Income receipt from RM}}{\text{Pre-retirement Earning}}$

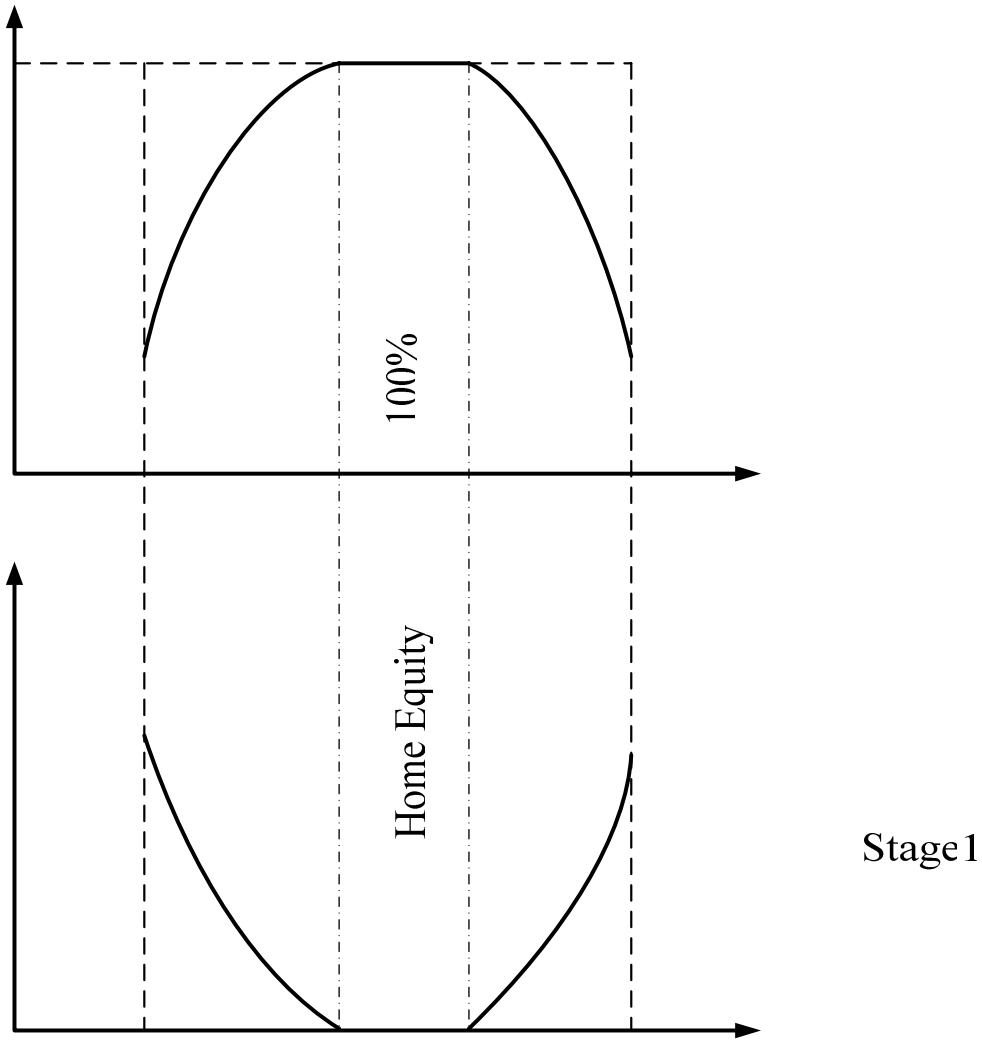


Figure 2

The Relationship between Home Equity

and Reverse Mortgage throughout the Life Span

Therefore, to provide a more dignified life for the elders and increase the liquidity of real estate, the RM can serve as a feasible option for them to enhance the retirees' life quality. As the homeowners apply for the RM, the home equity will decrease and the mortgage balance will increase as they receive the annuity from the creditor (stage 3). The amount of money they can receive depends on the borrower's age, the current interest rate, and the appraised housing value. Generally, the more valuable the house is, the lower is the interest; and the older borrower is, the more mortgage amount the borrower can acquire (HUD, 2006).

Overall, during the payment from the creditor in the RM, the debtors receives the money without repayment of interest or principal. All of them will be contained in the mortgage balance. As long as the debtors stay alive and are still living in the house, there won't be mortgage repayment even though the mortgage balance exceeds the house value. The repayment can only be made until the homeowners' demise or vacating their houses (Reed & Gibler, 2003).

3. Research Method

A two-phase study was designed to explore the feasibility of RM in aging societies from both supply and demand aspect. In the aspect of the borrowers, the study conducted a survey. A questionnaire was designed for the middle-aged homeowners in Taiwan regarding their opinions and attitudes towards the feasibility of RM. The definition of the middle-aged homeowners was further designated to be those from the range 30-60 years of age in 2008. The questionnaires are conducted through the Binary Logistic Regression Model to explore the respondents' willingness to apply for RM and relative factors.

As for the lenders' concerns, a simulation model and a RM pricing model are established in this study to indicate how much the disbursement the RM lenders could offer. Under the break-even hypothesis, the disbursement is determined by computing the LTV in RM. So, the study attempts to compute how much the LTV the RM lenders could offer with different RM payment programs. Furthermore, this study examines whether if the IRR_{-RM} in RM could meet the basic needs for the elders in Taiwan.

(1) Method 1: Logistic Regression Model

This study assumes that the middle-aged homeowners are the likely targets for the introduction of RM and could be the most eligible beneficiaries if RM is available in the coming decades. Accordingly, the participants of this research were middle-aged homeowners, selected from a stratified random sample of middle-aged homeowners in Taiwan. Among the 1,100 Taiwan middle-aged adults, 478 (43%) completed all phases of the survey, among which 70 (6.4%) cases were discarded due to the missing values. Therefore, the valid sample of the study is 396 respondents (α =95%, d =4.92%).

Data collection took one month (08/07/2008-09/07/2008). Data were collected through interview (27.3%), mail (27.3%), and e-mail (45.5%). The respondents were asked to fill out a questionnaire consisting of 23 items, which were divided into five main parts as follows:

Current circumstance of house

The respondents were asked to fill in the house age, the house value, how many houses they own, and whether if they rent their house.

Financial situation

The respondents were asked to answer about their financial status including asset holding, income, employment, and wealth.

Career planning

Two questions were designed to search for the planning for the respondents after retiring and the attitude toward inheritance.

Willingness

Respondents were asked for the intention of applying for reverse mortgages.

Demographic Characteristics

The demographic characteristics such as gender, age, address, marital status, career, number of children, and education level were asked in this section.

(2) Model Design

According to Gujarati, D. N. (2003), the probability density function of the binary logistic regression model could be written as follows:

$$f(z)=\left|\frac{\exp[(z-\mu)/\tau]}{c[1+\exp\{(z-\mu)/\tau\}]}\right|, \quad -\infty<z<\infty \tag{1}$$

The cumulative distribution function (CDF) is

$$P=\int_{-\infty}^{x} f(z)dz=\frac{\exp[(x-\mu)/\tau]}{1+\exp[(x-\mu)/\tau]} \tag{2}$$

Replacing the following items, $\beta_0=-\mu/\tau$ and $\beta_0=1/\tau$. The CDF is then

$$P\equiv\frac{\exp[\beta_0+\beta_1 x]}{1+\exp[\beta_0+\beta_1 x]} \tag{3}$$

The logistic regression model takes the following form:

$$\pi_i=E(Y_i)=P_i=\frac{1}{1+e^{-f(x)}}=\frac{e^{f(x)}}{1+e^{f(x)}} \tag{4}$$

$$Z_i=f(x)=\alpha+\beta_1 X_{i1}+\beta_2 X_{21}+.....+\beta_k X_{ik} \tag{5}$$

P_i is the probability of the willingness to apply for reverse mortgage from (4); and $(1-P_i)$ is the probability of unwillingness to apply for reverse mortgage , or

$$1-\pi_i=1-E(Y_i)=1-P_i=1-\frac{1}{1+e^{-(\alpha+\beta_1 X_{i1}+\beta_2 X_{i2}+.....+\beta_k X_{ik})}}=1-\frac{1}{1+e^{-Z_i}}=\frac{1}{1+e^{Z_i}} \tag{6}$$

Therefore, the odds ratio was:

$$\left(\frac{\pi(x_i)}{1-\pi(x_i)}\right)=\frac{P_i}{1-P_i}=\frac{1+e^{Z_i}}{1+e^{-Z_i}}=e^{Z_i}=e^{(\alpha+\beta_1 X_{i1}+\beta_2 X_{i2}+.....+\beta_k X_{ik})} \tag{7}$$

Taking the natural log of (7), we can obtain the following Logistic Equation L_i,

$$L_i=Z_i=\ln\left(\frac{\pi(x_i)}{1-\pi(x_i)}\right)=\ln\left(\frac{P_i}{1-P_i}\right)=\alpha+\beta_1 X_{i1}+\beta_2 X_{i2}+.....+\beta_k X_{ik} \tag{8}$$

<u>Definition of Variables</u>

The variables in the logistic regression model are described below. First, the dependence variable in the study is set as binary. In the questionnaire, respondents were asked whether or not they want to apply for RM. This study notes the answer "no" as "0" and "yes" as "1."

As shown in Table 1, this study developed 18 independence variables and divided them into four groups:

Panel A: Demographic Variables

Demographic Variables included three continuous variables (age, education level, and number of children) and three dummy variables (gender, career, and marital status).

Panel B: Real Estate Variables

Housing age, value and location of house, leasing house or not, having second house or not were obtained in this panel. The value of the house was estimated by means of 6-point scale. Moreover, the locations of the houses were classified into four categories of areas.

Panel C: Asset and Income Variables

Three dummy variables were formed in this panel: the financial assets were measured by asking respondents the major type of their asset (excluding the home equity). This study divides the major asset type into two parts and assumes people holding the stocks, bonds or funds as their major property are more risk-taking than people holding the cash, deposit, or gold. Furthermore, if respondents have income (whether the income came from full-time job, part-time job, or retirement pension), they are classified into employment level; denoted as "1". One continuous variable was the income, indicating the average household income per month.

Panel D: Subjective Perception Variables

Wealth variable was rated on a 5-point scale ranging from 1=poor to 5=wealthy. Two dummy variables were used for bequests and if they live alone, which indicated the respondent's subjective perception for bequest and retirement plan.

Table 1

The Description of Variables

Variables	Description	Willingness	p-value
Panel A: Demographic Variables			
Age	Age in years		0.068
Gender	Gender		0.418
female	=0 (40.4%)	31.3%	
male	=1 (59.6%)	35.2%	
Marital	Marital status		0.445
Married	=0 (81.1%)	32.7%	
Single	=1 (18.9%)	37.3%	
Education	Educational level		0.115
Career	Career type		0.112
no career or retired	=0 (8.3%)	21.2%	
primary Industry	=1 (1.0%)	0.0%	
secondary industry	=2 (7.3%)	44.8%	
tertiary industry	=3 (83.3%)	34.2%	
Childnu	Number of Children		0.529
Panel B: Real Estate Variables			
Sechouse	Having second home or more		0.528

no	=0 (70.5%)	32.6%	
yes	=1 (29.5%)	35.9%	
Hage	Housing age in year		0.919
Hvalue	Value of house (NT$)		0.931
less than 4,000 thousand	=2,000,000 (16.7%)	30.3%	
4,001-8,000 thousand	=6,000,000 (40.9%)	34.6%	
8,001-12,000 thousand	=10,000,000 (23.0%)	35.2%	
12,001-16,000 thousand	=14,000,000 (10.6%)	28.6%	
16,001-2,000 thousand	=18,000,000 (3.8%)	33.3%	
more than 2,001 thousand	=22,000,000 (5.1%)	40.0%	
Letting	Letting their house		0.696
no	=0 (75.5%)	34.1%	
yes	=1 (24.5%)	32.0%	
Location	House location		0.610
north area	=1 (88.4%)	33.7%	
central area	=2 (2.5%)	20.0%	
south area	=3 (7.1%)	32.1%	
east area	=4 (2.0%)	50.0%	
Panel C: Asset and Income Variables			
Employment	Having income		0.273
no	=0 (2.8%)	34.0%	
yes	=1 (97.2%)	18.2%	
Income	Average Domestic Income per month (NT$)		0.321
less than 37 thousand	=26,000 (7.1%)	25.0%	
37-56 thousand	=36,000 (13.6%)	33.3%	
57-76 thousand	=66,000 (17.7%)	25.7%	
77-10.6 thousand	=89,000 (24.7%)	39.8%	
more than 10.7	=136,000 (36.9%)	34.9%	
Asset	Major asset type		0.024
cash/deposit/gold	=0 (54.5%)	28.7%	
stock/bond/fund	=1 (45.5%)	39.4%	
Insurance	Have insurance		0.026
no	=0 (35.4%)	26.4%	
yes	=1 (64.6%)	37.5%	
Panel D: Subjective Perception Variables			
Wealth	5-point scale ranging from 1=poor to 5 = wealthy		0.385
Bequest	People have to take house as a bequest		0.022
not agree	=0 (41.7%)	40.00%	
agree	=1 (58.3%)	29.00%	
Livealone	Want to live without children after retirement		0.022
no	=0 (37.1%)	26.53%	
yes	=1 (62.9%)	37.75%	

(3) Method 2: The Pricing Model of Reverse Mortgage

Assumption

Un-Independence of Housing Value and Interest Rate

The most important risks for lender providing the reverse mortgage are the house value risk and the interest risk. To estimate the extent that the LTV lenders could offer in the RM, it is critical to realize the fluctuation of the house value and the interest rate. This study simulated these two risks according to the following assumptions: (1) the housing return follows geometric Brownian motion process; and (2) the risk-free interest rate follows the Cox-Ingersoll-Ross (CIR) model[5]. However, we argue that the asset price, particularly in property, is characterized by abrupt and unanticipated large changes known as "jumps" because of the shocks such as deregulated plot ratio, key zones for development, redevelopment of old region, and some restrictive or encouraging policy. Furthermore, the financial crisis will drag down the housing price. Accordingly, this study presents the housing geometric Brownian motion process with a mean revering jump-diffusion processes, which is a generalization of the standard Merton (1976) model[6].

Moreover, we noticed that the fluctuation of the house value and the interest rate are not independent in reality. Therefore we assume that the motion process of the housing value and the interest rate are correlated with one another. This study estimates the correlation coefficient between the housing value and the loan rate. According to the assumption above, the housing value and the interest rate simulation model are defined as follows:

$$
\begin{cases}
dr(t) = k(\theta - r(t))dt + \sigma_r \sqrt{r(t)} dZ_r(t) \\
\dfrac{dH(t)}{H(t)} = (r(t) - \delta_H)dt + \sigma_H dZ_H(t) + d(J(t) - \lambda_H \beta t)
\end{cases}
$$

$$
Cov(dZ_r(t), dZ_H(t)) = \rho_{rH} dt
$$

$$
J(t) = \sum_{i=1}^{N(t)} (Y_i - 1) \qquad (9)
$$

$$
N(t) \sim P(\lambda_H t)
$$

$$
\ln Y_i \sim N(\theta_N, \sigma_Y{}^2)
$$

Where

$dr(t)$ = the differentials of interest rate at some future time t following CIR model;

k = the mean-reverting intensity of interest rate;

---

[5] We developed the model presented by Shreve (2004), "Stochastic Calculus for Finance 2, Continuous-time models," p. 468-470.

[6] See: Merton (1976), "Option pricing when underlying stock returns are discontinuous," Journal of Financial Economics, p.3.

$\theta =$ the long-term mean-reverting level of the interest rate;

$dt =$ the differentials of time;

$\sigma_r =$ the volatility of risk-free rate;

$dZ =$ the Wiener process with the normal distribution with a mean of 0 and a standard deviation of 1;

$dH =$ the differentials of house value;

$\delta_H =$ the regular expenditure rate of housing;

$\sigma_H =$ the volatility of house value;

$\rho_{rH} =$ Correlation coefficient of house value and interest rate;

$d(J(t) - \lambda_H \beta t) =$ the jump process, where the $J(t)$ is the jump with Poisson distribution;

$Y_i =$ the jump with log-normal distribution: $\ln Y_i \sim N(\theta_N, \sigma_Y{}^2)$

$\lambda_H =$ the jump frequency, which is the average number of jumps per year;

$\sigma_Y =$ jump volatility, which is the standard deviation of the proportional jump.

Independence of Loan Terminations

After modeling the fluctuation of the house value and interest rate, the study supposes that the RM loan only terminates when the borrowers decease. That is, the loan termination in this study is only determined by the demise of borrowers, which is independent from the fluctuation of the interest rate and the housing price. The RM mortgage will not default during the loan term.

This study adopts the mortality of borrowers from the Taiwan Standard Ordinary Experience Mortality (2002 TSO). Once the loan terminated, this study assumes that the lenders will sell the house to repay the mortgage debt.

Break-even Program

This study suggests that the RM pricing model is conducted under the break-even program. The present value of the expected losses of the RMs should to be less than or equal to the present value of the expected premium of RMs. If the RM is under the insurance program, it is not a mutual program. The expect value of the mortgage insurance premium should be able to cover the expected losses. If the lenders provide the RM without the insurance program, they should charge the risk premium rate on the loan to incorporate the possible losses in RM.

(4) Model Design

This study derives the RM pricing model to determine the loan-to-value ratio in the RM under the break-even hypothesis based on Szymanoskis' (1994) HECM model. However, the HECM model assumes the RM is under the mortgage insurance program by Fannie Mae and Freddie Mac in the U.S. For the RM provider, the fundamental condition is that the present value of the expected losses on a pool of RMs equals the

present value of the expected premium of RM. We thus modified the original model as the following equation:

$$\sum_{t=0}^{\infty} E[L(t)](1+i)^{-t} \le \sum_{t=0}^{\infty} E[P(t)](1+i)^{-t} \quad (10)$$

Where

$E[\ ]=$ the expected value operator;

$L(t)=$ the loss incurred in period t;

$i=$ the periodic discount rate; and

$P(t)=$ the mortgage risk premium or the mortgage insurance premium, which is the scheduled premium collected in period t.

This study simulates the RM mortgage termination for 10,000 times to obtain the distribution of the loss and the mortgage premium. Further, the study replaces the expected value operator with the Conditional Tail Expectation (CTE) to reflect the practical uses in the insurance company. Thus, the RM pricing model in this study is described as follows:

$$CTE_{90}\left[L(t)\cdot(1+i)^{-t}\right] \le CTE_{90}\left[P(t)\cdot(1+i)^{-t}\right]; \quad (11)$$

where

$CTE_{90}[\ ]=$ the conditional tail expectation operator, which is under the 90% level.

In equation (11), the expected value of the $P(t)$ is related to the loan survival probability, which is dependent on the borrower's age. For the RM under the mortgage insurance program, the $P(t)$ is combination of the initial insurance premium and annual insurance premium, who respectively charge from the capped property value and the mortgage balance. And the mortgage balance at time t is:

$$BAL(t) = BAL(t-1) + Interest(t) + P(t) \quad (12)$$

For illustration, this study assumes the initial insurance premium is 2% of the capped property value, and the annual insurance premium is 0.5% of the outstanding balance. For the RM without insurance program, the lenders should assume high risk and consequently charge high risk premium. The current study supposes the interest premium rate is 3%.

On the left-side of the expression (11), the study estimates the expected loss value of $L(t)$ by computing the CTE_{90} of the mortgage loss. The CTE of the mortgage loss could be estimated through the simulation results of the loan termination, housing prices, and the interest rates. Yet, the loss only occurs when a loan is terminated, with the housing value lower than the mortgage balance. Thus,

$$L(t) = (BAL(t) - H(t))$$

When, (13)

$$\mathrm{BAL(t)} > H(t)$$

where

$BAL(t)$ = the outstanding of the RM when the loan termination at time t;

$H(t)$ = the house selling price at time t.

According to the fundamental relationship between the expected losses and the expected mortgage premium, the extent of LTV that the lender could offer in the RM can be calculated. This study further computes the $IRR_{\text{-RM}}$ of different RM programs in different main regions of Taiwan with different income.

(5) Parameter Setting

The housing prices and the interest rates are simulated 10,000 times. The parameters in the simulation model are shown in Table 2 and Table 3. The process of the parameter estimated in the study is described as follows:

First, the parameters in the interest rate simulation model are calculated by using the Ornstein-Uhlenbeck process in Vasicek Model[7]. The data of the interest rate adopted is the one-year deposit rate in Taiwan Post Office Deposits. There are 276 data ranging from 1986 January to 2008 December.

Table 2

Parameters in the process of simulation

Items	Parameters
Simulation times	10,000
Increments (dt)	1
Parameters in the Interest Rate Model	
mean reversion speed of interest rate (k)	0.0480
average long-term interest rate (θ)	0.0251
standard deviation of risk-free rate (σ_r)	0.0104
initial risk-free rate (r_0)	2.50%
Parameters in the Housing Value Model	
regular expenditure rate of housing (δ_H)	0.001
jump frequency (λ_H)	1
expected value of the jumps (θ_H)	0
jump volatility (σ_Y)	0.02

[7] If the Vasicek Model is formed as: $dr = a(b-r)dt + \sigma dZ$, the $AR(1)$ could be estimated as: $r_t = b(1-\exp(-a)) + \exp(-a)r_{t-1} + \sigma\left[\frac{1-\exp(-2a)}{2a}\right]^{0.5}\varepsilon_t$.

Second, the parameters in the housing price model, including the average housing price (H_0), the standard deviation of housing price (σ_H), the correlation coefficient of the housing price, and the interest rate (ρ_{rH}), are all computed from the housing transaction data and the one-year deposit rate in the Post Office. The housing transation data is collected by this study from an anonymous large real estate agency in Taiwan. The data ranges from 1997 January to 2008 December, with 66,540 cases in nine Taiwan administrative regions, ie., Taipei City, Taipei County, Taoyuan County, Hsinchu City, Taichung City, Tainan City, Kaohsiung City, Yilan City, and Keelung City). The jump factor in this study we assume the jump frequency (λ_H) is one time a year with the 0.02 volatility (σ_Y) and the expect value of the jumps (θ_H) is zero.

As shown in Table 3, it is noted that there are different parameters in the housing price models of different regions in Taiwan. According to the housing transaction data, Taipei city and Taipei county have higher housing prices with a lower standard deviation (σ_H =0.0491 & 0.039).

Table 3

Parameters in the Housing Value Model

	Average Housing Value (H_0)	Standard Deviation of House Value (σ_H)	Correlation Coefficient of House Value and Interest Rate (ρ_{rH})
Taipei City	11,912,343	0.0491	-0.1638
Taipei County	5,940,344	0.0390	-0.1309
Taoyuan County	3,540,344	0.0622	0.1899
Hsinchu City	4,292,867	0.0572	-0.0163
Taichung City	4,403,122	0.0979	-0.1380
Tainan City	3,242,146	0.0834	-0.1044
Kaohsiung City	3,604,704	0.0529	-0.1333
Yilan City	3,446,524	0.1043	-0.1907
Keelung City	2,748,612	0.1048	-0.3141

Table 4 presents the parameters in RM pricing model. The mortgage premium has distinct structures under different type of the RM, with or without the insurance program.

Table 4

Parameters in the RM Pricing Model

Items	Parameters
Simulation times	10,000
Increments (dt)	**1**
Mortgage premium rate (within insurance program)	
initial insurance premium (% of property value)	2.0%

annual insurance premium (% of outstanding balance)	0.5%
loan rate (plus in Risk-free Rate)	0.5%
Mortgage premium rate (without insurance program)	
risk premium rate (% plus in Risk-free Rate)	2.0%

4. Data Analysis and Finding

(1) From the Aspect of Borrowers

Among the 396 respondents, 33.6% were willing to apply for RM, with 66.4% of no intention. About 6.8% of the respondents were interested in lump-sum payment, 62.4% in annuity, and 30.8% in line-of-credit payment of RMs. As for the motivations, improving the quality of life (47%) and sharing daily living cost (33%) are the first and second place. On the contrary, compared to those who are not willing to apply for RM, the plan of taking their house as a bequest is in the first place (22.8%); the response of not understanding RM well in the second place (20.5%); and the intention to keep their houses after paying off the mortgage is in the third place (14.1%). Moreover, nearly half of the respondents (46.7%) declared that they will accept RM if it provides at least 41%~60% of the average monthly income. And about 14.9% of the respondents have heard about RM. It implies one of the goals could be to improve the knowledge of the reverse mortgage scheme for potential customers.

A binary logistic regression was conducted and the empirical results are shown in Table 5 and 6. The overall percentage for corrected classification was 67.4% with significant tests of model coefficients (x^2 =41.666, p=0.007) and the Hosmer-Lemeshow statistics indicated the suitability of the model (H-L= 4.961, p=0.762). In order to detect the severity of multi-collinearity between independent variables, the variance inflation factor (VIF) were calculated. The VIF in the independent variables were approximately below 2, except the variables of the number of children (VIF=2.196). Accordingly, all 18 variables were used in the logistics model.

Table 5

Classification Table

	Predicted*		
Observed	Without intention to apply for RM	With intention to apply for RM	Percentage Correct
Without intention to apply for RM	236	27	89.7
With intention to apply for RM	102	31	23.3
Overall Percentage			67.4

* The cut value is .50

Table 6

Results of the Logistic Regression

Covariate	B	Sig.	Odds Ratio	VIF
Hage	0.013	0.281	1.01	1.13
Sechouse	0.417	0.205	1.51	1.75
Hvalue	0.000	0.805	1.00	1.38
Letting	-0.416	0.224	0.66	1.64
Insurance	0.492	0.049 **	1.63	1.07
Employment	-0.066	0.940	0.93	1.15
Income	0.000	0.532	1.00	1.69
Asset	0.442	0.060 *	1.55	1.07
Wealth	-0.365	0.064 *	0.69	1.28
Bequest	-0.397	0.094 *	0.67	1.11
Livingalone	0.519	0.035 **	1.68	1.06
Gender	0.024	0.922	1.02	1.09
Age	0.000	0.989	1.00	1.87
Marital	0.353	0.335	1.42	1.65
Childnu	0.181	0.242	1.19	2.19
Area (north)	2.930	0.683		1.13
Area (east)	-0.779	0.297	0.45	
Area (central)	-1.259	0.256	0.28	
Area (south)	-0.876	0.308	0.41	
Education	0.402	0.010 ***	1.49	1.39
Career (tertiary)	20.959	0.411		1.19
Career (no/retired)	-0.603	0.213	0.54	
Career (primary)	-20.776	0.999	0.00	
Career (secondary)	0.423	0.327	1.52	
Constant	-2.037	0.119	0.13	

Hosmer and Lemeshow Statistic =4.961 With 8d.f. (p=0.762 n.s.)

Omnibus Tests of Model Coefficient: Chi-Square =41.666 With 22d.f (p=0.007***)

* p<0.1 ** p<0.05 *** p<0.01 n.s. p>0.1

The empirical evidence of the binary logistic regression model indicated that 6 out of the 18 variables were statistically significant at the 0.1 level (90% Level of confidence). The significant variables are discussed below as follows.

Education Level

Our analysis revealed that the higher the level of education, the greater the willingness to apply for RM. This may attributed to the fact that the higher educational level of the respondents are, the greater the possibility for them to accept a new type of financial products. As mentioned before, among the 396 participants, about 34% willing to apply for RM have a master's or doctoral degree.

Security Assets

The evidence shows that homeowners who hold assets of stocks, bonds and funds as their major property are more likely to apply for RM. The significant factors of the education level and the security asset are in accordance with Chou's (2006) results. The possible reason is that the homeowners who possess assets of stocks, bonds and funds are more willing to accept financial products and RM.

Insurance

Results show that those who are in insurance programs tend to participate the RM scheme. It suggests that if people plan for retirement, they are inclined to purchase investment insurance, and therefore more likely to consider applying for RM for income after retirement.

This evidence is also supported in a survey made by the American Association of Retired Persons (AARP). The AARP national survey of RM shoppers in the U.S. in 2006 showed that despite the high costs involved, 14% of respondents had looked into a RM scheme because they want to make investments or purchase annuities or long-term health care insurance (AARP, 2006).

Wealth

The evidence shows that the wealth was inversely proportional to the willingness to apply for RM. One would expect that homeowners who are more satisfied with their wealth may have more financial reserve for retirement and consequently reduce the demand for RM. The result is similar to Weinrobe's (1987) and Chou's (2006) findings, in which they indicated that the income variable and the value of financial assets had a negative effect on RM. However, the variables of income and house price are not significant in this study.

Bequest

While considering the reason not to apply for RM, respondents' desire to preserve their house as bequest for their children was ranked the first place. The empirical results also revealed the negative relation between the bequest variable and the demand of the RM. Furthermore, based on the survey by the AARP in 1990, the lesser the commitment to bequeath their houses to their children, the more likelihood of applying for RM may take place (Merrill & Finkel & Kutty, 1994). The result may be attributed to the traditional Chinese concept regarding real property, which may also be a hurdle for middle-aged homeowners to apply for RM.

Living Alone

Analysis points out the respondents who want to live without children after retired are more willing to apply for the RM. It may be explained that some households do not persevere the traditional Chinese concept --- living with their children as the major supporting source. Therefore, they have more financial autonomy in managing their asset and more motivation to apply for RM. This result could also be attributed to the possible reason for households not planning to pass their house to their children.

(2) From the Aspect of Lenders

Based on the parameters set above, we simulated the path of the risk-free interest rates and the return rates on housing in different places of Taiwan. We illustrated the results of Taipei city in Figure 5 and 6. It shows the simulated paths follow the rules that the simulation model developed. The initial risk-free interest rate is 2.5% with 2.51% average long-term interest rate and 1.04% standard deviation. And the average housing return rate is 2.41%, with 0.1% of the regular expenditure rate in housing and 4.91% of the standard deviation in housing return.

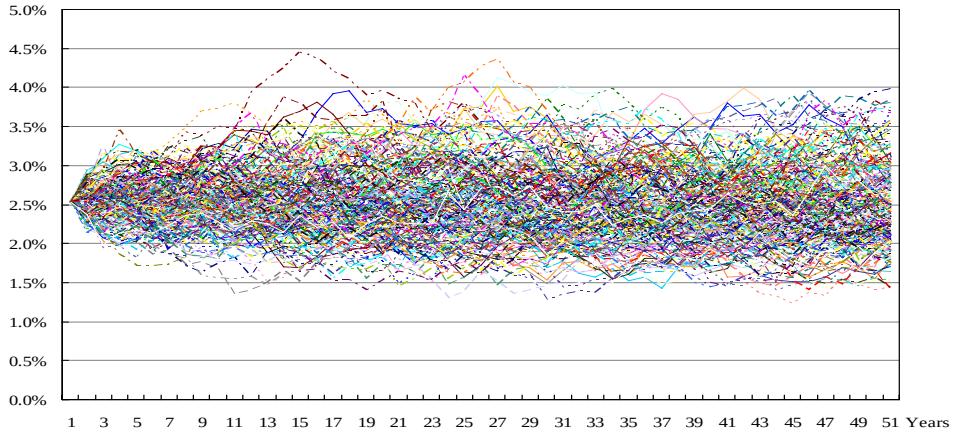


Figure 5

Simulated fluctuation of risk-free rate in Taipei city

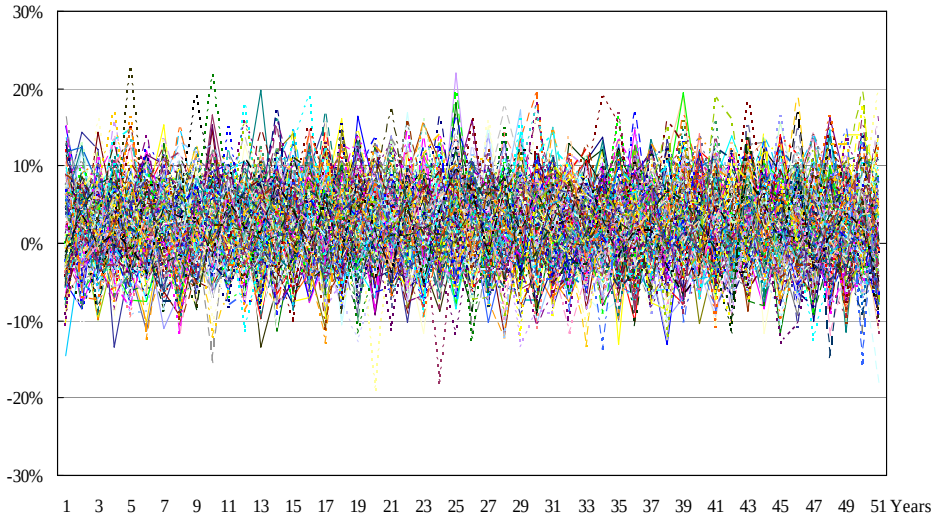


Figure 6

Simulated rate of return on housing in Taipei city

We further changed Figure 6 from the return rate on housing to the average house value in Figure 7, we could observe the “jump” effect in the housing value model. It is reasonable since the housing price is not always stable in reality.

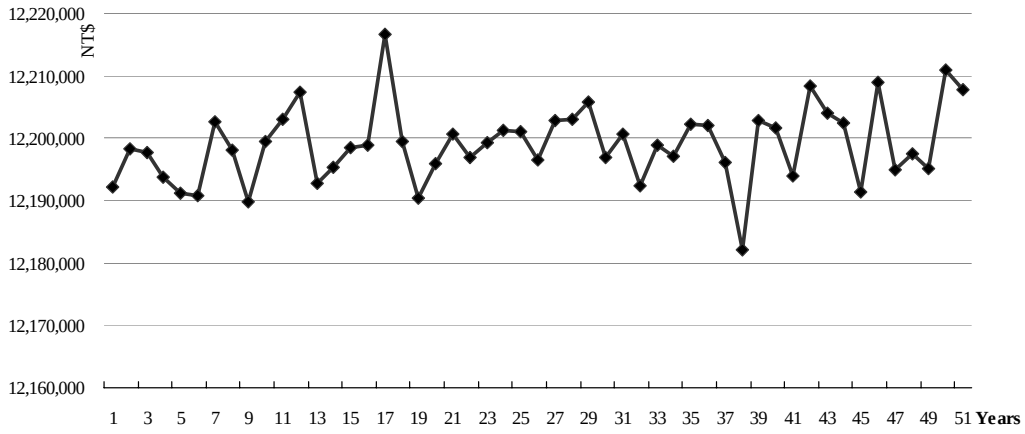


Figure 7

Simulated average housing prices in Taipei city

The following sections show the results of the RM pricing models. Two types of RM programs and the difference between lump-sum and annuity payment are discussed below in detail. However, the type of line-of-credit payment is not included in this study due to this type of RM is the mixed type of lump-sum and annuity payments. As an example of the RM pricing model, this study developed the RM program with a 65-year-old male and female household in Taipei City. In addition, the results of RM in different Taiwan regions are also presented with the sensitivity analysis.

Results with Insurance Program

According to the given assumptions and the parameters, this study conducted the RM pricing model to explore the LTV and $IRR_{\text{-RM}}$ in Taipei City. The CTE_{90} under the break-even level in different payment programs are Male: 997,329 in Lump-sum payment, 1,009,628 in Annuity payment; Female: 1,000,706 in Lump-sum payment, 1,060,221 in Annuity payment. The frequency data are given in Appendix 1.

Furthermore, the distribution of the expected loss in the two payment types is presented in Appendix 2. It shows that the loss generally occurs near the end of the tail. The reason is closely related to the mortality and the amount of the mortgage balance in RM. It is because that the termination of the RM is based on the mortality of borrowers. However, the mortality probability is high for people after they are 90 years old. Meanwhile, the mortgage balance also reaches a high level to outpace the housing price at termination. (see Appendix 3)

Through the break-even point of the RM, the LTV and the $IRR_{\text{-RM}}$ can be calculated. Table 7 shows the results of the LTV and $IRR_{\text{-RM}}$ for 65-year-old Male and Female borrower with the RM insurance program. The average housing price is $TWD 11,912,343 and the average wage for per household per year is $632,242 in Taipei City. As the LTV in RM is determined, the cash-to-borrower value can be computed by multiplying the loan amount by the annuity parameter[8]. And then this study calculates

[8] The annual parameter in this paper follows the method of the whole life annuity-due. The whole life annuity-due for a X aged person with Y dollars is:

the IRR_{-RM} by comparing the average per household annual wage income[9] and the cash-to-borrower value from RM.

Table 7

Results of the RM with insurance program (Taipei city) Unit: TWD

Average House Value							11,912,343
Average Wage (per-household, per year)							632,242
Initial insurance premium (% of property value)							*2.0%*
Annual insurance premium (% of outstanding balance)							*0.5%*
Loan rate (plus in Risk-free Rate)							*0.5%*
Age/Sex		LTV		Loan Amount		IRR_{-RM}	
		Lump-Sum	Annuity	Lump-Sum	Annuity	Lump-Sum	Annuity
65	M	43.65%	25.93%	5,199,187	3,088,591	67.80%	40.27%
	F	41.46%	24.08%	4,938,446	2,868,191	64.40%	37.40%

Table 7 shows that the lump-sum payment has higher IRR_{-RM} than annuity payment. The reason may be attributed to the different the risk premium incomes and the accumulating speeds of the mortgage balances between these two payment types. As shown in Figure 8 and 9, the lump-sum RM has a higher initial mortgage balance and has lower speed in the mortgage balance accumulation than the annuity RM. The higher initial mortgage balance implies the higher risk premium the lender or the insurance institution should assume.

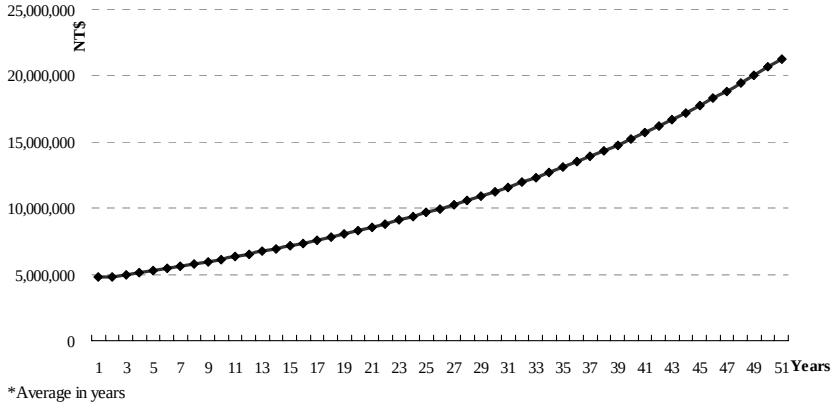


Figure 8

Mortgage balance in lump-sum payment of RM

$$Y \times \ddot{a} = Y \times \frac{N_x}{D_x}$$

[9] The income data in this study are collected form Ministry of Interior (2008).

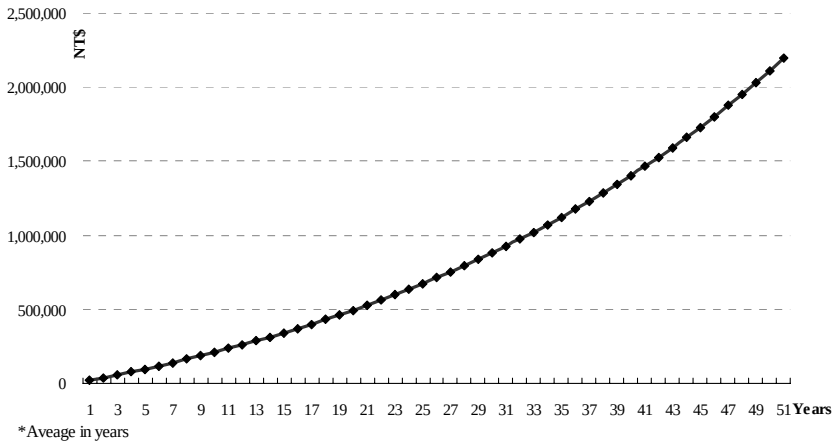


Figure 9

Mortgage balance in annuity payment of RM

As mentioned previously, results of our survey show that the basic need for RM ranges from 40% to 60%[10]. Compared with the investigation results, it is noted that the IRR_{-RM} in the simulation model basically meet the results in the survey (except the annuity payment the female apply for). However, the National Annuity System in Taiwan offers the elderly benefits around 34%[11] in the income replacement ratio for insured person. Hence, the study suggests that the IRR_{-RM} over 30% should be very helpful for the borrower when they are retired.

Results without Insurance Program

The average house value, the average wage for per household per year; the LTV and IRR_{-RM} are presented in Table 8. The CTE_{90} under the break-even level in this program is: Male: 91,829 in Lump-sum payment, 205,533 in Annuity payment; Female: 86,581 in Lump-sum payment, 205,495 in Annuity payment. The frequency and the distribution of expected loss is shown in Appendix 1 and Appendix 2.

As shown in Table 8, the premium structure of the RM without insurance program is different with the RM with insurance program. In the RM program without insurance, the lender should assume the risks by charging the premium on the loan rate. Furthermore, the lender receives the risk premium income only under the termination of RM, which is different from the annual receipt in insurance program. The distribution is illustrated in Appendix 3.

[10] This study accordingly supposes the feasible level of RM is the IRR could reach nearly 40% in Taiwan.

[11] With the assumption that the seniority of participant is 25 years and the basic wage is TWD 17,280. Data source: Council of Labor Affairs, Executive Yuan.

Table 8

Results of the RM without insurance program (Taipei city) Unit: $TWD

Average House Value							11,912,343
Average Wage (Per-household)							632,242
Risk premium rate (plus in Risk-free Rate)							*2.0%*
Age/Sex		LTV		Loan Amount		IRR_{-RM}	
		Lump-Sum	Annuity	Lump-Sum	Annuity	Lump-Sum	Annuity
65	M	40.21%	23.13%	4,790,423	2,754,736	62.47%	35.92%
	F	38.09%	21.47%	4,537,510	2,557,827	59.17%	33.35%

Table 8 indicates the IRR_{-RM} with the 2% of risk premium rate lower than the IRR_{-RM} with the insurance program. It is expected that the loan amount will moderately rise as the risk premium rate rises. Meanwhile, the mortgage balance will rise dramatically as well. The rapid accumulation of mortgage balance will aggrieve the benefits of the borrowers' heritors because the surplus of the house value after repaying the RM belongs to them.

We may conclude that not only the RM lender should assume the risks, but also the RM borrowers should take the risks, especially when the RM lenders go bankrupt or terminate the RM payment unilaterally. The study suggests that the RM without insurance program should be more cautious, since the RM loan has a major risk—the asset liquidity risk—for the RM provider if the RM loans lack the securitization scheme.

Sensitivity Analysis

We conducted the sensitivity analysis of the RM pricing model to figure out the diversification of LTV and IRR_{-RM} in the RM. We performed the replacement with different parameters to see the change as the expected value operator and borrowers' ages varied. Furthermore, the RM pricing model with different house locations and varied borrowers' income level are also conducted to explore the variance in the IRR_{-RM}.

Different Expected Value Operator

In this study, we define the expected loss value in RM as the Conditional Tail Expectation at 90% level (CTE_{90}). The reason is that we assume the RM lenders should be more conservative when they offer the RM in reality. As compared to the mean value in the simulated process shown in Table 9, it has higher value in the CTE_{90}.

Table 9

Risk Value of RM (Taipei City)

Risk level	Age	Sex	RM with insurance		RM without insurance	
			Lump-Sum	Annual	Lump-Sum	Annual
CTE_{90}	65	M	997,329	1,009,628	91,829	205,533
		F	1,000,706	1,060,221	86,581	205,495
Mean Value	65	M	789,482	539,047	106,167	133,800
		F	822,074	587,641	99,950	138,323

Since the duration of RM is over 30 years, the simulated results show the major expected loss occurs at the end of the duration. The RM lenders could compute the expected loss value by adopting the CTE_{90} value. The mean approach could cause the expected loss underestimated.

Table 10 shows that the LTV and IRR_{-RM} under the mean approach are obviously higher than CTE_{90}. Based on the different mortgage pools and risk tolerance the RM lenders assume, this study suggests that the RM lender could offer diverse LTV for borrowers according to different risk levels.

Table 10

Results of RM under Different Risk Levels (Taipei City)

RM with insurance

Risk level	Age	Sex	LTV		IRR_{-RM}	
			Lump-Sum	Annual	Lump-Sum	Annual
CTE_{90}	65	M	43.65%	25.93%	67.80%	40.27%
		F	41.46%	24.08%	64.40%	37.40%
Mean Value	65	M	58.77%	35.34%	91.29%	54.89%
		F	56.39%	33.07%	87.60%	51.37%

RM without insurance

Risk level	Age	Sex	LTV		IRR_{-RM}	
			Lump-Sum	Annual	Lump-Sum	Annual
CTE_{90}	65	M	40.21%	23.13%	62.47%	35.92%
		F	38.09%	21.47%	59.17%	33.35%
Mean Value	65	M	49.96%	29.28%	77.61%	45.49%
		F	47.44%	27.22%	73.70%	42.28%

Different Ages of the Borrowers

The study divided the RM borrower into six groups (male and female with 60, 65, and 70 years old, respectively) to calculate the LTV the lender could offer under different RM programs. We then discuss the IRR_{-RM} the borrowers could obtain at different age levels while they apply for RM.

As shown in Table 11, the older when borrowers apply for RM, the higher LTV and IRR_{-RM} they can get. Besides, the male borrowers could receive more loan amount than the female. The major reason for the different IRR_{-RM} is due to the difference of borrowers' mortality rates. According to the 2002 TSO, the older people and the male have higher probability of mortality. Since the termination of RM is based on the decease of borrowers, if one has higher expected death rate, the lenders assume the lower risk of mortgage balance exceeding the housing price. Therefore borrowers with higher expected death rate can obtain higher LTV.

Table 11

Results on different age of the borrowers (Taipei city) Unit: TWD

Age/Sex		LTV		Loan Amount		IRR_{-RM}	
		Lump-Sum	Annuity	Lump-Sum	Annuity	Lump-Sum	**Annuity**
RM with insurance program							
60	M	38.06%	21.46%	4,533,935	2,556,385	59.12%	33.34%
	F	35.94%	20.03%	4,281,174	2,385,731	55.83%	31.11%
65	M	43.65%	25.93%	5,199,187	3,088,591	67.80%	40.27%
	F	41.46%	24.08%	4,938,446	2,868,191	64.40%	37.40%
70	M	49.85%	31.89%	5,938,392	3,798,942	77.44%	49.54%
	F	47.28%	29.36%	5,632,480	3,497,904	73.45%	45.61%
RM without insurance program							
60	M	34.76%	18.96%	4,141,208	2,257,996	54.00%	29.44%
	F	32.50%	17.49%	3,871,306	2,084,011	50.48%	27.18%
65	M	40.21%	23.13%	4,790,423	2,754,736	62.47%	35.92%
	F	38.09%	21.47%	4,537,510	2,557,827	59.17%	33.35%
70	M	46.19%	28.60%	5,502,638	3,406,841	71.75%	44.42%
	F	43.57%	26.20%	5,190,549	3,120,801	67.68%	40.69%

Different Regions

Because of different features from different places of Taiwan, the study conducts the RM model with different parameters to explore the difference of LTV and IRR_{-RM} value in Taiwan. The result is shown in Appendix 4. With the relatively stable housing prices and the high housing price, results show that there is high feasibility of RM in Taipei city and Taipei county. However, the IRR_{-RM} in Yilan city and Taichung city take the third and fourth places, respectively. It is because the borrower in Yilan city

has lower wage (TWD 32,930), and the housing value is higher (TWD 4,403,122) in Taichung city.

Different Wage Levels

We further divides the RM borrower into different income levels to examine the change of the IRR_{-RM} that borrowers could get. First of all, borrowers are divided by sex and income levels. Second, to figure out the degree of IRR_{-RM} the elders can get, this study adopted the average wage of two groups of people (aged 55-64 and more than 65) as a pre-retirement income. It is based on the assumption that some people may tend to remain employed as they are worried about the financial instability after they are 60 years old. Hence, it may be a good choice for them to apply for RM.

Appendix 5 provides the results of the IRR_{-RM} at the wage level divided by sex. It shows the reverse condition in both the RM with or without insurance program as compare to Appendix 4. The IRR_{-RM} for the female borrower is higher than the male borrower could obtain even though the LTV the female could get is generally less than the male. It indicates that the female could be the major benefit receiver due to their pre-retirement wage is less than male in average.

In addition, according to Appendix 5, it provides the basic level of RM programs in lump-sum payment for the borrowers aged over 65 in Hsinchu and Taichung city. And the basic level of RM in Kaohsiung city and Taoyuan city is female borrowers of over 70 years old in lump-sum payment with insurance program. As for the IRR_{-RM} of the Taipei city and Taipei county, it ranges from 45.6% to 133.5% in Taipei city and 25.8% to 66.8% in Taipei county, which generally reaches the basic level of RM either with or without insurance program.

The results of the IRR_{-RM} of different ages and wages are shown in Appendix 6. It shows a great raise of IRR_{-RM} for the borrowers aged over 65. The IRR_{-RM} for them all reaches 100% level in all nine regions either with or without insurance program. However, the study indicates the result is less accurate due to the elder after 65 could receive the financial support from the government and may have other income source such as life insurance and interests from their deposits. We did not tend to estimate the exact income the household have in maintaining their basic life quality when they become senior. Nevertheless, the results in Appendix 6 still provide a direction that senior household could have substantial income support from RM.

According to the HUD (2008), the gender of borrower in the HECM program is 46.4% in single female, 17.3% in single male, and 36.3% in borrower irrespective of gender in average. The average borrower age is 75.2, which is higher than the marginal standard (aged over 62) of RM borrower in the U.S. It indicates the elder women borrower could be the main beneficiaries from RM, which is consistent with the simulation results in this study.

5. Conclusions and Policy Implications

(1) Conclusions

In Taiwan, the government has launched some schemes of social policy to cope with the aging problem. The National Annuity System has implemented in 2008, it is expected the older people could receive more welfare from the government. However, except the social policy, the government should play an active role in promoting the development of some financial products for people to plan for their retired life. Through appropriate asset allocation, it could be more effective to meet the specialized financial needs for the elderly. The Reverse Mortgage could provide the mechanism in helping the elder homeowners to transfer their home equity into cash. Besides, the "aging in place" policy could be implemented more successfully because the RM allows the elder homeowners not to move out.

Nevertheless, results in this study show the traditional conception is the major impediment of the implementation of RM in Taiwan. To cope with the aging trend, the government needs to focus on regulation regarding the RM. A counseling system of RM may help to reduce the suspicion and let the elderly could accept the RM more easily. In addition, complementary policies should be established according to the changing markets, and consequently the RM secondary markets may be developed for lenders to hedge risks. This study suggests that the RM with insurance program could be implemented at the early stage, and the government may serve as the insurer to reduce the uncertainty. The premium rate and the risk level could be more flexible to meet the needs of RM borrowers. And the payment receipts from the RM should be tax-free due to the income is generated form the equity of borrowers' property.

(2) Limitations

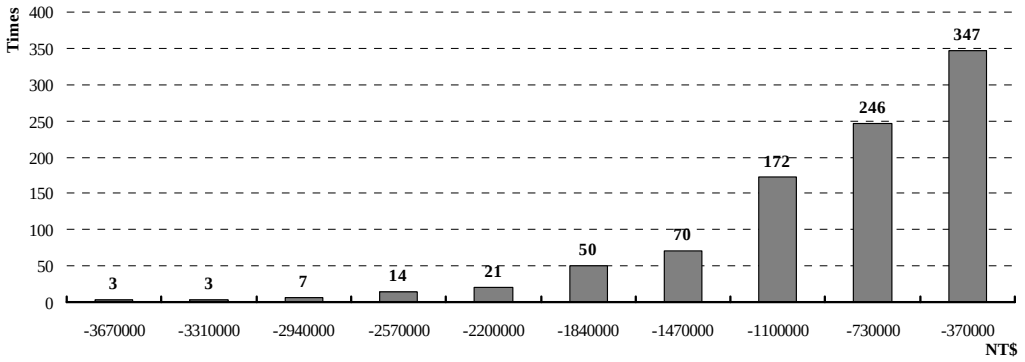
Even though this study provides valuable insights on the implementation of RM, it still encounters some limitations. First, although the results of descriptive analysis have shown the overall patterns of respondents' attitudes towards RM, there is little we can predict the intention of the population if the RM is really executed in the future. Second, only 396 observations were used in the survey. This sample of survey is too small for generalization. Third, the housing transaction data in the study is collected from one real estate agency, and the data only consists of nine regions in Taiwan, which may be not enough to represent the whole housing market in Taiwan.

(3) Recommendations

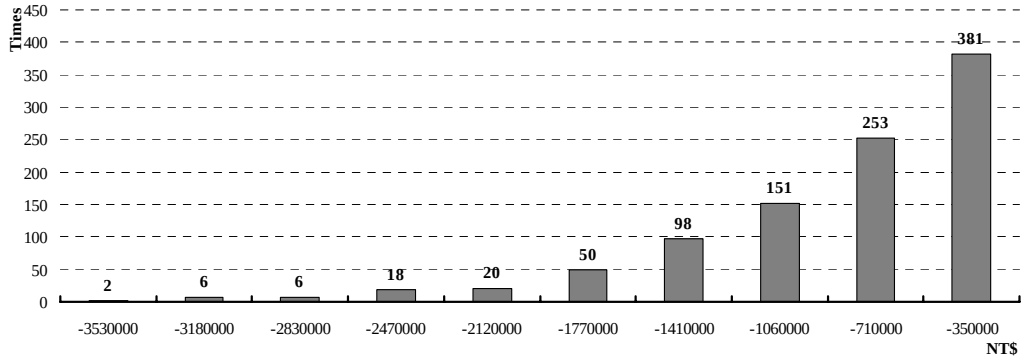
This study presents the preliminary results of the feasibility of RM in aging countries. Nevertheless, the potential of the implementation of RM clearly needs further exploration. Besides, it would be beneficial to conduct similar survey on a larger population group. To summarize, this study takes Taiwan as an example to show the feasibility of application of RM in aging countries. Results show that reverse mortgage could be the alternative for elderly people in aging societies in planning for their life after retirement.

Appendix 1

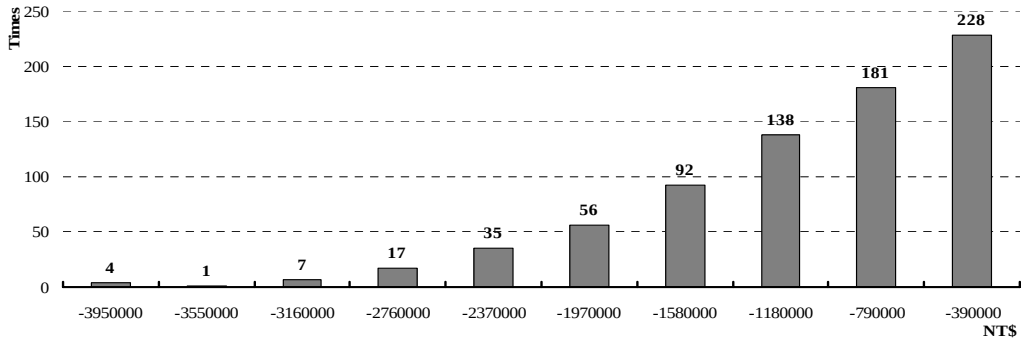
Frequency data of the expected loss in RM in Taipei city - with insurance program



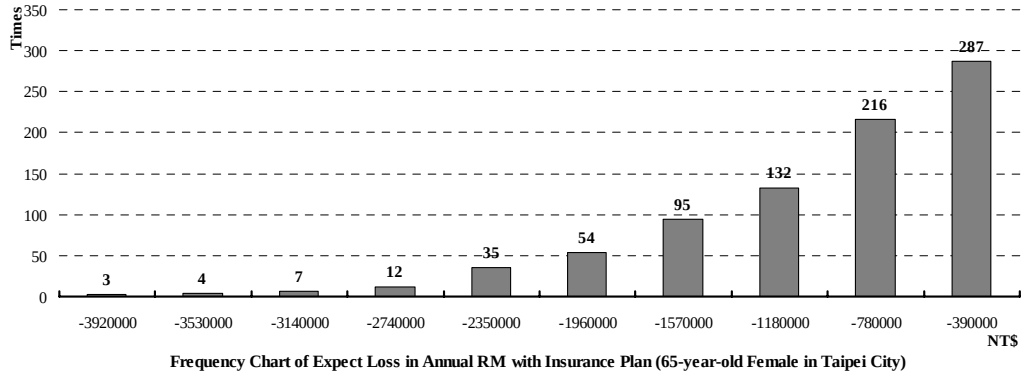
Frequency Chart of Expect Loss in Lump-Sum RM with Insurance Plan (65-year-old Male in Taipei City)



Frequency Chart of Expect Loss in Lump-Sum RM with Insurance Plan (65-year-old Female in Taipei City)

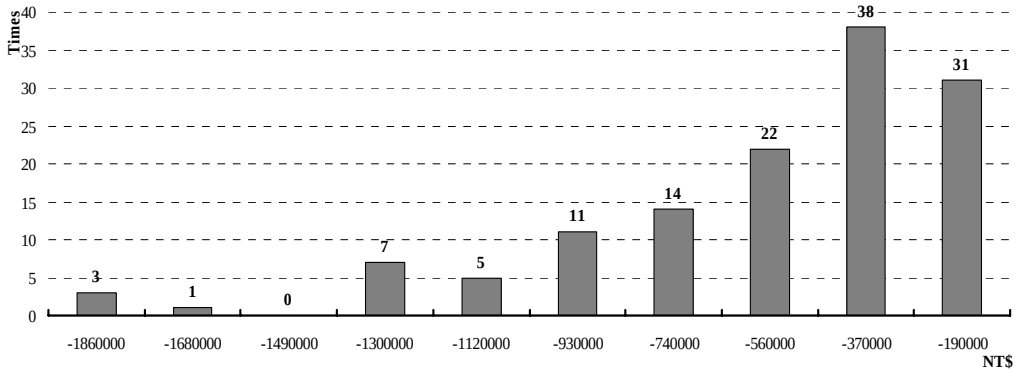


Frequency Chart of Expect Loss in Annual RM with Insurance Plan (65-year-old Male in Taipei City)

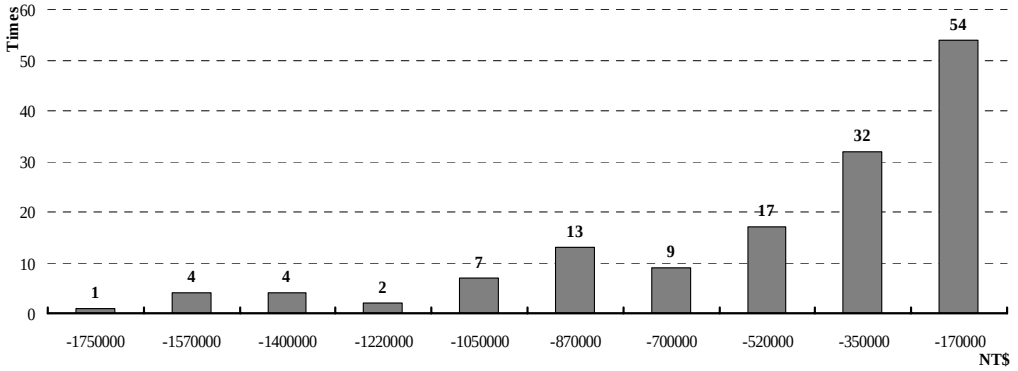


Frequency Chart of Expect Loss in Annual RM with Insurance Plan (65-year-old Female in Taipei City)

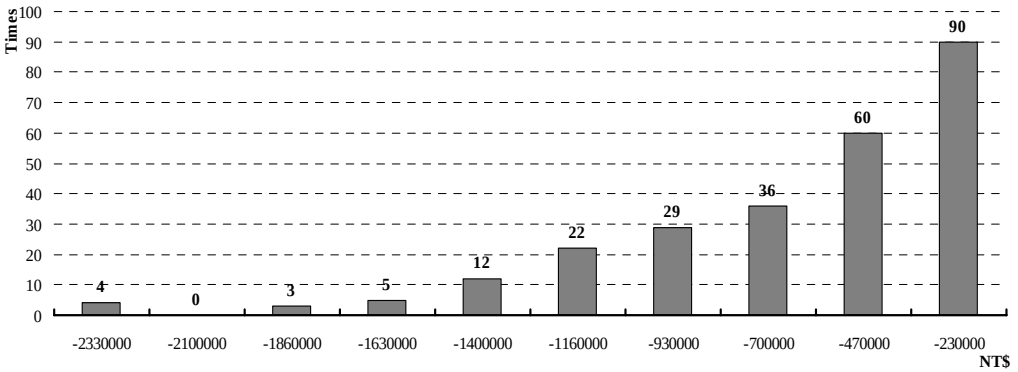
Frequency data of the expected loss in RM in Taipei city - without insurance program



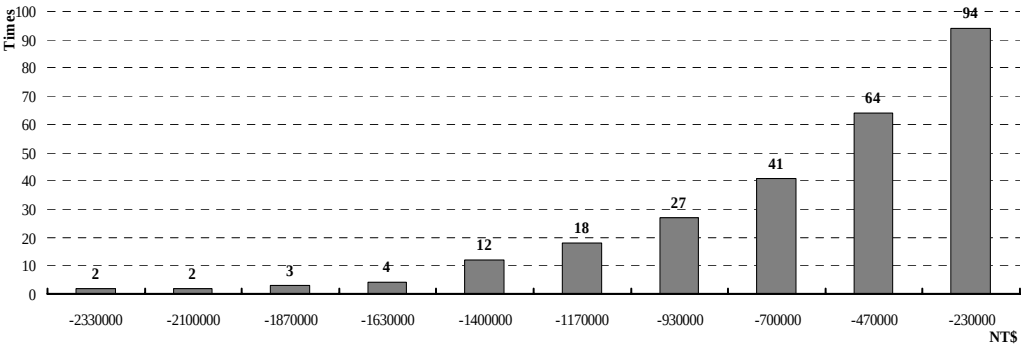
Frequency Chart of Expect Loss in Lump-Sum RM without Insurance Plan (65-year-old Male in Taipei City)



Frequency Chart of Expect Loss in Lump-Sum RM without Insurance Plan (65-year-old Female in Taipei City)



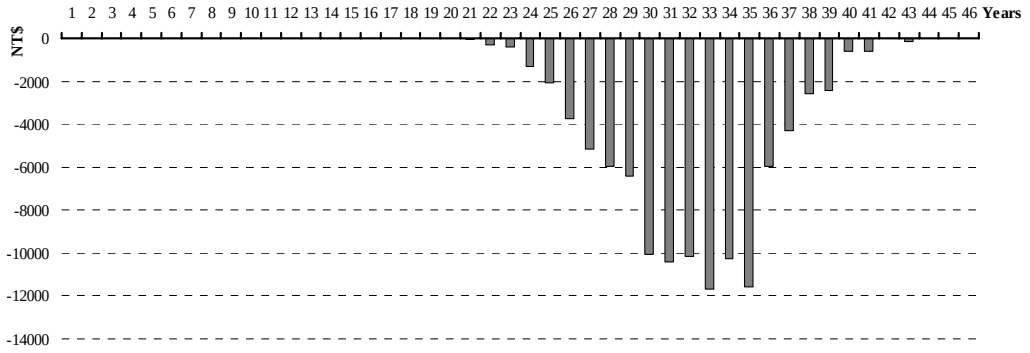
Frequency Chart of Expect Loss in Annual RM without Insurance Plan (65-year-old Male in Taipei City)



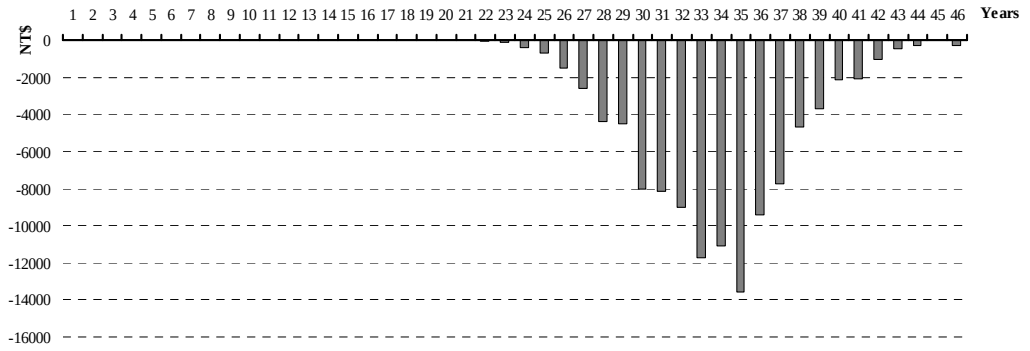
Frequency Chart of Expect Loss in Annual RM without Insurance Plan (65-year-old Female in Taipei City)

Appendix 2

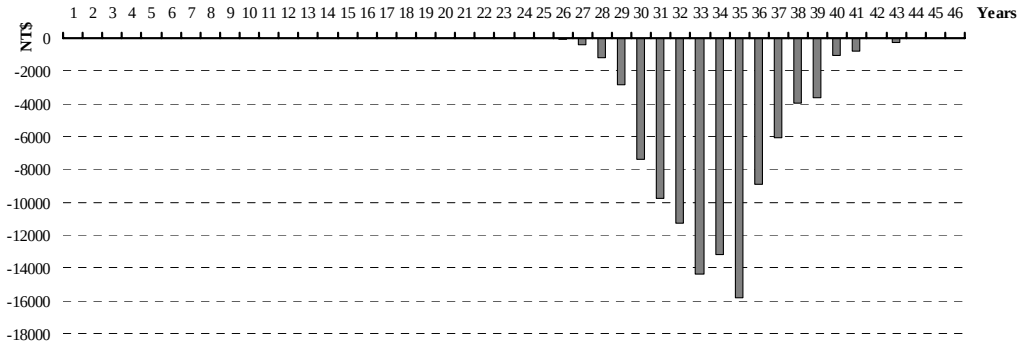
Distribution of average expected loss in RM in Taipei city - with insurance program



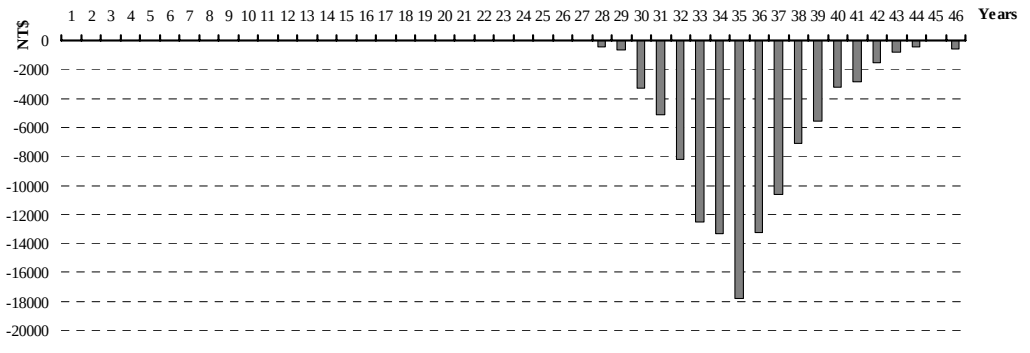
Distribution of Average Expected Loss in Lump-Sum RM with Insurance Plan (65-year-old Male in Taipei City)



Distribution of Average Expected Loss in Lump-Sum RM with Insurance Plan (65-year-old Female in Taipei City)

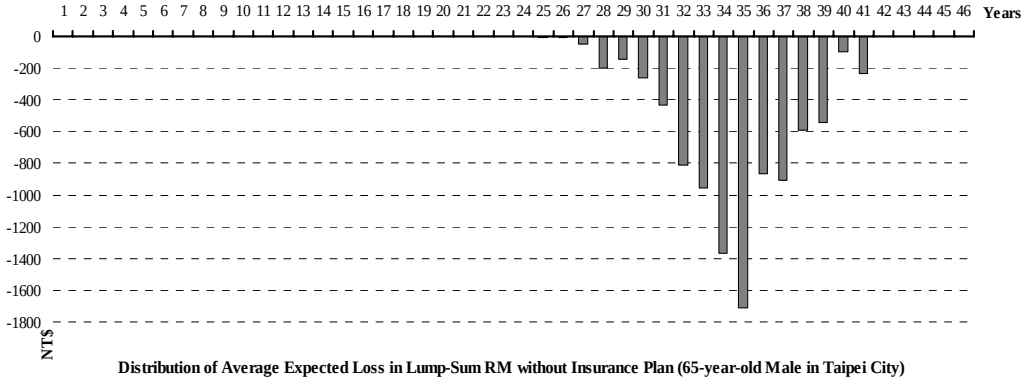


Distribution of Average Expected Loss in Annual RM with Insurance Plan (65-year-old Male in Taipei City)

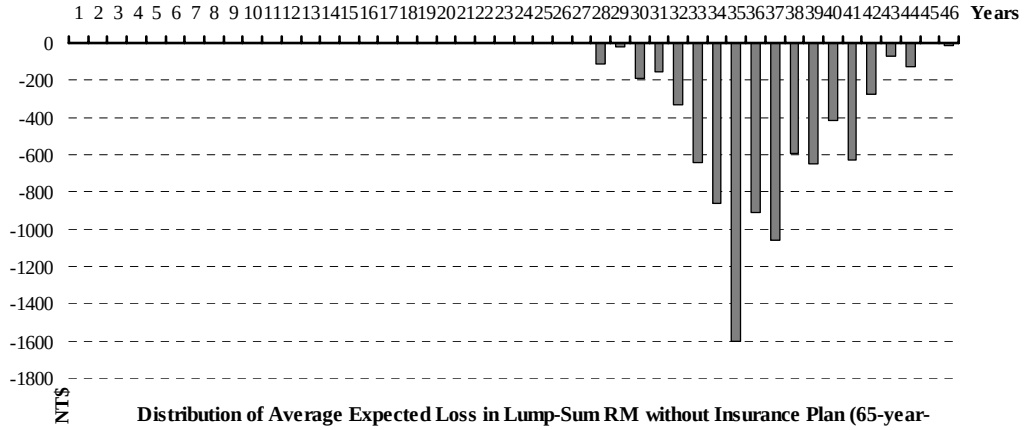


Distribution of Average Expected Loss in Annual RM with Insurance Plan (65-year-old Female in Taipei City)

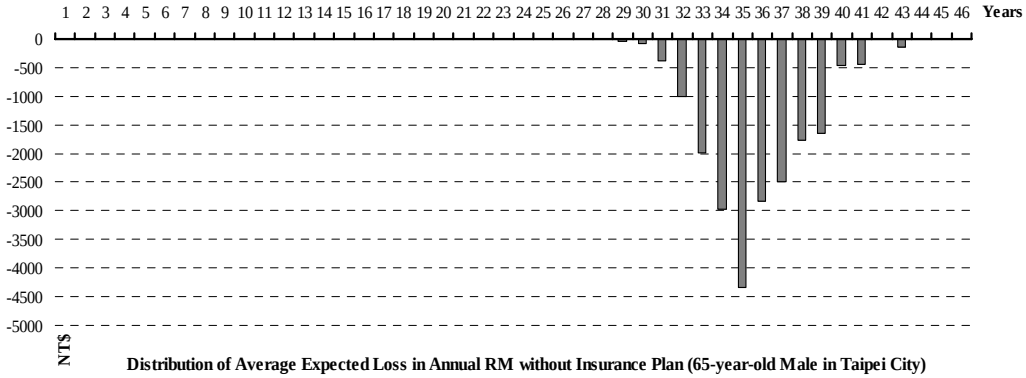
Distribution of average expected loss in RM in Taipei city - without insurance program



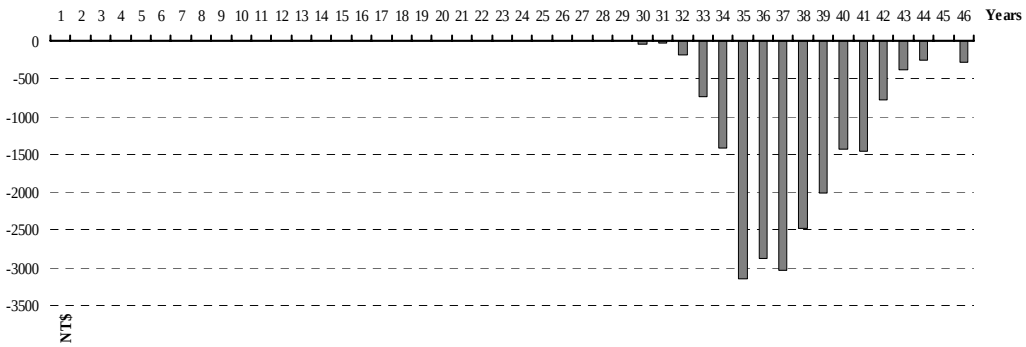
Distribution of Average Expected Loss in Lump-Sum RM without Insurance Plan (65-year-old Male in Taipei City)



Distribution of Average Expected Loss in Lump-Sum RM without Insurance Plan (65-year-old Female in Taipei City)



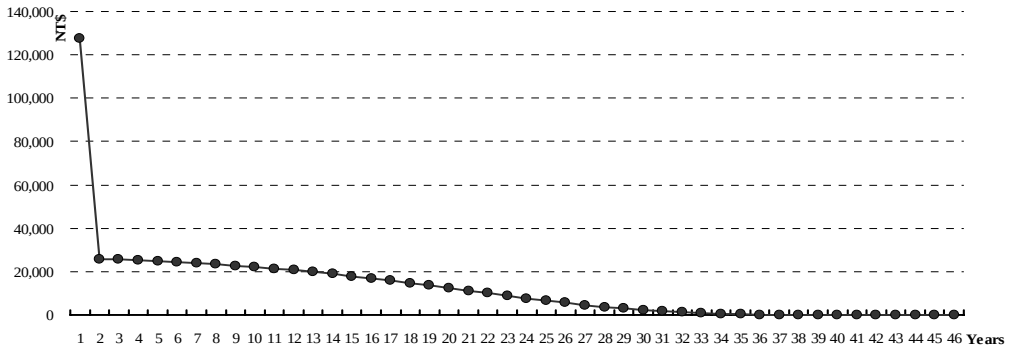
Distribution of Average Expected Loss in Annual RM without Insurance Plan (65-year-old Male in Taipei City)



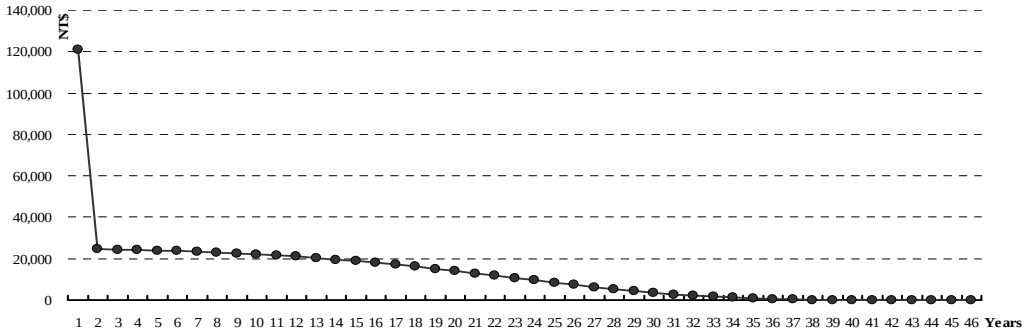
Distribution of Average Expected Loss in Annual RM without Insurance Plan (65-year-old Female in Taipei City)

Appendix 3

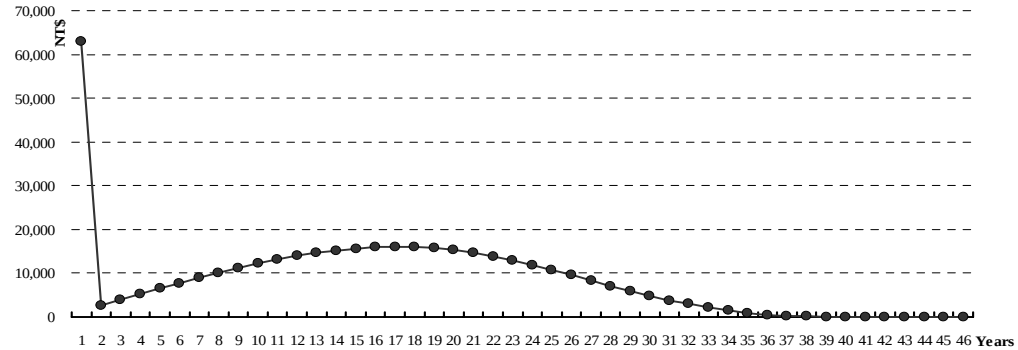
Distribution of average expected risk premium income in RM in Taipei City - with insurance program



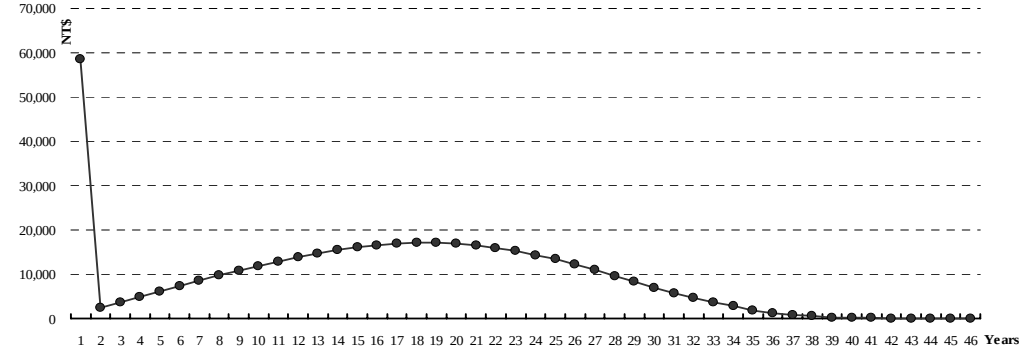
Average Expected Risk Premium Income in Lump-Sum RM with Insurance Plan (65-year-old Male in Taipei City)



Average Expected Risk Premium Income in Lump-Sum RM with Insurance Plan (65-year-old Female in Taipei City)

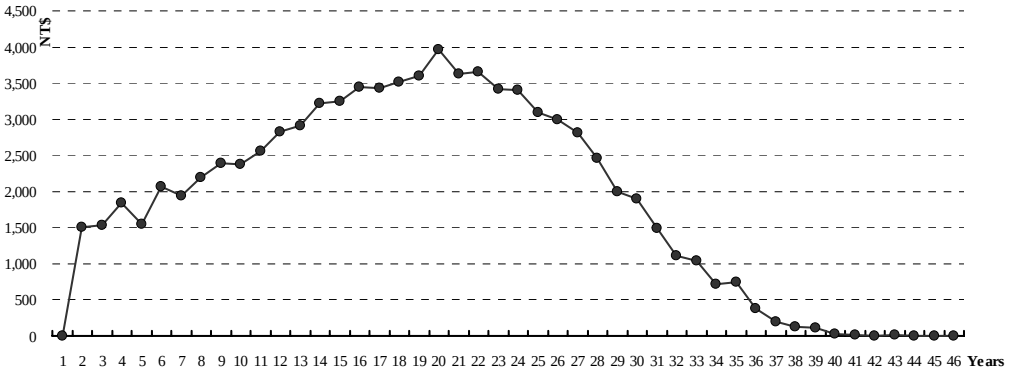


Average Expected Risk Premium Income in Annual RM with Insurance Plan (65-year-old Male in Taipei City)

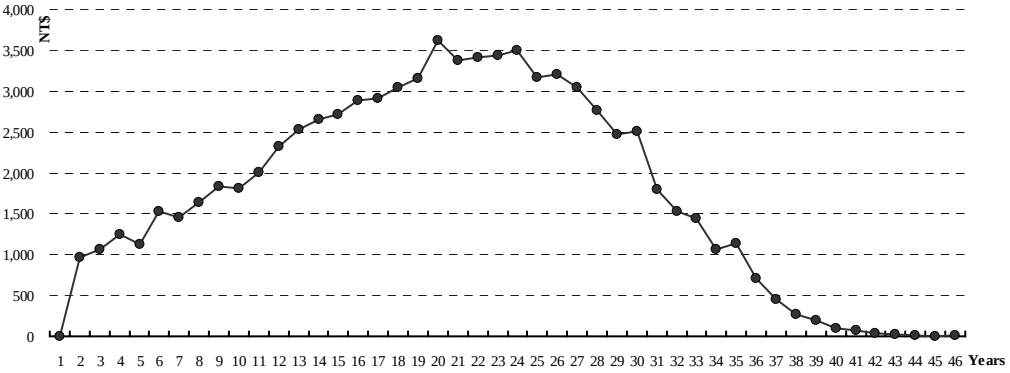


Average Expected Risk Premium Income in Annual RM with Insurance Plan (65-year-old Female in Taipei City)

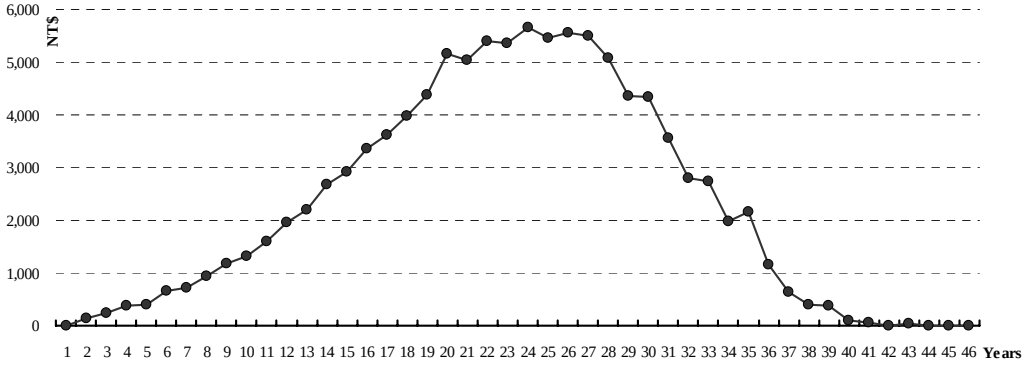
Distribution of average expected risk premium income in RM in Taipei City - without insurance program



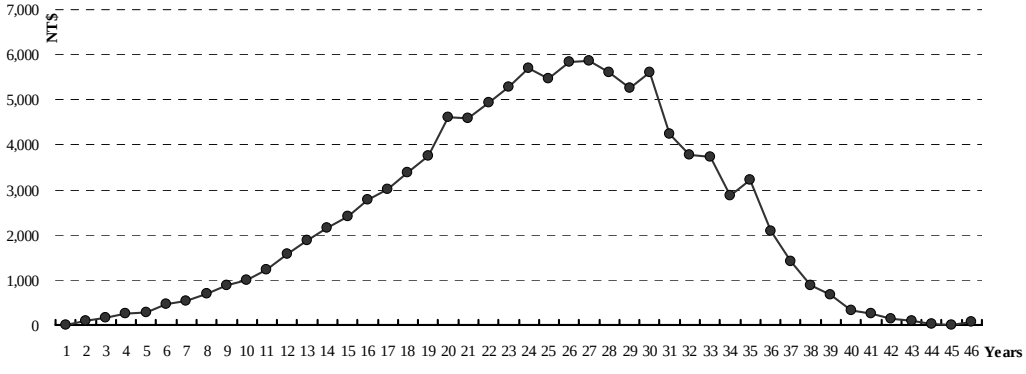
Average Expected Risk Premium Income in Lump-Sum RM without Insurance Plan (65-year-old Male in Taipei City)



Average Expected Risk Premium Income in Lump-Sum RM without Insurance Plan (65-year-old Female in Taipei City)



Average Expected Risk Premium Income in Annual RM without Insurance Plan (65-year-old Male in Taipei City)



Average Expected Risk Premium Income in Annual RM without Insurance Plan (65-year-old Female in Taipei City)

Appendix 4

Tables of LTV & IRR_{-RM} in Taiwan - with insurance program

LTV & IRR_{-RM} of the RM with insurance program in Taiwan — Unit: $TWD

Initial insurance premium (% of property value)						*2.00%*
Annual insurance premium (% of outstanding balance)						*0.50%*
Loan rate (plus in Risk-free Rate)						*0.50%*
Region	Age/ Sex		LTV		IRR_{-RM}	
			Lump-Sum	Annuity	Lump-Sum	Annuity
Taipei City	*Average House Value*					*11,912,343*
	Average Wage (per-household, per year)					*632,242*
	60	M	38.06%	21.46%	59.12%	33.34%
		F	35.94%	20.03%	55.83%	31.11%
	65	M	43.65%	25.93%	67.80%	40.27%
		F	41.46%	24.08%	64.40%	37.40%
	70	M	49.85%	31.89%	77.44%	49.54%
		F	47.28%	29.36%	73.45%	45.61%
Taipei County	*Average House Value*					*5,940,344*
	Average Wage (per-household, per year)					*439,488*
	60	M	38.15%	21.50%	42.51%	23.95%
		F	36.05%	20.07%	40.17%	22.37%
	65	M	43.79%	25.97%	48.80%	28.94%
		F	41.59%	24.13%	46.34%	26.88%
	70	M	50.00%	31.96%	55.72%	35.62%
		F	47.45%	29.43%	52.88%	32.80%
Taoyuan County	*Average House Value*					*3,540,344*
	Average Wage (per-household, per year)					*487,782*
	60	M	37.89%	21.38%	22.67%	12.79%
		F	35.72%	19.94%	21.38%	11.93%
	65	M	43.34%	25.81%	25.94%	15.45%
		F	41.24%	23.99%	24.68%	14.36%
	70	M	49.58%	31.76%	29.67%	19.00%
		F	47.01%	29.25%	28.13%	17.50%
Hsinchu City	*Average House Value*					*4,292,867*
	Average Wage (per-household, per year)					*673,985*
	60	M	37.96%	21.42%	19.94%	11.25%
		F	35.81%	19.98%	18.81%	10.49%
	65	M	43.34%	25.87%	22.76%	13.59%
		F	41.33%	24.03%	21.70%	12.62%
	70	M	49.70%	31.82%	26.10%	16.71%

		F	47.11%	29.30%	24.74%	15.39%
Taichung City	*Average House Value*					*4,403,122*
	Average Wage (per-household, per year)					*492,445*
	60	M	37.23%	21.13%	27.44%	15.58%
		F	35.05%	19.65%	25.84%	14.49%
	65	M	42.46%	25.47%	31.30%	18.78%
		F	40.39%	23.67%	29.78%	17.45%
	70	M	48.50%	31.32%	35.75%	23.09%
		F	45.98%	28.81%	33.89%	21.24%
Tainan City	*Average House Value*					*3,242,146*
	Average Wage (per-household, per year)					*385,188*
	60	M	37.54%	21.25%	26.05%	14.75%
		F	35.37%	19.79%	24.54%	13.73%
	65	M	42.88%	25.64%	29.75%	17.79%
		F	40.79%	23.83%	28.30%	16.53%
	70	M	49.01%	31.53%	34.01%	21.88%
		F	46.45%	29.02%	32.24%	20.14%
Kaohsiung City	*Average House Value*					*3,604,704*
	Average Wage (per-household, per year)					*478,720*
	60	M	38.02%	21.44%	23.60%	13.31%
		F	35.89%	20.01%	22.28%	12.42%
	65	M	43.58%	25.91%	27.05%	16.08%
		F	41.40%	24.05%	25.70%	14.93%
	70	M	49.78%	31.86%	30.90%	19.78%
		F	47.21%	29.33%	29.31%	18.21%
Yilan City	*Average House Value*					*3,446,524*
	Average Wage (per-household, per year)					*324,930*
	60	M	37.07%	21.08%	32.42%	18.43%
		F	34.89%	19.59%	30.51%	17.13%
	65	M	42.12%	25.39%	36.84%	22.20%
		F	40.20%	23.59%	35.15%	20.63%
	70	M	48.26%	31.22%	42.20%	27.30%
		F	45.74%	28.71%	40.00%	25.11%
Keelung City	*Average House Value*					*2,748,612*
	Average Wage (per-household, per year)					*448,864*
	60	M	37.08%	21.08%	18.72%	10.64%
		F	34.89%	19.59%	17.61%	9.89%
	65	M	42.27%	25.40%	21.34%	12.82%
		F	40.18%	23.57%	20.28%	11.90%
	70	M	48.25%	31.23%	24.36%	15.77%
		F	45.70%	28.69%	23.07%	14.48%

Table of LTV & IRR_{-RM} in Taiwan - without insurance program

LTV & IRR_{-RM} without Insurance program in Taiwan Unit: $TWD

Risk premium rate (plus in Risk-free Rate) *2.0%*

Region	Age/ Sex		LTV		IRR_{-RM}	
			Lump-Sum	Annuity	Lump-Sum	Annuity
Taipei City	*Average House Value*					*11,912,343*
	Average Wage (per-household, per year)					*632,242*
	60	M	34.76%	18.96%	54.00%	29.44%
		F	32.50%	17.49%	50.48%	27.18%
	65	M	40.21%	23.13%	62.47%	35.92%
		F	38.09%	21.47%	59.17%	33.35%
	70	M	46.19%	28.60%	71.75%	44.42%
		F	43.57%	26.20%	67.68%	40.69%
Taipei County	*Average House Value*					*5,940,344*
	Average Wage (per-household, per year)					*439,488*
	60	M	34.92%	19.00%	38.91%	21.18%
		F	32.69%	17.56%	36.43%	19.57%
	65	M	40.38%	23.19%	44.99%	25.84%
		F	38.27%	21.54%	42.64%	24.01%
	70	M	46.41%	28.68%	51.72%	31.96%
		F	43.83%	26.29%	48.84%	29.30%
Taoyuan County	*Average House Value*					*3,540,344*
	Average Wage (per-household, per year)					*487,782*
	60	M	34.43%	18.82%	20.60%	11.26%
		F	32.25%	17.38%	19.30%	10.40%
	65	M	39.84%	22.99%	23.84%	13.76%
		F	37.79%	21.35%	22.61%	12.78%
	70	M	45.76%	28.42%	27.38%	17.00%
		F	43.13%	26.03%	25.81%	15.57%
Hsinchu City	*Average House Value*					*4,292,867*
	Average Wage (per-household, per year)					*673,985*
	60	M	34.59%	18.89%	18.16%	9.92%
		F	32.34%	17.42%	16.98%	9.15%
	65	M	40.01%	23.05%	21.01%	12.10%
		F	37.91%	21.40%	19.91%	11.24%
	70	M	45.96%	28.50%	24.13%	14.97%
		F	43.31%	26.10%	22.75%	13.71%

Taichung City	*Average House Value*					*4,403,122*
	Average Wage (per-household, per year)					*492,445*
	60	M	33.45%	18.49%	24.66%	13.63%
		F	31.11%	16.96%	22.93%	12.50%
	65	M	38.51%	22.54%	28.39%	16.62%
		F	36.54%	20.86%	26.93%	15.38%
	70	M	44.22%	27.89%	32.59%	20.56%
		F	41.53%	25.47%	30.61%	18.78%
Tainan City	*Average House Value*					*3,242,146*
	Average Wage (per-household, per year)					*385,188*
	60	M	33.93%	18.66%	23.55%	12.95%
		F	31.61%	17.15%	21.94%	11.90%
	65	M	39.17%	23.04%	27.18%	15.99%
		F	37.13%	21.09%	25.77%	14.63%
	70	M	44.94%	28.16%	31.19%	19.54%
		F	42.27%	25.73%	29.34%	17.85%
Kaohsiung City	*Average House Value*					*3,604,704*
	Average Wage (per-household, per year)					*478,720*
	60	M	34.69%	18.93%	21.54%	11.75%
		F	32.42%	17.46%	20.13%	10.84%
	65	M	40.13%	23.09%	24.91%	14.34%
		F	38.01%	21.44%	23.60%	13.31%
	70	M	46.09%	28.56%	28.61%	17.73%
		F	43.46%	26.16%	26.98%	16.24%
Yilan City	*Average House Value*					*3,446,524*
	Average Wage (per-household, per year)					*324,930*
	60	M	33.23%	18.42%	29.06%	16.10%
		F	30.86%	16.87%	26.98%	14.76%
	65	M	38.16%	22.44%	33.37%	19.62%
		F	36.23%	20.75%	31.68%	18.14%
	70	M	43.86%	27.76%	38.35%	24.28%
		F	41.17%	25.35%	36.00%	22.17%
Keelung City	*Average House Value*					*2,748,612*
	Average Wage (per-household, per year)					*448,864*
	60	M	33.26%	18.42%	16.79%	9.30%
		F	30.81%	16.87%	15.55%	8.52%
	65	M	38.12%	22.43%	19.24%	11.32%
		F	36.19%	20.74%	18.27%	10.47%
	70	M	43.81%	27.76%	22.12%	14.01%
		F	41.15%	25.35%	20.77%	12.80%

Appendix 5

IRR_{-RM} with insurance program in Taiwan
- wage ordered by sex

IRR_{-RM} with insurance program - wage ordered by sex					Unit: $TWD
Initial insurance premium (% of property value)					*2.0%*
Annual insurance premium (% of outstanding balance)					*0.5%*
Loan rate (plus in Risk-free Rate)					*0.5%*
Average Wage (Male, per year)					*408,659*
Average Wage (Female, per year)					*347,824*
Region	**Age/ Sex**	**LTV**		**IRR_{-RM}**	
		Lump-Sum	**Annuity**	**Lump-Sum**	**Annuity**
	Average House Value				*11,912,343*
Taipei City	60 M	38.06%	21.46%	91.47%	51.57%
	60 F	35.94%	20.03%	101.48%	56.55%
	65 M	43.65%	25.93%	104.89%	62.31%
	65 F	41.46%	24.08%	117.05%	67.98%
	70 M	49.85%	31.89%	119.80%	76.64%
	70 F	47.28%	29.36%	133.51%	82.91%
	Average House Value				*5,940,344*
Taipei County	60 M	38.15%	21.50%	45.72%	25.76%
	60 F	36.05%	20.07%	50.75%	28.27%
	65 M	43.79%	25.97%	52.48%	31.12%
	65 F	41.59%	24.13%	58.56%	33.97%
	70 M	50.00%	31.96%	59.92%	38.30%
	70 F	47.45%	29.43%	66.81%	41.44%
	Average House Value				*3,540,344*
Taoyuan County	60 M	37.89%	21.38%	27.06%	15.27%
	60 F	35.72%	19.94%	29.98%	16.73%
	65 M	43.34%	25.81%	30.96%	18.44%
	65 F	41.24%	23.99%	34.60%	20.13%
	70 M	49.58%	31.76%	35.41%	22.68%
	70 F	47.01%	29.25%	39.44%	24.55%
	Average House Value				*4,292,867*
Hsinchu City	60 M	37.96%	21.42%	32.88%	18.55%
	60 F	35.81%	19.98%	36.44%	20.33%
	65 M	43.34%	25.87%	37.54%	22.41%
	65 F	41.33%	24.03%	42.06%	24.45%
	70 M	49.70%	31.82%	43.04%	27.55%
	70 F	47.11%	29.30%	47.94%	29.81%

	Average House Value					*4,403,122*
Taichung City	60	M	37.23%	21.13%	33.07%	18.77%
		F	35.05%	19.65%	36.58%	20.51%
	65	M	42.46%	25.47%	37.71%	22.63%
		F	40.39%	23.67%	42.16%	24.70%
	70	M	48.50%	31.32%	43.08%	27.82%
		F	45.98%	28.81%	47.99%	30.07%
	Average House Value					*3,242,146*
Tainan City	60	M	37.54%	21.25%	24.56%	13.90%
		F	35.37%	19.79%	27.18%	15.21%
	65	M	42.88%	25.64%	28.04%	16.77%
		F	40.79%	23.83%	31.35%	18.31%
	70	M	49.01%	31.53%	32.06%	20.62%
		F	46.45%	29.02%	35.70%	22.30%
	Average House Value					*3,604,704*
Kaohsiung City	60	M	38.02%	21.44%	27.65%	15.59%
		F	35.89%	20.01%	30.66%	17.09%
	65	M	43.58%	25.91%	31.69%	18.84%
		F	41.40%	24.05%	35.37%	20.55%
	70	M	49.78%	31.86%	36.20%	23.17%
		F	47.21%	29.33%	40.33%	25.06%
	Average House Value					*3,446,524*
Yilan City	60	M	37.07%	21.08%	25.78%	14.65%
		F	34.89%	19.59%	28.50%	16.00%
	65	M	42.12%	25.39%	29.29%	17.65%
		F	40.20%	23.59%	32.84%	19.27%
	70	M	48.26%	31.22%	33.56%	21.71%
		F	45.74%	28.71%	37.36%	23.45%
	Average House Value					*2,748,612*
Keelung City	60	M	37.08%	21.08%	20.56%	11.69%
		F	34.89%	19.59%	22.73%	12.76%
	65	M	42.27%	25.40%	23.44%	14.08%
		F	40.18%	23.57%	26.18%	15.36%
	70	M	48.25%	31.23%	26.75%	17.32%
		F	45.70%	28.69%	29.78%	18.69%

IRR_{-RM} without insurance program in Taiwan - wage ordered by sex

IRR_{-RM} without insurance program in Taiwan - wage ordered by sex					Unit: TWD
Risk premium rate (plus in Risk-free Rate)					*2.0%*
Average Wage (Male, per year)					*704,080*
Average Wage (Female, per year)					*502,636*
Region	**Age/ Sex**	**LTV**		**IRR_{-RM}**	
		Lump-Sum	**Annuity**	**Lump-Sum**	**Annuity**
Taipei City	*Average House Value*				*11,912,343*
	60 M	34.76%	18.96%	83.55%	45.55%
	60 F	32.50%	17.49%	91.76%	49.40%
	65 M	40.21%	23.13%	96.64%	55.57%
	65 F	38.09%	21.47%	107.55%	60.63%
	70 M	46.19%	28.60%	111.01%	68.73%
	70 F	43.57%	26.20%	123.03%	73.97%
Taipei County	*Average House Value*				*5,940,344*
	60 M	34.92%	19.00%	41.84%	22.77%
	60 F	32.69%	17.56%	46.03%	24.73%
	65 M	40.38%	23.19%	48.39%	27.79%
	65 F	38.27%	21.54%	53.88%	30.33%
	70 M	46.41%	28.68%	55.62%	34.37%
	70 F	43.83%	26.29%	61.71%	37.02%
Taoyuan County	*Average House Value*				*3,540,344*
	60 M	34.43%	18.82%	24.59%	13.44%
	60 F	32.25%	17.38%	27.07%	14.58%
	65 M	39.84%	22.99%	28.46%	16.42%
	65 F	37.79%	21.35%	31.71%	17.92%
	70 M	45.76%	28.42%	32.69%	20.30%
	70 F	43.13%	26.03%	36.19%	21.84%
Hsinchu City	*Average House Value*				*4,292,867*
	60 M	34.59%	18.89%	29.95%	16.36%
	60 F	32.34%	17.42%	32.91%	17.73%
	65 M	40.01%	23.05%	34.65%	19.96%
	65 F	37.91%	21.40%	38.58%	21.78%
	70 M	45.96%	28.50%	39.80%	24.69%
	70 F	43.31%	26.10%	44.07%	26.56%

	Average House Value					*4,403,122*
Taichung City	60	M	33.45%	18.49%	29.71%	16.43%
		F	31.11%	16.96%	32.47%	17.70%
	65	M	38.51%	22.54%	34.21%	20.03%
		F	36.54%	20.86%	38.13%	21.77%
	70	M	44.22%	27.89%	39.28%	24.78%
		F	41.53%	25.47%	43.34%	26.58%
	Average House Value					*3,242,146*
Tainan City	60	M	33.93%	18.66%	22.20%	12.21%
		F	31.61%	17.15%	24.29%	13.18%
	65	M	39.17%	23.04%	25.62%	15.07%
		F	37.13%	21.09%	28.53%	16.21%
	70	M	44.94%	28.16%	29.40%	18.42%
		F	42.27%	25.73%	32.49%	19.77%
	Average House Value					*3,604,704*
Kaohsiung City	60	M	34.69%	18.93%	25.23%	13.77%
		F	32.42%	17.46%	27.70%	14.92%
	65	M	40.13%	23.09%	29.18%	16.79%
		F	38.01%	21.44%	32.47%	18.32%
	70	M	46.09%	28.56%	33.52%	20.77%
		F	43.46%	26.16%	37.13%	22.35%
	Average House Value					*3,446,524*
Yilan City	60	M	33.23%	18.42%	23.11%	12.80%
		F	30.86%	16.87%	25.21%	13.79%
	65	M	38.16%	22.44%	26.54%	15.60%
		F	36.23%	20.75%	29.60%	16.95%
	70	M	43.86%	27.76%	30.50%	19.30%
		F	41.17%	25.35%	33.63%	20.71%
	Average House Value					*2,748,612*
Keelung City	60	M	33.26%	18.42%	18.44%	10.22%
		F	30.81%	16.87%	20.07%	10.99%
	65	M	38.12%	22.43%	21.14%	12.44%
		F	36.19%	20.74%	23.58%	13.51%
	70	M	43.81%	27.76%	24.29%	15.39%
		F	41.15%	25.35%	26.81%	16.51%

Appendix 6

IRR_{-RM} with insurance program in Taiwan - wage ordered by age

IRR_{-RM} with insurance program - wage ordered by age					Unit: $TWD
Initial insurance premium (% of property value)					*2.0%*
Annual insurance premium (% of outstanding balance)					*0.5%*
Loan rate (plus in Risk-free Rate)					*0.5%*
Average Wage Recipients of Elder (55-64)					*339,774*
Average Wage Recipients of Elder (65-)					*92,484*
Region	**Age/**	**LTV**		**IRR_{-RM}**	
	Sex	**Lump-Sum**	**Annuity**	**Lump-Sum**	**Annuity**
	Average House Value				*11,912,343*
Taipei City	60 M	38.06%	21.46%	110.01%	62.03%
	60 F	35.94%	20.03%	103.88%	57.89%
	65 M	43.65%	25.93%	463.47%	275.33%
	65 F	41.46%	24.08%	440.23%	255.68%
	70 M	49.85%	31.89%	529.37%	338.65%
	70 F	47.28%	29.36%	502.10%	311.82%
	Average House Value				*5,940,344*
Taipei County	60 M	38.15%	21.50%	54.98%	30.98%
	60 F	36.05%	20.07%	51.96%	28.93%
	65 M	43.79%	25.97%	231.89%	137.53%
	65 F	41.59%	24.13%	220.22%	127.76%
	70 M	50.00%	31.96%	264.77%	169.25%
	70 F	47.45%	29.43%	251.27%	155.85%
	Average House Value				*3,540,344*
Taoyuan County	60 M	37.89%	21.38%	32.55%	18.36%
	60 F	35.72%	19.94%	30.69%	17.13%
	65 M	43.34%	25.81%	136.79%	81.47%
	65 F	41.24%	23.99%	130.14%	75.72%
	70 M	49.58%	31.76%	156.46%	100.24%
	70 F	47.01%	29.25%	148.35%	92.32%
	Average House Value				*4,292,867*
Hsinchu City	60 M	37.96%	21.42%	39.54%	22.31%
	60 F	35.81%	19.98%	37.31%	20.81%
	65 M	43.34%	25.87%	165.86%	99.00%
	65 F	41.33%	24.03%	158.17%	91.95%
	70 M	49.70%	31.82%	190.18%	121.75%

		F	47.11%	29.30%	180.30%	112.12%
Taichung City	*Average House Value*					*4,403,122*
	60	M	37.23%	21.13%	39.77%	22.58%
		F	35.05%	19.65%	37.44%	21.00%
	65	M	42.46%	25.47%	166.64%	99.98%
		F	40.39%	23.67%	158.55%	92.90%
	70	M	48.50%	31.32%	190.38%	122.93%
		F	45.98%	28.81%	180.47%	113.10%
Tainan City	*Average House Value*					*3,242,146*
	60	M	37.54%	21.25%	29.53%	16.72%
		F	35.37%	19.79%	27.82%	15.57%
	65	M	42.88%	25.64%	123.92%	74.11%
		F	40.79%	23.83%	117.89%	68.86%
	70	M	49.01%	31.53%	141.64%	91.12%
		F	46.45%	29.02%	134.26%	83.87%
Kaohsiung City	*Average House Value*					*3,604,704*
	60	M	38.02%	21.44%	33.25%	18.75%
		F	35.89%	20.01%	31.39%	17.50%
	65	M	43.58%	25.91%	140.02%	83.24%
		F	41.40%	24.05%	133.03%	77.30%
	70	M	49.78%	31.86%	159.97%	102.37%
		F	47.21%	29.33%	151.69%	94.26%
Yilan City	*Average House Value*					*3,446,524*
	60	M	37.07%	21.08%	31.00%	17.63%
		F	34.89%	19.59%	29.18%	16.38%
	65	M	42.12%	25.39%	129.42%	78.01%
		F	40.20%	23.59%	123.51%	72.46%
	70	M	48.26%	31.22%	148.27%	95.93%
		F	45.74%	28.71%	140.52%	88.21%
Keelung City	*Average House Value*					*2,748,612*
	60	M	37.08%	21.08%	24.73%	14.06%
		F	34.89%	19.59%	23.27%	13.07%
	65	M	42.27%	25.40%	103.58%	62.23%
		F	40.18%	23.57%	98.45%	57.76%
	70	M	48.25%	31.23%	118.22%	76.52%
		F	45.70%	28.69%	111.98%	70.30%

IRR_{-RM} without insurance program in Taiwan - wage ordered by age

IRR_{-RM} without insurance program -wage ordered by age					Unit: $TWD
Risk premium rate (plus in Risk-free Rate)					*2.0%*
Average Income Recipients of Elder (55-64)					*339,774*
Average Income Recipients of Elder (65-)					*92,484*
Region	**Age/**	**LTV**		**IRR_{-RM}**	
	Sex	**Lump-Sum**	**Annuity**	**Lump-Sum**	**Annuity**
	Average House Value				*11,912,343*
Taipei City	60 M	34.76%	18.96%	100.48%	54.79%
	60 F	32.50%	17.49%	93.93%	50.57%
	65 M	40.21%	23.13%	427.04%	245.57%
	65 F	38.09%	21.47%	404.49%	228.01%
	70 M	46.19%	28.60%	490.53%	303.70%
	70 F	43.57%	26.20%	462.70%	278.20%
	Average House Value				*5,940,344*
Taipei County	60 M	34.92%	19.00%	50.33%	27.39%
	60 F	32.69%	17.56%	47.12%	25.31%
	65 M	40.38%	23.19%	213.82%	122.80%
	65 F	38.27%	21.54%	202.65%	114.09%
	70 M	46.41%	28.68%	245.75%	151.87%
	70 F	43.83%	26.29%	232.09%	139.22%
	Average House Value				*3,540,344*
Taoyuan County	60 M	34.43%	18.82%	29.57%	16.17%
	60 F	32.25%	17.38%	27.71%	14.93%
	65 M	39.84%	22.99%	125.74%	72.56%
	65 F	37.79%	21.35%	119.26%	67.39%
	70 M	45.76%	28.42%	144.43%	89.68%
	70 F	43.13%	26.03%	136.11%	82.14%
	Average House Value				*4,292,867*
Hsinchu City	60 M	34.59%	18.89%	36.03%	19.67%
	60 F	32.34%	17.42%	33.68%	18.15%
	65 M	40.01%	23.05%	153.12%	88.21%
	65 F	37.91%	21.40%	145.09%	81.90%
	70 M	45.96%	28.50%	175.88%	109.08%
	70 F	43.31%	26.10%	165.76%	99.88%

	Average House Value					*4,403,122*
Taichung City	60	M	33.45%	18.49%	35.73%	19.76%
		F	31.11%	16.96%	33.24%	18.12%
	65	M	38.51%	22.54%	151.15%	88.49%
		F	36.54%	20.86%	143.41%	81.87%
	70	M	44.22%	27.89%	173.55%	109.48%
		F	41.53%	25.47%	163.01%	99.97%
	Average House Value					*3,242,146*
Tainan City	60	M	33.93%	18.66%	26.70%	14.68%
		F	31.61%	17.15%	24.87%	13.49%
	65	M	39.17%	23.04%	113.20%	66.58%
		F	37.13%	21.09%	107.32%	60.95%
	70	M	44.94%	28.16%	129.89%	81.39%
		F	42.27%	25.73%	122.18%	74.36%
	Average House Value					*3,604,704*
Kaohsiung City	60	M	34.69%	18.93%	30.34%	16.56%
		F	32.42%	17.46%	28.36%	15.28%
	65	M	40.13%	23.09%	128.94%	74.21%
		F	38.01%	21.44%	122.13%	68.89%
	70	M	46.09%	28.56%	148.10%	91.77%
		F	43.46%	26.16%	139.65%	84.05%
	Average House Value					*3,446,524*
Yilan City	60	M	33.23%	18.42%	27.79%	15.40%
		F	30.86%	16.87%	25.81%	14.11%
	65	M	38.16%	22.44%	117.25%	68.94%
		F	36.23%	20.75%	111.32%	63.74%
	70	M	43.86%	27.76%	134.75%	85.29%
		F	41.17%	25.35%	126.49%	77.88%
	Average House Value					*2,748,612*
Keelung City	60	M	33.26%	18.42%	22.18%	12.29%
		F	30.81%	16.87%	20.55%	11.25%
	65	M	38.12%	22.43%	93.40%	54.96%
		F	36.19%	20.74%	88.68%	50.81%
	70	M	43.81%	27.76%	107.34%	68.01%
		F	41.15%	25.35%	100.83%	62.11%

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