

行政院國家科學委員會專題研究計畫 成果報告

臺灣原生知識體系之制度分析(第3年) 研究成果報告(完整版)

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第一篇論文（初稿）

司馬庫斯檉木撿拾案例及達娜伊谷生態公園發展的法律面向探討

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摘要：本論文從生態經濟與永續發展的角度切入，強調原鄉部落經濟體（本來）具有生態經濟學家 Herman Daly (1973, 1977, 2005) 所闡述之永續經濟穩定狀態 (steady-state economy) 的特性：一個永續經濟體耗用自然資源不會超過環境再生的能力，而其污染自然環境亦不會超過環境所能吸收負荷的程度。本論文以司馬庫斯檉木撿拾及達娜伊谷生態公園發展的兩個實際個案為例，分析國內原住民同胞發展部落經濟邁向永續發展過程中所可能面臨之法律限制、障礙或挑戰。

關鍵詞：司馬庫斯，達娜伊谷，內部習慣，外部法律，永續經濟

一、前言

在來自中國大陸的移民尚未進入臺灣之前，原住民部落已經散聚在臺灣各個角落，以自給自足的方式，快樂地生活了很長的一段時間。永續發展 (sustainable development) 是現代主流社會努力追求的重要目標，但對於絕大多數的政府官員、民眾和學者來說，他們並不清楚原鄉部落經濟體其實具有生態經濟學家 Herman Daly (1973, 1977, 2005) 所闡述之永續經濟穩定狀態 (steady-state economy) 的特性：一個永續經濟體耗用自然資源不會超過環境再生的能力，而其污染自然環境亦不會超過環境所能吸收負荷的程度。實際上，原住民同胞是永續台灣生活模式的先行者，他們已經在台灣這塊土地上實踐並力行低碳、低耗能與低污染的（永續經濟）生活模式有幾百年、幾千年了。

台灣島上過去幾十年盲目追求經濟成長的結果，使得許許多多善良無辜的原住民同胞淪為環境難民 (environmental refugees) 而被迫遷徙離開其原來的自然環境，而原住民同胞暨其族群所具備的原生知識 (indigenous knowledge) 也在不斷地流失中。可堪告慰的是，近年來原住民同胞對於恢復其固有經濟及土地資源的意識逐漸抬頭，政府單位為了積極保障原住民同胞的權益，也訂定並修改了一連串的法規，如民國九十四年的第七次憲法增修時，便將對原住民經濟及政治參與的保障，訂為我國的基本國策，並於憲法增修條文的第十條中做了明文的規定。此外，為了符合對於原住民的權益保障，政府在許多的單行及特別法規如森林法及野生動物保護法等…，也都做了對於原住民權益保障的修訂；最後，在民國九十四年二月五日，總統頒布了由立法院所通過的《原住民基本法》¹，由於此法對於我國的原住民族政策及保護，不論是在經濟、文化、土地、教育等…各方面，都做了全面性的規定，使得我國對於原住民權益的規範，不再是散見於各單行或特別法規，而是有了統整性的規劃，也因此，此法的通過及施行，對於我國的原住民保護有著劃時代的意義。

雖然我國對於原住民族在法律面向的保護，做了相當多的修改，然而法律此等外部制度的改變，是否真能配合原住民部落的內部生活習慣與經濟運作模式來促進原鄉部落永續發展，我們還是必須藉由實際的案例來進行分析。以下本文就以民國九十四年發生在新竹縣司馬庫斯部落的原住民撿拾檫木遭起訴判刑案件以及阿里山達娜伊谷生態園區設立兩個實際個案，做為對於原住民保護等相關規範施行現況的分析案例，並藉此二案例的分析與比較，討論我國目前對於原住民族群之法律制度規範在施行上所面臨的矛盾與困境。

二、案例簡介

(一) 司馬庫斯檫木撿拾案件簡介

¹ 原住民族基本法，中華民國 94 年 2 月 5 日總統華總一義字第 09400017741 號令制定公布全文 35 條；並自公布日施行。 <http://law.moj.gov.tw/Scripts/Query4A.asp?FullDoc=all&Fcode=D0130003> (last visit 2008/8/15)

居住在新竹縣尖石鄉玉峰村司馬庫斯之泰雅族原住民三人，於民國 94 年 9 月間，因協助搶修通往斯馬庫斯之道路，而在新竹縣尖石鄉玉峰村大溪事業局 81 林班地旁道路，發現了因為颱風豪雨過後，而折斷倒置於路旁並遭周圍崩落土石沖刷、掩蓋的國有林地所有臺灣檫木 1 株，於是該三名原住民便將之移置路旁。嗣後行政院農業委員會林務局新竹林區管理處，也發覺該傾倒於路邊之檫木，而於 94 年十月初前往該處將該檫木樹身部分鋸下後載離，然而由於樹根及部分枝幹因掩埋於土石中而無法取出，因此林務局林管處於檫木之樹根上噴紅漆並烙上鋼印後將該樹根暫時留置於現場。該三名泰雅族原住民受其部落會議指派，前往搬運上開檫木 1 株，雖明知傾倒之檫木樹根及枝幹係屬於國有，但是仍然結夥駕駛部落共同使用之拼裝車及自用小貨車各 1 輛，將檫木鋸成 5 段，並將該 5 段檫木以拼裝車及小貨車載回部落。在搬運途中，被新竹縣警察局橫山分局分局長及警員所發覺，而會同新竹林區管理處竹東工作站人員前往司馬庫斯部落扣得前述之臺灣檫木，新竹地方法院檢察署檢察官偵查後聲請法院以簡易判決處刑，新竹地方法院審理後依違反森林法第五十二條第一項第四款及第六款²，觸犯加重竊取森林主、副產物罪判決有期徒刑六個月，併科罰金新臺幣十六萬元，緩刑二年³，本案上訴至台灣高等法院後，台灣高等法院維持有罪判決，但將有期徒刑降為三個月，併科之罰金也降為七萬九千四百八十八元，同樣緩刑二年⁴。

（二）阿里山達娜伊谷保育園區設立案件簡介

位於嘉義縣屬於曾文溪上游的達娜伊谷溪，原先有著秀麗的風景，然而隨著經濟的發展及公路的開通，大量的遊客湧入，隨之而來的電魚及濫捕，也使得達娜伊谷溪的自然環境受到了嚴重的破壞，為了保護鄉土的自然環境，居住在當地的山美社區鄒族原住民，組成了巡守隊輪流巡視並保護溪流，此外當地村民也積極地復育溪中的原生魚種高山鮭魚，經過多年的努力，達那伊谷溪終於恢復了過往的美麗景觀；在 1995 年時，山美社區設立了達娜伊谷自然生態園區，並開放部分河段供外地人垂釣，採取酌收小額費用的商業化行為（每人五十元），山美社區利用這些收入，一方面用於對於達娜伊谷環境維護及推動保育，另一方面也使社區發展獲得所需的經費來源，但是由於達娜伊谷生態公園的部份區域，屬於國有林地，山美部落是否可以未經許可及使用該塊國有林地，且圈地成立生態公園並收費，引起了相當大的爭議；在這樣的爭議中，達娜伊谷生態公園也因此停止收費了一年。之後在阿里山鄉公所與嘉義縣相關社區發展輔導單位協助下，山美社區依據社區發展工作綱要第 17 條第 2 款⁵，社區發展協會

² 參見：森林法第五十二條，中華民國 93 年 1 月 20 日總統華總一義字第 09300008131 號令修正公布第 6、7、15、25、34、48、56-2、56-3 條條文；增訂第 17-1、38-1 條條文。

<http://law.moj.gov.tw/Scripts/NewsDetail.asp?no=1M0040001&FL> (last visit 2008/8/20)

³ 參見：新竹地方法院 96 年易字第 4 號判決之判決理由及判決主文。

⁴ 參見：臺灣高等法院 96 年上訴字第 2092 號判決之判決理由及判決主文。

⁵ 參見：社區發展工作綱要第十七條，中華民國八十年五月一日台內社字第 915261 號發布。

<http://law.moj.gov.tw/Scripts/Query4A.asp?FullDoc=all&Fcode=D0050077> (last visit 2008/8/20)

之經費來源可包括社區生產收益解套，因此成立了山美社區發展協會，且以達娜伊谷園區的收費可促進山美社區發展為理由，而引據社區發展工作綱要作為達娜伊谷的園區收費法源依據。2003年時，達娜伊谷生態園區的年收益達到新台幣三千萬元，也因此財政部台灣省南區國稅局要求經營達娜伊谷生態園區的山美社區發展協會依營業稅法規定繳稅；然而後來在阿里山鄉公所及相關社區發展輔導單位的協助之下，山美部落籌組了「嘉義縣阿里山鄉山美社區合作社」，藉原住民工作權保障法第八條規定：「原住民合作社，其成立六年內應免徵所得稅及營業稅」⁶，而使山美社區發展協會對於達娜伊谷生態園區的門票收入，得以免除課徵營業所得稅。

三、案例評析

在以上兩個案例中，我們可以發現，我國法規範在對於原住民族使用自然資源的處理上，有著截然不同的處理方式，在司馬庫斯的檫木撿拾案件中，取用森林中自然折倒檫木的原住民，遭檢察官起訴並被法院判刑且科以罰金，但是在同樣是利用自然環境資源而設立達娜伊谷生態園區的案件中，雖該園區的設立，也有諸多不合乎法律規定之處，但這些問題，卻在各相關單位的共同努力下獲得了解決。

前述二個案件都是發生在原住民族對於自然環境資源的利用事實上，然而在我國現今制度的適用下，二個案件的結果竟有著如此大的差距，一者遭判刑，一者卻受到政府的輔導及協助，究竟為何在一個國家體制之下，相似的案例卻會有著如此不同的結果，以下本文就針對案件中的法規適用及其適用切入角度，剖析觀察我國對原住民族的權益保障。

（一）阿里山達娜伊谷保育園區設立案件

阿里山山美社區設立達娜伊谷園區的案件中，雖說達娜伊谷園區的經營及設立過程中，遇到了部分園區用地無權的佔用了國有林地和山美社區並非營利事業卻設立達娜伊谷園區而對遊客收取門票取得收益，以及設立園區鎖收入的營利所得遭國稅局要求繳交所得稅等眾多的法律問題，然而在面對這些法律問題時，達娜伊谷園區的設立，顯然獲得了政府主管機關較多的協助與關愛；舉例而言：達娜伊谷生態園區無權使用國有林地的問題，山美社區事後以由阿里山鄉公所代為和嘉義縣林管處補簽定租賃國有林地的方式加以解決；對於非營利事業卻收取門票的問題，相關單位於協助山美社區成立社區發展協會後，以社區發展工作綱要做為法源依據，引據其中的第17條第2款⁷，將園區的門票收入解釋為社區發展經費的合法收入，解決了門票收入正當性的問題；當國稅局對於山美社區達三千萬的門票收益要課徵營業稅時，主管機關也協助山

⁶ 參見：原住民族工作權保障法第八條，九十年十月三十日總統（九〇）華總一義字第 990002213960 號令制定公布。 <http://law.moj.gov.tw/Scripts/NewsDetail.asp?no=1D0130006&FL> (last visit 2008/8/20)

⁷ 同前揭註 5。

美社區成立原住民合作社，並以原住民工作權保障法第八條為法源依據⁸，認定依法經營之原住民合作社，得免除課徵營業稅及所得稅；山美社區擅自封溪護漁的行為，也因為嘉義縣政府引據漁業法第四十四條規定⁹，以曾文溪主管機關的資格，公告實施和山美社區封溪護於相同的禁漁措施，並委託由山美社區發展協會的溪流管理委員會執行，使山美社區發展協會取得了管理達娜伊谷溪的權限。

由前面這些山美村民設立達娜伊谷生態園區所遇到的問題，以及這些問題後來的解決方式來看，我們可以發現，政府主管機關對於山美社區設立達娜伊谷生態園區，以較為寬容的態度看待這件事，甚至政府主管機關在山美社區設立達娜伊谷生態園區遇到問題時，也主動的給予協助並幫忙解決，此外由於達娜伊谷園區的成立，協助政府達成了環境保護和生態保育的工作，而且達娜伊谷生態園區在媒體及政治人物的大力吹捧和公開表揚之下，也成了生態復育成功最好的範例，是以主管機關當然也樂於園區繼續的維持與經營；在這樣的情形之下，我們可以發現，縱使相關主管機關對於達娜伊谷生態園區設立的支持及協助，其出發點未必是以為保障原住民族群對於其傳統生活領域土地等資源的利用為目的，更大部分反而是著眼於環境保護的成效以及為了符合社會在這件事上對政府的期待，然而實際上山美社區當地的原住民族，對於其傳統的生活領域資源的使用，在這樣的情況下也間接的獲得了保障，使當地的鄒族原住民族，得以於其傳統生活領域內，善用原住民族的傳統知識維護環境並加以經營並發展經濟，進而創造了政府環境保護政策得以推行、原住民族對傳統生活領域得加以運用的雙贏狀況。

（二）司馬庫斯檫木撿拾案件

1. 法院的見解

(1) 新竹地方法院 96 年易字第 4 號判決

檫木撿拾案第一審的新竹地方法院，在 96 年易字第 4 號判決中，由以下幾點認定該三名原住民取走檫木樹根的行為，是屬於違反森林法第五十二條的加重竊盜森林主、副產物罪¹⁰。

- A. 三名搬走倒置於路旁檫木樹根泰雅族原住民，他們明知該檫木經林管處噴上紅漆並蓋有鋼印而屬於國有，卻私自將檫木以為自己所有的意思搬回部落，有竊盜的故意。
- B. 縱使被告抗辯取走檫木是屬於原住民之生活習慣且主張依原住民族基本法第二十條第一項：「政府承認原住民族土地及自然資源權利。」及同法第二十三條規定：「政府應尊重原住民族選擇生活方式、習俗、服飾、社會經濟組織型態、資源利

⁸ 同前揭註 6。

⁹ 參見：漁業法第四十四條，中華民國 97 年 1 月 9 日總統華總一義字第 09700002351 號令修正公布第 41 條條文。

<http://law.moj.gov.tw/Scripts/NewsDetail.asp?no=1M0050001&FL>(last visit 2008/8/20)

¹⁰ 同前揭註 2。

用方式、土地擁有利用與管理模式之權利。」認為原住民族有權使用自然環境之相關資源，但法院仍認為，該檫木屬於國家所有，原住民既然對該檫木屬於他人所有有所認識，即應對於他人之所有權加以尊重，不得以其有自然資源的使用權利，就擅自侵害他人的所有權。

- C. 法院認為，本案中原住民撿拾檫木之地點，距離部落約 12 公里，有著相當的距離，這樣的撿拾行為，已經超過了一般日常生活所會運用的範圍，因此不能認為他們的行為是屬於合法範圍內之使用自然資源。
- D. 法院也認定，縱使原住民族基本法第二十條雖規定原住民對於其土地等之運用雖應加以尊重，但是仍須依照法定之方式，而於法定之範圍內對資源加以運用，對於為犯了森林法的竊取森林主產物行為，已超越合法的界線。

綜合上述四點，法院認為在本案中，三名泰雅族原住民之撿拾檫木行為，已經違反了森林法第五十二條的加重竊盜森林主、副產物罪，因此均判處有期徒刑六個月並併科罰金十六萬元，緩刑二年¹¹。

(2) 台灣高等法院 96 年上訴字第 2092 號判決

本原住民撿拾檫木案件經新竹地方法院做成 96 年易字第 4 號判決而判決該三名原住民有罪後，該三名原住民不服提起上訴，台灣高等法院經過審理後，做出了 96 年上訴字第 2092 號判決，除了認可新竹地方法院於判決中所舉的理由之外，另外也提出了數點看法，同樣認定該三名原住民觸犯了森林法第五十二條的加重竊盜森林主、副產物罪。

- A. 台灣高等法院認為，雖依森林法第十五條第四項，原住民族對於位於傳統領域土地之森林，依生活慣俗需要，原住民族於遵行相關規範下，可採取森林產物，森林法的此規定目的，也是為了使原先訂於森林法施行細則的原住民權益，以法律明文加以保障。然而此法律所保障的原住民權利，應僅限於原住民族可對於森林內的「雜草」、「枯枝」、「落葉」可自由的撿拾採集，本案中被告所撿拾之檫木樹根，已不屬於此等可自由撿拾、採集之自然資源。
- B. 雖原住民族基本法第十九條規定，原住民族可於原住民族地區內，依法採及野生植物及菌類，縱使現今政府及相關主管機關尚未將詳細之管理規則訂出，但由於國有林產物處分規則第十四條規定，原住民採取、撿拾漂流竹木，均須先向管理機關「專案申請」而獲得核准後始得為之，故本案中之三名原住民，未依此程序而擅自取用資源，當然有違法之情形。

台灣高等法院綜合了新竹地方法院的審判理由，在加上其所提出的二點，認定本案之三名原住民，確實違反森林法，但由於三人先前並無犯罪紀錄，且該撿拾之檫木並非被告所砍伐，而是因為天然力而伏倒，也因此法院從輕量刑將有期徒刑降低為三個月，罰金也降為七萬九千四百八十八元，並同樣緩刑兩年¹²。

¹¹ 同前揭註 3。

¹² 同前揭註 4。

2. 司馬庫斯檫木撿拾案之評析

前段所介紹的新竹地方法院及台灣高等法院對司馬庫斯檫木撿拾案的判決中，法院在審理司馬庫斯原住民撿拾檫木的案件時，援引了許多各相關規定和先前法院的類似判決作為其論述的依據，就其論述而言，固有其（依法）道理，但是為何原住民族撿拾自然傾倒的森林資源而加以利用，會遭受到法律的懲罰？原住民族利用自然資源的權利，不是已經明文的定入各法規中了嗎？是否是我國的法律規範制度，有著何種的闕漏？亦或是我國對原住民族的保護，並沒有獲得真正的落實？以下，本文就針對以下兩點加以評論：

(1) 我國對原住民保護法律建置的不完備

不論從新竹地方法院或是台灣高等法院的判決中我們都可以發覺，被告的辯護人，在法庭中都曾主張，三名原住民撿拾檫木的地點是在屬於泰雅族馬里光群（Mrqwang）傳統領域土地範圍之內，而依據我國原住民基本法第十九條¹³及森林法第十五條第二項¹⁴，原住民族對於其生活範圍內的自然資源應該是有加以利用的權利；但法院卻認為，原住民族基本法及森林法中，確實對保障原住民族利用自然資源權利有著明文的規定，然而此二法規卻仍規定原住民族應「依法」或「依相關辦法」利用自然資源，然而詳查我國的法律規定後，卻發現在原住民族基本法通過後，許多應該一同訂定的相關附隨辦法或規定，如原住民族土地及海域法、傳統生物多樣性知識保護條例等…，都仍在行政院討論中，或是仍在等待立法院議決通過，是以法院在無其他附隨辦法或規定可援引或參照的情形之下，甚難認定原住民的利用行為是合於法律的。

且由於原住民族基本法，從其基本法的特性來看，此法的規定最重要的是在於宣示我國對於原住民族，於各個不同層面所應給予的保障，至於相關的細部內容，原住民族基本法並沒有太多的詳細規定，而是希望藉由其他個別的立法來加以充實，然而以我國目前相關法律及附隨辦法尚有欠缺的情況下，顯而易見的，這也使得雖然原住民族基本法對於原住民族的權利，作了許多立意良善的規範和保障，但是在缺乏可供援引的實際規範情形下，原住民族基本法的保障，並無法發揮實質的作用，而可能僅淪為「口號上」或「條文上」的保護規範條款。

由此可見，我國雖有原住民族基本法作為原住民族保護之綱要，卻無施行辦法及相關法規來達成這個目標，在我國原住民族保護的相關法律及辦法建置齊全之前，本文認為，我國對於原住民族的保障，仍會因為規範的不完備，而有許多的闕失及漏洞，使保護原住民族權益的目標無法達成。

(2) 法院對法規過度保守的解釋

¹³ 參見：原住民族基本法第十九條，中華民國 94 年 2 月 5 日總統華總一義字第 09400017741 號令制定公布全文 35 條；並自公布日施行。

<http://law.moj.gov.tw/Scripts/Query4A.asp?FullDoc=all&Fcode=D0130003> (last visit 2008/8/15)

¹⁴ 同前揭註 2。

不論是新竹地方法院或是台灣高等法院，在遇到被告引據原住民族基本法或是森林法之特別規定，而主張原住民族應可在其傳統生活領域中利用自然資源作為抗辯時，法院除了以特別法規尚未訂定而不採納被告的抗辯之外，縱使森林法第十五條明文規定：依原住民族之生活習慣，原住民族可採取森林資源。但是法院卻仍然認定依森林法第十五條，原住民族所可以取用的森林資源，僅限於「雜草」、「枯枝」和「落葉」，而司馬庫斯案中原住民所撿拾的檫木，已有相當的材積和經濟價值，不能被認定為可取用的「枯枝」，對於法院此般的法規解釋，本文認為此等解釋不僅保守而且過時，雖森林法第十五條，是將原先訂於森林法施行細則第十六條原住民可對森林中之「雜草」、「枯枝」和「落葉」加以利用的規定訂於森林法中而授予其法律位階，以期能保障原住民之權益，然而試想，若森林法第十五條的立法意義在於保障原住民族的權益，然而卻又將原住民族能自傳統生活領域中的取用的資源僅限於「雜草」、「枯枝」和「落葉」，而排除實際上具有經濟價值的木材等…，這樣的法律規範對原住民族的生活究竟能有什麼樣的幫助實在令人懷疑，且在當今社會的生活環境之下，若只允許取用「雜草」、「枯枝」和「落葉」，很明顯的已經不具有實質的意義。此外，法院僅以本案件中的檫木有相當的材積，即認定此檫木不可被認定為「枯枝」，法院在論述上的理由，顯然過於草率，今既然該檫木因自然力而伏倒，為何此檫木不能被認定為枯枝或枯木？另外，從森林法第十五條的立法意旨來看，既然此規定著重於保障原住民族對於其生活週遭資源的使用權利，則我們在法規的解釋上，也就不應該採取過度限縮的解釋，雖說法院可能是為了避免原住民族以取用自然資源作為理由，而隨意砍伐森林資源進而破壞了脆弱的山林資源，才採取了較嚴格的解釋方式，但試想在本案的情形中，單純撿拾因為自然力而伏倒木材的原住民，其情形明顯的和故意為了獲利而砍伐山林資源的人有所不同，但法院在對森林法第十五條規定原住民族所可採取的自然資源範圍做解釋時，卻仍採取一貫保守的嚴格解釋方式，雖說此種一致性的法律解釋及統一的適用有助於法規的安定性，但相對的，這卻也使得森林法第十五條原先保障原住民族權益的良善立意無法辦法實現了。

另外在被告主張原住民族對於其傳統生活領域內之資源有權加以利用時，法院表示該檫木撿拾地點距離原住民族居住之部落約 12 公里，而撿拾檫木也有相當的材積和經濟價值，故不可以認定是為一般生活運用之用，然而法院此種的解釋論，顯然過度狹隘的定義原住民可使用的資源，因為任何對於環境資源的利用，本來就是以取得經濟上利益做為出發點，原住民族既然以製作雕刻等製品為其職業，而維持其生活，法院卻否定其撿拾木材的行為是屬於生活上運用的正當性？此種解釋甚難認為合理。

四、綜合評析以及建議

從前述的討論中我們可以得知，我國對於原住民族的保護法規，仍有許多建置上的不完備之處，然而縱使目前的立法仍處於不完備的階段，對於原住民族權益，我們仍然應該積極的給予保障，政府主管機關在達娜伊谷生態園區案例中，靈活的適用各種法律規範，且儘量擴大規範的解釋，成功的維護原住民族的權益就是一個值得讚許

的例子；以下本文就下列幾點提出建議，或許可以作為解決我國目前原住民族保護面臨問題之方法：

（一）憲法增修條文第十條基本國策條款的運用

我國憲法增修條文第十條基本國策部份，其中的第十項及第十一項，提到了「國家肯定多元文化，並積極維護發展原住民族語言及文化」和「國家應依民族意願，保障原住民族之地位及政治參與，並對其…經濟土地之社會福利事業予以保障扶助並促其發展」¹⁵，並規定其保障辦法另外以法律定之，是可見我國對於原住民族的保護，乃是有憲法增修條文明文規定且是屬於國家的基本國策，也要求國家應該以法律對原住民族的此等權利加以保障；然而此一定訂於憲法增修條文中對原住民族權利加以保護的基本國策，於我國法律上的效力究竟為何？而我國的原住民族是否可以本於憲法增修條文第十條第十項及第十一項的精神，向法院請求保護，似值探討。

憲法的基本國策規定，最早出現在德國的威瑪憲法之中，在當時探討基本國策條款是否具有拘束力時，德國學者安序茲（Gerhard Anschütz）提出了「區分論」，認為基本國策條款可分為狹義、嚴格且具有拘束力的法規或是不具拘束力的立法原則規定而種，至於基本國策條款中的條文內容究竟表達的何種的法律性質，則必須用此一文所用文句而推敲其意旨，進而探求條文究屬具有拘束力的法規或是宣示性效果的方針條款。然而德國威瑪憲法的實際運用並不成功，而德國的基本法於第二次世界大戰後，也做了相當大幅度的修改，是以近代以來對於規定於憲法中的基本國策條款效力，德國學說也提出了新的解釋學說而將基本國策的效力，依據各條文的規定內容及規範目的之不同，區分為僅具宣示意義的方針條款、授權由立法機關訂定相關規定的憲法委託、及保障制度成立及內容完整的制度性保障和直接保障人民權利的公法權利四種分類¹⁶。

我國公法學者對於憲法上之基本國策部分在論著上的討論並不多，而若有提及基本國策效力問題的學者，大也都仍是採納德國早期區分論的見解，且認為我國的基本國策除少數具有直接規範效力者之外，大部分仍應當屬於僅具有指導宣示性效力的方針條款，此外縱使因國家立法未健全而使國家的措施有違背基本國策的情形出現，國家的行為仍不能被認為違背憲法¹⁷。然而，我國憲法學者亦有認為，我國對於憲法基本國策條款的解釋及適用上，應當採取德國新修正學說中將條款內容區分為方針條款、憲法委託、制度性保障及工法權利的四種分類說¹⁸；其中學者陳新民即認為「我國憲法的基本國策的內容極為豐富，各個條文中亦具有各種不同的規範效果，不僅是

¹⁵ 參見：中華民國憲法增修條文第十條，中華民國八十九年四月二十五日總統令修正公布。

<http://law.moj.gov.tw/Scripts/Query4A.asp?FullDoc=all&Fcode=A0000002> (last visit 2008/8/15)

¹⁶ 參見：陳新民，《憲法學釋論》。台北：著者自行出版；台北：三民總經銷，2005，頁 896 以下。

¹⁷ 參見：林紀東，《中華民國憲法逐條釋義（四）》。台北：三民，1988，頁 248。陳慈陽，《憲法學》。台北：著者自行出版；台北：元照總經銷，2004，頁 63。李惠宗，《憲法要義》。台北：元照，2004，頁 620-621。

¹⁸ 參見：陳新民，《憲法學釋論》。台北：著者自行出版；台北：三民總經銷，2005，頁 905。陳新民，《憲法導論》。台北：新學林，2005，頁 429。呂秉寬、項程華、楊智傑合著，《中華民國憲法精義》。台北，五南，2007，頁 187。

威瑪憲法時代安序茲教授所為的法律規範或方針條款的二分法，不能完全是用外，仍須參照德國基本法實施後的憲法委託及其他工法理論架構，來加以歸類與討論」¹⁹。

從我國憲法增修條文第十條第十項及第十一項的規定觀之，我們可以發現，制憲者於憲法增修條文中明文規定對於住民族的保障「其辦法另以法律定之」，由此可見制憲者乃是有意授權委託立法機關訂定相關法規，以實現憲法增修條文中對原住民族的保障，故若我們對憲法基本國策的效力採取四種分類說來分析，我們可以發現，此種基本國策條款應當是屬於憲法委託的條款，立法者於受到憲法的委託後，應當以積極的立法行為實現憲法規範上所欲達成的目標。由此可見，我國既已明文將對原住民族的權利保障訂於憲法增修條文之基本國策中並授權委託立法機關訂定法律加以實踐，則我國的立法機關在此情形下，則應儘速積極的制訂相關法規，避免人民的權利受有損害。在我國現今的體制之下，雖說立法機關於理論上應受基本國策中憲法委託條款的拘束，然而若是立法機關怠於行使其職權而遲未規定相關辦法時，則此些憲法上所欲達成的保障仍無法有效的被實踐，且由於我國面對這種立法機關之怠惰情形時，並無法以其他方法創設相關法律救濟之措施，是而這樣的情況也可能造成基本國策條款中的良善立意成為徒然，也因此有學者認為，在我國欠缺救濟立法怠惰造成的困境情形下，我國基本國策中屬於憲法委託的條款，其僅有類似方針條款般不具拘束力的建議效果²⁰。

就目前而言，由於我國目前的大法官解釋中，出現了所謂的「警告性裁判」，而可於解釋書中宣示立法者負有積極立法的作為義務，雖然此種警告性裁判仍欠缺具體的效力，但是藉由警告性裁判的做成，大法官解釋仍可引起社會大眾的重視，進而能間接的藉由社會大眾以輿論之力量使立法機關積極實踐憲法的基本國策條款保障，也因此，若我國立法機關對於憲法基本國策的憲法委託，遲遲未制定法律加以實現而有損於原住民權益的情形下，或許原住民族可藉由釋憲案的提起，由大法官會議做成警告性裁判，督促立法機關積極立法，以保全原住民族的權益不受損害。

（二）以原住民族權益保護為法條的解釋出發點

我們除了督促並期待立法機關儘速立法以達成保護原住民族的目標外，由於目前我國許多對於原住民族有所規範的法條，其用語上常使用概括條款或是較抽象性的文字，如原住民族基本法第十九條第二項中規定原住民族採用自然資源，應以「傳統文化」、「祭儀」或自用為限用，又如森林法第十五條第二項所稱的原住民族得依其「生活慣俗需要」採取森林產物，和野生動物保育法第二十一條之一中規定，原住民族基於其「傳統文化」、「祭儀」，而有獵捕、宰殺或利用野生動物之必要者，其得獵捕、宰殺野生動物；在前述的這些法條中，其所使用的「傳統文化」、「祭儀」、「生活慣俗需要」等字，其實都並非是一個精確的用語，而是一種抽象性的描述用字，此種概括、抽象的立法方式，本來就是為了使法條可以靈活的適用在各種不同的案例中，

¹⁹ 陳新民，《憲法學釋論》。台北：著者自行出版；台北：三民總經銷，2005，頁905。

²⁰ 參見：呂秉寬、項程華、楊智傑合著，《中華民國憲法精義》。台北，五南，2007，頁188。

而使法院在適用法規時，可以靈活的運用以達到實際保障原住民族權利的目標。

德國著名法學家耶林 (Rudolf von Jhering) 曾說「目的是所有法律的創造者」，也因此本文認為，為了使原住民族的權益能獲得保障，當法院在對案例適用法條並加以評價時，若我們僅以單純的文意解釋或是過去歷史解釋來詮釋法條所欲達成的規範目標，或許並不能真實的體現出這個法條所欲表達的意涵，法院在解釋法條並加以適用時，或許可藉由條文中使用文字可能的字義和文義目的，在和法律意義脈絡一致的範圍內，尋求該法條所欲表現的規範目的來審視案件，而以法學方法論上所稱之目的性解釋做為法律解釋適用的方法²¹。在本文前所舉出的司馬庫斯檉木撿拾案例中，法院對於森林法第十五條第二項所規定，原住民族得依其生活習慣而採取森林產物解釋，是認為原住民可撿石採取的自然資源僅限於「落葉」、「竹木」以及「枯枝」，然而若我們從此法條的訂立，是立法者希望對原住民族就其傳統生活領域範圍內資源運用的權利加以保護而訂定的角度來看，法院或許也能認定該三名原住民依法即有利用自然資源的權利，其撿拾檉木的行為及不具有違法性可言，也因此我們可以發現，若法院對於具有解釋空間的法條加以適用時，從保護原住民族的立場出發，則本文認為，或許藉由靈活的操作運用概括抽象法規範的特性，以目的性解釋詮釋法條意涵，將可使我國對於原住民族的保護更為落實。

五、結語

由於我國對於原住民族權利加以保障的觀念，仍在起步的階段，雖說近年來如原住民族基本法等…法律規範已經訂定完成並開始施行，然而我國不論在法規範的建構亦或是國民觀念的培養，都仍尚有欠缺。在目前體制不完備的階段，我們除了應該督促立法機關儘速擬定相關法案、建構完備的制度以及建議法院以更靈活的法條解釋方法使各法規中對於原住民族的保護得以被實現之外，我們更應以積極的態度去瞭解不同原住民族群的內部生活習慣與經濟運作模式，以維繫並促進每一個原鄉部落的永續發展。

²¹ 參見：李太正、王海南、法治斌、陳順連、黃源盛、顏厥安，《法學入門》。台北：元照出版社，2006，頁 165。Karl Larenz 著，陳愛娥譯，《法學方法論》。台北：五南出版社，1996，頁 232 以下。

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第二篇論文（初稿）

Spending Cooperation for the Provision of International Public Goods

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Abstract: Under the current global environment with rapid changes in both formal and informal institutions, people have faced more and more uncertainties and instabilities. This paper stresses the urgency of economic planning initiated by all levels of the government for pursuing the goals of social long-term development. With special reference to the central government, this paper emphasizes the significance of spending cooperation between national authorities for the provision of international public goods. From a global village perspective, *national defense*, for example, can not be considered as a pure public good any longer but, instead, is considered as a special type of hostile club good. In this regard, central governments around the world should abandon traditional individual spending on national defense, and seek to cooperate on various schemes for promoting global peace and security.

In its active form, responsibility is leadership...The danger for world stability is the weakness of the dollar, the loss of dedication of the United States to the international system's interest, and the absence of candidates to fill the resultant vacua.

— Charles P. Kindleberger, 1988, pp. 208-210

Moreover, public finance represents economic 'planning', i.e. positive intervention, and not just an automatic mechanism as in the abstract theory of harmony.

— Nobel Laureate Gunnar Myrdal, 1990, p. 156

It's politically fashionable to rant against government spending and demand fiscal responsibility. But right now, increased government spending is just what the doctor ordered, and concerns about the budget deficit should be put on hold.

— Nobel Laureate Paul Krugman, 2008

Introduction

The importance of international (or global) public goods (IPGs) has recently given rise to intense analyses in the academic literature (see, for example, Kaul *et al.* 1999 and Ferroni and Mody 2002). A pure IPG, in principle, can generate benefits that spill over borders, regions, ethnic groups, and generations. Morrissey *et al.* (2002) classify IPGs into five categories: environment, health, knowledge, security, and governance. Types of IPGs as diverse as internet securities, financial market stability, biodiversity preservation, and knowledge can be framed in terms of the so-called *weakest link*, *weaker link*, *better shot*, and *best shot* public goods (Sandler 1998 and Arce M. 2004). The introduction of these adjectives characterizes the variety of ways in which the international collective action is translated into the provision of public goods. For instance, the smallest effort or contribution uniquely determines the public good level for a *weakest link* technology, while the largest effort or contribution uniquely determines the public good level for a *best shot* technology. Sandler (1998, p. 232) pointed out that some of the most worrisome public good challenges facing human beings adhere to the best-shot technology. It is quite conceivable that the provision of global public goods has remained under-provided and faced with a global governance challenge.

To help advance the provision of IPGs, this paper stresses the urgency of enhancing spending cooperation and coordination mechanisms between national authorities. The second section investigates the planning property of the government and analyzes ideal types of economic planning initiated by the local government and the central government. The third section uses several game examples to illustrate the provision of public goods. The fourth section analyzes global planning for the provision of IPGs via spending cooperation between national authorities. The fifth section concludes.

Economic Planning of the Government

In economic academia, the mainstream approach tends to treat the economy and other subjects such as politics as distinct areas, namely, the economy as one topic and politics as another. This mode of dichotomy, indeed, can be regarded as a general practice of dualism, a concept applied to describe a phenomenon of two co-existing but independent elements (Dow 1990). Under the mainstream frame of reference, the prevalence of the price or market mechanism dominates economic analyses and “individuals and their wants are the main focus” (Rosen 2005, p. 7). The economic role of government, as a result, has been logically reduced to resolving market failure.

The mainstream narrow view has, unfortunately, not only blurred the planning property of the government but has also created obstacles in the long-run progress of promoting society. The emergence or existence of government represents the collective will of a society to fulfill its goals, and this realization requires the implementation of various cooperative and institutional mechanisms initiated by the government. The market mechanism is *de facto* an important institution of the society’s planning process, but any overestimation or underestimation of the market mechanism will certainly lead to a distorted perspective on the economic role of government.

Competition, the dynamic process of interaction between buyers and sellers in markets,

puts the free market economy into action. One might wonder whether the full implementation of a free market economy (along with its institutions) caters to all the interests of differential people and communities. People, for instance, might be eager to pursue economic equality for social justice or to develop a self-reliant type of planning economy with limited external trade, and so on. Under these circumstances, the government has to assume a more active and positive role for planning an economy compatible with the expectations of its citizens.

The growth of income and wealth inequality has become a global phenomenon which has rapidly emerged as one of the most formidable challenges facing public finance economists. Indeed, the rich communities (nations) have tended to waste resources, whereas the poor communities (nations) have tended to destroy resources. Due to rising wealth inequalities all over the world and limited resources on earth, the global community has become less and less sustainable. To maintain a sustainable society with an efficient use of resources, it is necessary to achieve a more equitable distribution of wealth (Lin 2006, 2007).

It can be fairly understood that the central planning experiences shown in past communist economies have led many people to develop a deep mistrust (and misunderstanding) of economic planning. It's time, however, for us to seriously re-recognize the significance of economic planning and to re-evaluate the prevalence of radical market liberalism launched in the 1980s by the former Great Britain Prime Minister Margaret Thatcher and the late U.S. President Ronald Reagan. Over the past several decades, mainstream academics have, on the one hand, tended to underestimate the limitations of the market mechanism and, on the other hand, tended to overlook the advantages of economic planning for social long-term development.

In a modern society, economic planning can be understood as a wide search and participation process of coordinating a system of policy measures for bringing about the long-term development of a society. Individual behavior within this framework of collective

action is verified by the network existing in the institutional structure and cultural setting. The nature of economic planning is different from that of competitive economic activity. To proceed with the work of economic planning, the government is obligated to initiate various cooperative and institutional mechanisms to internalize individual choices, to coordinate various needs and interests, and to ensure an equal chance for people of all classes in their participation.

Economic planning of the government will become more and more important in the twenty-first century. This tendency will be reflected in the increasing understanding about the causes and consequences of pressing issues such as environmental degradation and growing economic inequality in a capitalistic society. To help build a sustainable globally-planned economy under the “think globally, act locally” guideline, this paper suggests that it is better for the local government to play a leading role in planning the local economy and, alternatively, for the central government to cooperate with foreign central governments in planning the global economy.

The aforementioned arrangement of economic planning of the government has several advantages. First, the system of more centralized planning at the local government level can help local policies better address local needs and interests. National planning, i.e., economic planning at a national level, frequently cannot cater to the specific interests of local residents. Thus, the central government had better play a supporting role for the local government (Lin 2008). Secondly, the cooperation of a country’s central government with foreign central governments is founded on the implementation of its own country’s economic possibilities. Under this circumstance, the domestic economy will not be vulnerable to external shock since the central government is not easily subject to the clout of foreign governments.

Finally, the implementation of proper economic planning cannot only allow the operation of normal market activity but also help the efficient and timely provision of public goods. To better allocate limited resources on earth and to resolve some pressing issues such

as poverty, all levels of government should abandon the principle of sectionalism and learn how to cooperate with each other to greatly enhance the provision of public goods. That is, each local government must try to learn how to cooperate with other local governments on a national basis and such endeavors will lead to genuine emergence of national public goods (different from that under the dominance of a single central government). Similarly, each central government should learn how to cooperate with other central governments on an international basis and such endeavors will greatly contribute to the emergence of IPGs in a global community.

Poverty, for instance, is frequently entangled with the phenomena such as contagious diseases and criminal activities, which cause great negative impact on other individuals and communities. Reducing poverty, in a sense, possesses the property of public good if poverty reduction induces greater public health and security. From a global village perspective, the reduction of poverty has become even more significant if it contributes to disease eradication and global peace, both of which are considered as important IPGs. To further illustrate the significance of spending cooperation for the provision of (international) public goods, it might be useful to review some examples of public goods in Section three.

Some Examples of Public Goods: A Review

It is well known that the non-excludable property of public goods may result in the under-provision of public goods. This concept can be illustrated by the following simple game. Consider that there are two players, A and B. Each player can provide one unit or none of a public good. Each unit of public good yields a benefit of 4 to each player, at a cost of 6 to the contributor. The two players' payoffs under different outcomes are illustrated in Figure 1, where C stands for "contribute", and N stands for "not contribute."

When the two players decide not to provide any public good, the net benefit is zero for both players. If A contributes, but B does not, then A's net benefit equals -2, and B's net

benefit is 4. Since this game is symmetric, if B contributes but A does not, the payoffs for the two players are reversed. Finally, if both players contribute, then each receives a net benefit of 2. We can easily verify that the Nash equilibrium outcome is $\{N, N\}$, in which neither player would provide the public good. Indeed, the strategy of “not contribute” is a dominant strategy; that is, for each player, choosing the strategy of N always generates a higher payoff than choosing C, regardless of the other player’s strategy.

This simple game is the famous Prisoner’s Dilemma game. A well-known consequence of the Prisoner’s Dilemma game is the emergence of a Pareto-inferior equilibrium. In Figure 1, each player receives the net benefit of 2 in the outcome of $\{C, C\}$, whereas each of them receives nothing in the equilibrium outcome $\{N, N\}$. Although the outcome in which the two players contribute gives rise to higher payoffs for each of them, each player has an incentive to be a free rider. For example, if player A deviates away from the outcome of $\{C, C\}$, then he can receive a higher net benefit of 4. Since the payoffs are symmetric in this simple game, both players have the incentive to deviate away from $\{C, C\}$. Thus, $\{C, C\}$ is not the equilibrium outcome.

However, the non-excludable property of public goods does not necessarily lead to the under-provision of public goods. In what follows, we propose some examples to demonstrate this point. First, we reverse the benefit and cost per unit of public good. That is, each unit of public good provided yields a benefit of 6 to each player, at a cost of 4 to the contributor. Figure 2 illustrates the payoffs under the four possible outcomes.¹ In this game, for the two players, the strategy of contributing is the dominant strategy. Namely, for each player, choosing the strategy of C always generates a higher payoff than choosing N, regardless of the other player’s strategy. As a result, $\{C, C\}$ is the unique Nash equilibrium. This result indicates that if the benefit from providing the public good is sufficiently large, then the property of non-excludability need not bring about a Pareto-inferior outcome.

Another possible situation in which $\{C, C\}$ will be the Nash equilibrium outcome is

the assurance game described by Cornes and Sandler (1996). The assurance game is illustrated by Figure 3. In this game, we assume that the public good gives rise to a positive benefit only when the two players contribute. Neither one receives a positive benefit when only one player contributes. Both players have to contribute a unit of the public good for the players to receive a benefit of 4 from each unit of public good provided. If the two players contribute a unit, then each receives a total benefit of 8 from the two units of public good, at a unit cost of 6, and thus the net benefit for each player is 2. However, if only one player contributes, then the contributor pays the costs but receives nothing.

We can verify that the assurance game possesses two pure-strategy Nash equilibria: {C, C} and {N, N}; that is, the two players contribute or no one contributes. Although the structure of the benefit and cost is the similar to the Prisoner's Dilemma game, cooperation is a possible equilibrium outcome in the assurance game, whereas it does not occur in the Prisoner's Dilemma game. The reason for this is that the free rider obtains nothing in the assurance game, and thus the two players have the incentive to cooperate. From these examples, we have learned that the incentive to being a free rider is sensitive to the structure of the benefits and costs of public goods.

The emergence of the cooperation may stem from the consideration of altruism. Altruism refers to feeling of concern for other people. Although the notion of altruism does not meet the self-interest assumption made by the standard model, it will not affect the analysis tools adopted. That is, a player still seeks to achieve the highest level of utility in the presence of altruism.

We use Figure 4 to show how the presence of altruism may lead the cooperation to be a Nash equilibrium outcome. Suppose each unit of public good yields a benefit of 4 to each player, at a cost of 6 to the contributor. But now the existence of altruism will provide an additional benefit v to the contributor. As a result, the total benefit for the contributor is equal to $4 + v$, and the net benefit equals $-2 + v$.

We note that if v equals zero, then this game is reduced to the Prisoner's Dilemma game described above. If v is less than 2, then $\{N, N\}$ is the unique Nash equilibrium outcome. If, however, v is greater than 2, then the strategy of contribution becomes the dominant strategy, and thus $\{C, C\}$ is the unique Nash equilibrium outcome. This simple game indicates that cooperation may be the equilibrium outcome in the presence of altruism.

Global Economic Planning: Spending Cooperation for the Provision of International Public Goods

In some instances, the provision of public goods can generate very large benefits not only for the contributing country but also for other countries. National authorities around the world to a great extent, as the "fully privileged" game shown in the previous Section, have a better chance of cooperating with others to contribute the provision of IPGs and to enjoy the benefits. From a global village perspective, several types of (national) public goods such as *national defense* can not be considered as a pure public good any longer. Instead, it is appropriately considered as a special type of hostile club good. In this regard, central governments around the world should abandon traditional individual spending on national defense, and cooperate on various spending schemes for regional or global peace.

Take peacekeeping for example. Peacekeeping within a region or a country requires close cooperation between countries. In order to succeed, every country at stake has to actively participate in resolving the conflicts. If one country chooses to free-ride on the efforts of others, the efforts done by all other countries will eventually become futile. This type of condition is very similar to the assurance game in which the public good will give rise to a positive benefit only when both players contribute.

The free-rider problem has been well documented in the models such as the tragedy of the commons, the prisoner's dilemma, and the logic of collective action (primarily developed by Olson, 1965). According to the aforementioned models, the choice of free-riding

may tend to dominate the decision process and the public or collective benefit will not be created. This paper, however, wants to point out that countries will gradually realize that there has not been an abundance of room for them to free-ride. First, the global economy has become much more complicated and integrated, and countries around the world will increasingly perceive the pressure of resolving some common problems such as the current global financial crisis. Thus, they will be forced to (or choose to) work together to restore the global financial market stability. Second, free-riding could generate an implicit daily cost. Since it is tempting to be a free rider, the provision of international public goods has been (and will be) substantially delayed. It can be well anticipated that the cost of providing public goods in the present global community could substantially increase. If countries later decide to participate in the provision of public goods which they previously refuse, they might incur a higher cost due to such a time delay (or lag).

Altruism has recently drawn attention in the analysis of a sustainable society and has been considered instrumental for global sustainability. According to van den Bergh (1996, p. 59), the ethical-utopian perspective of sustainable development emphasizes “new individual value systems (respect for nature and future generations, basic needs fulfillment) and new social objectives (steady state); ... long-run policy based on changing values and encouraging citizens (altruistic) behavior as opposed to individual (egoistic) behavior.” When an individual takes the public benefit into account, he will obtain a higher level of satisfaction due to his devotion to public affairs. Or, he might experience the feeling of a reduction in his own efforts or costs (as he has done a good thing for many people). Similarly, a country might earn a better reputation and therefore obtain a higher sense of achievement if it cares about the global pressing issues. If this level of achievement or satisfaction derived from altruism is sufficiently large, as demonstrated in Figure 4, then the outcome of cooperation will appear.

In reality, economic planning for the provision of public goods in a global community

is not an automatic mechanism. As Hayden (1987, p.1281) has shown, critical to “any planning is the question of *when* actions and events are to occur.” For illustrative purposes, we might consider the following hypothetical scheme. Suppose country A is very vulnerable to avian flu and decides to eradicate avian flu via the government budget. It is better for other countries to financially and economically acknowledge country A’s spending efforts (in promoting the emergence of an IPG). Country A, however, might have a budget shortfall to carry out other domestic policies (after the execution of its limited budget in the prevention of avian flu). Under this circumstance, we would expect some other countries to execute policy measures (possibly taking precedence over the needs of their individual country) that could provide or generate benefits (of another IPG) catering to country A’s need.

Conclusions

Keynes has long understood the unstable nature of capitalism and emphasized that the government has to pay close attention to the frequent occurrence of economic instability and crises. As the global economy has become much more volatile as compared to a century ago, central governments all over the world must seriously plan how to cooperate with each other and give priority to the provision of international public goods. This paper also points out that the cooperation of a country’s central government with foreign central governments should be founded on the implementation of its own country’s economic possibilities. That is, it is better for the local government to play a leading role in promoting the long-term development of the local economy and the central government should play a crucial supporting role for the local government.

If we investigate the ongoing global financial crisis and serious economic downturn, we will soon comprehend the significance of initiating global economic planning. The current Keynesian approach of increasing public (deficit) spending adopted by each individual country could only generate limited and temporary impact on the economy. To restore the

global financial market stability, an important type of IPG, and to further global economic sustainability, what we urgently need is a comprehensive economic plan for reinforcing government spending cooperation.

Note

1. Cornes and Sandler (1996) refer to this game as the “fully privileged” game, because each player is motivated to privilege the other player.

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A \ B	N	C
N	0 0	4 -2
C	-2 4	2 2

Figure 1

A \ B	N	C
N	0 0	6 2
C	2 6	8 8

Figure 2

A \ B	N	C
N	0 0	0 -6
C	-6 0	2 2

Figure 3

A \ B	N	C
N	0 0	4 -2+v
C	-2+v 4	2+v 2+v

Figure 4

第三篇論文（初稿）

IS-LM-EE 模型：引入汙染對人力資本的影響

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摘要：本篇論文延伸了由 Heyes (2000) 所提出之 IS-LM-EE 架構，考慮人力資本與自然資源兩種生產要素。由於經濟活動所導致之汙染，傷害了人力資本之邊際產值，進而不利於長期經濟成長，而本文將以上的概念具體化並引入模型中，並藉此試圖從生產者的角度—極小化投入要素成本之目標出發，探討總體經濟可藉由該過程，讓自然資源要素之使用受到抑制，由此建立出能夠讓總體-環境均衡 (macro-environmental equilibrium) 自我調節之機制。

關鍵詞：IS-LM-EE；環境；人力資本

1. 前言

主流經濟學並未通盤考慮經濟活動與生態環境之間的關連性，但事實上這兩者之間是息息相關的。以全球暖化為例，目前科學家已充分證實二氧化碳的過度排放是造成當前氣候變遷的主要因素，因此二氧化碳的減量課題已成為當前全球學術界、各國政府與環保團體共同關注的焦點（參見如 Broecker, 2007 及 Chameides and Oppenheimer, 2007）。此外，目前關注的焦點集中於二氧化碳，然而未來有可能成為最大的挑戰課題卻是甲烷 (methane) 的過度排放（見 Shine and Sturges, 2007）。以上二氧化碳、甲烷等溫室氣體之過度排放與當前人類社會執著於經濟之高度成長有密不可分的關係，為了後代子孫的永續發展，我們必須及早作出明智的抉擇。從全球暖化的事實觀察，經濟的永續發展必須倚賴一個健全的生態系統，同時一個尊重環境的經濟制度亦可以培育出健康的生態體系。顯而易見地，我們必須加強瞭解自然生態系統和人類經濟活動之間的相互作用與影響，並詳加探究能夠維繫兩者間長期動態平衡之關鍵所在。

本文利用 Heyes (2000) 所提出之 IS-LM-EE 模型之新架構，將有限環境資源的考量，納入凱因斯的 IS-LM 模型中，同時我們亦考慮環境品質對人力資本生產力之作用，使原先的模型分析得以更加豐富。在 Heyes 的文章中，除了原本代表商品市場與貨幣市場結清的方程式外，引進了代表滿足環境可供給且承受的資源取用與污染的環境資源限制式，當人類活動滿足三條方程式時，代表商品與貨幣市場的均衡不僅達到，此時經濟活動亦不致使自然環境遭到傷害；Sim (2006) 認為在 Heyes 的文章中，總體環境均衡 (macro-environmental equilibrium) 之達成，是必須倚賴來自外生的調節，如政府可提高管制資源使用的成本，但前提是政策制定者需充分掌握資訊，了解究竟該給予經濟體系多大的貨幣或財政上的刺激，剛好使得市場均衡是環境可負擔的。於是 Sim 根據 Heyes 的架構基礎，針對均衡的內生收斂，探討是否市場均衡有依自我回復至環境可承受之機制。Sim 認為若經濟活動過度發展，則會造成過多的汙染，超過自然環境可負荷吸收的範圍。該汙染可視為過度生產的成本，能夠抑制市場經濟的過度成長，使其回到滿足環境可持續承受之水準 (sustainable level of economic activity)。透過該機制，當市場均衡產量造成過多汙染時，市場經濟體系可自動將其引導至環境可接受的水準。

本文延伸 Sim 的觀點，引進了人力資本的考量並亦建立出新的自我調整機制。當過度生產所導致的汙染超過環境可吸收負荷的限度時，汙染將對人力資本的發揮造成傷害。例如摩洛哥由於水汙染的關係，當地人力資本遭受相當大的損害（如腦部受損）。生態與公共衛生等相關領域專家建議摩洛哥政府官員，可從加強水質維護與公共衛生方面下手，同時延遲當地投資速度，以避免汙染惡化（見 World Bank, 1996）。而專家的意見雖對短期的經濟成長造成不利的影響，但對於後代福祉與長期發展而言，卻是最好的選擇。本文亦納入了人力資本可進行研發（如針對綠能產業投資）的管

道。投入於技術研發的人力資本可提升自然環境吸收負荷污染與更新再生的能力，或是降低人類倚賴環境資源的程度，如此雖對當下的國民生產毛額的增加沒有立即而明顯的益處，然而此機制卻能打造經濟永續發展的基礎。

2. 理論模型

2.1 人力資本的供給

假設勞動者於 t 期借錢接受教育，並選擇接受教育的時間，以培養出人力資本。勞動者可利用其人力資本賺取工資所得，將所得分配於消費與償付借貸之利息成本。

$$H_t = e(L_t) \quad (1)$$

假設勞動者的行為模式為齊質(homogeneous)，因此考慮代表性勞動者即可。定義 L_t 為勞動者所選擇的受教育時間，也可視作為了培養人力資本而必須投入的代價。 e 為教育函數；受教時間透過此函數，可得到可投入至勞動市場中賺取所得之人力資本， H_t 。

$$M_t = W_t H_t \quad (2)$$

其中 M_t 為 t 期時勞動者所賺取之工資所得；而 W_t 為 t 期之工資率。 $(1+r_t)L_t$ 代表為了累積人力資本而受教育所借貸的金額並加上利息，即受教育之成本。²² 因此 t 期時消費即為當期薪資所得與必須償付金額之差距，由 C_t 表示之。

$$\begin{aligned} \max_{\{L_t\}} C_t &= W_t H_t - (1+r_t)L_t \\ &= W_t e(L_t) - (1+r_t)L_t \end{aligned} \quad (3)$$

將人力資本以 $e(L_t)$ 替換，則 C_t 可表示成 L_t 的函數。勞動者為使得消費極大化，故透過此目標函數，選擇最適之 L_t 。故，一階條件為，

$$W_t e_L(L_t) = 1 + r_t \quad (4)$$

$$e_L(L_t) = \frac{1+r_t}{W_t} \quad (5)$$

²² 一單位時間內，受教育之成本為借貸金額（如學費，以 u 表示）加上利息（ u 與 r 之乘積），因此可加總為 $u(1+r)$ 。而個體在決定受教時間(L)後，其全部受教育之成本即為 $u(1+r)L$ 。由於本文假設該借貸金額(u)固定，故將其簡化令為 1。

$$L_t = e_L^{-1} \left(\frac{1+r_t}{W_t} \right) \quad (6)$$

在第四式中， e_L 為 $\frac{\partial e}{\partial L}$ 。經過整理，可得到第五式與第六式。第六式代表，受教時間的選擇決定於實質利率與工資率比值。由於假設培養人力資本過程中邊際報酬遞減，故 e_L 為一遞減函數。因此，若實質利率工資率比越高，意味受教的報酬不敷成本支出，故勞動者於 t 期時所選擇的受教時間越低，而人力資本供給量也越少。

$$H_t^S = H^S \underset{(-)}{r_t}, \underset{(+)}{W_t} \quad (7)$$

第七式代表人力資本之供給決定於兩個因素，一為當期之實質利率，另一為當期之工資率；前者對人力資本供給產生負面效果，因為實質利率上升即受教成本提高，故不利於人力資本之養成。而工資率則對人力資本供給有著正面的影響；越高的工資率將會帶動勞動者願意累積人力資本的意願。

2.2 生產者的決策

假設模型建立在間斷時間上，且生產者存在於完全競爭市場之中。

$$Y_t = E_t^\alpha (A\pi_t)^{1-\alpha} \quad (8)$$

Y 表示產出； E 為環境資源的使用量²³； π 為受到污染影響的人力資本； A 為技術。下標代表時間。為了方便起見，假設 $A=1$ 。由於在生產的過程中，若是過度的濫用環境資源，會帶來污染（模型中以 γ 表示）。而污染將會傷害人力資本的品質（如健康），減低其生產力，故我們另外假設新的人力資本定義， π 。

$$\begin{aligned} \pi_t &= \pi(\beta H_t, \gamma_t) \\ &= \pi(\eta_t, \gamma_t) \end{aligned} \quad (9)$$

假設生產者在雇用人力資本(H)時，將 β 的比例分配於生產財貨，但在生產時，人力資本可能受到污染影響。在考慮此因素下，我們假設 π 為真正投入於生產過程中的人力資本 (realized human capital)。²⁴ 其中 η 代表 βH 。並假設這些因素對 π 的一階偏

²³ 針對生產者對環境資源的使用，一方面可視作環境所提供之自然資源，如樹木、礦產等等；而另一方面，則可將其看作自然環境吸收廢棄物之能力，如森林可淨化受污染的空氣。

²⁴ 在沒有污染產生的情況下（即 $\gamma = 0$ ），此時 $\pi = \pi(\beta H, \gamma = 0) = \beta H$ ，代表生產者所僱用之人力資

微分爲 $\pi_\eta > 0$ ， $\pi_\gamma < 0$ 與 $\pi_{\gamma\gamma} < 0$ 。²⁵ 倒數第二項即代表，污染程度(γ)加重時，會使得真正可用於生產的人力資本生產力下降；而最後一項則代表在污染不斷惡化的情況下，可使用之人力資本被傷害的幅度將愈加嚴重。

生產者除了生產財貨之外，也將所雇用人力資本中 $1 - \beta$ 的比例，投入於對自然環境有利的研發上，如太陽能或能源科技 (energy technology; ET) 的研究與應用，可舒緩人們對石油的依賴程度。因此，我們可定義污染， γ 。

$$\gamma_t = E_t - s(\phi_t)T_t \quad (10)$$

第十式中的 ϕ 代表 $(1 - \beta)H$ ，也就是生產者投入於研發過程中的人力資本數量 (假設此一部門之人力資本不會受到污染影響)，²⁶ T 爲自然環境所提供的資源存量 (如森林)， s 則爲其自我更生的速度 (如樹木生長速度)，並假設研發出之技術會對自我更生速度有正面影響， $s_\phi > 0$ (如廢水處理技術可淨化有毒廢水)。 $s(\phi_t)T_t$ 則爲 t 期時，環境資源所增加的量，而 E_t 則是 t 期時，人們需求的資源使用量。故若需求大於供給，則代表自然所提供的資源不敷人類的需要，因此污染產生 (如工廠倒廢水至河川，若廢水排倒過多，將使得河川難以自我改善水質，造成污染)。將污染定義爲資源需求與供給的差距。

生產者在求取利潤極大化所做出的決策，同時也是在極小化成本；故假設生產者的目標函數爲，

$$\begin{aligned} \min_{\{H, E\}} \hat{C} &= WH + \Lambda E \\ \text{subject to } Y &= E^\alpha \pi^{1-\alpha} \end{aligned} \quad (11)$$

其中 \hat{C} 表示廠商之總成本，而 Λ 代表使用一單位環境資源，所必須負擔的成本。而一階條件則爲，

本並未受到污染影響，因此真正可從事生產之人力資本量爲 βH 。

²⁵ 在本文中，變數下標若爲 t 則代表時間；若爲其他變數，則表示其他變數對該變數之一階偏微分。舉例， π_t 爲 t 期廠商所僱用之 realized human capital，而 π_γ 則爲污染(γ)對 π 之一階偏微分。

²⁶ 本文假設當投入於研發部門之人力資本數量越多時 (即 $(1 - \beta)H$ 上升)，所研發出之技術 (針對能源或綠能科技而言，非直接提高生產效率之技術) 越進步。

$$W = \lambda[(1-\alpha)E^\alpha \pi^{-\alpha} (\pi_\eta \beta + \pi_\gamma \gamma_s s_\phi (1-\beta))] \quad (12)$$

$$\Lambda = \lambda[\alpha E^{\alpha-1} \pi^{1-\alpha} + (1-\alpha)E^\alpha \pi^{-\alpha} \pi_\gamma] \quad (13)$$

式中之 λ 為 Lagrange 乘數。

定義 $x = \frac{E}{\pi}$ 與 $\theta = \pi_\eta \beta + \pi_\gamma \gamma_s s_\phi (1-\beta)$ 。第十二式與第十三式經過整理後，可得到以下結果。

$$x = \frac{\alpha W}{(1-\alpha)(\Lambda\theta - W\pi_\gamma)} \quad (14)$$

由於 $(\pi_\eta, s_\phi) > 0$ 與 $(\pi_\gamma, \gamma_s) < 0$ ，故 $\theta > 0$ 並且 $x > 0$

將第(14)式帶回限制條件後，可得生產要素使用量之決策。

$$E = \left[\frac{\alpha W}{(1-\alpha)(\Lambda\theta - W\pi_\gamma)} \right]^{1-\alpha} Y \quad (15)$$

$$\pi = \left[\frac{\alpha W}{(1-\alpha)(\Lambda\theta - W\pi_\gamma)} \right]^{-\alpha} Y \quad (16)$$

從第(16)式，我們可得知，生產者在面對越高的工資率，將會雇用較少的人力資本及使用較多的環境資源，並產生污染。而此兩因素將造成 π 下降。

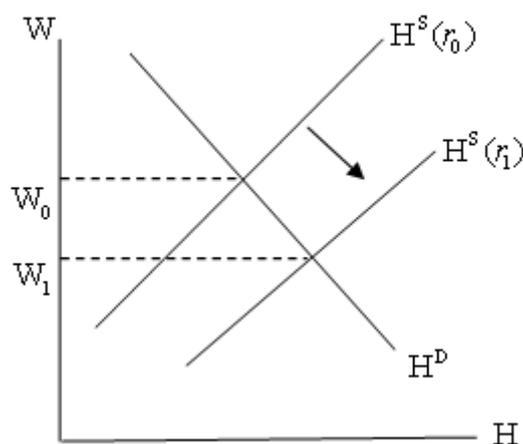


圖 1: 人力資本市場均衡

考慮第(7)與第(16)式，可得到人力資本需求與供給分別對應至工資率的關係(見上圖)。當實質利率下降時，受教育的成本下滑，因此人力資本供給增加，故人力資本市場中均衡的工資率減少，均衡的人力資本量上升。透過上圖，我們可將均衡工資率的函數表達如下：

$$W = W(H(r), r) \quad (17)$$

$$\frac{\partial W}{\partial r} = \frac{\partial W}{\partial H} \cdot \frac{\partial H}{\partial r} + \frac{\partial W}{\partial r} \quad (18)$$

$\begin{matrix} (-) & (-) & (+) \end{matrix}$

由第七式可知，若維持 $1+r/W$ 比率固定，則人力資本供給數量不變，故(18)式中最後一項偏微分（實質利率對工資率的直接影響）為正。而前一項偏微分則代表，實質利率透過人力資本對工資率產生之間接影響。利率下降時會導致人力資本供給上升，故 $\frac{\partial H}{\partial r}$ 負。並且從圖中可知，供給線右移的結果為均衡的人力資本雇用量上升，而滿足此條件的要求為工資率下跌，故 $\frac{\partial W}{\partial H}$ 亦為負。因此，實質利率對工資率影響之綜合效果為正；也就是實質利率的上升會帶動工資率的提高，故第(17)式亦可表示為下式：

$$W = W(r) \quad (19)$$

$\begin{matrix} (+) \end{matrix}$

故第(15)式與第(16)式可改寫如下，

$$E = \left[\frac{\alpha W(r)}{(1-\alpha)(\Lambda\theta - W(r)\pi_\gamma)} \right]^{1-\alpha} Y \quad (20)$$

$$\pi = \left[\frac{\alpha W(r)}{(1-\alpha)(\Lambda\theta - W(r)\pi_\gamma)} \right]^{-\alpha} Y \quad (21)$$

利用(20)式，將實質利率對環境資源使用量做偏微分，可得到，

$$\frac{\partial E}{\partial r} = Y(1-\alpha) \left[\frac{\alpha W}{(1-\alpha)(\Lambda\theta - W\pi_\gamma)} \right]^{-\alpha} \left[\frac{\alpha(1-\alpha)\Lambda\theta \frac{\partial W}{\partial r}}{((1-\alpha)(\Lambda\theta - W\pi_\gamma))^2} \right] > 0 \quad (22)$$

上式代表，生產者在面對較高的實質利率時，考慮到高利率將使得培養人力資本的負擔加重，因此人力資本供給減少，造成市場中的均衡工資率勢必提高，故在產出水準維持不變下，傾向使用較多的環境資源，以替代較高價格的人力資本。²⁷ 同樣地，將產出水準對環境資源使用量做偏微分，可得到

$$\frac{\partial E}{\partial Y} = \left[\frac{\alpha W}{(1-\alpha)(\Lambda\theta - W\pi_\gamma)} \right]^{1-\alpha} \quad (23)$$

第(23)式代表環境資源為正常要素；同理，人力資本亦為正常要素。

2.3 β 的內生調整

前面文中皆假設 β 為不被生產者所決定之常數。故接下來我們考慮 β 的內生調整及其效果。由(12)式可知，人力資本的邊際生產力即 $(1-\alpha)E^\alpha \pi^{-\alpha}\theta$ ，而 θ 定義為

$\pi_\eta\beta + \pi_\gamma\gamma_s s_\phi(1-\beta)$ 。廠商決定出兩種生產要素(見(21)與(22)式)後，接著進行人力資本

的兩部門配置。而人力資本的邊際生產力即反映於 θ 上。 θ 當中的 $\pi_\eta\beta$ 與 $\pi_\gamma\gamma_s s_\phi(1-\beta)$

分別代表分配於生產財貨部門以及研發部門中的人力資本(H)，對真正能為廠商創造利潤與進行生產的人力資本(π)所帶來的影響。故廠商希望能透過 β 的調整，使得 θ 極大

化，而一階條件為 $\frac{\partial \pi_\eta\beta}{\partial \beta} = \frac{\partial \pi_\gamma\gamma_s s_\phi(1-\beta)}{\partial 1-\beta}$ ，亦即人力資本 H 的最適分配可使得兩部門

²⁷ 廠商之生產函數可包括實質資本，而該雇用成本則同樣為實質利率。在 Heyes 與 Sim 的文章中，兩人皆假設生產投入為環境資源與實質資本，且該兩要素在生產財貨過程中，可彼此替代；即實質利率上升（使用實質資本的價格提高），則生產者將以環境資源投入取代之。

的邊際效果一致²⁸。

2.4 污染對於均衡的影響

若政府今採行擴張性的財政政策或貨幣政策，將使得財貨的需求上升，而生產者在面臨此情況下，以增加生產要素使用量來因應需求。但若是過度的使用環境資源，讓自然環境來不及產生供給或吸收廢棄物，將造成污染。故生產者必須進行第二階段的生產要素使用調整。

$$\frac{\partial E}{\partial \gamma} = Y(1-\alpha) \left[\frac{\alpha W}{(1-\alpha)(\Lambda\theta - W\pi_\gamma)} \right]^{-\alpha} \left[\frac{-\alpha(1-\alpha)W(\Lambda \frac{\partial \theta}{\partial \gamma} - W\pi_\gamma)}{((1-\alpha)(\Lambda\theta - W\pi_\gamma))^2} \right] \quad (24)$$

其中， $\frac{\partial \theta}{\partial \gamma} = \pi_\gamma \gamma_s s_\phi (1-\beta) > 0$ ，故 $\frac{\partial E}{\partial \gamma} < 0$ 。表示當污染產生時，生產者將選擇使用較少的環境資源，以避免污染的增加持續對人力資本的生產力造成傷害，故改用人力資本替代來生產財貨。

但若生產者並未使用任何人力資本於研發上，即 $\beta = 1$ ，此時生產要素的調整過程為，

$$\frac{\partial E}{\partial \gamma} = Y(1-\alpha) \left[\frac{\alpha W}{(1-\alpha)(\Lambda\theta - W\pi_\gamma)} \right]^{-\alpha} \left[\frac{\alpha(1-\alpha)W^2 \pi_\gamma}{((1-\alpha)(\Lambda\theta - W\pi_\gamma))^2} \right] \quad (25)$$

比較(24)式與(25)式，可得知，

$$\left| \frac{\partial E}{\partial \gamma} \right|_{\beta=1} < \left| \frac{\partial E}{\partial \gamma} \right|_{\beta<1} \quad (26)$$

第(26)式表示，若生產者願意投入一部分的人力資本於研發上，則污染所造成的負面影響較少，因為生產者可透過研發，使得自然資源的自我更生能力得以加強；此時生產者能夠用較快的速度調節生產要素的使用。由於雖然環境與人力資本兩要素皆是廠商生產投入來源，當人力資本產值下降後，廠商並不見得能夠立即調整對於環境要素的

²⁸ 假設 π 與 s 的函數設定可滿足最適 β 的存在條件。

依賴（可看做短期之間，生產者對環境要素的使用維持一定程度的僵固性）。因此若生產者平時願意投入於綠能產業的研發，則生產要素替代轉換的過渡期可加快，而不是廠商面對員工產值不斷下降，造成短期間利潤損失，但卻無法立刻轉變其生產決策。

2.5 IS-LM-EE 的均衡

考慮政府此時採擴張性財政政策，IS 線右移。並定義環境總體經濟限制式 (EE 線):²⁹ $E_t(r, Y; \gamma = 0) = s(\phi_t)T_t$ ，也就是沒有汙染的情況。³⁰ 同時配合代表商品市場與貨幣市場結清的 IS 與 LM 曲線，我們以下面二式表示之：

$$IS: Y = \Phi(Y, r; G, T) \quad (27)$$

$$LM: \frac{M^s}{P} = \Gamma(r, Y) \quad (28)$$

其中 G 表示政府採取擴張性財政政策，而 T 則代表政府課稅， $\frac{M^s}{P}$ 為實質貨幣供給， Φ 為商品需求函數，而 Γ 為實質貨幣需求函數，且假設 $\Phi_Y > 0$ 、 $\Phi_r < 0$ ³¹、 $\Phi_G > 0$ 、 $\Phi_T < 0$ 、 $\Gamma_r < 0$ ，以及 $\Gamma_Y > 0$ 。因此我們可建立以下之 IS-LM-EE 模型。

²⁹ 本文循 Heyes 對 EE 線斜率之假設，認為與 IS 線比較下，環境資源的使用對利率較不敏感，因此 EE 線較 IS 線陡，並將其表現於圖四中。

³⁰ 在 Heyes 的文章中，EE 線可看作，政府為了達到生態與經濟能夠永續發展，而在市場經濟體系上加上的環境總體經濟的目標或條件；但在 Sim 文內則表示市場本身已有動機去滿足該環境總體經濟限制式。本文分析類似 Sim 的結果，但其中調整過程中所耗費的時間，則和該市場對於綠能技術之研發呈反比。

³¹ 利率對總和需求的影響，也包括了對培養人力資本的投入(L)。利率上升將抑制社會對於花費在人力資本培育的投入。

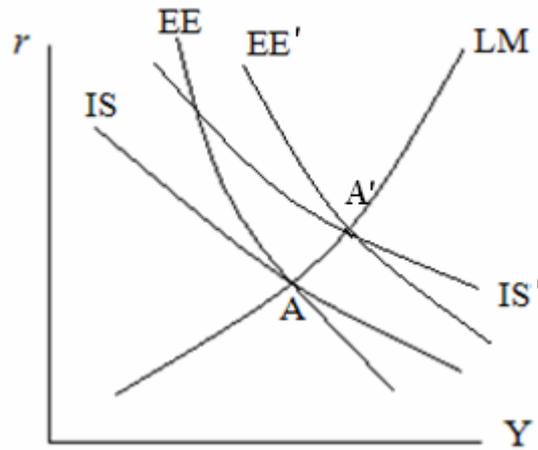


圖 2: IS-LM-EE 均衡

當 IS 右移後，新的 IS-LM 均衡點為 A' ，而該均衡點並不滿足環境總體經濟限制式。由於 A' 在 EE 線之右側，代表此時使用過多的環境資源，因此污染產生³²，即 $E_t > s(\phi_t)T_t$ 。而生產者也以減少對於環境資源的依賴來因應 ($E \downarrow$)，改採用人力資本，此舉將導致 EE 線右移，直到汙染不再存在，即 $E_t = s(\phi_t)T_t$ ，而這也意味著均衡點 A' 回到了 EE 線上，達到 steady-state 的狀態。

根據第(26)式，對於投入研發過程的生產者而言，其將得以更快的速度使 IS，LM 與 EE 線重合。因此研發部門的存在將有利於社會。故政府政策若能配合生產者的研發努力，則政策效果則越能立即有效發揮。

3. 結論

IS-LM-EE 的模型架構提供我們一個清晰且簡便的工具，使環境資源的考量不再只能以個體經濟的角度思考，而是能夠放進總體經濟的範疇之中，使我們得以在看待環境議題時，亦可以利用總體經濟模型，獲得財政與貨幣等相關政策的啟發。

本文嘗試納入個體經濟基礎分析，並考慮人力資本為生產要素之一，其生產力會受到汙染影響而降低，因此該機制可驅使生產過多的社會，減輕對環境資源使用的依賴度，如此市場均衡將會回到生態環境品質不致於遭受傷害的水準。雖然透過該可自我調整之機制，即使沒有政府部門之干預，市場均衡終究會滿足環境資源限制式並回歸 IS-LM-EE 均衡，但是到時候可能已造成龐大的社會與生態環境成本，因此本文亦

³² 雖然汙染也會影響廠商供給的數量，即汙染上升時，IS 線將左移，但是不會對基本結論產生影響，因為對於投入於研發的社會，EE 線可以更快地調整，讓最終均衡的產出仍可保持在 A 點右方。

納入研發科技的考量。生產者可僱用人力資本，投入於研發綠能相關技術的提升，如此生產者將可以更快的速度改變生產決策與調整生產要素的投入量，而污染所導致的負面影響也得以緩和。

然而文中的生產者面對人力資本產值會被污染影響的事實，故必須完全承擔污染所造成的成本，此意味著污染在本文內所帶來的外部性問題，並未如現實中來得嚴重。由於在現實生活中，個別小廠商意識到只靠自身的對綠能產業的研發努力，以及鼓勵人力資本的使用，也無法解決存在於社會上的污染問題，故可能出現搭便車者。亦或是可能存在廠商在面臨勞動力生產品質受到污染傷害時，即立刻解聘並雇用新的健康員工，如此廠商並不負擔污染成本，而將其完全轉嫁於社會。雖然在此情況下，廠商可短期不需面對汙染成本，但長期看來，當社會與環境被污染嚴重影響，廠商仍必須承擔該成本（例如找不到健康的勞動力），故生產者還是得改變生產決策並進行研發投資，以降低對環境資源的倚賴程度，與減少污染。但此過度轉變時期，亦可能拉得過長，對社會與生態環境造成巨大負面影響，因此政府對於生產者排放污染量，所訂定的管制法規事實上仍然有其必要性。而後續研究亦可針對政府管制的部份多加著墨，或是政府可直接對生產者設立研發部門的行動進行補貼，以及對生產者課徵能源稅等相關措施，刺激廠商對人力資本使用，以替代環境資源的誘因。

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第四篇論文（初稿）

Green Spending, Environmental Sustainability, and Optimal Taxation

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Abstract: The main purpose of this paper is to investigate the implementation of government green spending as an effective instrument for enhancing both environmental sustainability and economic efficiency. By utilizing a model with two types of households that is examined in the optimal taxation literature, this paper analyzes the impact of green spending, the properties of optimal tax rates, and the optimal provision of the public good. Our results indicate that the overall effect of green spending measured in terms of the government's revenue is subject to several factors such as the influence of green spending on environmental sustainability, the cost of green spending, the polluting effect, and so on. To figure out the optimal provision of public goods, the above-mentioned factors have to be taken into account. For instance, if the polluting effect is strengthened, the individual marginal effective tax rate and the commodity tax rate on the polluting good will both rise to discourage the demand for the consumption of polluting commodities.

Keywords: Green Public Goods; Environmental Sustainability; Greened Samuelson Rule

Obama rightly sees an expanded role for government as vital to meeting the 21st-century challenge of sustainable development.

— Jeffrey D. Sachs, 2009

Only a handful of economies devoted a significant chunk of their total fiscal stimulus to green projects. Most were cautious about making low-carbon and other environmental investments during a recession, and some did not implement any green stimulus measures at all...Supported by the right policies, green spending can be very effective.

— Edward Barbier, 2010

1. Introduction

Environmental issues have become the focus of more and more attention, and the analysis of market-based policy instruments such as taxes and charges for reducing environmental externalities has been well documented in the literature. Although a wide range of environmental externalities such as various types of pollution have been examined, the practical experiences have shown that the role of environmental taxes and charges is very limited. Clearly, higher tax rates create a political obstacle to the promotion of the environmental tax base and system. To help resolve the critical issues related to the deterioration of the environment, this paper proposes that the government initiate a spending scheme for the provision of green public goods.

To demonstrate that government green spending can be an effective measure for not only lowering tax rates but also improving environmental quality, we extend the model on optimal taxation examined in the literature by incorporating the condition of environmental sustainability. To the best of our knowledge, we are the first to discuss the problem of environmental sustainability in the optimal taxation literature. Our approach can also be seen as part of a literature that integrates environmental sustainable development with optimal taxation.

Pirttilä and Tuomala (1997) employ a self-selection approach that is characterized by a two-type economy (i.e., two types of households with different earning ability) to analyze the impact of environmental externalities on proportional commodity taxation and non-linear income taxation. They show that increased negative externalities will lead to higher marginal tax rates and also affect the optimal provision of public goods. This paper differs from that of Pirttilä and Tuomala (1997) in terms of the inclusion of a government with foresight that has a goal of achieving environmental sustainability. In this regard, the government provides not only traditional public goods (such as national defense weapons which are detrimental to the environment) but also green public goods used for promoting

sustainable environmental development. The provision of green public goods includes, for example, toxic clean-up and pollution prevention, biodiversity conservation, wetland conservation and management, the supply of renewable energy sources or/and technologies, fuel-efficient public transportation, research and development for reducing greenhouse-gas emissions, strict enforcement of environmental law for improving environmental quality, and spending measures to help the environment self-renew sustainably, and so on.

In the double dividend literature, environmental taxes have been generally regarded as a method for reducing environmental deterioration and also for improving efficiency by cutting other distortionary tax revenues. This paper points out that the implementation of green spending will not only give rise to benefits from the so-called double dividend, but will also generate additional benefits. The provision of green public goods contributes to the attainment of the macro-environmental equilibrium. In addition, the provision of green public goods could lead to a reduction in the individual marginal effective tax rate.

The rest of the paper is organized as follows. Section 2 extends the model developed by Pirttilä and Tuomala (1997) by introducing the government environmental sustainability condition. After deriving the first-order conditions for the government's optimization problem, Section 3 presents a modified *greened* version of the Samuelson rule, i.e., the optimal provision of the public good in connection with environmental sustainability. Section 4 analyzes the optimal tax structure, including individual effective marginal tax rates and commodity taxes. Section 5 provides some discussion about the policy implications and concludes.

2. The Model

2.1 The Consumer's Optimization Problem

We consider an economy consisting of two types of households with identical preferences similar to that in Pirttilä and Tuomala (1997). Type-2 households have higher productivity and receive a higher wage rate: $w^2 > w^1$. Households supply labor and earn income $Y^h = w^h L^h$, where Y^h denotes income and L^h denotes the labor supply of household h . Assume that each household has a utility function such that

$$u^h = u(X^h, l^h, G, E), \quad h = 1, 2, \quad (1)$$

where X^h is the quantity consumed of the private good by household h ($h=1, 2$ indicating a household's type) and $X^h = (X_i)$, $i = c, d$. Good c is environmentally clean. Good d , however, is environmentally polluting or harmful, and creates negative externalities. Leisure is given by $l^h = 1 - L^h$ after we normalize the time endowment. We further assume that the government provides not only traditional public goods (such as national defense weapons

which are detrimental to the environment), G , but also green public goods, E , for promoting environmental sustainability. The fact that the green public good, E , appears in the household's utility function indicates that consumers are increasingly aware of the importance of environmentally sustainable development and enjoy the provision of green public goods.

To analyze the government's optimization problem, we follow Christiansen (1984) and Edwards et al. (1994) and break the consumer's optimization into two stages. With given labor supply, a fixed amount of after-tax income, B^h , is optimally allocated over the consumption goods in the first stage. We denote the vector of consumer prices by $Q = (q_i) = (p_i + t_i)$, where p_i and t_i stand for the constant producer price and tax rate of good i . The consumer's first-stage optimization provides conditional indirect utility

$$V^h(Q, B^h, Y^h, G, E, w^h) = \max_X \left\{ u(X^h, \frac{Y^h}{w^h}, G, E) \mid \sum_i q_i X_i^h = B^h \right\}. \quad (2)$$

Solving (2) gives conditional demand functions

$$X_i^h(Q, B^h, Y^h, G, E, w^h) = -\frac{V_i^h}{V_B^h}, \quad (3)$$

where $V_i^h = \partial V^h / \partial q_i$.

In the second stage, given the budget constraint $B^h = Y^h - T(Y^h)$, the optimal working hours will be determined to maximize the conditional utility function, where T is the income tax function. The second stage optimization gives the following condition

$$V_B^h(1 - T') + V_Y^h = 0, \quad (4)$$

where T' is the marginal income tax rate.

2.2 The Government's Optimization Embedded with a Vision of Environmental Sustainability

Since the dawn of the twenty-first century, environmental degradation has rapidly emerged as one of the most formidable challenges in the pursuit of the goal of sustainable development (e.g., Dietz et al. 2003; Diamond 2005; Meadows et al. 2005; and Broecker 2007)). So far, the exploration of sustainability has led to several alternative definitions such as *weak sustainability*, *strong sustainability*, and so on. In this paper, environmental sustainability refers to a sustainable state that satisfies the following condition: the total employment of environmentally harmful resources generated in an economy can be equally offset by the provision of government green public goods. The above-mentioned notion is partly inspired by Daly's exposition of a sustainable economy, a steady-state economy (SSE). According to Daly (1973, 1977, 2005), the SSE refers to an economy whose scale

remains at a constant level. This level neither depletes the materials from the environment beyond its regenerative capacity nor pollutes the environment beyond its absorptive capacity.

To help promote the SSE in practice, we argue that the government can play a leading role in initiating various schemes for promoting environmental sustainability. Among the various plausible measures, we suggest that the implementation of government green spending can be an effective instrument for enhancing both environmental sustainability and economic efficiency. To manage a macro-environmental sustainable economy, the environmental sustainability constraint is given by

$$\eta(E) = \sum_h X_d^h(Q, B^h, Y^h, G, E, w^h). \quad (5)$$

In (5) $\eta(E)$ can be regarded as environmental quality or the supply of environmental resources, and the provision of green public goods is instrumental for elevating environmental quality (i.e., $\eta_E > 0$). The right-hand side of (5) can be regarded as the summation of environmentally harmful or polluted goods produced in an economy or the demand for environmental resources. Take the emission or waste from polluted and toxic goods as an example. The environmental sustainability condition will be satisfied as long as the amount involved in implementing toxic clean-up and pollution prevention in the government sector is equal to the total emission or waste from polluted and toxic goods generated by all households.

Given the environmental sustainability condition, the government's budget constraint is given by

$$\sum_h (Y^h - \sum_i p_i X_i^h(Q, B^h, Y^h, G, E)) = [\Omega\varphi(\sum_h X_d^h) + (1-\Omega)\phi(G)]E + G, \quad (6)$$

where the left-hand side has been rewritten using the consumer's budget constraints. The right-hand side of (6) is the total expenditure of the green public good and the traditional public good. The price of the public good is normalized to one and the price of the green public good is denoted by $\Omega\varphi(\sum_h X_d^h) + (1-\Omega)\phi(G)$, where $\varphi' > 0$, $\phi' \geq 0$, $0 < \Omega < 1$,

$\varphi(0) = 1$, and $\phi(0) = 1$. The symbol Ω measures the level of the polluting effect on the price of the green public good. When the pollution level increases, it will become more difficult for the government to improve the environment by providing the green public good. Thus, the price of the green public good will rise. The relationship between public goods and green public goods is captured by $\phi(G)$. If the public good and the green public good are complements, the price of the green public good will decrease.

In introducing the Lagrange multipliers θ , λ , γ , and μ , the appropriate Lagrangean function of the government's optimization problem is

$$\begin{aligned}
\Gamma = & V^1(Q, B^1, Y^1, G, E) + \theta[V^2(Q, B^2, Y^2, G, E) - \bar{V}^2] \\
& + \lambda[V^2(Q, B^2, Y^2, G, E) - \hat{V}^2(Q, B^1, Y^1, G, E)] \\
& + \gamma\left\{\sum_h (Y^h - \sum_i p_i X_i^h(Q, B^h, Y^h, G, E)) - [\Omega\phi(\sum_h X_d^h) + (1-\Omega)\phi(G)]E - G\right\} \quad (7) \\
& + \mu\left[\sum_h X_d^h(Q, B^h, Y^h, G, E, w^h) - \eta(E)\right],
\end{aligned}$$

where \hat{V}^2 refers to the type-2 person mimicking the low-ability person. In (7) the government chooses to maximize V^1 subject to achieving a given utility level \bar{V}^2 for a type-2 person. In addition, the government faces three further constraints. The second constraint is the binding self-selection constraint. The third constraint is the government budget constraint and the fourth constraint is the macro-environmental sustainability constraint. The first-order conditions are

$$V_Y^1 - \lambda\hat{V}_Y^2 + \gamma(1 - \sum_i p_i \frac{\partial X_i^1}{\partial Y^1}) - \gamma\Omega\phi' E \frac{\partial X_d^1}{\partial Y^1} + \mu \frac{\partial X_d^1}{\partial Y^1} = 0, \quad (8)$$

$$V_B^1 - \lambda\hat{V}_B^2 - \gamma \sum_i p_i \frac{\partial X_i^2}{\partial B^1} - \gamma\Omega\phi' E \frac{\partial X_d^1}{\partial B^1} + \mu \frac{\partial X_d^1}{\partial B^1} = 0, \quad (9)$$

$$(\theta + \lambda)V_Y^2 + \gamma(1 - \sum_i p_i \frac{\partial X_i^2}{\partial Y^2}) - \gamma\Omega\phi' E \frac{\partial X_d^2}{\partial Y^2} + \mu \frac{\partial X_d^2}{\partial Y^2} = 0, \quad (10)$$

$$(\theta + \lambda)V_B^2 - \gamma \sum_i p_i \frac{\partial X_i^2}{\partial B^2} - \gamma\Omega\phi' E \frac{\partial X_d^2}{\partial B^2} + \mu \frac{\partial X_d^2}{\partial B^2} = 0, \quad (11)$$

$$-V_B^1 X_j^1 - (\theta + \lambda)V_B^2 X_j^2 + \lambda\hat{V}_B^2 \hat{X}_j^2 - \gamma \sum_h \sum_i p_i \frac{\partial X_i^h}{\partial q_j} \quad (12)$$

$$- \gamma\Omega\phi' E \sum_h \frac{\partial X_d^h}{\partial q_j} + \mu \sum_h \frac{\partial X_d^h}{\partial q_j} = 0,$$

$$V_G^1 + (\theta + \lambda)V_G^2 - \lambda\hat{V}_G^2 - \gamma \sum_h \sum_i p_i \frac{\partial X_i^h}{\partial G} \quad (13)$$

$$- \gamma[\Omega\phi' \sum_h \frac{\partial X_d^h}{\partial G} + (1-\Omega)\phi']E + 1 + \mu \sum_h \frac{\partial X_d^h}{\partial G} = 0,$$

and

$$V_E^1 + (\theta + \lambda)V_E^2 - \lambda\hat{V}_E^2 - \gamma \sum_h \sum_i p_i \frac{\partial X_i^h}{\partial E} - \gamma[\Omega\phi' + (1-\Omega)\phi] \quad (14)$$

$$- \gamma\Omega\phi' E \sum_h \frac{\partial X_d^h}{\partial E} + \mu(\sum_h \frac{\partial X_d^h}{\partial E} - \eta_E) = 0.$$

3. The Samuelson Rule for Optimal Provision with the Green Public Good (The Greened Samuelson Rule)

After deriving the first-order conditions for the government's optimization problem, we

can further discuss the optimal provision of green public goods and public goods associated with the environmental sustainability constraint. Adding and subtracting $\lambda \hat{V}_B^2 (V_E^1 / V_B^1)$ in (14) gives

$$\begin{aligned} & (V_B^1 - \lambda \hat{V}_B^2) \frac{V_E^1}{V_B^1} + (\theta + \lambda) V_B^2 \frac{V_E^2}{V_B^2} - \lambda \hat{V}_B^2 \left(\frac{\hat{V}_E^2}{\hat{V}_B^2} - \frac{V_E^1}{V_B^1} \right) \\ & - \gamma \sum_h \sum_i p_i \frac{\partial X_i^h}{\partial E} - \gamma [\Omega \varphi + (1 - \Omega) \phi] - \gamma \Omega \varphi' E \sum_h \frac{\partial X_d^h}{\partial E} + \mu \left(\sum_h \frac{\partial X_d^h}{\partial E} - \eta_E \right) = 0. \end{aligned} \quad (15)$$

Now let MWP_{EB}^h denote the marginal willingness to pay for the green public good, or the marginal rate of substitution between the green public good and after-tax income (V_E^h / V_B^h). Substitutions of (9) and (11) into (15) yield

$$\begin{aligned} & MWP_{EB}^1 \left(\gamma \sum_i p_i \frac{\partial X_i^1}{\partial B^1} + \gamma \Omega \varphi' E \frac{\partial X_d^1}{\partial B^1} - \mu \frac{\partial X_d^1}{\partial B^1} \right) \\ & + MWP_{EB}^2 \left(\gamma \sum_i p_i \frac{\partial X_i^2}{\partial B^2} + \gamma \Omega \varphi' E \frac{\partial X_d^2}{\partial B^2} - \mu \frac{\partial X_d^2}{\partial B^2} \right) - \lambda \hat{V}_B^2 (M\hat{W}P_{EB}^2 - MWP_{EB}^1) \\ & - \gamma \sum_h \sum_i p_i \frac{\partial X_i^h}{\partial E} - \gamma [\Omega \varphi + (1 - \Omega) \phi] - \gamma \Omega \varphi' E \sum_h \frac{\partial X_d^h}{\partial E} + \mu \left(\sum_h \frac{\partial X_d^h}{\partial E} - \eta_E \right) = 0. \end{aligned} \quad (16)$$

Use $\lambda^* (> 0)$ as a notation for $\lambda \hat{V}_B^2 / \gamma$ and introduce the conditional demand function

$$\tilde{X}_i^h(Q, Y^h, \tilde{u}, G, E, w^h) = \arg \min_x \left\{ \sum_i q_i X_i^h \mid u(X^h, \frac{Y^h}{w^h}, G, E) \geq \tilde{u} \right\}. \quad (17)$$

Then, by using the Slutsky equation, we can show that $\frac{\partial X_i^h}{\partial E} = \frac{\partial \tilde{X}_i^h}{\partial E} + MWP_{EB}^h \frac{\partial X_i^h}{\partial B^h}$ and

$\sum_i p_i \frac{\partial \tilde{X}_i^h}{\partial E} = -MWP_{EB}^h - \sum_i t_i \frac{\partial \tilde{X}_i^h}{\partial E}$ (see Appendix A.1 & A.2). Using the above-mentioned properties and results, (16) can be rearranged as

$$\begin{aligned} & \sum_h MWP_{EB}^h - \sum_h \sum_i t_i \frac{\partial \tilde{X}_i^h}{\partial E} - \lambda^* (M\hat{W}P_{EB}^2 - MWP_{EB}^1) - [\Omega \varphi + (1 - \Omega) \phi] \\ & - \Omega \varphi' E \sum_h \frac{\partial \tilde{X}_d^h}{\partial E} - \frac{\mu}{\gamma} (\eta_E - \sum_h \frac{\partial \tilde{X}_d^h}{\partial E}) = 0. \end{aligned} \quad (18)$$

To evaluate the impact of the green public good on environmental sustainability, we denote

the feedback parameter as $\sigma \equiv \frac{1}{\eta_E - \sum_h \frac{\partial \tilde{X}_d^h}{\partial E}}$. The value of σ will become smaller if the

emergence of the green public good leads to lower consumption of the environmentally

polluted goods.³³ The substitution of σ in (18) yields the following proposition:

PROPOSITION 1 In Pareto-efficient mixed taxation, the increased environmental quality via the provision of the green public good (or the shadow benefit of the green public good), measured in terms of government's revenue, $\frac{\mu}{\gamma}$, is given by

$$\frac{\mu}{\gamma} = \sigma \left\{ \sum_h MWP_{EB}^h + \sum_h \sum_i \frac{\partial(t_i X_i^h)}{\partial E} - \lambda^* (M\hat{W}P_{EB}^2 - MWP_{EB}^1) - [\Omega\varphi + (1-\Omega)\phi] \right\} + \Omega\varphi' E(1 - \eta_E \sigma). \quad (19)$$

Proposition 1 shows that the valuation of the green public good consists of six different impacts: (i) the feedback parameter, σ ; (ii) the consumer's willingness to pay for the green public good, $\sum_h MWP_{EB}^h$; (iii) a commodity tax revenue effect, $\sum_h \sum_i \frac{\partial(t_i X_i^h)}{\partial E}$; (iv) the self-selection impact, $(M\hat{W}P_{EB}^2 - MWP_{EB}^1)$; (v) the price effect of the green public good, $\Omega\varphi + (1-\Omega)\phi$; and (vi) the polluting effect, $\Omega\varphi' E$.

To evaluate the sign of the shadow benefit of the green public good, we first consider the feedback parameter. If the improvement in the environment leads to a lower demand for the dirty goods, the value of σ falls. There are two opposing effects resulting from a decrease in σ . We focus on the following effect: a reduction in σ will raise the value of $\frac{\mu}{\gamma}$ as long as φ' and η_E are positive. The intuition is straightforward: the greater the impact of the green public goods on environmental sustainability, the more benefits that will be generated by the green public goods.

The first term inside the brackets measures the sum of the marginal willingness to pay for the green public good. The benefit is bigger if the consumers have placed much emphasis on the environment. The next term takes the impact of the green public good on the commodity tax revenues into account. If an increase in the green public good provision leads to a higher amount of tax revenue being collected, the value of $\frac{\mu}{\gamma}$ will rise, which in turn will affect the green public good provision.

The sign of the self-selection effect is determined by the magnitude of the green public good's relative valuation by the type-1 person and by the type-2 person mimicking the

³³ It is reasonable to assume that the green public good provision leads to a lower demand for the polluted goods, i.e., $\frac{\partial \tilde{X}_d^h}{\partial E} < 0$. Thus, the value of σ is positive.

type-1 choice. If the green public good and leisure are complements ($\frac{\partial MWP_{EB}^h}{\partial l^h} > 0$), the type-2 person can work fewer hours than the type-1 person to earn a given level of income. In this case, $M\hat{W}P_{EB}^2 > MWP_{EB}^1$ and the influence of the self-selection term on the shadow benefit of the green public good is negative. On the contrary, if $M\hat{W}P_{EB}^2$ is smaller than MWP_{EB}^1 , i.e., the weakened self-selection constraint, then the self-selection effect will raise the value of $\frac{\mu}{\gamma}$. If the price of the green public good increases, the expenditures on the green public good will increase and the value of $\frac{\mu}{\gamma}$ will also fall. Finally, under the condition that $1 - \eta_E \sigma$ is positive, a higher polluting effect will increase the benefit of the green public good. Overall, the sign of the shadow benefit of the green public good is ambiguous. To help discuss the design of government policy, we mostly assume that it is positive in the subsequent analysis.

To proceed, we further derive the Samuelson rule for optimal provision with the green public good. Maximizing the Lagrangean function given in (7) with respect to G and using MRS_{GB}^h to denote the marginal rate of substitution of type h between the public good and private consumption (V_G^h / V_B^h) gives the following proposition:

PROPOSITION 2 (Greened Samuelson Rule) Pareto-improvement in the level of the public good provision and in income taxation, when the government has taken the environmental sustainability condition into account, requires that

$$\begin{aligned} \sum_h MRS_{GB}^h = 1 + \lambda^* (M\hat{R}S_{GB}^2 - MRS_{GB}^1) - \sum_h \sum_i t_i \frac{\partial X_i^h}{\partial G} \\ - \left(\frac{\mu}{\gamma} - \Omega \phi' E \right) \sum_h \frac{\partial X_d^h}{\partial G} + (1 - \Omega) \phi' E. \end{aligned} \quad (20)$$

The expression in (20) represents the Samuelson rule for optimal provision with the public good or, in simple terms, the greened Samuelson rule. The traditional Samuelson rule is represented by $\sum_h MRS_{GB}^h = 1$, where the left term is regarded as the benefit raised by the increase in the public good, and the right term is the cost arising from the public good provision. Hence the reductions in the terms on the right-hand side of (20) can bring about a Pareto-improvement. The greened Samuelson rule differs from the condition for the Pareto-efficient provision of the public good presented in Proposition 4 of Pirttilä and Tuomala (1997) in several ways. The first three terms, as usual, measure the price of the public good,

the self-selection impact, and the tax revenue impact. Provided that $\frac{\partial X_d^h}{\partial G} > 0$ is positive,

the fourth term indicates that a Pareto-improving reform will take place if $\frac{\mu}{\gamma}$ rises or ϕ' falls. The fifth term shows that a decrease in ϕ' will lead to a Pareto-improvement.

4. The Optimal Tax Structure

4.1 Individual Effective Marginal Tax Rates

After examining the modification to the Samuelson rule, this section considers the tax policy decision in the presence of externalities and green public goods. The government employs the measures of non-linear income taxation and linear commodity taxation to finance the expenditures on public goods and green public goods. The total taxes paid by individuals h are

$$\tau(Y^h) = T(Y^h) + \sum_i t_i X_i^h(Q, Y^h - T(Y^h), Y^h, G, E, w^h). \quad (21)$$

Differentiating (21) with respect to Y gives the marginal effective tax rate (see Appendix A.3)

$$\tau'(Y^h) = (1 - \sum_i p_i \frac{\partial X_i^h}{\partial Y^h}) + (\frac{V_Y}{V_B}) \sum_i p_i \frac{\partial X_i^h}{\partial B^h}. \quad (22)$$

To investigate the alternative marginal effective tax rates faced by the two types of households, (10) can be divided by (11) and by rearranging terms becomes

$$\frac{V_Y^2}{V_B^2} \sum_i p_i \frac{\partial X_i^2}{\partial B^2} = -(1 - \sum_i p_i \frac{\partial X_i^2}{\partial Y^2}) + (\Omega \phi' E - \frac{\mu}{\gamma}) (\frac{\partial X_d^2}{\partial Y^2} - \frac{V_Y^2}{V_B^2} \cdot \frac{\partial X_d^2}{\partial B^2}). \quad (23)$$

By combining (22) and (23), the marginal tax rate faced by the high-ability household is given by

$$\tau'(Y^2) = (\Omega \phi' E - \frac{\mu}{\gamma}) (\frac{\partial X_d^2}{\partial Y^2} - \frac{V_Y^2}{V_B^2} \cdot \frac{\partial X_d^2}{\partial B^2}). \quad (24)$$

Provided that $\frac{\mu}{\gamma} > 0$ and $\frac{\partial X_d^2}{\partial Y^2} - \frac{V_Y^2}{V_B^2} \cdot \frac{\partial X_d^2}{\partial B^2} > 0$,³⁴ the marginal effective tax rate faced by the

high-ability person will be determined by $\Omega \phi' E$ and $\frac{\mu}{\gamma}$. On the one hand, the marginal ef-

fective tax rate of the high income person rises if there is an increase in the relative weight of the polluting impact, in the price of the green public good caused by increasing pollution, or in government green spending. On the other hand, the marginal effective tax rate of the high income person decreases if the green public good provision leads to an improvement in

³⁴ The sign of $\frac{V_Y^h}{V_B^h}$ is negative. We assume that the polluting good is a normal good, so that the derivatives of

X_d^h with respect to B and Y are positive.

environmental quality (i.e., a rise in the value of $\frac{\mu}{\gamma}$).

Similarly, (8) can be divided by (9) and by rearranging terms becomes

$$\begin{aligned} \frac{V_Y^1}{V_B^1} \sum_i p_i \frac{\partial X_i^1}{\partial B^1} = & -(1 - \sum_i p_i \frac{\partial X_i^1}{\partial Y^1}) + \frac{\lambda \hat{V}_B^2}{\gamma} (\frac{\hat{V}_Y^2}{\hat{V}_B^2} - \frac{V_Y^1}{V_B^1}) \\ & + (\Omega \varphi' E - \frac{\mu}{\gamma}) (\frac{\partial X_d^1}{\partial Y^1} - \frac{V_Y^1}{V_B^1} \cdot \frac{\partial X_d^1}{\partial B^1}). \end{aligned} \quad (25)$$

By substituting (25) into (22), the marginal effective tax rate faced by the low-ability household is given by

$$\tau'(Y^1) = \lambda^* (\frac{\hat{V}_Y^2}{\hat{V}_B^2} - \frac{V_Y^1}{V_B^1}) + (\Omega \varphi' E - \frac{\mu}{\gamma}) (\frac{\partial X_d^1}{\partial Y^1} - \frac{V_Y^1}{V_B^1} \cdot \frac{\partial X_d^1}{\partial B^1}). \quad (26)$$

The first term on the right-hand side is the marginal tax rate without externalities. The second term is a similar kind of externality-included term that is discussed in the case of the type-2 tax rule.

PROPOSITION 3 In a Pareto-efficient mixed taxation framework with the presence of externalities and green public goods, the marginal effective tax rates faced by both ability types of households will be determined by the following factors: (i) the relative weight of the polluting impact, (ii) the price of the green public good caused by increasing pollution, (iii) government green spending, and (iv) the value of $\frac{\mu}{\gamma}$. A rise in any of the first three factors

will increase the marginal effective tax rate, whereas a rise in the value of $\frac{\mu}{\gamma}$ will decrease the marginal effective tax rate.

4.2 Optimal Commodity Taxation

Next we analyze the commodity taxes on the clean good and the polluted good in a Pareto-efficient mixed taxation framework. Rearranging (12) gives

$$-\sum_h \sum_i p_i \frac{\partial X_i^h}{\partial q_j} = \frac{1}{\gamma} [V_B^1 X_j^1 + (\theta + \lambda) V_B^2 X_j^2 - \lambda \hat{V}_B^2 \hat{X}_j^2] + \sum_h \frac{\partial X_d^h}{\partial q_j} (\Omega \varphi' E - \frac{\mu}{\gamma}). \quad (27)$$

The consumer's budget constraint can be written as

$$\sum_h \sum_i t_i \frac{\partial X_i^h}{\partial q_j} = -\sum_h X_j^h - \sum_h \sum_i p_i \frac{\partial X_i^h}{\partial q_j} \quad (\text{see Appendix A.4}). \quad (28)$$

For convenience, we can define $\xi_j = \frac{1}{\gamma} [V_B^1 X_j^1 + (\theta + \lambda) V_B^2 X_j^2 - \lambda \hat{V}_B^2 \hat{X}_j^2] - \sum_h X_j^h$.

Combining (27) and (28) and substituting ξ_j in the matrix form, we obtain

$$\begin{pmatrix} \sum_h \frac{\partial X_c^h}{\partial q_c} & \sum_h \frac{\partial X_d^h}{\partial q_c} \\ \sum_h \frac{\partial X_c^h}{\partial q_d} & \sum_h \frac{\partial X_d^h}{\partial q_d} \end{pmatrix} \cdot \begin{pmatrix} t_c \\ t_d \end{pmatrix} = \begin{pmatrix} \xi_c + \sum_h \frac{\partial X_d^h}{\partial q_j} (\Omega \varphi' E - \frac{\mu}{\gamma}) \\ \xi_d + \sum_h \frac{\partial X_d^h}{\partial q_j} (\Omega \varphi' E - \frac{\mu}{\gamma}) \end{pmatrix}. \quad (29)$$

The coefficient matrix on the left is the transpose of the Hessian matrix and its determinant can be denoted as J . By using Cramer's rule, we can state the following proposition:

PROPOSITION 4 In a Pareto-efficient mixed taxation framework, the commodity tax on the clean good, t_c , and the commodity tax on the polluted good, t_d , are given by

$$t_c = \frac{1}{J} \sum_h (\xi_c \frac{\partial X_d^h}{\partial q_d} - \xi_d \frac{\partial X_d^h}{\partial q_c}), \quad (30)$$

and

$$t_d = \frac{1}{J} \sum_h (\xi_d \frac{\partial X_c^h}{\partial q_c} - \xi_c \frac{\partial X_c^h}{\partial q_d}) + (\Omega \varphi' E - \frac{\mu}{\gamma}). \quad (31)$$

Proposition 4 indicates that the term $(\Omega \varphi' E - \frac{\mu}{\gamma})$ disappears from the tax rule for the environmentally clean good. The magnitude of $(\Omega \varphi' E - \frac{\mu}{\gamma})$ depends on (i) the relative weight of the polluting impact, (ii) the price of the green public good caused by increasing pollution, (iii) government green spending, and (iv) the value of $\frac{\mu}{\gamma}$. A rise in any of the first

three factors will increase the commodity tax rate, whereas a rise in the value of $\frac{\mu}{\gamma}$ will decrease the commodity tax rate.

three factors will increase the commodity tax rate, whereas a rise in the value of $\frac{\mu}{\gamma}$ will decrease the commodity tax rate.

5. Discussions and Conclusions

From the perspective of the sustainable development of humans, every generation of people has a big stake in the government's provision of green public goods. To be considered *green*, a public good certainly cannot be allowed to have an environmentally harmful or polluting impact (such as excessively using non-renewable resources, fostering waste and pollution, or discouraging conservation), regardless of whether this occurs in the consumption process or is employed as an input in a production process. Furthermore, green public goods possess the property that the present generation's consumption will not reduce the

consumption of the future generation. This characteristic of intergenerational joint-consumption contrasts significantly with that of traditional public goods which, once consumed or utilized as an input in a region or a country, can no longer be of further service to the future generation.

The analysis of optimal tax structures has always been the primary concern of tax policy economists. Although the optimal tax literature has devoted a considerable amount of analysis to the correction of environmental externalities, the concept of environmental sustainability has not yet been taken into account. To further discuss the optimal tax structure and macro-environmental issues, this paper explicitly introduces the environmental sustainability constraint into the government's optimization problem. Specifically, the environmental sustainability condition can be met as long as the total usage of environmentally polluting resources generated by households does not exceed the equivalent absorptive capacity provided through the provision of green public goods.

By utilizing a model with two types of households as examined in the optimal taxation literature, our results indicate that the overall effect of green spending measured in terms of the government's revenue is subject to several factors such as the influence of green spending on environmental sustainability, the cost of green spending, the polluting effect, and so on. We also derive the greened Samuelson rule, a modified Samuelson rule associated with the environmental sustainability condition.

We show that a Pareto-improving reform will take place if the shadow benefit of the green public good increases.

Appendix

A.1

Since consumers are assumed to be rationally behaved, we can manipulate the dual properties to derive following equations:

$$X_i^h(Q, Y^h, I^h, G, E) = \tilde{X}_i^h(Q, u, G, E). \quad (1.1)$$

$$I^h(Q, Y^h, u, G, E) = B^h. \quad (1.2)$$

Differentiating both (1.1) and (1.2) yields

$$\frac{\partial X_i^h}{\partial E} + \frac{\partial X_i^h}{\partial I^h} \cdot \frac{\partial I^h}{\partial E} = \frac{\partial \tilde{X}_i^h}{\partial E}, \quad (1.3)$$

$$\frac{\partial I^h}{\partial E} = -\frac{V_E^h}{V_B^h}. \quad (1.4)$$

Combining (1.3) and (1.4) and substituting the notation for MWP_{EB}^h , we obtain

$$\frac{\partial X_i^h}{\partial E} = \frac{\partial \tilde{X}_i^h}{\partial E} + MWP_{EB}^h \frac{\partial X_i^h}{\partial B^h}. \quad (1.5)$$

A.2

Using (1.2), (1.4) and $\sum_i p_i \tilde{X}_i^h = I^h - \sum_i t_i \tilde{X}_i^h$, we obtain

$$\sum_i p_i \frac{\partial \tilde{X}_i^h}{\partial E} = \frac{\partial I^h}{\partial E} + \sum_i t_i \frac{\partial \tilde{X}_i^h}{\partial E} = -MWP_{EB}^h + \sum_i t_i \frac{\partial \tilde{X}_i^h}{\partial E}. \quad (2.1)$$

A.3

Differentiating $\tau(Y^h)$ gives

$$\tau'(Y^h) = T'(Y^h) + \sum_i t_i \left[\frac{\partial X_i^h}{\partial B^h} (1 - T') + \frac{\partial X_i^h}{\partial Y^h} \right], \quad (3.1)$$

where $B^h = Y^h - T(Y^h)$. Replacing the marginal income tax rate $T'(Y^h)$ by $1 + \frac{V_Y^h}{V_B^h}$ and

rearranging (3.1), we obtain

$$\tau'(Y^h) = 1 + \sum_i t_i \frac{\partial X_i^h}{\partial Y^h} + \frac{V_Y^h}{V_B^h} \left(1 - \sum_i t_i \frac{\partial X_i^h}{\partial B^h} \right). \quad (3.2)$$

Due to $p_i = q_i - t_i$ and $\sum_i q_i X_i^h = B^h$, the following two properties can be derived:

$$\sum_i p_i \frac{\partial X_i^h}{\partial B^h} = 1 - \sum_i t_i \frac{\partial X_i^h}{\partial B^h} \quad (3.3)$$

$$\sum_i p_i \frac{\partial X_i^h}{\partial Y^h} = - \sum_i t_i \frac{\partial X_i^h}{\partial Y^h} \quad (3.4)$$

Equation (22) could be obtained after we substitute (3.3) and (3.4) into (3.2).

A.4

Differentiating the individual budget constraint and using $p_i = q_i - t_i$, we obtain

$$\sum_i p_i \frac{\partial X_i^h}{\partial q_j} = -X_j^h - \sum_i t_i \frac{\partial X_i^h}{\partial q_j}. \quad (4.1)$$

Equation (28) is simply the summation of (4.1) over h .

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實地走訪北歐永續城市並觀察哥本哈根氣候會議

這次和就讀交大科技法律研究所的研究助理張愷致一起前往的北歐參訪行程，我們分別前往了丹麥以及瑞典，針對當地對再生能源的運用以及永續發展的實踐進行實地的訪查及瞭解。在此趟行程，我們分別參訪了瑞典南方小城韋克舍 (Växjö) 以及丹麥的小島 Samsø，這兩個地方均以有計畫減少使用化石燃料、建構邁向永續發展的社會機制而著稱於國際社會。

被譽為歐洲最綠城市的韋克舍，從丹麥哥本哈根機場搭乘火車約 2 小時可抵達，人口總數約 8 萬餘人，平均每人所得約 25 萬克朗。韋克舍最具特色的是該市的電力供應設施，韋克舍的唯一發電廠完全依賴採用當地伐木業所產生的木屑、木渣等廢棄物作為發電來源，除了供應電力所需外，該發電廠亦能將發電所產生的熱能供給城市作為暖氣、熱水之用；在交通運輸方面，該市的運輸工具也大量採用酒精作為燃料的低碳公車。距離市中心騎自行車約莫 15 分鐘可抵達韋克舍大學 (Växjö University)，韋克舍大學是政大的姐妹校，該校配合韋克舍市的「無化石燃料」永續發展目標，系、所的研究與發展方面亦十分重視對於再生能源以及木造建築科技的研發。韋克舍大學即將於明年 1 月與 University of Kalmar 合併成立為學生總數超過 3 萬人的綜合性大學，新的校名為 Linnaeus University，新校成立之後的永續發展潛力可以預期。

地處丹麥中央的珊索 (Samsø) 是一個面積 112 平方公里的小島，從哥本哈根機場先搭乘火車約 1 個半小時至西蘭島 (Zealand) 西方港口城市 Kalundborg，之後再轉搭渡輪約 2 小時可抵達。珊索全島地勢平坦，居民 4 千餘人，主要農作物為馬鈴薯與洋蔥，小型畜牧業亦十分發達。該島之特別之處在於其基本上可以成為一個 100% 使用再生能源的島嶼，島上主要的電力是由風力發電所供應，此外亦設有太陽能面板作為輔助發電系統；特別的是，目前 Samsø 島上每個城鎮的熱水其暖氣供應系統，大多是由公用的供給站供應，目前僅有少數居民仍沿用傳統的燃油燒水及暖氣系統，而且島上的熱水及暖氣供給站，是以島上自己生產的稻草以及島上森林的木材作為燃燒的燃料，因此並未使用任何的化石燃料而達到自給自足的能源利用。雖然 Samsø 島在夏季時為丹麥著名的度假勝地，但是整個島上並沒有看見太多的開發，島上的旅館也不過七間，在和居民的訪談中我們也發現，多數當地居民仍希望維持原有的務農生活，並保持當地原有的景觀面

貌，無意將該島開發程度假中心，也許正也是因為居民的此種理念，使 Samsø 島得以保持其原有的生態環境。在行程中我們也造訪了島上能源計畫的發展中心 Energy Academy，並和該中心的執行長 Soren Hermansen 就 Samsø 島上推行及發展再生能源等議題進行討論並交換意見；而 Mr. Soren 表示，在丹麥各地均有像 Samsø 島上這類的能源計畫正在推行，也許若有機會能致台灣訪問，也許也可以就此相關議題更進一步得進習探討。

此趟參訪中，讓人印象深刻的在北歐各國，推廣使用再生能源的政策似乎相當的普遍，從政府大量鋪設完善的自行車道並在各地設置腳踏車停放處鼓勵人民少用汽機車外，北歐各地在飲料販賣時，對於飲料瓶多會另外加收台幣 5~15 元的保證金，當消費者確實將飲料瓶擲回後才將款項退還，此亦有效的協助資源回收的進行。

最後在哥本哈根的行程，雖說因為全球氣候變遷框架會議會場管制措施，而無法順利進入會場進行旁聽，然而在此次行程中我們也藉此次機會和會場外的 NGO 團體進行交流，在談話中我們發現，其實遊行群眾中有許多人士都是從歐洲各地來的大學生，相較於台灣學生對此一問題的默示及忽略，他們積極並以行動展現對於地球暖化此一議題的關注，也許這值得台灣的學生加以省思。

此趟七天六夜的丹麥、瑞典參訪行程，很快的就結束了，然而此趟行程當中我們看見了北歐各國約莫在十年前（90 年代末期）開始推動的減碳及永續發展計畫，在經過十年得努力後事如何的開花結果，有時讀萬卷書真的不如行萬里路，雖說我們常說永續發展永續發展，但是一直到實際到國外看了別人怎麼執行後，才真得驚覺我們起步得似乎太晚了，在石化能源有限以及全球暖化問題日趨嚴重的情勢下，台灣雖說因為目前的國際情勢而無法簽署京都議定書等環境公約而不受其規範，但是既然減碳及永續發展已經成為當前不可忽視的趨勢，而且實際上台灣為了避免進出口貿易受到不利益亦仍必須遵守相關規定，目前排碳量居全球第 22 位的台灣，自然也應及早思考該如何有效的將產業轉型，降低對於化石燃料的依存並減少碳排放，以避免日後國際公約制定後我國將因此而受有不利益，另外我國也應當針對如何使台灣這片土地能夠永續發展進行規劃，期待台灣能儘早開始推動相關措施，並期待在不久的未來能看見台灣的努力開花，並能收取甜美的果實。

98 年度 (2009. 8.1~2010.7.31) 出席國際會議報告

(1) Lin, Chi-ang, “An Institutional Analysis of Taiwan’s Educational and Religious Groups,” presented at 74th Annual Meeting of Midwest Economics Association, Evanston, Illinois, USA, March 19-21, 2010.

本人於 2010 年 3 月 18 日至 26 日，赴美國伊利諾州 Evanston 參加美國「中西部經濟學會」(Midwest Economics Association，簡稱 MEA) 的第 74 次年會，除了於大會中發表文章外，並擔任論文評論的工作。MEA 是美國重要的經濟學會之一，本次年會與會者約莫五百人左右。

在為期 3 天的會議期間，大會總共安排了 10 個同時發表論文的議程 (concurrent sessions)，會議的前 2 天，每日皆有 4 個時段的議程同時進行，第 3 天有 2 個同時段的議程。每一個議程底下 (至少) 安排了 10 個不同的主題 (topics)，而針對每一個單獨的主題則有 3-4 篇的文章發表。總計，本次會議探討的主題數量超過一百，涵蓋面非常廣泛，幾乎包括了美國以及世界各國關注的經濟課題，至於發表的文章總數超過三百篇。

茲將會議期間探討的主題舉例如下：

2010.03.19 Friday

Concurrent Sessions 1

1a: Health Care Nationalization

1b: Economics of Crime

1c: Evaluating and Improving Price Indexes

1d: Game Theory I

1e: Wage and Income Inequality

1f: Financial Regulation I

1g: Globalization and Climate Change

1h: Health I

1i: Economic Growth and Development

1j: International Labor

2010.03.20 Saturday

Concurrent Sessions 5

5a: Health Economics

5b: Economics of Corruption

5c: Political Economy

5d: Econometrics

5e: Investments in Skill

5f: Information Economics

5g: Monetary Policy I

5h: International Stock Market Volatility

5i: Foreign Investment

5j: Household Wealth

5k: Environmental Economics I

5l: Teaching Intermediate Microeconomics

5m: Entrepreneurship

2010.03.21 Sunday

Concurrent Sessions 9

9a: Environmental Economics II

9b: Foreign Aid

9c: Topics in Undergraduate Education

9e: Fundraising for Charity (本人發表論文的 session)

9f: Commodity Prices

9g: Stock Prices

9h: Technology

9i: Offshoring and FDI

9j: International Trade, Firm Heterogeneity and Productivity

本人的論文是發表於第三天 (March 21, 2010) 之 Concurrent Session 9e: Fundraising for Charity 當中，題目為 *An Institutional Analysis of Taiwan's Educational and Religious Groups*。本篇論文的主旨在於嘗試分析如何經由募款活動來創造教育公共財，研究內容獲得不少與會學者的迴響。

以下 2 段分別是節錄自文章中的摘要與結論。

(Abstract) In Taiwan, public higher educational groups (i.e. national colleges and universities) have not been active and successful in fundraising practices. At the same time, one could easily observe that several prominent religious groups such as Tzu-Chi (founded by Master Cheng Yen in 1966), Fo Guang Shan (founded by Master Hsing Yun in 1967), and Dharma Drum Mountain (founded by Master Sheng Yen in 1989) have constantly been growing. These religious groups have not only attracted regular donors but also wealthy people within society and

have been exceptionally successful in raising funds. Above all, they have established for themselves as a worldwide reputation and, as a matter of fact, have become *multi-national religious enterprises*. The aforementioned religious groups and national universities share several similar characteristics. First, they are nonprofit organizations. They are, however, well-organized groups. Second, they are extensive users of the mass media. In order to attract more members, they both use and increasingly rely upon modern forms of mass media to attract attention, formulate impressions, and establish institutional prestige. Third, one might, in a sense, regard them as non-profit-making firms in the service industry. In this regard, they share a similar kind of social version, i.e. that of upgrading the quality of society in the long run. For example, the primary missions of Dharma Drum Mountain are to raise the quality of mankind and to build a pure land on earth. Specifically, higher educational groups provide advanced knowledge and religious groups mental comfort and/or consolation. Fourth and more importantly, both higher educational and religious groups need sufficient funds to fulfill their respective missions. To provide quality services, universities need funds to expand research facilities, to recruit first-tier faculty members, and to upgrade academic programs. To provide reliable services and timely charity aid, religious groups have to operate like a modern enterprise. When faced with funding difficulties, a modern enterprise cannot operate, compete, and succeed. The main purpose of this paper is to explain why the fundraising performance of the aforementioned religious groups has been superior to that of public higher educational groups. Fundamental to this analysis is the increasing recognition that the religious and educational groups compete with each other for funds in Taiwan. The opaque competitiveness between them, in the author's opinion, cannot, however, be properly identified and evaluated through mainstream economic analysis. This paper, consequently, introduces some concepts of institutions and also suggests several propositions on fundraising, entrepreneurship and institutions.

(Conclusions) In Taiwan, it is certain that fundraising receipts are becoming a key determinant of the development of public higher educational institutions in the twenty-first century. This paper demonstrates that the success of those fundraising drives will be institutionally determined. In actual fact, there are certain religious

enterprises that, accompanied by influential entrepreneurship, have taken a lead. However, in the case of public higher educational institutions, unless their fundraising base grows, they will face a big challenge ahead. According to the analysis above, it is perhaps not surprising to observe that some of these religious enterprises have established private colleges and universities in recent years. As the religious system has entered a stage of institutional change, the fundraising base associated with the religious system has been exogenous. Furthermore, donors seeking to promote education are finding a shortcut for achieving their educational objectives through the religious system (rather than through the political system). In the case of public higher educational institutions, we might to a certain extent observe some of the following adjustments and/or transformations in the long run. First, more and more academic programs in religious studies might appear on campus. Second, there is the likelihood that a private higher educational institution, which is owned by a religious enterprise, will merge with a national university. Third, the privatization of public higher educational institutions associated with a changing institutional structure of higher education may take place.

無研發成果推廣資料

96 年度專題研究計畫研究成果彙整表

計畫主持人：林其昂		計畫編號：96-2415-H-004-016-MY3					
計畫名稱：臺灣原生知識體系之制度分析							
成果項目		量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）	
		實際已達成數（被接受或已發表）	預期總達成數（含實際已達成數）	本計畫實際貢獻百分比			
國內	論文著作	期刊論文	0	1	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	2	2	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	4	4	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	0	3	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	2	2	100%		
		專書	0	0	100%		章/本
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

<p>其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)</p>	<p>無</p>
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	成果項目	量化	名稱或內容性質簡述
科 教 處 計 畫 加 填 項 目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與(閱聽)人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

達成目標

未達成目標（請說明，以 100 字為限）

實驗失敗

因故實驗中斷

其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文： 已發表 未發表之文稿 撰寫中 無

專利： 已獲得 申請中 無

技轉： 已技轉 洽談中 無

其他：（以 100 字為限）

執行本計畫 3 年期間，先後完成 4 篇論文初稿，成果豐碩。

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以 500 字為限）

已經完成的四篇論文初稿，估計未來均能一一發表於國內外的優良學術期刊。