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參加 SEACEN 研訓中心年度研究計畫
「全球流動性及其對 SEACEN 經濟體之影響」
出國報告書

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目錄

參加 SEACEN 研訓中心年度研究計畫

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壹、前言

東南亞國家中央銀行聯合會(South East Asian Central Banks, SEACEN)所屬研訓中心 2016 年度研究計畫為「全球流動性及其對 SEACEN 經濟體之影響」(Global Liquidity and the Impact on SEACEN Economies)，計畫目的係探討並評估全球流動性對 SEACEN 經濟體之影響，俾助未來政策研擬。

本次研究計畫之參與成員包括來自台灣、南韓、印尼、馬來西亞、菲律賓、斯里蘭卡及越南等 7 國之中央銀行研究人員，計畫主持人為 Peter Tillmann(Justus Liebig University Giessen 教授)。研究計畫援例在馬來西亞吉隆坡之 SEACEN 研訓中心召開兩次研討會，分別為 2016 年 8 月 8 日至 8 月 12 日，以及 2017 年 3 月 9 日至 3 月 10 日，討論內容包括全球流動性對貨幣政策之影響、研擬研究報告之大綱及提交時程等，並探討量化研究方法，以利計畫執行。

報告共分為柒個部分。除前言外，第貳至第柒部分，包括研究簡介、台灣、美國、歐元區及英國政策利率走勢之定態特徵(stylized facts)、研究方法及資料說明、實證模型設定及估計結果，最後為結論與建議。提交 SEACEN 研訓中心之英文版本詳如附件。

貳、研究簡介

自 2000 年起，各國中央銀行與學界對全球流動性(global liquidity)投入大量討論，迄今對全球流動性的定義仍無統一定論(詳見 Committee on the Global Financial System, 2011; Domanski et al., 2011; European Central Bank (ECB), 2012; Gourinchas, 2012; International Monetary Fund (IMF), 2014; Landau, 2014)，但可區分成三種面向，第一為官方流動性 (official liquidity)，主要透過中央銀行調整自身資產負債表創造基礎貨幣之行為，如各類公開市場操作具有改變官方流動性的作用。第二是民間流動性 (private liquidity)，民間金融機構透過參與廣義貨幣創造過程而成；上述兩種與金融穩定有密切關係。第三種則為金融市場流動性(financial market liquidity)，市場所能提供買賣雙方快速成交的能力，或是在快速交易過程中不會造成價格大幅變動的能力。

若由金融穩定角度觀察，全球流動性有可能使大量資金跨國移動，由傳遞國(transmitter)散播至接受國(recipient)並影響其金融市場運作，致公私部門需重新思考因應對策。基於此觀點，中央銀行在全球流動性則扮演相當重要的角色，並可透過貨幣政策抑制資金流動，尤其是新興經濟體如何抵擋資金流入，避免資產價格過度膨脹，故可知貨幣政策是全球流動性狀況傳遞機制之一[1]。本文將在此觀點探討全球流動性對於 SEACEN 經濟體之影響。

為了衡量全球流動性之影響，本文將以政策利率做為代理變數，主要原因有二，第一，從 IMF(2014)之全球流動性架構觀察[2]，政策利率因應總體經濟情勢變化而有所調整，進而使民間流動性產生改變，故政策利率屬於全球驅動(global driver)要素之一。第二是依據全球流動性衡量方式，利率變數屬於價格指標[3]，並可提供不同市場對於流動性供給的訊息(詳見 Domanski et al.

[1]Committee on the Global Financial System(2011)指出全球流動性狀況與總體經濟變數有關，如貨幣政策、匯率區間、資本帳政策、私部門政策及金融因素等。

[2]IMF(2014)建構全球流動性三大架構，分別為全球驅動因子，如利率、風險偏好等；傳遞過程(transmission)，如國際資本流動、跨國銀行資金流動等；當地結果(local outcome)，如信用擴張、信用條件改變等。

[3]根據 Domanski et al. (2011)之說明，衡量全球流動性的方式包含數量指標、價格指標及風險指標，數量指標

(2011), ECB (2012), Caruana(2014), McGuire and Sushko (2015))，如政策利率走勢易受市場預期及當前經濟情勢影響。此外，利率變數的變化可觀察全球流動性是否會造成一國之金融市場波動，主要係因先進國家可透過利率調整影響新興經濟體，因為新興經濟體的貨幣當局會避免與先進國家產生過大的利差(interest rate differentials)，而過大的利差不利金融穩定，加以利差可能造成新興經濟體的匯率升值，導致貿易競爭力下滑。另一方面，利差恐帶來短期性投機資金，使資產價格上揚，造成投資者對金融市場過度樂觀，產生金融資產錯誤定價與貸款標準過度寬鬆等問題，不利金融穩定。

本文主要目的在於，透過 Diebold and Yilmaz(2009, 2012, 2014, 2015)所提出的網絡關聯分析(network connectedness)討論美國、歐元區、日本、英國與南韓、台灣、新加坡、印尼及馬來西亞等 SEACEN 經濟體之全球流動性傳遞關係。運用此方法的優點在於，透過變異數分解分別計算出影響及被影響之比例，進一步再區分成流入關聯(to directional connectedness)、流出關聯(from directional connectedness)、淨向關聯(net directional connectedness)與總和關聯(total connectedness)等靜態及動態關係，有助於了解體系內各國彼此影響關係。

本文以政策利率作為全球流動性之代理變數，並透過網絡關聯分析模型了解研究對象之靜態與動態關係，主要研究發現包含，(1)由靜態關係可發現，英國、美國與歐元區為全球流動性的主要傳遞國，而台灣、南韓、新加坡及印尼為接受國。(2)觀察動態關係發現，在 2008-2012 年間，總和關聯持續維持高檔，顯示全球流動性與全球金融海嘯及歐洲主權債務危機有密切關係。若以各國而言，台灣、南韓、新加坡與印尼等 SEACEN 經濟體仍是全球流動性的接受國。

鑒於上述實證發現，若金融及總體環境要維持穩定，中央銀行決策者則

主要是捕捉全球流動性在不同條件及市場下所造成的曝險風險，如國際結算銀行(Bank for International Settlements)所編製的美元信用指標；風險指標則是衡量投資者對於風險承擔程度的變化，如恐慌指數(Volatility Index)。

需要了解全球流動性的傳遞關係，再進一步區分各國屬性(如傳遞國及接受國)，有助於制訂更有效的貨幣政策，避免全球流動性所造成的衝擊。

參、台灣與美國、歐元區及英國政策利率走勢之定態特徵

台灣是 SEACEN 重要成員之一，且為小型開放經濟體，易受國際經濟情勢影響，本小節將概述台灣政策利率的定態特徵。圖 1 為台灣政策利率時間趨勢圖。在過去 15 年間，台灣政策利率可以區分成三個階段，分別為 2000-2003 年、2004-2008 年與 2009 年至現在。觀察圖 1 可發現，台灣政策利率由2000年初期的4.16%下滑至2003年的1.02%，主要受科技泡沫(dot-com bubble)、美國 911 恐怖攻擊與嚴重急性呼吸道症候群(Severe Acute Respiratory Syndrome, SARS)等影響，造成國內經濟情勢表現不佳，中央銀行採行寬鬆貨幣政策所致。

隨著 2004 年下半年起，經濟情勢逐漸好轉進入第二階段，政策利率由 2004 年 5 月之 0.97%逐步升息至 2008 年底的 1.90%。最後，第三階段則因全球金融海嘯襲擊造成，中央銀行連續降息，至 2009 年第一季到達歷史低點，之後因美國、歐元區、英國與日本採行量化寬鬆貨幣政策，中國大陸採進口替代政策等因素，衝擊國內經濟情勢，使中央銀行持續維持寬鬆貨幣政策，致利率維持低檔。

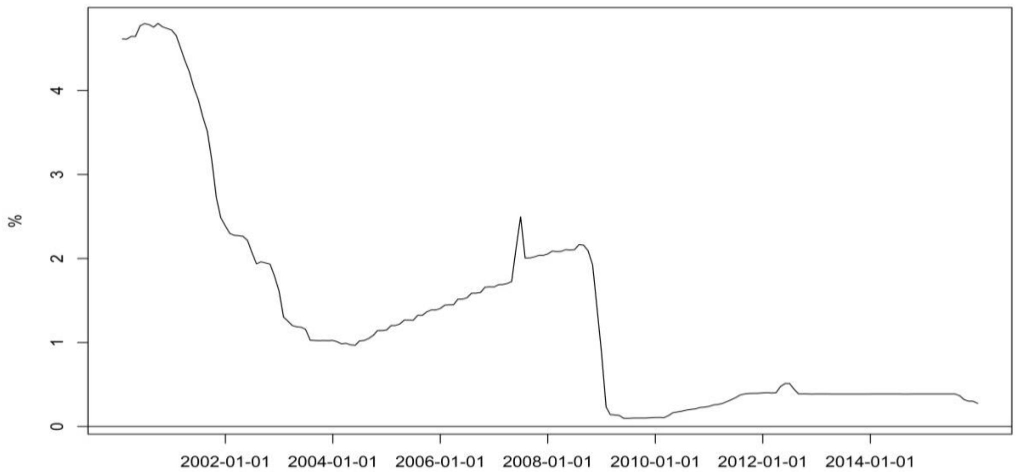


圖 1 台灣政策利率時間序列走勢

圖 2 為台灣與美國、歐元區、英國等三個主要經濟體之政策利率時間趨勢圖。首先，比較美國、歐元區與英國之政策利率，從圖 2 發現，不論是歐元區或英國之政策利率均與美國之政策利率具有高度相關性，惟歐元區的波動程度小於英國。比較台灣與三個主要經濟體之走勢可發現，台灣政策利率與三個經濟體明顯存在共移性(co-movement)，可能係因台灣為小型開放經濟體，易受經濟大國(如美國、歐元區與英國)之經濟衝擊影響，故有此現象產生。 由上述初步發現可知，美國、歐元區、英國與台灣的政策利率可能存在相互影響效果，雖圖中無法提供明確影響關係，但已提供本文網絡關係分析重要的提示。

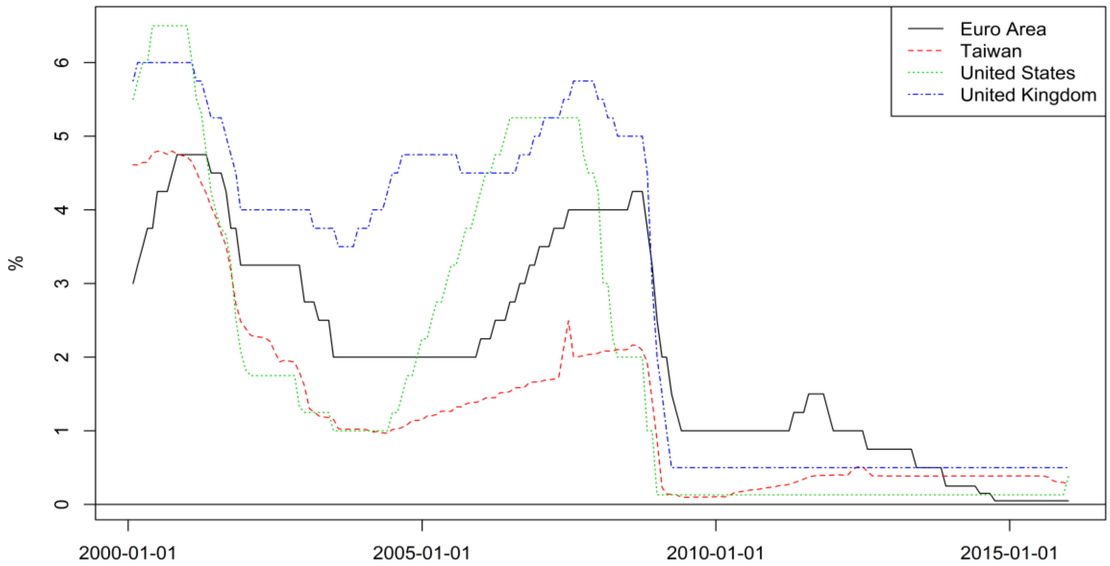


圖 2 歐元區、台灣、美國及英國政策利率時間序列走勢

肆、研究方法

為研究全球流動性的網絡影響效果，本文採用研究方法為 Diebold and Yilmaz(2009, 2012, 2014, 2015)之網絡關聯衡量指標[4]。此方法的優點在於計算

[4]此方法已廣為被運用於總體經濟議題，如金融市場(Diebold and Yilmaz, 2014, 2016)、政策不確定性(Klobner and Sekkel, 2014)、通膨外溢效果(Halka and Szafranek, 2016)與油價及資本市場關係(Maghyereh et al., 2016)等。

出各國的影響力與被影響程度後，再將其區分成流入關聯、流出關聯、淨向關聯等，有助於了解體系各國彼此影響關係。以下說明 Diebold and Yilmaz(2009, 2012, 2014, 2015)之模型設定。

首先，假設N個國家流動性指標(GI)且落後 p 期的向量自我迴歸(vector autoregression, VAR)模型：

$$GI_t = \sum_{i=1}^{p} \Phi\, GI_{t-i} + \varepsilon_t,$$

其中$GI_t = (GI_{1t}, GI_{2t}, \ldots, GI_{Nt})'$ 為$\mathrm{N} \times 1$的向量，本文將以短期政策利率為全球流動性指標代理變數。Φ為一個 $\mathrm{N} \times \mathrm{N}$維度的矩陣，代表對應於各落後期 GI_t 的待估參數；ε為一個 $\mathrm{N} \times 1$ 維度的行向量，代表第 i 期之干擾項，並假設其服從一平均數為 0、變異數為 Σ 之多元常態分佈。

由於內生變數排列對於傳統變異數分解有顯著影響，故 Diebold and Yilmaz(2014)應用 Koop et al.(1996)與 Pesaran and Shin(1998)所提出的一般化變異分解(generalized variance decomposition, GVD)避免變數排序所造成的影響。國家 j 對國家 l 在第 H 期的 GVD，網絡關聯(d_{ij}^{gH})可表示為：

$$d_{lj}^{gH}(\mathrm{H}) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e_l' A_h \Sigma e_j)}{\sum_{h=0}^{H-1} (e_l' A_h \Sigma A_h' e_l)}$$

其中e_j表示第 j 個國家為 1 其他國家為 0 的向量，σ_{jj} 則為第 j 條方程式誤差項的標準差，A_h 為領先 h 期的移動平均係數。雖然一般化預期誤差變異數分解具有不須認定變數排序的優點，但其分子之加總並不等於分母，故在本文後續在定義網絡關聯時，必須額外進行標準化，即

$$\tilde{d}_{lj}^{gH}(\mathrm{H}) = \frac{d_{lj}^{gH}(\mathrm{H})}{\sum_{j=1}^{N} d_{lj}^{gH}(\mathrm{H})}$$

其中$\sum_{j=1}^{N} \tilde{d}_{lj}^{gH}(\mathrm{H}) = 1$ 且 $\sum_{l,j=1}^{N} \tilde{d}_{lj}^{gH}(\mathrm{H}) = N$。一般而言，我們會以$C_{l \leftarrow j}(H)$ 來表示國家 j 對國家 l 的成對網絡關聯(pairwise directional connectedness)程度，且

$C_{l\leftarrow j}(H) \neq C_{j\leftarrow l}(H)$。因此，我們可以藉由成對網絡關聯程度，加以計算分為具有方向性之網絡關聯，即流入與流出關聯性，將其相減可得淨向關聯，以及整個體系總和關聯程度，各關聯性可表示如下：

1. 流入關聯 ("*FROM others*")：國家 l 接收其他所有國家 j 外溢而來的總效果，

$$C_{l\leftarrow\cdot}(H) = \sum_{\substack{j=1 \\ j\neq l}}^{N} \tilde{d}_{lj}^{gH}(\mathrm{H}),$$

   由此關聯程度可知國家 l 受到其他所有國家 j 影響程度。

2. 流出關聯 ("*TO others*")：由國家 j 外溢至其他所有國家 l 的總效果，

$$C_{\cdot\leftarrow l}(H) = \sum_{\substack{j=1 \\ j\neq l}}^{N} \tilde{d}_{jl}^{gH}(\mathrm{H}),$$

   由流出關聯程度可觀察國家 j 受到其他所有國家 l 影響程度。

3. 淨向關聯 ("*NET*")：為流出關聯和流入關聯之差異：

$$C_l(H) = C_{\cdot\leftarrow l}(H) - C_{l\leftarrow\cdot}(H),$$

   若$C_l(H) > 0$，代表國家 l 影響其他所有國家 j 的程度大於其他所有國家影響 l 的程度，則可為衝擊傳播者(transmitter)；反之，若$C_l(H) < 0$，則稱為衝擊接受者(receiver)。

4. 總和關聯程度：

$$\boldsymbol{C}(\boldsymbol{H}) = \frac{\sum_{\substack{l,j=1 \\ l\neq j}}^{N} \tilde{d}_{ij}^{gH}(\mathrm{H})}{N}$$

   代表整個體系之網絡總和關聯性，以刻劃網絡系統中各變數流入與流出關聯性之平均影響。

上述各項關聯程度可整理成表 1，作為後續實證研究分析之依據[5]。

表 1 網絡關聯程度表

	GI_1	GI_2	…	GI_N	流入 (FROM others)
GI_1	$\tilde{d}_{11}^{gH}$	$\tilde{d}_{12}^{gH}$	…	$\tilde{d}_{1N}^{gH}$	$C_{1\leftarrow\cdot}$
GI_2	$\tilde{d}_{21}^{gH}$	$\tilde{d}_{22}^{gH}$	…	$\tilde{d}_{2N}^{gH}$	$C_{2\leftarrow\cdot}$
⋮	⋮	⋮		⋮	⋮
GI_N	$\tilde{d}_{N1}^{gH}$	$\tilde{d}_{N2}^{gH}$	…	$\tilde{d}_{NN}^{gH}$	$C_{N\leftarrow\cdot}$
流出 (TO others)	$C_{\cdot\leftarrow 1}$	$C_{\cdot\leftarrow 2}$	…	$C_{\cdot\leftarrow N}$	$\boldsymbol{C}$

[5]此處關聯程度皆為各國雙邊影響下的結果，並無法衡量透過第三國的間接效果，為目前的研究限制，詳見 Greenwood-Nimmo et al. (2015)。

伍、資料說明

為了衡量全球流動性衝擊對於 SEACEN 經濟體之外溢效果，本文將運用政策利率做為流動性的代理變數，但受限於資料取得問題，無法以全部為 SEACEN 經濟體為研究對象，故以下將說明各研究對象之政策利率的基本統計量特性及時間趨勢。

本文研究對象包含美國(USA)、英國(UK)、歐元區(EA)、日本(JPN)及南韓(KOR)、台灣(TWN)、印尼(IDN)與新加坡(SGP)等四個 SEACEN 經濟體，研究期間為 2000 年 1 月至 2015 年 12 月。其中，在全球金融海嘯後，美國、英國、歐元區與日本因零利率區間(zero lower bound)限制，無法再下修政策利率，故無法直接以其政策利率做為衡量依據，據此本文以「影子短期利率」(shadow short rate, SSR)做為代理變數(詳見 Bullard, 2012; Lombardi and Zhu, 2014; Krippner, 2015)[6]，SSR 之資料來源取自於 Krippner 資料庫[7]。南韓、台灣、印尼與新加坡則仍以政策利率為討論對象，其中南韓、印尼與新加坡之資料來源為國際貨幣基金(IMF)之國際金融統計資料庫(International Financial Statistics, IFS；Concept: Interest Rate, Central Bank Policy Rate)，台灣則取自於中央銀行統計資料庫。

表 2 為政策利率(包含 4 個國家 SSR)之基本統計量表，觀察 8 個研究國家平均數，僅日本為-1.56%，其餘國家平均利率皆為正值；標準差方面，則以英國波動最大，其次為印尼。圖 3 則為 8 個國家之利率趨勢圖，我們可以發現各國走勢十分相似，在全球金融危機期間皆有大幅度下滑，且難以回到全球金融海嘯之前的水準。

[6]SSR 已被運用於衡量美國非傳統貨幣政策對於其自身及全球經濟影響的變數之一，詳參閱 Chen et al.(2014)；亦被運用於分析美國及日本貨幣政策的外溢效果，詳參閱 Claus et al. (2016)；Wu and Xia(2016)則以 SSR 做為探討量化寬鬆貨幣政策的代理變數。

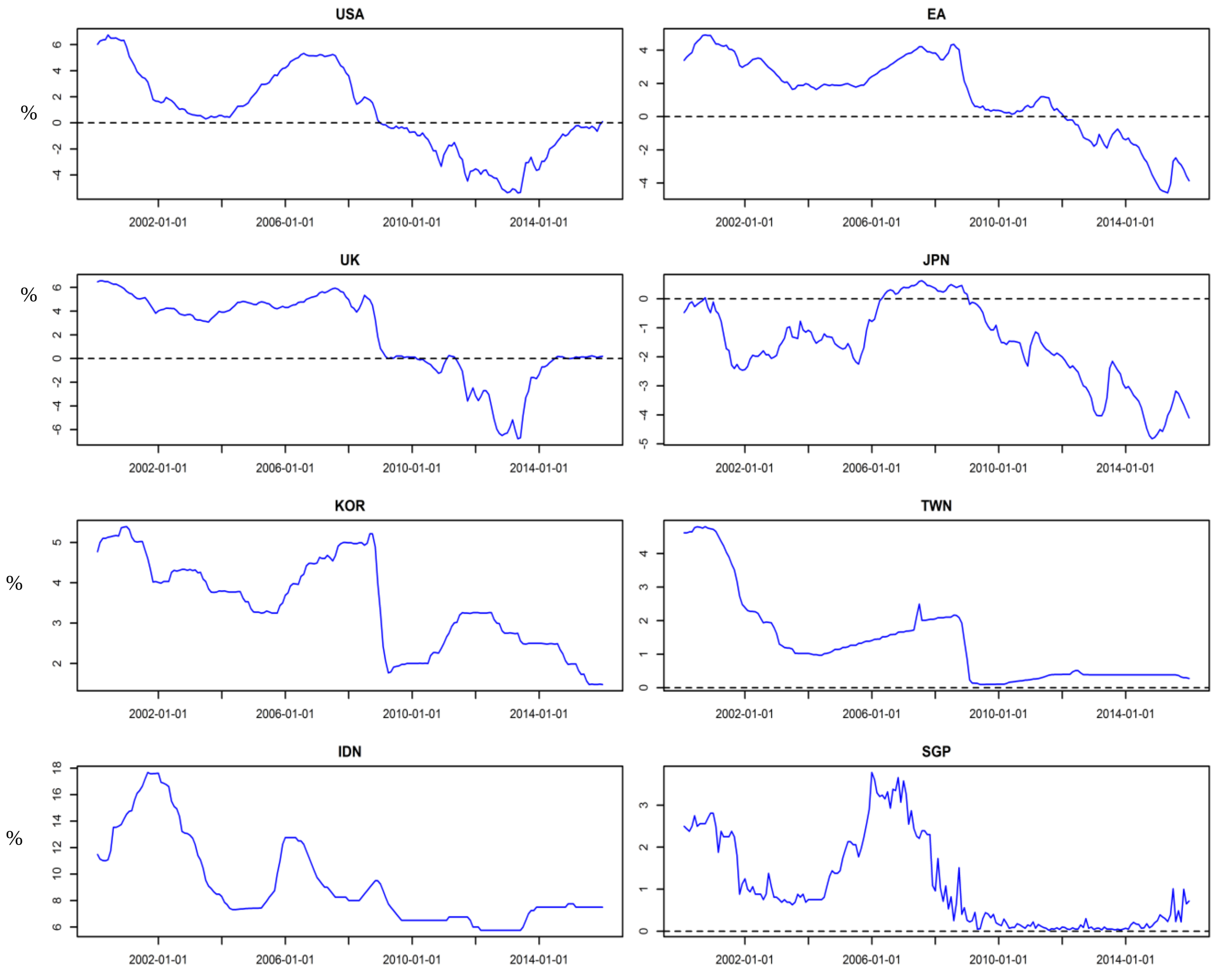
[7]http://www.rbnz.govt.nz/research-and-publications/research-programme/additional-research/measures-of-the-stance-of-united-states-monetary-policy/comparison-of-international-monetary-policy-measures. Kippner(2016) 說明影子利率係建構於高斯仿設期限結構(Gaussian affine term structure)模型，並以無套利(arbitrage-free)Nelson-Siegal 模型進行配適。

表 2 政策利率(包含 4 個國家 SSR)之基本統計量表

單位：%

	美國 (SSR)	歐元區 (SSR)	英國 (SSR)	日本 (SSR)	南韓	台灣	印尼	新加坡
平均數	0.74	1.32	1.98	-1.56	3.48	1.35	9.20	1.07
標準差	3.20	2.39	3.45	1.4	1.11	1.29	3.24	1.07
最小值	-5.37	-4.59	-6.76	-4.82	1.48	0.1	5.75	0.02
最大值	6.74	4.92	6.56	0.62	5.39	4.8	17.67	3.78

資料來源：Krippner 資料庫、IFS 資料庫與中央銀行統計資料庫；本研究自行計算



資料來源：Krippner 資料庫、IFS 資料庫與中央銀行統計資料庫

圖 3 政策利率(包含 4 個國家 SSR)時間序列趨勢圖

陸、實證結果

一、靜態網絡關聯

在政策利率之靜態網絡方面，本文利用落後期數為 3 期的 VAR 模型[8]估計全樣本期間，再依據估計結果計算領先期間為 3 個月之一般化預期誤差變異數分解[9]，並依照前揭之定義，計算各國家全球流動性之網絡關係並彙整於表 4。表 4 中對角線部分為各個國家自身的關聯性，而非對角線(off-diagonal)部分則為成對網絡關係，是本文最為關心的國與國相互影響關係。進一步將非對角線橫向加總與縱向加總，則分別可得流入關聯(“*FROM others*”)與流出關聯(“*TO others*”)，若流出關聯與流入關聯相減則為淨向關聯(“*NET*”)，而整個政策利率的總和關聯則列於右下角。

首先，衡量 8 國政策利率衝擊緊密程度之總和關聯為 35.66%。再者，從各國流出關聯(各國衝擊對於其他國家之影響程度)觀察，各國之值介於 4.36%~67.82%，彼此間之差距相當大，流出關聯最大的國家為英國，達 67.82%，亦即英國之全球流動性衝擊可解釋其他國家的變動達 67.82%；其次為美國之 66.85%及歐元區的 61.24%，可知採行量化寬鬆貨幣政策之國家為主要傳遞國家。觀察流入關聯觀察，美國受影響程度亦為最高，達 52.96%，亦即美國全球流動性變動受其他國家全球流動性衝擊影響為 52.96%，可能係因美國制訂貨幣政策時，仍會考慮其他國家對其影響，致其流入關聯較高。流入關聯第二及第三高國家則分別為英國之 45.18%與台灣之 43.47%。

最後則為淨關聯效果，淨向關聯性約介於-24.57%與 22.64%之間。淨向關聯性最高為英國的 22.64%，亦即英國的流出關聯大於流入關聯；其次為歐元區的 18.22%與美國的 13.89%。淨向關聯性最低的三個國家則為台灣-24.57%，新加坡-10.97%及南韓-11.09%。上述結果顯示英國、美國與歐元區

[8] VAR 模型落後期挑選標準為一般化序列概似檢定(general-to-specific sequential Likelihood Ratio test)，最適落後期為 3。

[9] Klobner and Sekkel (2014)亦運用領先期間為 3 個月之一般化預期誤差變異數分解分析政策不確定性衝擊。

為主要全球流動性衝擊的傳遞國，在其採行量化寬鬆貨幣政策下，致資本移動至新興市場，使台灣、南韓、新加坡與印尼等 SEACEN 經濟體為衝擊接受國。

表 4 靜態全樣本關聯表

單位: %

	美國	歐元區	英國	日本	南韓	台灣	印尼	新加坡	*FROM others*
美國	47.04	9.71	25.44	8.80	1.01	2.56	0.21	5.22	52.96
歐元區	11.44	56.98	16.83	5.98	1.76	3.20	0.02	3.79	43.02
英國	20.43	13.10	54.82	6.75	1.24	1.75	0.47	1.44	45.18
日本	11.46	11.14	6.51	70.60	0.03	0.08	0.14	0.04	29.40
南韓	4.89	9.16	10.03	0.22	62.54	9.45	0.72	2.99	37.46
台灣	8.18	9.35	6.96	0.09	15.75	56.53	1.49	1.65	43.47
印尼	0.34	1.63	0.45	1.18	0.36	0.73	93.81	1.49	6.19
新加坡	10.11	7.15	1.59	0.09	6.23	1.13	1.31	72.39	27.61
TO others	66.85	61.24	67.82	23.12	26.37	18.90	4.36	16.64	**35.66**
NET	13.89	18.22	22.64	-6.29	-11.09	-24.57	-1.83	-10.97	

資料來源：本研究自行計算

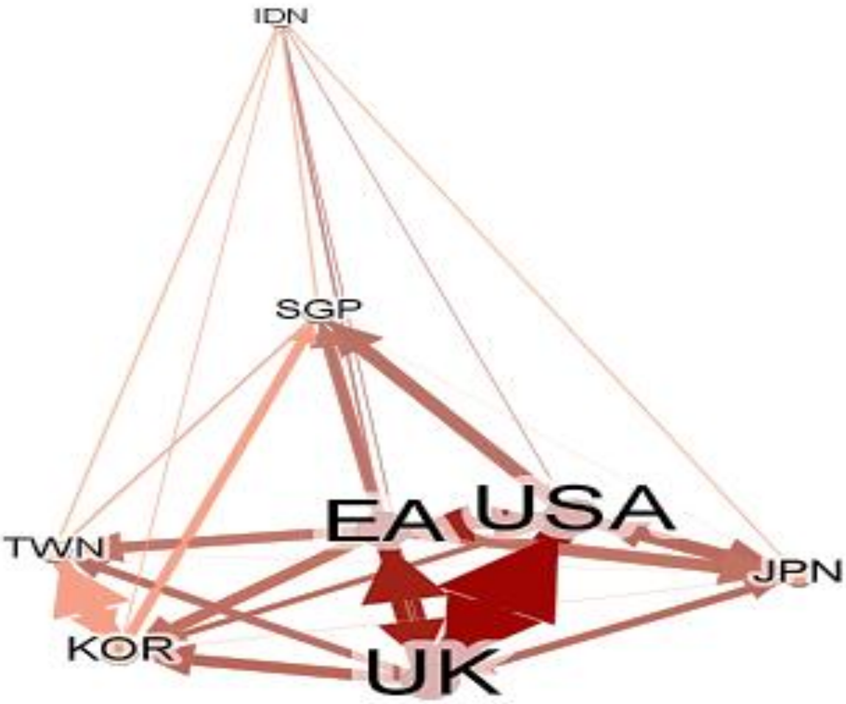
圖 4 為全樣本靜態網絡全樣本關係圖[10]，其中，節點之大小與顏色由深至淺(如暗紅色表示流出關聯較大，米色則表示流出關聯較小)皆反應各國流出關聯性；連接線之箭頭代表成對關聯性，粗細大小與顏色由深至淺則反應相對關係。由圖 4 可發現，英國、美國及歐元區的節點顏色呈暗紅色，表示流出關聯較大，其次為韓國與日本的桃紅色，台灣及新加坡則為亮鮭紅色，流出關聯較小的印尼則為米色。

進一步觀察圖 4 之各國成對關係，我們發現有兩組關係較為密切的國家組合，分別為美國、英國及歐元區與台灣及南韓。美國、英國及歐元區之組合中，由美國流向英國的成對關聯性為全樣本最高，達 25.44%(表示美國流動性衝擊可解釋英國流動性變動約為 25.44%)，且由英國流向美國的成對關聯性 20.43%(表示英國流動性衝擊可解釋英國流動性變動約為 20.43%)，為全

[10]應用 Jacomy et al. (2014) 中的 *ForceAtlas2* 繪製網絡關係圖。

樣本第二高，造成兩國關係緊密的可能原因為美國與英國景氣同步性(synchronization)較強。此外，由於英國及歐元區緊密的金融關係，使由英國流向歐元區及由歐元區流向英國的兩個成對關係為 16.83%與 13.10%。鑑於上述原因，美國、英國與歐元區成為關係較為密切的國家組合。

第二個群聚國家組合為台灣與南韓，觀察成對關聯性，不論是由台灣流入南韓(9.45%)與由南韓流入台灣(15.75%)均高於台灣及南韓與先進國家之成對關係。兩國擁有高度關聯性的原因，可能係因兩國的產業關聯性、出口產品類別相似度均高且皆為亞洲重要金融中心所致。



資料來源：本研究自行計算

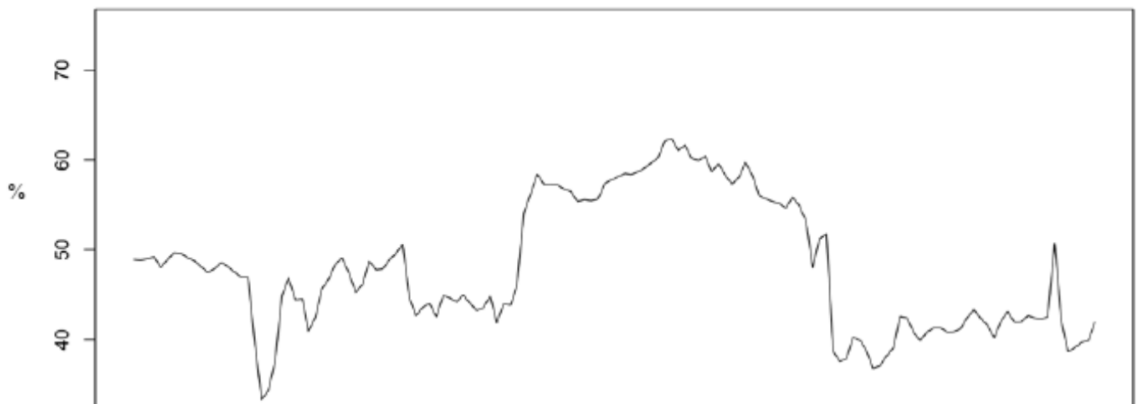
圖 4 靜態網絡全樣本關係圖

二、動態網絡關聯

雖靜態網絡分析可以提供各國於樣本期間內全樣本的特性，但無法提供各國關係的跨時變化。因此，本小節將透過移動視窗(rolling-sample windows)

法分析動態全球流動性關聯走勢，移動視窗大小為 48 個月，重新估計 VAR(3) 模型之領先期間為 3 個月之一般化預期誤差變異數分解，與靜態分析相同，關聯效果包含圖 5 之總關聯效果及圖 6 的流出關聯、流入關聯、與淨向關聯。

圖 5 為動態總和關聯效果，從圖型中可區分成兩個階段並與全球重要經濟事件有密切關係。第一個階段是 2004 年中至 2006 年底，此時總關聯效果因美國、英國與歐元區採緊縮性貨幣政策[11]，致總關聯效果約介於 33%至 50%。第二個階段則是 2008-2012 年間，主要受全球金融海嘯及歐洲主權債務問題影響，美國、英國、歐元區與日本等國採寬鬆貨幣政策致政策利率降至 0%，及施行量化寬鬆貨幣政策，使全球流動性增加，總關聯效果則由 2008 年 5 月的 41%升至同年 12 月的 56%，2010 年 11 月更升至 62%，隨著美國量化寬鬆的退場，總關聯效果隨之下降，如 2012 年底扭轉操作(Operation Twist)結束，2014 年 10 月量化寬鬆退場，均造成總關聯效果下滑。

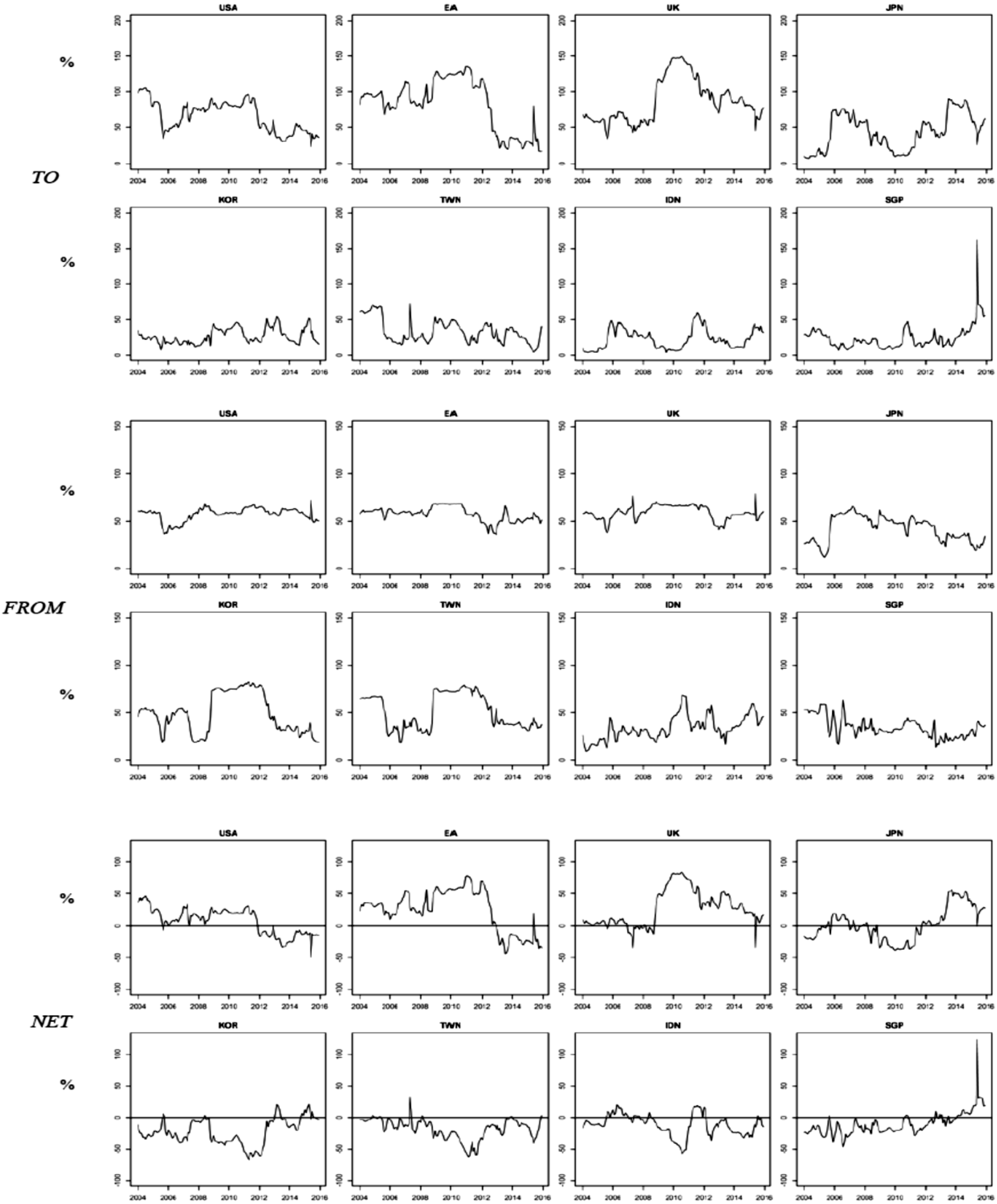


資料來源：本研究自行計算

圖 5 動態總和關聯效果

圖 6 包含流出關聯、流入關聯與淨向關聯等三種動態關聯效果。首先，觀察動態流出關聯，整體而言，日本、南韓、台灣、印尼與新加坡皆變化相對有限，而美國、英國及歐元區則波動相對劇烈，尤其是在全球金融海嘯到

[11]如美國聯邦準備理事會在 2004-2006 年間，17 次調高聯邦準備利率，由 1.0%升至 5.25%。



資料來源：本研究自行計算

圖 6 政策利率之動態關聯效果

歐洲主權債務危機期間，其中英國上揚超過 100 個百分點，而歐元區增加也超過 40 個百分點。再者，在樣本期間內，美國、英國與歐元區流入關聯皆在 50%左右，而在 2008-2011 年間，SEACEN 經濟體則有明顯上揚，如台灣與南韓，由原先的低於 40%上升至 80%；印尼亦有相同走勢。此發現證明美國、英國與歐元區的貨幣政策對於 SEACEN 經濟體具有外溢效果，與 Chen et al. (2012)和 Rogers et al.(2014)相似，美國、英國與歐元區為主要造成貨幣政策外溢效果的國家。

最後則為淨向關聯效果，我們可以發現美國及歐元區在 2004-2012 年間為正的淨向關聯效果，平均分別為 30%及 50%；英國則是在 2008-2015 年皆於 40%至 80%之間；日本則因「安倍三箭」，加以負利率政策與質化與量化寬鬆貨幣政策等因素，使其正的淨向關聯效果發生於 2012-2014 年間。上述發現皆可證明此四個國家為主要全球流動性衝擊傳遞國。至於台灣、南韓、印尼與新加坡的淨向關聯效果大部分為負值，顯示他們為全球流動性衝擊的接收國[12]。此發現與 Choi et al.(2014)與 Hofmann and Takat(2015)之發現類似，全球流動性主要是透過已開發國家傳遞至新興市場國家。

柒、結論與政策建議

本文探討美國、歐元區、日本、英國與南韓、台灣、新加坡、印尼及馬來西亞等 SEACEN 經濟體之全球流動性衝擊傳遞關係，並以全球驅動要素的政策利率做為代理變數，研究期間為 2000 年 1 月至 2015 年 12 月，應用 Diebold and Yilmaz(2009, 2012, 2014, 2015)變異數分解之網絡關聯程度。由實證結果可發現，(1)在靜態關係中，英國、美國與歐元區為全球流動性的主要傳遞國，而台灣、南韓、新加坡與印尼為接受國。(2)動態分析則發現，在 2008-2012

[12]值得注意的是新加坡，其淨向效果於 2015 年突然跳高，可能係因新加坡金融管理局(Monetary Authority of Singapore)於 2015 年初採寬鬆貨幣政策(調整其名目有效匯率之斜率)且為市場未預料到之政策與 2015 年 10 月再度放寬貨幣政策所致。

年間，總和關聯持續維持高檔，顯示全球流動性與全球金融海嘯及歐洲主權債務危機有密切關係。若以各國而言，台灣、南韓、新加坡與印尼等 SEACEN 經濟體仍是全球流動性的接受國。

由政策角度分析，由於利率是全球流動性主要驅動來源，且本文發現 SEACEN 經濟體為全球流動性主要接受國，故渠等中央銀行不僅要瞭解其國內經濟情勢變化，更要洞悉國際經濟環境改變，方能研擬正確的政策(如總體審慎措施及資本管制)以因應所受之衝擊。此發現與 He 和 McCauley（2013）研究類似，全球流動性由主要先進國家流向亞洲經濟體，亞洲經濟體之決策者不僅要考慮當前國內經濟情況，更要將主要國家貨幣政策納入考量，才能制訂有效的政策。此外，同為全球流動性衝擊接受國之 SEACEN 經濟體，可透過國際協調(International Coordination)方式，定期舉行會議，降低全球流動性之衝擊，有助於區域經濟與金融之穩定。

目前，本文主要研究發現皆基於兩國間之雙邊關係，對於間接關係的捕捉較為薄弱，亦無法研究單一全球性衝擊對於整個體系之影響。在未來研究方面，本文建議可引入 Pesaran et al.(2004)所提出之全球向量自我迴歸模型(Global Vector Autoregressive)，不僅可擴充成多國間之關係，亦可探討全球性衝擊之影響。

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附件

1. Introduction

Global liquidity has become a popular concept in academic and policy discussion since the early 2000s. Global liquidity is a multifaceted concept that can be defined and measured in several different ways (Committee on the Global Financial System, 2011; Domanski et al., 2011; European Central Bank (ECB), 2012; Gourinchas, 2012; International Monetary Fund (IMF), 2014; Landau, 2014). One is “official liquidity,” which is funding provided by the public sector. The central bank supplies official liquidity in domestic currency in the form of reserve balances or reserve currencies, on terms and conditions that do not depend on the availability of funding in financial markets. Another is “private liquidity,” which is created by market participants in the private sector, including international banks, institutional investors, non-bank financial institutions (including shadow banks) and so on. The other is “financial market liquidity”, which is described as the ease with which large volumes of financial securities can be bought or sold without affecting the market price. In particular, the point of official and private liquidity is based on the financial stability perspective.

From the financial stability perspective, global liquidity spreads through international financial flows which are determined by choice made in both transmitter and recipient economies and by public and private sectors. In this perspective, central banks’ policy decisions making play an important role in influencing capital flows, in particular in massive capital flows from advanced economies into emerging markets during the past two decades. Monetary policies might be the main driver of global liquidity condition.[13]

In order to capture the drive of monetary policy, we use interest rates, policy rates and long-term interest rate, as the proxy variables. As we know, an interest rate is a price-based indicator which could provide information about the liquidity supply condition in different markets, e.g., Domanski et al. (2011), ECB (2012), McGuire and Sushko (2015), among others.[14] The stance of monetary policy determines domestic short-term interest rates through

[13] Committee on the Global Financial System (2011) states that global liquidity conditions are the results of interactions among macroeconomic factors, monetary policy, exchange rate regime, capital account policies, public sector policies, and financial factors.
[14] The quantity-based indicator is another kind of global liquidity indicator. It could capture how far such

expectations about the future path of policy rates. Longer-term interest rates are driven by more than simply monetary policy, and can be affected by factors such as global savings and investment patterns.

It is important to understand how the advanced countries influence liquidity in emerging markets. From a theoretical perspective, interest rate in advanced countries might affect interest rates in emerging markets because emerging markets' policymakers tend to act against the emergence of large interest rate differentials. A large interest rate differential might lead to exchange rate appreciation which could result in a loss of trade competitiveness and induce speculative short term capital inflows. Elevated interest rate differentials across currency areas might be associated with over-optimistic risk perceptions and elevated risk tolerance, leading to a mispricing of assets and excessive easing of lending standards. Both of these reasons could increase financial stability risk. However, relatively few empirical contributions have tried to understand the transmission of global liquidity.

The aim of this paper is to analyze the transmission of major countries' interest rates (policy rate and long-term interest rate) to SEACEN member economies because the rise of emerging markets in the globalization process, particularly SEACEN members, has been one of the major changes in the global economy. Especially, Taiwan is known for its economic miracle and the fast expansion of financial markets. Therefore, we would focus on Taiwan in this paper.

In our empirical approach, we adopt the connectedness methodology developed in Diebold and Yilmaz (2009, 2012, 2014, 2015) covering the United States, the EAo area, the United Kingdom, Japan and some SEACEN members (i.e., Indonesia, Malaysia, Singapore, South Korea and Taiwan), using monthly data spanning 2000-2015.[15] The advantage of this method is that the proposed measures (i.e., "*TO others*", "*FROM others*", and "*NET*") are dynamic and directional. We could judge the extent of connectedness between countries at any particular date.

The main findings of this paper suggest that total connectedness indexes show quite robust interdependence of global liquidity across our sample countries, and SEACEN members in our sample become "net receivers" of global liquidity shocks. For policy rates, we find that the United Kingdom, the United States, and the Euro area appear to be dominant transmitters, and

conditions translate into changes in exposures and risks (Domanski et al., 2011).

[15] The connectedness concept quantifies to which extent two variables are related.

Taiwan, South Korea, Singapore, and Indonesia are net recipients in the static analysis. The dynamic analysis clearly shows that there has been a substantial increase in the total connectedness indexes since the global financial crisis and the European sovereign debt crisis. Taiwan, South Korea, Singapore, and Indonesia are also net receivers over time.

For long-term interest rates, our static results indicate that the United States and the United Kingdom act as net transmitters of global liquidity shocks. In contrast, Malaysia, Taiwan and South Korea are net recipients. The dynamic analysis indicates that the total connectedness reached a peak high during the global financial crisis. Japan seems to be the dominant transmitter of shocks, and South Korea, Taiwan, and Malaysia are net recipients during our sample period.

Our findings have obvious policy implications. For example, in order to monitor financial and macroeconomic stability, central banks need to understand the direction of global liquidity spillovers among major countries. When central banks are able to distinguish net transmitters from net recipients of global liquidity spillovers under different economic conditions, they can more accurately formulate effective policies.

The rest of the paper is organized as follows: The next section provides some information on Taiwan and some stylized facts about global liquidity. Section 3 outlines the directional connectedness measures proposed by Diebold and Yilmaz (2009, 2012, 2014, 2015). Section 4 provides a description of the dataset. In Section 5, we perform a full sample static analysis and a rolling sample analysis to check the dynamics of the connectedness across time. Finally, Section 6 contains some concluding remarks.

2. Preliminary Evidence on the Effects of Global Liquidity on Taiwan

Taiwan is one of the important economies among SEACEN members. We briefly introduce the effects of global liquidity on Taiwan in this section. Figure 1 shows the change of the policy rate in Taiwan. In the past fifteen years (2000-2015), policy rate changes could be broken down into three periods. The first period is roughly from 2000 to 2003. The policy rate fell from 4.16% in 2000 to 1.02% in 2003. It exhibits a downward trend in this period because the central bank adopted accommodative monetary policies to foster an economic recovery. The poor economic performance could be explained by the bursting of the dot-com bubble, the 9/11 terrorist attacks and the SARS epidemic.

The second is roughly from 2004 to 2008 as economic activity picked up. The policy rate trended upward during this period, rising from 0.97% in May 2004 to 1.9% at the end of 2008. The third is from 2009 to now. The fallout from the global financial crisis continued to overshadow Taiwan's economy during the first half of 2009. The policy rate sharply went down in the first quarter of 2009 and then stayed low under monetary easing. During the continuing economic slowdown, the rate remained broadly stable at a low level.

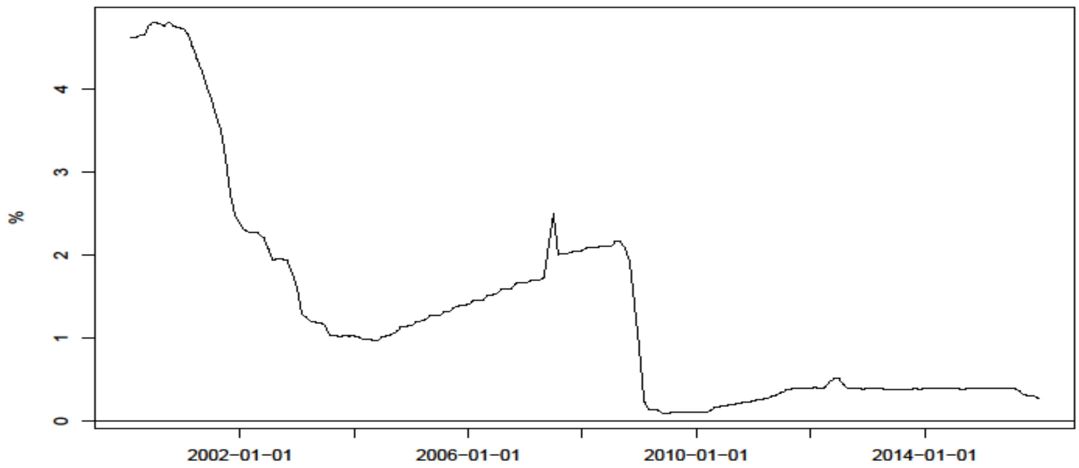

Figure 1 Policy Rate in Taiwan

Figure 2 illustrates the policy rate in the euro area, Taiwan, the United States, and the United Kingdom. We confirm that, while the correlation between the rates of the Euro area/ United Kingdom vis-à-vis the United States rates is very high, the amplitude of the interest rate cycle is much smaller in the euro area/the United Kingdom than in the United States. Comparing the policy rates in Taiwan, the Euro area, the United States, and the United Kingdom, we also could find a clear co-movement among them. Because Taiwan is a small and highly open economy, the policy rates in the United States and the euro area might have a greater influence on Taiwan's. The preliminary evidence proposes above the point to the existence of a possible interaction among Taiwan, the Euro area, the United States, and the United Kingdom. In the rest of paper, we propose an empirical framework of analysis in which we evaluate this relationship.

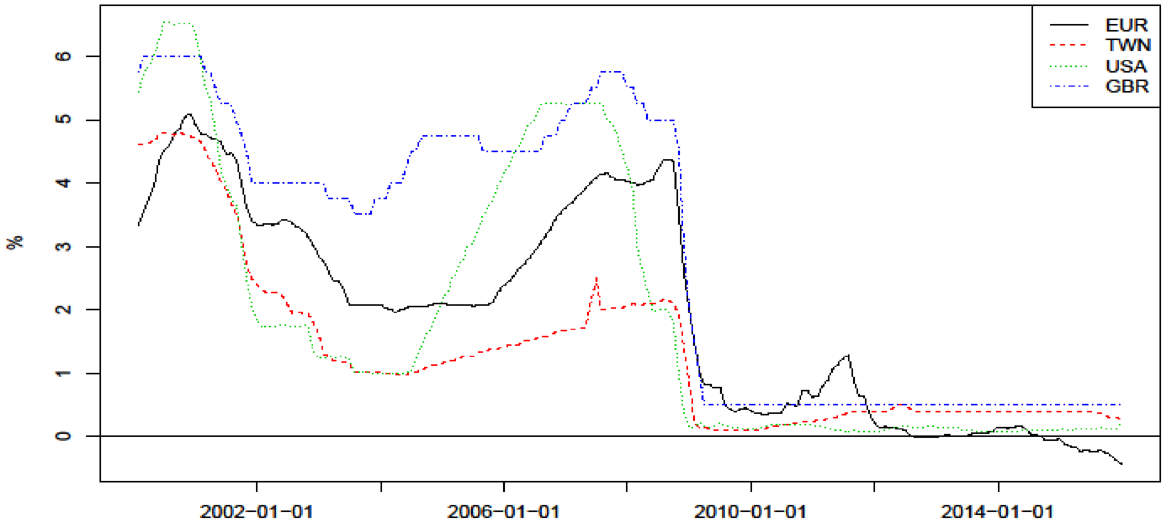

Figure 2 Policy Rates in the Euro area, Taiwan, the United States, and the United Kingdom

3. Econometric Methodology

We employ the network connectedness measures that are proposed by Diebold and Yilmaz (2009, 2012, 2014, 2015). This method has been widely used in economic fields, such as financial markets (Diebold and Yilmaz, 2014, 2016), policy uncertainty (Klobner and Sekkel, 2014), inflation spillovers (Halka and Szafranek, 2016), oil price and equity markets (Maghyereh et al., 2016) and so on. The objective of this econometric technique is to compute various interesting measures, "*TO others*", "*FROM others*", and "*NET*", from the transmissions of global liquidity in a system that contains Indonesia, Singapore, South Korea, and Taiwan, the euro area, Japan, the United Kingdom, and the United States.[16]

Assume that global liquidity indexes, GI, are modeled as a vector autoregressive (VAR) process that can be written as

$$GI_t = \sum_{i=1}^{p} \Phi \, GI_{t-i} + \varepsilon_t,$$

where $GI_t = (GI_{1t}, GI_{2t}, \dots, GI_{Nt})'$ denotes a $(\mathrm{N} \times 1)$ vector of countries. In our paper, as proxy variables of global liquidity, we use the policy rates and long-term interest rates. Φ is a $\mathrm{N} \times \mathrm{N}$ matrix of parameters to be estimated. The error term, ε, is a vector of independently and identically distributed errors with zero mean and Σ covariance matrix.

Diebold and Yilmaz (2014) suggest using the generalized variance decomposition (GVD)

[16] The limitation of this method is that it is designed for the multi-country univariate or single-country multivariate case (Greenwood-Nimmo et al., 2015).

developed by Koop et al. (1996) and Pesaran and Shin (1998) in order to avoid the difficulties of identifying orthogonal shocks in VAR models. The GVD framework has an advantage over the orthogonalized variance decomposition because it is invariant to the ordering of the variables entering the VAR system. Country *j*'s contribution to country *i*'s H-step-ahead GVD, d_{ij}^{gH}, is calculated as

$$d_{ij}^{gH}(\mathrm{H}) = \frac{\sigma_{jj}^{-1}\sum_{h=0}^{H-1}(e_i' A_h \Sigma e_j)}{\sum_{h=0}^{H-1}(e_i' A_h \Sigma A_h' e_i)}, \qquad \mathrm{H}=1, 2,\ldots,$$

where Σ is the covariance matrix for the error variance ε, σ_{jj} is the standard deviation of the error term for the j^{th} equation, A_h is H-th step moving average coefficient matrix and e_i is the selection vector with one as the i^{th} element and zero otherwise. In other words, a connectedness exists if country *j*'s liquidity measure contributes to the variance of country *i*.

Because shocks are not necessarily orthogonal in the GVD environment, sums of variance contributions are not necessarily equal to unity. We normalize them by dividing all entries of the GVD matrix with corresponding value of the row-sum:

$$\tilde{d}_{ij}^{gH}(\mathrm{H}) = \frac{d_{ij}^{gH}(\mathrm{H})}{\sum_{j=1}^{N} d_{ij}^{gH}(\mathrm{H})},$$

where $\sum_{j=1}^{N}\tilde{d}_{ij}^{gH}(\mathrm{H}) = 1$ and $\sum_{i,j=1}^{N}\tilde{d}_{ij}^{gH}(\mathrm{H}) = N$. $\tilde{d}_{ij}^{gH}(\mathrm{H})$ can be seen as a natural measure of the pairwise directional connectedness from country *j* to country *i* at horizon H. In general we use the notation $C_{i\leftarrow j}(H)$ to represent this transmission. Note that in general $C_{i\leftarrow j}(H) \neq C_{j\leftarrow i}(H)$. The net pairwise directional connectedness is

$$C_{ij} = C_{i\leftarrow j}(H) - C_{j\leftarrow i}(H).$$

We are particularly interested in determining how all countries together are contributing to a single country, so we aggregate partially. The total directional connectedness from all countries to country *i*, denoted by $C_{i\leftarrow \cdot}(H)$("*FROM others*"), is computed as

$$C_{i\leftarrow \cdot}(H) = \sum_{\substack{j=1 \\ j\neq i}}^{N}\tilde{d}_{ij}^{gH}(\mathrm{H}).$$

We are also able to compute how a particular country *i* is contributing to the shocks in all other countries by aggregating partially. The total connectedness from country *i* to all countries, denoted by $C_{\cdot\leftarrow i} = (H)$ ("*TO others*"), is computed as

$$C_{\cdot\leftarrow i}(H) = \sum_{\substack{j=1 \\ j\neq i}}^{N}\tilde{d}_{ji}^{gH}(\mathrm{H}).$$

In general, net total directional connectedness (“*NET*”) is

$$C_i(H) = C_{\cdot\leftarrow i}(H) - C_{i\leftarrow\cdot}(H).$$

This is an informative measure that might define the role of a country in the whole system of countries as a net transmitter or receiver of shocks.

The total aggregation of the variance decompositions across all countries measures the system-wide connectedness. The total directional connectedness in all countries is given by

$$\boldsymbol{C}(\boldsymbol{H}) = \frac{\sum_{\substack{i,j=1 \\ i\neq j}}^{N} \tilde{d}_{ij}^{gH}(\mathrm{H})}{N}.$$

We could apply the connectedness table such as Table 1 to understand the various connectedness measures and their relationships. For instance, $\tilde{d}_{12}^{gH}$ presents the pairwise directional connectedness from country 2 to country 1. $C_{\cdot\leftarrow 1}$ is the total directional connectedness from country 1 to all countries. $C_{1\leftarrow\cdot}$ is the total directional connectedness from all countries to country 1. The total directional connectedness in all countries is $\boldsymbol{C}$.

Table 1 Schematic Connectedness

	GI_1	GI_2	...	GI_N	*FROM others*
GI_1	$\tilde{d}_{11}^{gH}$	$\tilde{d}_{12}^{gH}$	...	$\tilde{d}_{1N}^{gH}$	$C_{1\leftarrow\cdot}$
GI_2	$\tilde{d}_{12}^{gH}$	$\tilde{d}_{22}^{gH}$	...	$\tilde{d}_{2N}^{gH}$	$C_{2\leftarrow\cdot}$
⋮	⋮	⋮		⋮	⋮
GI_N	$\tilde{d}_{N1}^{gH}$	$\tilde{d}_{N2}^{gH}$	...	$\tilde{d}_{NN}^{gH}$	$C_{N\leftarrow\cdot}$
TO others	$C_{\cdot\leftarrow 1}$	$C_{\cdot\leftarrow 2}$	...	$C_{\cdot\leftarrow N}$	$\boldsymbol{C}$

4. Data description and preliminary statistics

As mentioned previously, to understand the spillover effect of global liquidity, we use policy rates and long-term interest rates to capture the effect.[17] After the global financial crisis, the Euro area (EA), Japan (JPN), the United Kingdom (UK), and United States (USA) have reduced their policy rate to near or almost zero. It has become very difficult to accurately assess monetary policy when interest rate are at the zero lower bound. Therefore, we use the "shadow short rate" (SSR) as a proxy variable for those countries whose policy rate is in a zero lower bound monetary policy environment (Bullard, 2012; Lombardi and Zhu, 2014; Krippner, 2015).[18] For other countries we still use policy rates. The SSR data is collected from the Krippner data set.[19] The policy rates for Indonesia (IDN), South Korea (KOR) and Singapore (SGP) are collected from the IMF's IFS dataset (Concept: Interest Rate, Central Bank Policy Rate).[20] The Taiwan's policy rate is the interbank overnight call- loan rate collected from the dataset of the Central Bank of the Republic of China (Taiwan). Our sample begins in January 2000 and ends in December 2015.

We provide a variety of descriptive statistics for (shadow) policy rates in Table 2. Means of policy rates are mostly positive (only JPN is negative). Figure 3 displays the time series plot of policy rates over the sample period. As can be seen in the figure, the pattern of policy rates is very close in all countries in our sample. Although the policy rate in TWN is quite low, it is not constrained by the zero lower bound. [21]

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[17] We use two different samples in this paper due to dataset restrictions. Data on interest rates, policy rates and long-term interest rates, is only available for some SEACEN member economies in the IMF's IFS dataset.

[18] Chen et al. (2014) introduce estimated SSR to assess the domestic and global impact of the United States unconventional monetary policy. Claus et al. (2016) apply SSR to investigate the United States and Japanese monetary policy spillover effect. Wu and Xia (2016) use the SSR as a quantitative measure of monetary policy in a factor-augmented vector autoregression.

[19] http://www.rbnz.govt.nz/research-and-publications/research-programme/additional-research/measures-of-the-stance-of-united-states-monetary-policy/comparison-of-international-monetary-policy-measures

[20] Data on policy rates is available for these SEACEN members in the IMF's IFS dataset.

[21] Perng Fai-nan, the governor of the Central Bank of the Republic of China (Taiwan), said that Taiwan will not go to a zero interest rate environment. (https://englishnews.ftv.com.tw/read.aspx?sno=15DF2B22E969CB4A30C18EBBF9E9BDA5) He also said that Taiwan does not need negative rates yet. (https://englishnews.ftv.com.tw/read.aspx?sno=346F2EB16325C2362420302ECC19CD74)

Table 2 Descriptive Statistics of (Shadow) Policy Rates

Unit：%

	USA (SSR)	*EA (SSR)*	*UK (SSR)*	*JPN (SSR)*	*KOR*	*TWN*	*IDN*	*SGP*
Mean	0.74	1.32	1.98	-1.56	3.48	1.35	9.20	1.07
Std. Dev	3.20	2.39	3.45	1.4	1.11	1.29	3.24	1.07
Min	-5.37	-4.59	-6.76	-4.82	1.48	0.1	5.75	0.02
Max	6.74	4.92	6.56	0.62	5.39	4.8	17.67	3.78

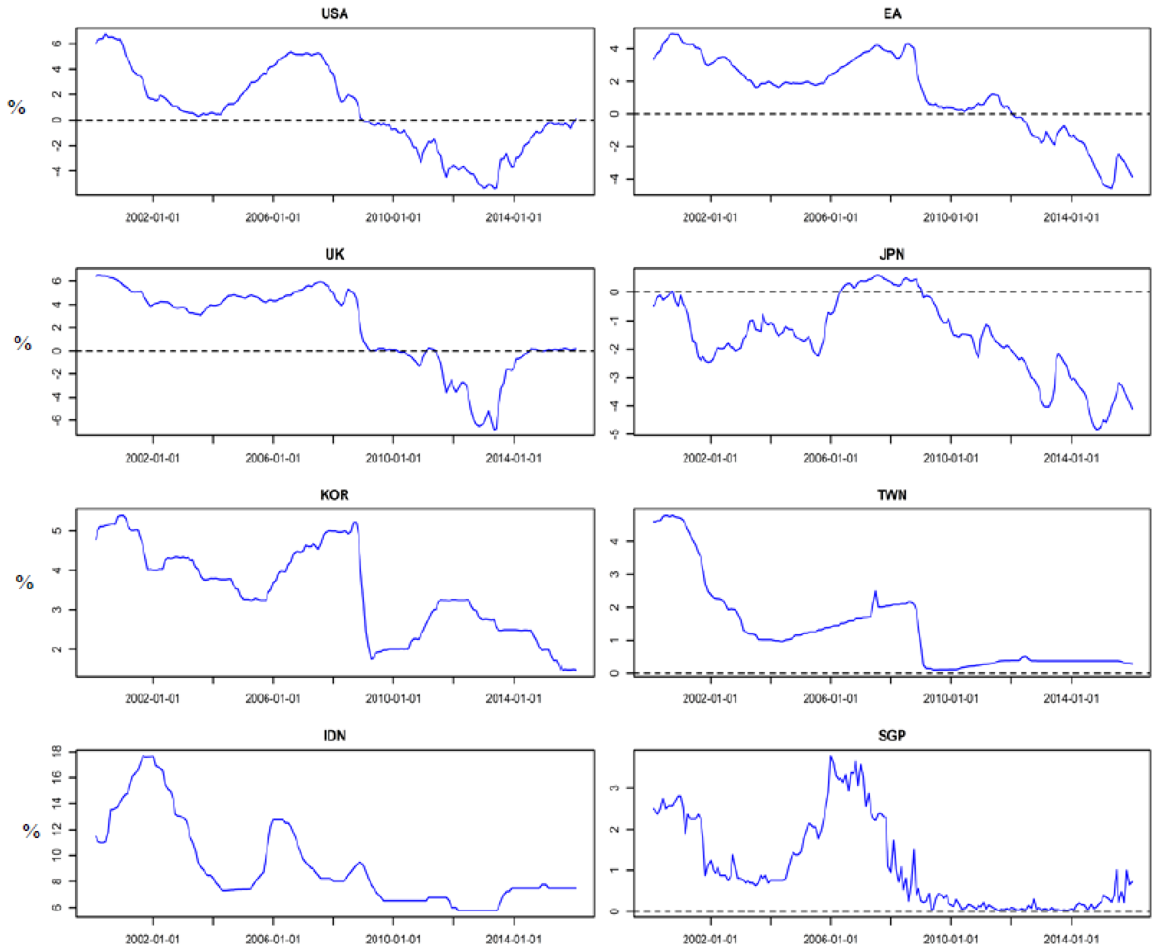

Figure 3 Time Series Plot of the (Shadow) Policy Rates

The other global liquidity indicator is the long-term interest rate. Long-term interest rates serve as proxies for liquidity since they reflect expected future monetary conditions. We put together a dataset for eight countries: USA, EA, JPN, UK, KOR, TWN, SGP and Malaysia (MYS), from January 2000 to December 2015, taken from the IMF's IFS dataset (Concept: Interest Rate, Government Securities, Government Bonds) [22] and the dataset of the Central Bank of the Republic of China (Taiwan) (Concept: 10 Year Government Bond Rates in Secondary Market).

We also provide a variety of descriptive statistics for long-term interest rates in Table 3. KOR has the highest mean interest rate, followed by UK, EA, USA, MYS, SGP and TWN. We plot the long-term interest rates as in Figure 4. As can be seen in Figure 4, in all eight countries, interest rates follow a downward trend.

Table 3 Descriptive Statistics of Long-Term Interest Rates

Unit: %

	USA	*EA*	*JPN*	*UK*	*KOR*	*TWN*	*SGP*	*MYS*
Mean	3.71	3.84	1.19	3.89	4.84	2.28	2.79	3.70
Std. Dev	1.21	1.06	0.43	1.17	1.59	1.2	0.78	0.49
Min	1.53	0.85	0.27	1.59	1.91	1.11	1.30	2.79
Max	6.66	5.7	1.92	5.82	9.91	6.06	4.67	5.52

[22] Data on long-term interest rates is available for these SEACEN members in the IMF's IFS dataset.

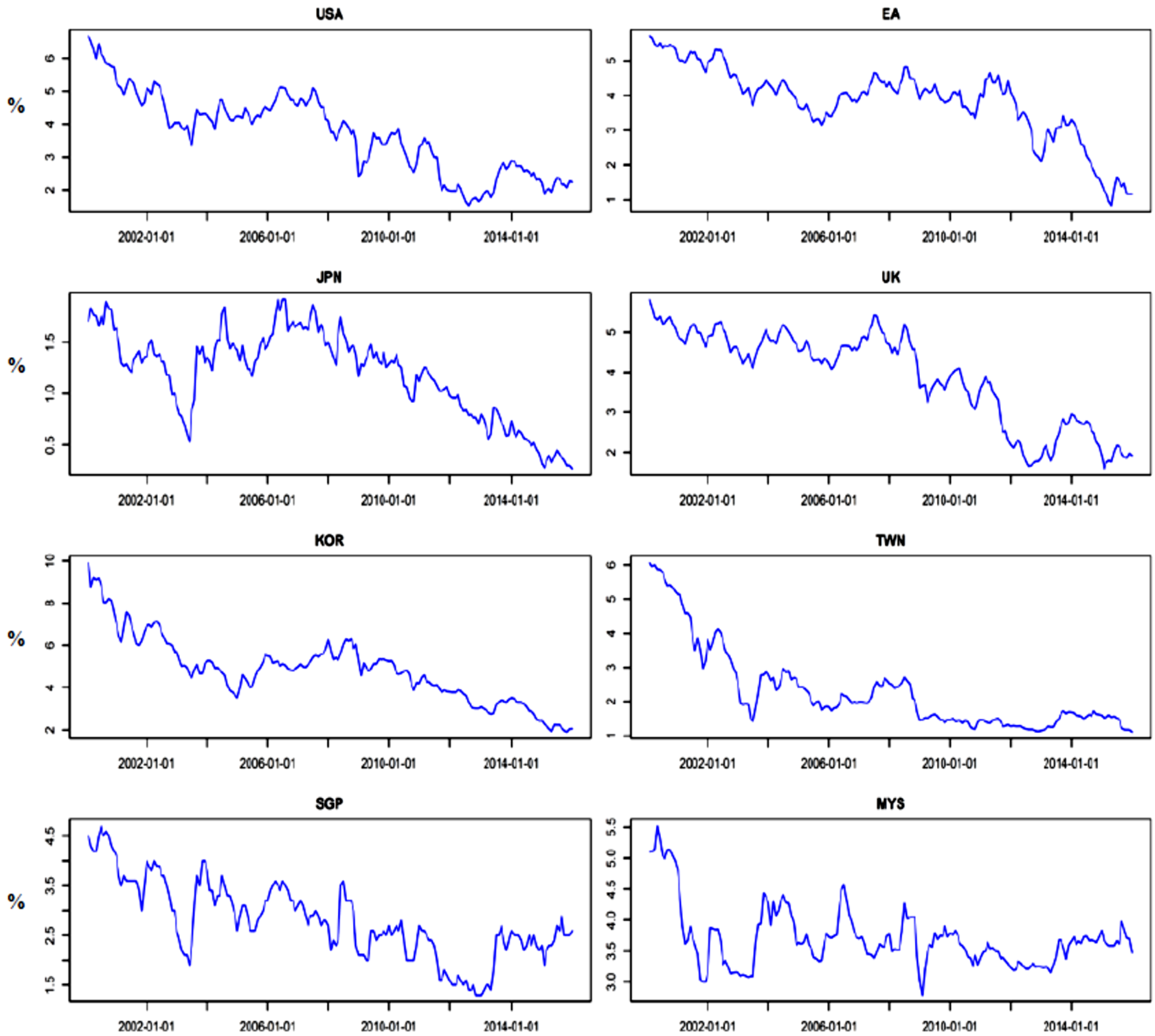

Figure 4 Time Series Plot of the Long-Term Interest Rates

5. Empirical Results

In the following context, we analyze the transmission of global liquidity using policy rates and long-term interest rates. We would perform a static (full sample) and dynamic (rolling sample) analysis for connectedness across our sample countries.

5.1 Policy Rates

5.1.1 Static Analysis

The matrix presented in Table 4 reports the full sample cross country connectedness of the policy rate. All results in the table are based on vector autoregressions of order 3, selected by the general-to-specific sequential Likelihood Ratio test and generalized variance decompositions of 3-month step ahead forecast errors.[23]The diagonal elements of the matrix represent the own country connectedness.[24] The off-diagonal elements of the matrix measure the pairwise directional connections and are particularly interesting in our research. The off-diagonal column sums or row sums are the directional connectedness "*TO others*" (measured by $C_{\cdot\leftarrow i}$) and "*FROM others*" (measured by $C_{i\leftarrow\cdot}$), and the difference between the "*TO others*" and "*FROM others*" is the "*NET*" directional connectedness. The total connectedness index is presented in the bottom-right corner.

The total connectedness index for the full sample period is 35.66%, indicating that less than 40% of the total variance of the forecast errors for the eight countries is explained by the connectedness of shocks across countries. In the connectedness "*TO others*" row, the UK is the country that contributed the most to other countries' forecast error variance (67.82%), followed by the USA (66.85%) and EA (61.24%). JPN, KOR and TWN contributed 23.12%, 26.37%, and 18.90%, respectively. In terms of the directional connectedness received "*FROM others*", IDN appears to be the country that received the lowest percentage of shocks from other countries (6.19%), followed by SGP (27.61%) and JPN (29.40%). The USA received the highest percentage (52.96%) of shocks from other countries, followed by the UK (45.18%) and TWN (43.47%).[25]

23 Klobner and Sekkel (2014) also apply 3-month step ahead forecast error variance decomposition to investigate policy uncertainty shocks.

24 Diebold and Yilmaz (2015) denote that connectedness is based on assessing shares of forecast error variation in various locations due to shocks arising elsewhere.

25 The US Federal Reserve might consider the shock of foreign interest rate because it is the key variable of foreign activity in the FRB/US model. Fischer (2016) introduces the simulations that underlie the estimates of the effect of foreign interest rate disturbance for the federal funds rate, using simulations of the FRB/US model.

Table 4 Full Sample of Directional Policy Rate Connectedness

Unit: %

	USA	*EA*	*UK*	*JPN*	*KOR*	*TWN*	*IDN*	*SGP*	*FROM others*
USA	47.04	9.71	25.44	8.80	1.01	2.56	0.21	5.22	52.96
EA	11.44	56.98	16.83	5.98	1.76	3.20	0.02	3.79	43.02
UK	20.43	13.10	54.82	6.75	1.24	1.75	0.47	1.44	45.18
JPN	11.46	11.14	6.51	70.60	0.03	0.08	0.14	0.04	29.40
KOR	4.89	9.16	10.03	0.22	62.54	9.45	0.72	2.99	37.46
TWN	8.18	9.35	6.96	0.09	15.75	56.53	1.49	1.65	43.47
IDN	0.34	1.63	0.45	1.18	0.36	0.73	93.81	1.49	6.19
SGP	10.11	7.15	1.59	0.09	6.23	1.13	1.31	72.39	27.61
TO others	66.85	61.24	67.82	23.12	26.37	18.90	4.36	16.64	**35.66**
NET	13.89	18.22	22.64	-6.29	-11.09	-24.57	-1.83	-10.97	

The difference between the total directional connectedness "*TO others*" and the total directional connectedness "*FROM others*" gives the "*NET*" total directional connectedness to others ($C_i = C_{\cdot\leftarrow i} - C_{i\leftarrow\cdot}$). The "*NET*" connectedness varies from the lowest, -24.57%, for TWN, to the highest, 22.64%, for the UK. In between, the EA, USA, IDN, JPN, SGP and KOR have "*NET*" connectedness of 18.22%, 13.89%, -1.83%, -6.29 %, -10.97 %, and -11.09 %, respectively. To sum up, the UK, the USA, and EA appear to be dominant transmitters, and TWN, KOR, SGP and IDN are net recipients. These results indicate that advanced counties (the UK, the USA, and EA) might channel capital to emerging markets.

Figure 4 presents the full-sample static connectedness plot. The nodes represent the eight countries included in our paper. The size and color of each node indicate the size of the total connectedness of the policy rate "*TO others*" (from dark red (strongest) to peach, light salmon and beige (weakest)). Edge thickness also indicates the average pairwise directional connectedness. The size of edge arrows indicate pairwise directional connectedness "*TO others*".[26] This graph displays connections based upon their distance and thickness. The UK, the USA and EA have the highest total connectedness "*TO others*" as indicated by their dark red colored nodes. They are followed by KOR and JPN whose nodes are peach, and TWN and SGP

[26] The node location is determined by the *ForceAtlas2* algorithm of Jacomy et al. (2014).

with light salmon nodes. IDN has the lowest connectedness "*TO others.*"

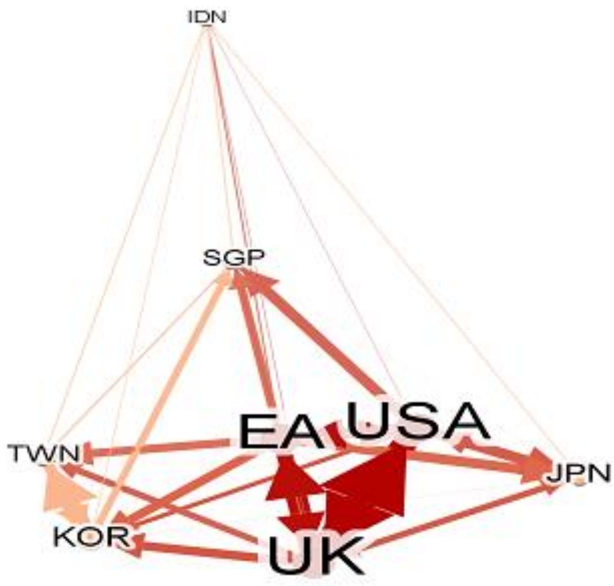

Figure 4 Pairwise Directional Connectedness over the Full Sample

Let us focus on the cross-country directional connectedness measures. We find that there are two main clusters. One is the USA, the UK, and EA, the other is TWN and KOR. The highest pairwise connectedness measure observed is from the UK to the USA (25.44%). In turn, the pairwise connectedness from the USA to the UK (20.43%) ranked second. One factor behind the high pairwise directional connectedness between the USA and the UK tends to result from a high degree of business cycle synchronization. Furthermore, the connectedness from the UK to EA, 16.83%, and from EA to the UK, 13.10%, are due to the fact that there is a strong tie between their financial sectors.

Another important pair of countries is TWN and KOR. The connectedness from TWN to KOR, 9.45% and the connectedness from KOR to TWN, 15.75%, both exceed the pairwise directional connectedness between TWN (KOR) and advance countries. Based on our bilateral analysis, the high pairwise connectedness between the two countries could be due to the fact that they have several similarities, i.e. their industrial structure, a common export markets and major financial markets in Asia.

5.1.2 Dynamic Analysis

The static analysis provides the characterization of connectedness over the full sample. It cannot help us understand how connectedness changes over time. Hence, we re-estimate the connectedness using a 48-month rolling sample, and we assess the extent and the nature of variation in connectedness over time via the corresponding time series of connectedness indices. In Figure 5, we plot total connectedness over 48-month rolling-sample window. From a bird's-eye perspective, the total connectedness plot in Figure 5 has some revealing patterns. The first cycle starts in mid-2004 and ends in 2006, and the total connectedness index fluctuates between 33% and 50%. It coincides with the tightening of monetary policy for the USA, the UK and EA. For example, during 2004 to 2006, the FOMC raised the federal funds rate target in 17 consecutive meetings, lifting the federal funds rate from 1.0% to 5.25%.

The second cycle coincides with the development of the global financial crisis and the European sovereign debt crisis of 2008 to the end of 2012. The index records the biggest jump in its history. The index increases sharply from 41% in May 2008 to 56% in December 2008, and then to 62% in November 2010. We could also see that the index falls during the taper tantrum. This cycle results from monetary authorities of the USA, the UK, EA, and JPN, quickly responding to financial crisis shocks, yet ongoing downward adjustments of policy rates are constrained by the zero nominal bound. We could find monetary spillovers taking place from these countries to these SEACEN members.

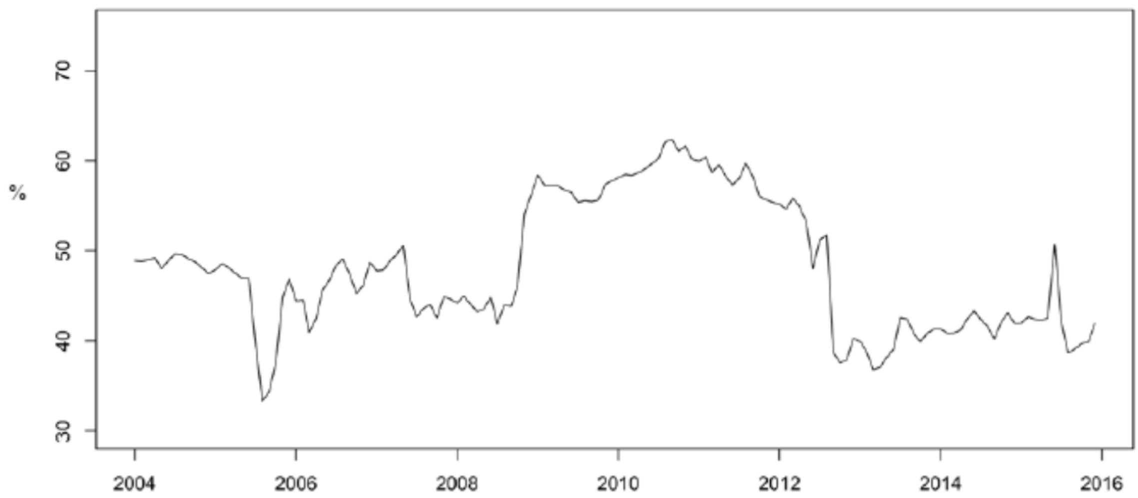

Figure 5 Total Policy Rate Connectedness (48-month Window)

We now estimate the above-mentioned rows and columns of Table 4 dynamically in a fashion precisely parallel to the total connectedness plot discussed earlier. The upper panel of Figure 6 presents the "to others" connectedness. As we discussed earlier, it is the directional connectedness from each country to others and corresponds to the "*TO others*" row in Table 4.

The middle panel of Figure 6 presents the "*FROM others*" connectedness. It is directional connectedness from others to each country and corresponds to the "*FROM others*" column in Table 4. Finally, the lower panel shows the "*NET*" connectedness of each country as measured by the difference between its "*TO others*" and "*FROM others*" connectedness.

Looking at the upper panel of Figure 6, we could find that the "*TO others*" connectedness measures of JPN, KOR, TWN, IDN, and SGP are much smoother compared to the other countries. This is because the USA, EA, and the UK generated the volatility connectedness to others during the global financial crisis until the end of 2011. For example, the "*TO others*" connectedness measure of the UK jumped significantly (100 percentage points) following the crisis. The "*TO others*" connectedness measure of EA jumped by 40 percentage points. This is expected owing to the century low, near zero interest rates in the USA, the UK, and EA after the global financial crisis of 2008/2009 and the European sovereign debt crisis of 2010-2012. They wanted to use the monetary policy in an attempt to provide liquidity and stimulate the economy. Therefore, there might be policy spillovers. In particular, we could find that SGP jumped significantly (over 100 percentage points) in 2015. The reason of this might be because the Monetary Authority of Singapore (MAS) decided to further ease its monetary policy.[27]

Next, we focus on the "*FROM others*" connectedness measures in the middle panel of Figure 6. The "*FROM others*" connectedness measure of the USA, EA and the UK are around 50% during this long period. Obviously, the "*FROM others*" connectedness measures of KOR and TWN explode during the global financial crisis and the European sovereign debt crisis. While the "*FROM others*" connectedness stayed below 40%, they turn to a new high after crisis by fluctuating around to 80%. The IDN's "*FROM others*" connectedness is less than 40% before 2008. The "*FROM others*" connectedness measure surges to above 70% in early 2010 and to approximately 50% in early 2012. This finding suggests that the monetary policies of the USA, EA, and the UK have sizable spillovers to SEACEN members.

The "*NET*" connectedness measures (in the lower panel of Figure 6) of the USA and EA are mostly positive from 2004 to the end of 2012. The "*NET*" connectedness of them around are 30% and 50%, respectively. From late 2008 to 2015, the "*NET*" connectedness of the UK

[27] The MAS made a surprise cut to the slope of its Singapore dollar nominal effective exchange rate (S$NEER) in January 2015. In October 2015, the MAS kept the Singapore dollar nominal effective exchange rate policy band on a modest and gradual appreciation path.

fluctuates between 40% and 80%. It means that they are the main contributors to other countries. We also find that JPN's "*NET*" connectedness reaches a peak from 2012 until the end of 2014, and this might result in "Abenomics" which includes correction of the excessive yen appreciation, setting negative interest rates, radical quantitative easing, and so on. The "*NET*" connectedness measures of KOR, TWN, IDN, and SGP, on the other hand, have been mostly negative through our sample period. These countries are net receivers over time. This finding is consistent with that of Chen et al. (2012) and that of Rogers et al. (2014), both of which provide evidence on the international spillovers of monetary policy by the USA, EA and the UK.

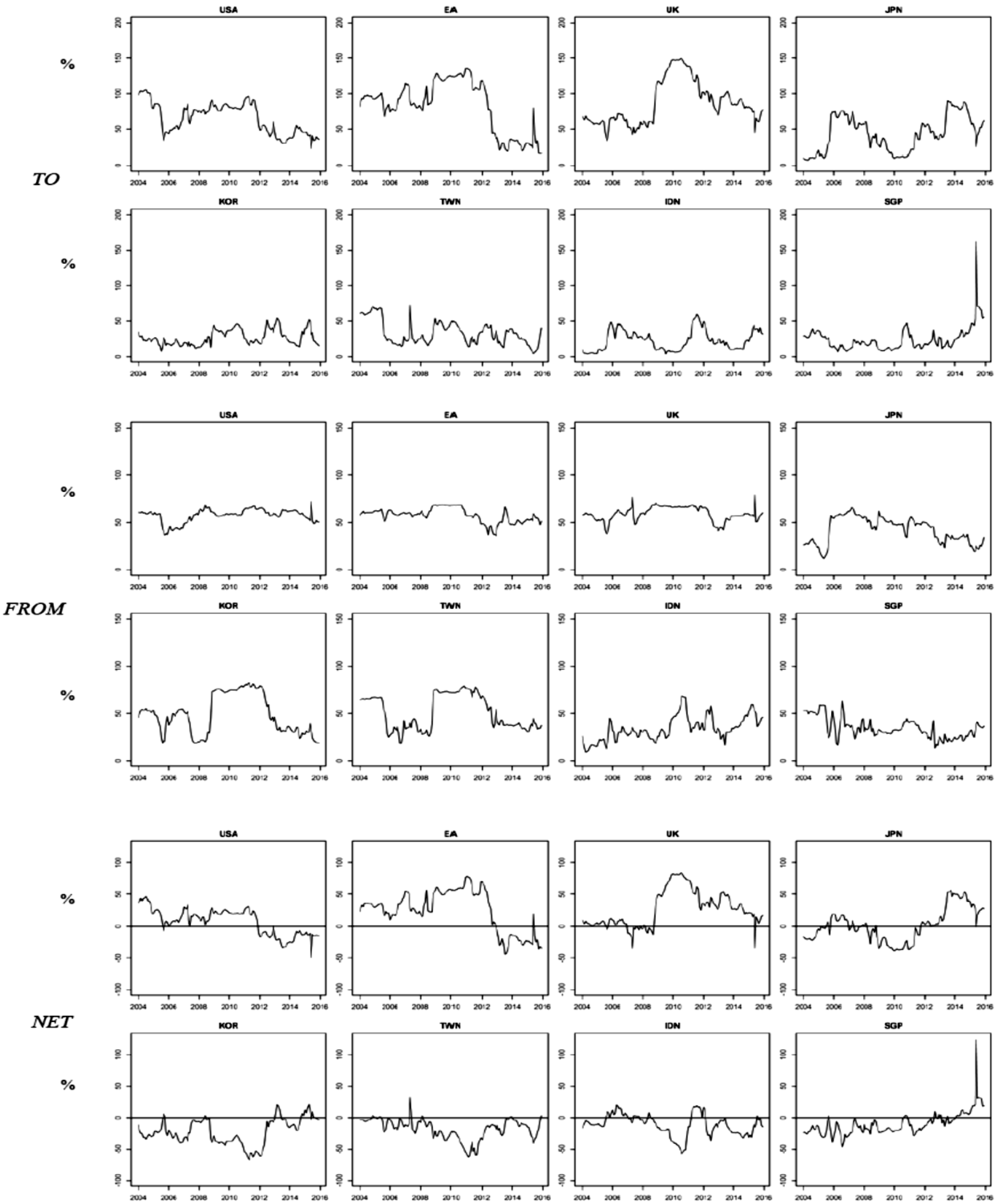

Figure 6 Directional Policy Rate Connectedness

5.2 Long-term interest rates

5.2.1 Static Analysis

Next, in Table 5, we analyze the connectedness among long-term interest rates in eight countries. The results are based on VAR (6) selected by the general-to-specific sequential Likelihood Ratio test, and the 3-month step ahead forecast error variance decomposition is used. The total connectedness over the entire period is 60.54%, as shown in the lower right corner of Table 5. This result indicates that our sample countries are highly interconnected.[28] The UK has the highest "*NET*" connectedness value, 27.41%, followed by the USA at 26.62%, indicating that the two countries are net transmitters of long-term interest rate shocks. In contrast, TWN, EA, MYS, and KOR have negative "*NET*" connectedness values, -32.22%, -28.28%, -23.49%, and -13.07%, respectively, suggesting that these countries are net recipients.

According to the connectedness table, we find that the movement in long-term interest rates of the USA, EA, and the UK are susceptible to other countries. The USA, EA and the UK also contribute to large proportions in other countries. To have a more intuitive understanding of the spillover effects, we use the evidence in Table 5 to plot the network graph in Figure 7. This figure shows connections based upon the distance and the thickness of connections. We find that there is only one cluster, consisting of the USA and the UK. The pairwise connectedness from USA to UK is 20.18%, while the pairwise connectedness from UK to USA is 23.90%. The higher degree of financial linkages, the higher is the level of contagion from global liquidity shocks to long-term interest rates. We can also see that there is a large distance between EA and MYS, and it seems that there is no significant direct connection between these two countries.

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[28] This is relatively high compared to other papers' findings, for instance, 27.1% for policy uncertainty (Klobner and Sekkel, 2014), 28.8% for business cycle (Diebold and Yilmaz, 2015), 33.3% for inflation spillover (Halka and Szafranek, 2016), 39.5% for stock market volatilities (Diebold and Yilmaz, 2009), and 42.7% for macroeconomic uncertainty (Yin and Han, 2014).

Table 5 Full Sample of Directional Long-Term Interest Rates Connectedness

Unit: %

	USA	*EA*	*JPN*	*UK*	*KOR*	*TWN*	*SGP*	*MYS*	*FROM others*
USA	27.88	8.04	9.76	23.90	5.52	4.21	13.71	6.98	72.12
EA	13.07	37.33	8.43	18.37	6.48	4.82	9.72	1.78	62.67
JPN	12.97	3.13	50.71	9.63	2.73	2.93	14.03	3.87	49.29
UK	20.18	7.98	11.22	34.7	3.42	6.06	12.09	4.36	65.3
KOR	10.91	4.71	3.79	10.27	51.68	1.14	13.22	4.27	48.32
TWN	12.63	4.64	12.94	9.63	2.39	39.28	11.38	7.11	60.72
SGP	14.79	3.82	16.31	13.15	7.29	4.62	32.98	7.03	67.02
MYS	14.18	2.07	7.90	7.76	7.41	4.72	14.86	41.11	58.89
TO others	98.74	34.39	70.34	92.71	35.25	28.50	89.00	35.41	60.54
NET	26.62	-28.28	21.05	27.41	-13.07	-32.22	21.98	-23.49	

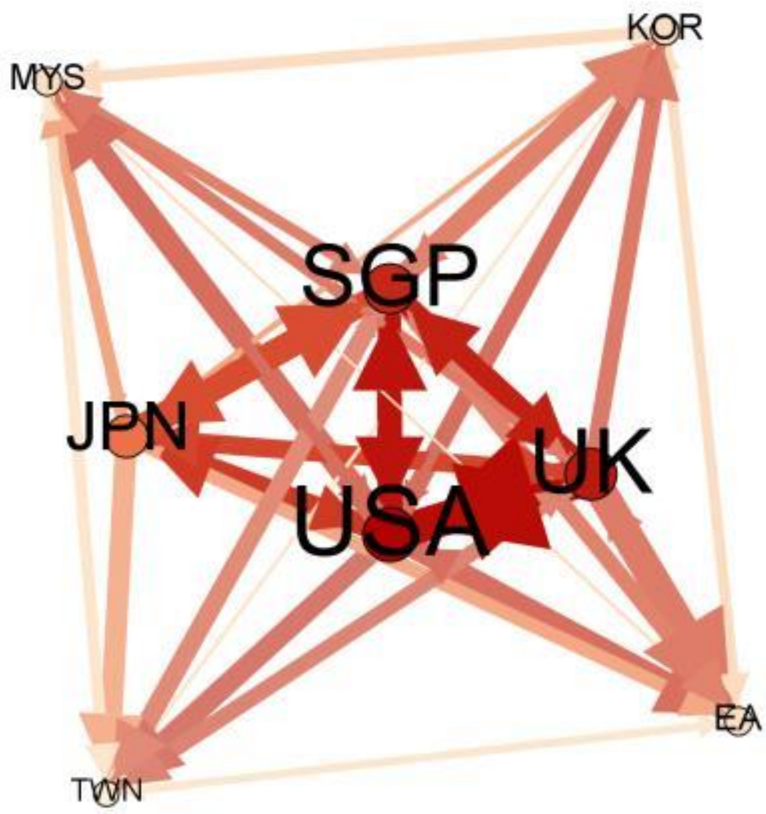

Figure 7 Pairwise Directional Connectedness over the Full Sample

5.2.2 Dynamic Analysis

Total connectedness over time, obtained from a 48-month rolling windows approach is illustrated in Figure 8. According to this figure, we observe a variation in the total connectedness measure, which turns out very responsive to extreme economic events. For instance, the total connectedness reaches a peak during the global financial crisis period.

Figure 8 Total Long-Term Interest Rate Connectedness (48-month Window)

Time-varying pictures of directional connectedness of "*FROM others*", "*TO others*", and "*NET*" are displayed in Figure 9. Let us focus on the upper panel of Figure 9, the dynamic behavior of the directional connectedness is quite different across countries. The "*TO others*" connectedness measures of the USA and the UK have increased gradually since 2008. JPN's "*TO others*" connectedness is relatively volatile over our sample period. It mounts to over 100% in late 2005, the global financial crisis and the European sovereign debt crisis. Generally, the "*TO others*" connectedness measure of SEACEN members (expect SGP) is relatively low over the examined sample.

In order to explore the roles of the countries under investigation, e.g., whether they are net transmitters of net receivers of global liquidity shocks, we concentrate only on the "*NET*" directional connectedness measures. It is evident in the lower panel of Figure 9 that JPN seems to be the dominant transmitter of global liquidity shock in our sample, with the USA, EA, the UK and SGP are at the epicenter of the transmission process in the period the global financial crisis and the European sovereign debt crisis.[29] Conversely, KOR, TWN, MYS are mostly negative during the sample period, meaning that they are mainly receiving net transmission. Among them, we could find that the "*NET*" connectedness of TWN especially moves only mildly.

Overall, no matter whether it is the policy rate or long-term interest rate, the results for the transmission of global liquidity among the USA, the UK, EA, JPN and SEACEN members are consistent with our hypothesis. A bigger country is a net transmitter of the global liquidity shocks to the smaller countries. The results are broadly in line with what Choi et al. (2014) and Hofmann and Takat (2015) reported that global liquidity generated from advanced economies embarks an impact on emerging markets.

[29] In the long-term interest rate perspective, SGP might be a transmitter because it's exchange rate-based monetary policy. The Singapore dollar is managed against a basket of currencies of our major trading partners and competitors (i.e. the USA, the UK, and EA etc.). The choice of the exchange rate as the intermediate target of monetary policy implies that MAS gives up control over domestic interest rates.

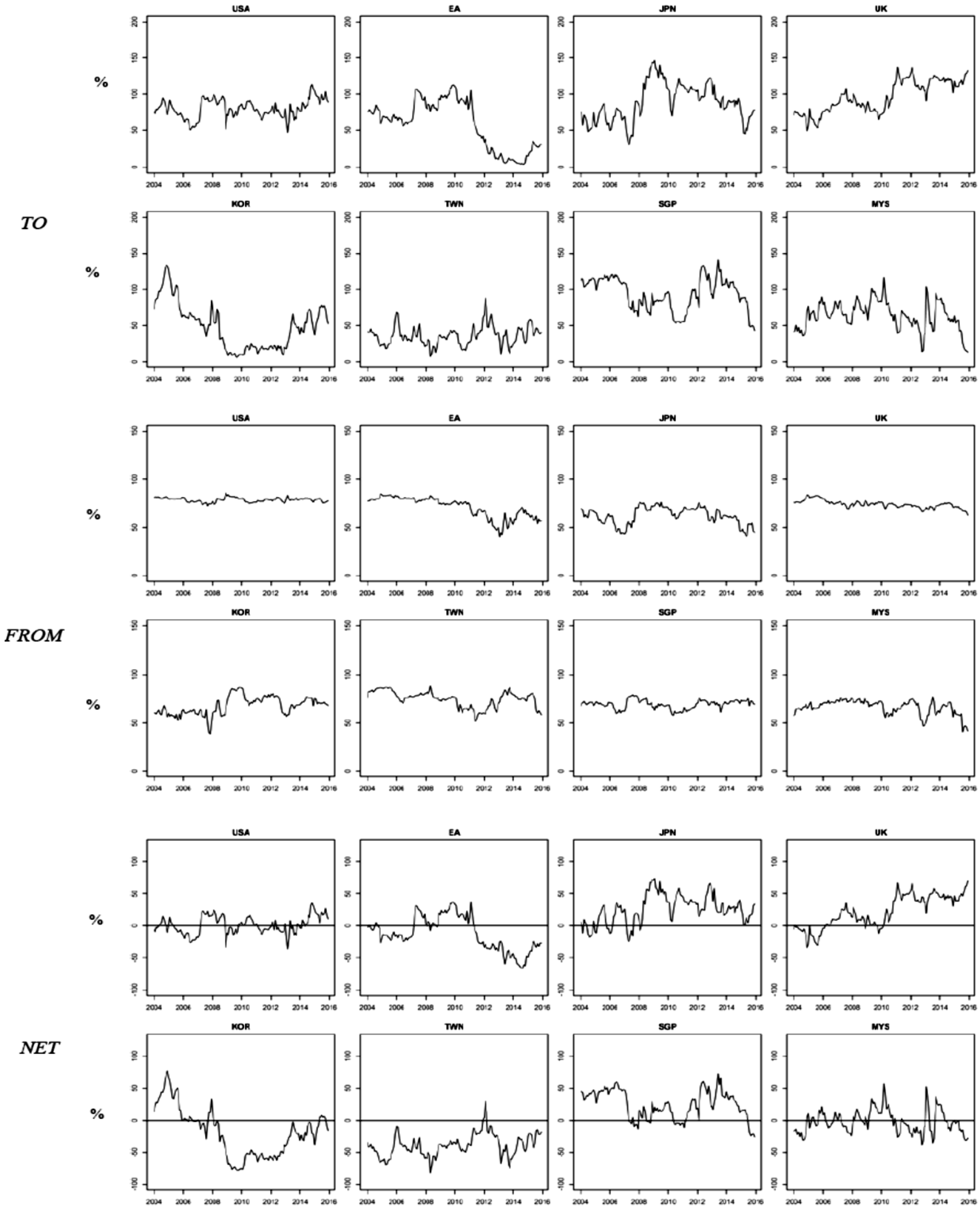

Figure 9 Directional Long-Term Interest Rate Connectedness

6. Conclusions

This paper aims to investigate the global liquidity transmission among advanced countries and some SECEAN members, using monthly data over 2000-2015. We apply the VAR-based connectedness approach by Diebold and Yilmaz (2009, 2012, 2014, 2015), which is well suited to this issue, but has rarely been used in this strand of literature so far.

By monitoring connectedness of global liquidity shocks, we could prove that total connectedness indexes suggest quite robust interdependence of global liquidity across our sample countries, and SEACEN members in our sample become "net receivers" of global liquidity shocks in our sample period. For policy rates, we find that Taiwan, South Korea, Singapore, and Indonesia are net recipients from the United Kingdom and the United States, with Taiwan being the biggest one in the static analysis. The dynamic analysis clearly shows that there has been a substantial increase in the total connectedness index since the global financial crisis and the European sovereign debt crisis. Taiwan, South Korea, Singapore, and Indonesia are also net receivers over time.

For long-term interest rates, our static results show that the United States and the United Kingdom have sizable spillovers to the rest of the countries. Conversely, Malaysia, Taiwan and South Korea are net receivers of global liquidity shocks. The dynamic analysis indicates that the total connectedness index displays no trend, but clear bursts and reaches the highest level during the global financial crisis. Japan seems to be the dominant exporter of shocks, whereas South Korea, Taiwan, and Malaysia are net importers over the examined sample period. Despite the significant findings, the limitation of this paper is that we only show up as various bilateral linkages are shown in the research. We do not have global shocks in our model and cannot capture all the dimensions of the effect of global liquidity.

From a policy perspective, the transmission of global liquidity to SEACEN member economies needs to be understood and taken into account by central banks. Our research indicates that central banks should look carefully not only at the evolution of the domestic conditions but also at the external surroundings. This result is similar with He and McCauley's (2013) statement that the transmission of global liquidity to Asian economies needs to understand and taken into account by policy makers in major countries. Caruana (2012) also suggests that global conditions have a growing economic impact on domestic economic conditions in an interconnected world.

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