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译文标题：

北美、欧洲和亚洲股市的价格和波幅溢出

译文：

摘要：本文研究了北美，欧洲和亚洲股票市场的价格和波幅溢出。收益溢出通过 VAR（15）建模，其中考虑了代表其股票市场的 15 个世界指数。还使用带有外生变量的 VAR 和 AR 分析了当日收益率对解释收益溢出的影响。波动溢出是通过包含当天影响的 AR-GARCH 建模的。在收益率和波动率溢出中，都发现特定指数主要受到在其之前开/关的指数的影响。我们还发现，亚洲和欧洲股票市场在区域中的影响更大。我们的论文为文献做出了贡献，包括涵盖整个时间线的市场，并且还对当日效应进行了建模，并在需要时保留了同时性。只要有证据，就可以将结果推广到未包括在内的其他市场。

关键词：收益外溢；波动外溢；VAR（15）；具有外生变量的 VAR；新兴市场

1. 介绍

当前，金融市场目睹了资本自由化，金融改革，计算机技术和信息处理的进步。在发达国家和发展中国家，这种趋势都很明显。这些因素可能减少了国内市场的孤立性，并增强了它们对来自世界其他地区的新闻和冲击迅速做出反应的能力。结果，世界各地股票市场之间的联系可能变得更加牢固。市场的国际联系对国内经济和国际多样化具有重大影响。紧密的联系会减少国内市场免受全球冲击的影响，而弱的市场联系会从国际多元化中获得潜在收益。了解不同市场的回报和波动之间的短期相互依存关系，有助于对多元化和对冲策略产生深刻见解。

在过去的 15 年中，投资组合经理对新兴资本市场的兴趣与日俱增，因为与发达市场相比，它们有望提供更高的资产回报。但是，随着经济的开放，新兴市场和发达市场之间的日益融合导致信息和情感从一个市场扩散到另一个市场。在全球多个证券交易所上市的股票也增加了市场的整合（Bennett＆Keller，1988）。

跨市场的信息传递已被广泛研究，大多数研究侧重于股票市场之间的长期相互依赖性和

因果关系，以期通过回报来发现这些市场之间的长期或短期相关性（Constantinou，Kazandjian，Kouretas＆Tahmazian，2005；Eun＆Shim，1989）。但是，跨市场的信息传递可能不仅通过收益，而且还通过波动（Baele，2002；Bekaert＆Harvey，1997；Christiansen，2003；Ng，2000；Worthington＆Higgs，2004）。有人认为，如果将两个市场整合在一起，那么一个市场的任何外部冲击不仅会影响其他市场的均值而且会影响收益的方差。了解市场之间的波动性溢出非常重要，因为波动性是一种风险度量，有助于评估国际多元化投资组合的风险。这在执行对冲策略，资产分配以及制定与市场资本流入相关的政策中也很重要。该领域的研究考虑了时变波动率框架中整个市场的波动率溢出。但是，大多数研究都没有使用最新数据，或者忽略了当日影响或没有对同时性进行建模。因此，有必要从经验上研究这些联系。

这项研究的目的是探讨亚洲（中国，香港，印度，印度尼西亚，日本，韩国，马来西亚，巴基斯坦，新加坡和台湾），欧洲（德国，法国和英国）和 北美（加拿大和美国）市场。在本研究中，首先使用 VAR（15）对回报溢出进行建模，该模型解释了一个市场对另一个市场的部分影响。由于 VAR 不对当天的效果进行建模，因此在使用 VAR / AR 合并了市场的当天效果之后，我们进一步对收益溢出进行建模，在这种情况下，在被检查市场之前开盘/关闭的市场收益为 用作解释变量，以及在之后打开/关闭的变量，则使用一天的滞后收益。例如，在对 CAC 和 DAX 进行建模时，我们获取所有在其之前开盘的市场（日经，Kospi 等）的当日收益，而在其之后开盘的市场（纳斯达克和 S＆P / TSX 60）的滞后收益。最后，使用两步 AR-GARCH 模型（Liu＆Pan，1997）估算波动性溢出，并使用与收益溢出相同的方法来捕获当日效应。本文以多种方式为现有文献做出了贡献。首先，我们考虑 15 个市场，包括亚洲，欧洲和北美的重要市场。这些市场合在一起涵盖了整个地理范围和时间范围。所选市场的交易时间几乎全天都在进行，这提供了一个机会来全面分析全球信息的流动。只有当我们采用代表每个地理区域的市场，更重要的是涵盖整个时间范围时，才能自信地说明某些重要市场的主导地位。我们还将重点放在更多的亚洲国家，因为大多数亚洲国家的新兴市场和与它们相关的文献较少。现有的大多数研究仅考察五、六个市场之间的相互联系，并不涵盖整个时间跨度。在这种情况下，我们可能会看到两个市场之间的溢出，因为可能缺少一些重要的市场，从而影响了这两个市场。VAR（15）给我们带来了市场经常相互影响的局部影响。其次，我们的数据通常包括一段时间（2000 年至 2008 年），在此期间，亚洲市场通常经历了贸易自由化，相当大的工业放松管制，其他结构性改革以及以出口为导向的增长战略。另外，亚洲国家也试图加强彼此之间的合作与贸易。同样，在欧洲市场中，主要的变化

是通过引入欧元（1999 年 1 月 1 日）。在大多数工作都着眼于美国对亚洲市场或欧洲市场的影响的情况下，我们的工作通常会同时考虑亚洲，欧洲和北美市场长达 8 年的情况。第三，我们在运行溢出模型时纳入了当天效应。在当今时代，新闻和信息会在很短的时间内从一个国家传播到另一个国家，包括当天的影响，同时需要对市场之间任何可能的溢出影响进行建模。当日影响是指合并当天开放但通常领先于其他市场的市场影响。在另一个市场影响它之前打开的市场，将其纳入模型很重要。此外，由于同时开放多个市场，因此我们需要在考虑同步性的同时对它们进行建模。因此，这里将带有外部变量的 AR / VAR 纳入当日效应。就我们所知，同时性和当日影响都没有在任何论文中一起建模。第四，我们对从新兴市场到发达市场的可能溢出进行建模。先前在该领域的研究，特别是在新兴亚洲市场的研究中，着眼于发达市场对新兴亚洲市场的影响，新兴市场之间区域间或区域间的相互依存关系，同时控制了发达市场的影响。但是，近年来，新兴市场与发达市场之间存在动态关系的明显可能性。

我们发现，信息在打开/关闭时从一个市场流向另一个市场。在当前市场之前开盘的市场对其有很大的影响。交易时间在通过市场产生的收益和波动性溢出中的作用通过包括当日影响来显示。该结果与收益率和波动率溢出均一致。即使在控制了其他市场的部分影响之后，美国市场也会影响大多数市场。我们发现，影响新兴市场的不仅是发达市场。新兴市场也影响了许多发达市场。在亚洲，日本，新加坡和香港市场占主导地位，在欧洲，英国和德国市场更具影响力。由于结果是通用的，因此发现的结果对于未包括在研究中的其他市场也很有用。其他市场也很可能会受到在其之前开/关的市场以及美国市场的影响。

本文的其余部分安排如下。第 2 节简要介绍了有关整个市场回报率和波动率溢出研究的文献。第 3 节中提供了数据及其描述性统计数据。第 4 节中说明了用于回报溢出的方法。本节还报告了回报溢出的结果。第 5 节描述了波动溢出的发现，并讨论了波动溢出的结果。最后一节总结和总结。

2. 文献综述

在两个广泛的背景下研究了国际市场之间的相互依赖性：回报的相互依赖性和波动性的相互依赖性。大多数研究集中在发达市场，尤其是美国，日本和主要欧洲市场之间的相互依存关系。在亚洲发达市场和新兴市场环境下也进行了一些研究，其中研究了新兴市场（例如东亚，拉丁美洲和中东）与发达股票市场之间的相互关系。

Liu 和 Pan（1997）研究了从美国和日本股票市场到其他四个亚洲股票市场的均值和波动率溢出，发现美国市场在将收益和波动率传递给其他四个亚洲市场方面比日本市场更具影

响力。Ng（2000）研究了从日本和美国市场到太平洋盆地股市的波动性溢出。Alagan 和 Bhar（2002）使用双变量 GARCH 模型研究了在澳大利亚和美国双重上市的澳大利亚股票交易之间的信息流，发现从美国市场到澳大利亚市场的单向信息流。Baele（2002）研究了从美国（全球效应）和整个欧洲股票市场（区域效应）到单个欧洲股票市场的波动溢出的时变性质。Christiansen（2003）研究了美国和欧洲市场对单个欧洲债券市场的均值和波幅溢出效应，发现均值-溢流可以忽略不计，但波幅溢出的影响很大。Wongswan（2006）研究了从美国和日本到韩国和泰国股票市场的信息传递，并得出结论，在较短的时间范围内，发达市场与新兴市场波动之间存在着很大的关联。有效市场的“即时调整”属性是 Fama 提出的[7]，他认为历史序列不能有效地预测未来数值。根据有效市场假说，自从任何有用信息将被金融市场迅速吸收，传导效应在理论上在不同的金融市场是不存在的。然而，溢出效应和市场间信息传递在丰富的文献中得到了观察和讨论，近年来研究者开始关注不同金融市场之间的联动关系。较早的研究主要集中于股票市场[8-11]。例如，Hamao 等人[8]检验了美国、英国赫尔日本股票市场之间的波动溢出效应，显示出一种有趣的不对称性。

在欧洲国家的背景下，许多作者研究了引入欧元（1999 年 1 月 1 日）对欧洲市场的联系以及欧美市场之间的联系的影响。大多数研究发现，引入欧元后，欧洲市场之间的联系增加了（Melle，2003）。但是，欧洲和美国市场之间联系的证据尚无定论。Cheung 和 Westermann（2001）得出结论，在引入欧元之前和之后，美国和欧洲市场之间的溢出并未改变。Veiga 和 McAleer（2003）在使用高频数据分析美国，英国和日本市场之间的波动溢出时，发现波动溢出发生在英国到美国和日本以及从美国到英国的地方。Savva，Osborn 和 Gill（2004）使用动态相关框架研究了美国，德国，英国和法国市场之间的溢出效应，发现欧洲市场（仅英国和德国）受到美国市场的影响。他们还得出结论，在引入欧元之后，欧洲市场之间的相关性增加了。Bartram，Stephen 和 Wang（2007）使用通用的时变 copula 依赖模型分析了欧洲和非欧洲欧洲国家之间的市场联系。他们调查了引入欧元对欧洲股票市场依存度的影响，发现欧元区内部的市场依存度增加仅是由于某些国家（例如法国，德国，意大利，荷兰和西班牙）欧洲一体化程度提高的可能结果 。Syriopoulos（2007）研究了新兴市场和发达欧洲股票市场之间的短期和长期联系，发现新兴市场与发达市场股票之间的整合很好。

在亚洲市场的背景下，贝卡尔特和哈维（Bekaert and Harvey，1997）分析了新兴股票市场的波动性，发现在综合市场中，全球因素会影响波动性，而本地因素会影响细分市场。在 Kim，Yoon 和 Viney（2001）中，研究了 1997 年至 1998 年亚洲金融危机期间亚洲国家之间的波动传递。他们发现，香港和韩国之间存在相互溢出效应。Jang and Sul（2002）研究了

亚洲金融危机之前，之中和之后亚洲股市的共同变动。他们发现，在金融危机期间，亚洲市场之间的共同运动有所增加。Johnson and Soenen（2002）研究了 12 个亚洲股票市场与日本的整合程度，发现澳大利亚，中国，香港，马来西亚，新西兰和新加坡的股票市场与日本的股票市场高度融合。Miyakoshi（2003）使用二变量 EGARCH 模型研究了日本和美国市场对七个亚洲股票市场的收益和波动溢出的幅度，发现亚洲股票市场之间的区域整合远不如美国 Bala 和 Premaratne（2004）的研究。波动率从香港，日本，美国和英国市场溢出到新加坡股市。他们还发现新加坡市场与香港，美国，日本和英国市场之间存在高度波动的联动。沃辛顿和希格斯（Worthington and Higgs，2004）发现在 9 个亚洲股票市场上存在正均值和波幅溢出。Chuang，Lu 和 Tswei（2007）使用 VAR-BEKK 框架研究了六个东亚市场之间的波动溢出效应。他们发现，日本市场最不容易受到来自其他市场的波动性刺激的影响，但对将波动性传递给其他东亚市场影响最大。Dao 和 Wolters（2008）使用多元随机波动率模型研究了道琼斯，日经，恒生和 STI 等四种股市指数的波动率相互依赖性。他们发现这些指数的波动性一起移动。Lee（2009）使用二元 GARCH 模型，研究了六个亚洲国家之间的波动溢出效应。他发现，这六个国家的股票市场在统计上都具有重大的波动溢出效应。

3. 指数回报率的数据和描述性统计

数据市场的开放和关闭 GMT 时机（本地和 GMT 时机）如图 1 所示。表 1 给出了本地和 GMT 时机。本研究使用了这些指数在 2000 年 1 月 1 日至 2008 年 2 月 22 日期间的每日开盘价和收盘价。这些指数的数据取自雅虎财经网站 3。仅采用所有指数均具有价值的日期，这导致收盘价系列的数据点为 1441，开盘价的值为 1369。指数的每日收盘价和开盘价收益是通过获取时间“ t”处的价格与时间“ t-1”处的价格的对数来计算的。表 2a 和 2b 给出了指数收益的描述性统计数据。

4. 使用向量自回归（VAR）模型估算收益

溢出效应如引言中所述，我们应该在考虑其他市场的部分影响后对收益两个市场之间的任何溢出效应进行建模。相同的信息可能会以相似的方式影响所有指标，并且通过双变量 VAR4 模型估计的相关性对于所有指标都将是重要的，并且可能会产生误导。例如，日本和韩国指数在其他亚洲市场之前开盘，这些市场可能会影响其他市场，例如新加坡，台湾或香港。对印度市场与新加坡，台湾或香港进行双变量模型分析可能显示出显着的互相关性，但影响可能来自日本或韩国。为了解决这个问题，我们考虑了所有指数的回报来估计 VAR 模型。索引返回值的 VAR（15）模型如下：

$$r_t = \delta + \sum_{i=1}^{p} \phi_i r_{t-i} + \varepsilon_t$$

其中 $r_t = \left(r_{1t}, r_{2t}, \ldots . r_{15t}\right)'$，

通过 VAR（15）模型估计了部分互相关，结果在表 3a 和 3b 中列出。表 3a 解释了平仓至平仓收益的部分互相关，表 3b 解释了平仓至开市收益的部分互相关。不出所料，我们发现纳斯达克，S＆P / TSX 60，DAX 和 FTSE 收益的一天滞后影响了大多数亚洲和其他国家的当期收益。欧洲（FTSE，CAC 和 DAX），美国和加拿大市场在其他亚洲市场之后开盘/收盘，因此任何信息（新/旧）将被包含在这些市场中，并且将影响该指数第二天的开盘/收盘收益。然而，某些日经指数，日经指数，韩国证券交易所指数，海峡时报指数，新加坡证交所，台湾证交所和恒生指数等亚洲指数的开盘即开盘收益也互相影响。重要的是要注意，欧洲指数彼此之间大多相关，并且受纳斯达克滞后收益的影响。在此分析中，忽略了指数收益的当天影响。

为了更深入地了解信息流和市场在信息消散中的重要性，我们使用具有外生变量的指数收益执行 VAR / AR 模型，并纳入了在考虑中的指数之前开/关的指数收益的当日效应 5。如果指数同时打开/关闭，我们将它们视为内生变量，并使用 VAR 模型估算参数，否则将分析指数收益的 AR 模型。在被检查指数之前打开/关闭的指数，这些指数的当天收益被用作解释变量，在一天之后滞后收益打开/关闭的那些指数被用作解释变量。例如，在对 BSE 30（印度指数）收益进行建模时，日经指数，KOSPI，STI，TSEC，KLSE，SSE，恒生和 JSX 的当天收益（这些指数在 BSE 30 之前打开/关闭），而一天的收益滞后 KSE，FTSE，CAC，DAX，NASDAQ，S＆P / TSX 60（这些指数在 BSE 30 之后打开/关闭）被视为解释性变量。在 AR 情况下，应考虑因变量的 VAR 模型中的五个滞后长度和一个滞后长度。在开/关时间相同的市场中，我们使用 VAR 模型将这些市场作为内生变量，而其他市场作为外生变量。下面给出了同时开放的具有外生变量的 VAR 模型。

$$r_t = \delta + \sum_{i=1}^{p} \phi_i r_{t-i} + \sum_{1}^{k} \psi_{kt} r_{kt} + \sum_{1}^{1} \chi_{lt} r_{lt-1} + \varepsilon_t \qquad (2)$$

其中，$r_t = \left(r_{1t}, r_{2t}, \ldots . r_{jt}\right)'$，（1，..，j）是同时打开并内生建模的索引，k 是在（1，..，j）索引，l 是在（1，..，j）之后打开/关闭的索引数。 对于与其他任何市场都不同时开放的市场，我们使用带有外生变量的 AR 模型，如下所示：

$$r_{it} = \alpha_i + \sum_{1}^{p} \beta_{it} r_{it-1} + \sum_{1}^{k} \chi_{kt} r_{kt} + \sum_{1}^{1} \chi_{it} r_{it-1} + \varepsilon_{it} \quad (3)$$

其中，“ k”是在第 i 个索引之前打开/关闭的索引数，“ l”是在第 i 个索引之后打开/关闭的索引数。

我们估计了所有 15 个指数以及开盘价和收盘价的参数。表 4a 和 4b 分别给出了所有指数的收盘价和开盘价收益的结果。VAR 和 AR 模型的结果支持这样一个事实，即指数的开盘价或收盘价回报率主要受到在其之前开/关的指数的影响。但是，这也表明了某些市场在通过回报传递信息方面的优势。日经指数和 KOSPI 市场首先开放（根据格林尼治标准时间），并执行以日经指数和 KOSPI 收益作为内生变量，其他指数收益滞后作为解释变量的 VAR 模型。发现纳斯达克，S＆PTCX DAX 和 CAC 的过去收益（最后一天）会影响它们的收益。STI，TSEC 和 KLSE 市场开盘后不久，其收益主要受到日经指数和 KOSPI 收益的同一天影响。但是，纳斯达克的一日回报系数对于这些市场也很重要。上证所的回报只受 KLSE 回报的影响，恒生的回报受其他亚洲市场（日经，KOSPI 和 STI）以及欧洲和美国市场（FTSE 和纳斯达克）的回报的影响。印度和巴基斯坦市场在亚洲其他市场之后开盘。巴基斯坦指数仅受 KLSE 影响，但是 BSE 30 与 KOSPI，STI 恒生指数和 JKSE 之间有很强的相关性。亚洲市场的结果表明，信息从日本，韩国流向新加坡，台湾，马来西亚，再到香港再到印度。香港市场也受到欧洲市场的影响。在分析欧洲市场时，我们发现 FTSE 收益率（在 DAX 和 CAC 之前开市）受日经指数，STI 和恒生指数等亚洲市场的当日收益率以及纳斯达克指数的一天后收益的影响。重要的是要注意，许多亚洲市场在日经指数，海峡时报指数和恒生指数之后开盘，但它们并不影响富时指数的回报。DAX 和 CAC 主要受 FTSE 市场的影响。

温度 T 越大，绝对能量偏离绝对值的概率就越大。如果我们把温度 T 设置为 0，这个问题就会变成对应每个时间 t 的绝对最小值的搜寻。在现实中，由于距离矩阵中包含大量的噪声，两序列是不完全光滑的。因此，最佳路径应该对温度 T 是非常敏感的。为了达到目的，我们应该选择一个适当的温度，以避免过度拟合或防止信息缺失。

在亚洲市场，DAX 退货仅受日经指数影响。纳斯达克的收益主要受当日 DAX 收益的影响；但是，印度和韩国市场也影响了纳斯达克的收益。打开/关闭最后一个市场的加拿大市场（根据 GMT）主要受纳斯达克市场的影响。对于收盘价和开盘价收益率都发现了类似的模式。

从分析中可以得出结论，信息在打开/关闭时从一个市场流向另一个市场。但是，在亚洲，日本，新加坡和香港市场比其他市场更具影响力。它还支持以下事实：在引入欧元之后

（1999 年 1 月 1 日），欧洲市场之间的相关性增加了。在欧洲市场中，英国和德国市场似乎是最重要的市场。美国对亚洲和欧洲市场都有影响力，而美国市场则是最具影响力的市场（与其他有影响力的亚洲和欧洲市场整合并对其产生影响）。

5. 使用 AR-GARCH 的波动性溢出

经常有人争辩说，通过收益（第一时间的相关性）在整个市场上流通的信息可能并不重要，也不可见。但是，它们可能会通过波动（第二时刻的相关性）产生强大的影响。Clark（1973），Tauchen 和 Pitts（1983）和 Ross（1989）也认为波动性是更好的信息代理。在发现波动性溢出时，我们还考虑了当日影响并估计了参数的偏系数。在第一阶段，我们估计每个指标的 AR（1）-GARCH（1,1）模型，并从均值方程中获得残差。

$$r_{jt} = a + b_{j1} r_{jt-1} + \varepsilon_{jt}$$

其中 $\varepsilon_{jt} \mid \psi_{jt-1} \sim N\left(0, \sigma_{jt}^2\right)$

$$\sigma_{jt}^2 = \alpha_0 + \alpha_{j1} \varepsilon_{t-1}^2 + \beta_{j1} \sigma_{jt-1}^2 \tag{4}$$

r_{jt} 是第 j 个索引在时间的返回 t 和 ε_j 是第 j 个索引的错误或意外返回。然后，在第二阶段，将残差用于其他索引的 GARCH 方程中，如下所示：

$$\sigma_{jt}^2 = \alpha_0 + \alpha_{j1} \varepsilon_{t-1}^2 + \beta_{j1} \sigma_{jt-1}^2 + \sum_{1}^{k} \chi_{kt} \varepsilon_{kt}^2 + \sum_{1}^{I} \chi_{it} \varepsilon_{it-1}^2 \tag{5}$$

其中 $\alpha_0 > 0, \alpha_{j1}, \beta_{j1} \geq 0, \alpha_{j1} + \beta_{j1} \leq 1$ ，“ k”是在第 j 个索引之前打开/关闭的索引数，“ l”是在第 j 个索引之后打开/关闭的索引数。例如，为了模拟 BSE 30 的波动率，我们使用了日经指数，KOSPI，STI，TSEC，KLSE，SSE，恒生指数和 JSX 的当日残差（这些指数在 BSE 30 之前打开/关闭）以及 KSE，FTSE 的滞后一日残差。，CAC，DAX，NASDAQ，S&P / TSX 60（这些指数在 BSE 30 之后打开/关闭），如 GARCH 公式中所使用。

我们使用 AR-GARCH 模型估计了指数的部分效应和当日效应，并将结果呈现在表 5a 和 5b 中，AR（1）-GARCH（1,1）模型的结果估计了波动性溢出，表明显著的波动性溢出需要遍布亚洲、欧洲、美国和加拿大。与收益溢出的结果类似，特定指数的波幅主要受即将开盘的指数的影响。从美国市场到日本和韩国，出现了明显的波幅溢出。日本和韩国市场影

响大多数亚洲和欧洲市场。在日本和韩国市场之后，新加坡，台湾和香港市场开盘/收盘，并且从这些市场向其他亚洲，欧洲和美国市场发生了重大溢出。这些市场的局部影响高于日本和韩国。该结果在“平仓至平仓”和“平仓至开仓”收益系列中都是一致的。英国市场主要受日本，新加坡和香港市场的影响，并影响法国和德国的市场波动。从韩国，新加坡，马来西亚，台湾和香港到美国市场的波动很大。可以得出结论，波动率溢出发生在日本和韩国到新加坡，台湾和马来西亚，香港到英国，德国到美国到日本等。印度市场受到其他亚洲市场的影响，并严重影响巴基斯坦，德国和美国市场。

6. 结论

本文调查了 15 个国家/地区的回报和波动溢出效应。这些国家及其代表股票指数是印度（BSE 30）、法国（CAC 40）、德国（DAX 30）、英国（FTSE 100）、香港（Hang Seng），印度尼西亚（JSX 综合）、马来西亚（KLSE）、韩国（KOSPI）、巴基斯坦（KSE 100）、美国（NASDAQ）、日本（日经 225）、中国（SSE 综合）、新加坡（STI）、加拿大（S＆P / TSX 60）和台湾（TSEC）。对 2000 年 1 月 1 日至 2008 年 2 月 22 日期间的开盘价和收盘价进行了分析。我们选择的国家/地区包含沿时间线的所有重要市场，这将有助于调查由于时差或特定市场由于其他市场时间的影响而导致的信息流。

本文的主要贡献是多方面的。收益率和波动率溢出方面的大部分工作都使用最多 5 到 6 个变量的 VAR 模型（用于计算过去收益率/波动率的影响的方法）。当天影响以及动态信息溢出的调查受到限制。但是，重要的是，当同时期收益率和期末收益率不同时，使用同期收益率（波动性）（Kim，2005；Lee，2009）。通常，将发达市场（美国，日本和欧洲市场）用作外生（控制）变量。但是，在当前的经济（贸易）和金融自由化（FII 和双重上市）的情况下，新兴市场也可能影响发达市场是合理的。在本文中，首先，采用向量自回归模型，其中所有 15 个指标均用于估计一日滞后收益的影响。为了进一步纳入当日影响，我们为同时开/关的市场建模 VAR，而外生变量是不与它们同时开市的市场。当日开盘前的市场使用开盘即日收益，而使用母马后开盘的市场则使用滞后一天的收益。对于没有与其他任何市场一起开市/关闭的市场，我们使用 AR 模型对收益溢出进行建模，该模型具有在当前市场之前开市/关闭的其他市场的当日收益和在市场之后开市/关闭的市场的滞后一天的收益。当前市场作为外生变量。最后，使用具有当日影响的 AR-GARCH 估计了通过波动的同时（共同运动）和动态（因果关系）信息溢出。

指导教师评语：

所翻译文献与论文选题高度相关，对毕业论文的理论及实证分析具有较好指导意义。译文翻译规范、准确，语言表达流畅、通顺，基本符合翻译要求。

签字：贾蕊

2019 年 10 月 22 日

Price and volatility spillovers across North American, European and Asian stock markets

Abstract

This paper examines price and volatility spillovers across North American, European and Asian stock markets. The return spillover is modeled through VAR(15) in which fifteen world indices, representative of their stock market are considered. The effect of same day return in explaining the return spillover is also analyzed using VAR and AR with exogenous variables. Volatility spillover is modeled through AR-GARCH incorporating the same day effect. In both return and volatility spillover, it is found that a particular index is mostly affected by the indices which open/close just before it. It is also found that there is a greater regional influence among Asian and European stock markets. Our paper contributes to the literature by including markets that span the whole time line and also modeling the same day effect with simultaneity preserved where required. Given the evidence, the results can be generalized for the other markets that were not included.

1.Introduction

Currently, the financial markets are witnessing liberalized capital movements, financial reforms, advances in computer technology and information processing. This trend is evident in both developed and developing countries. These factors may have reduced the isolation of domestic markets and increased their ability to react promptly to news and shocks originating from the rest of the world. As a result, the linkages between stock markets around the world may have grown stronger. International linkage of markets has major implications for domestic

economies and for international diversification. Strong linkage reduces the insulation of domestic market from any global shock whereas weak market linkage offers potential gains from international diversifications. Understanding short-run interdependence in returns and volatility across different markets adds to insights on diversification and hedging strategies.

Over the past 15 years, there has been a growing interest among the portfolio managers in the emerging capital markets as they are expected to provide higher asset returns compared to the developed markets. However, with opening of the economies, the increasing integration between the emerging and the developed markets has led to information and sentiment spillover from one market to another. The listing of stocks at multiple stock exchanges all over the globe also adds to integration of markets (Bennett & Keller, 1988).

Information transmission across markets has been widely studied.Most of the studies focus on the long-term interdependence and causality among stock markets, with a view to find long-term or short term correlation among these markets through the returns (Constantinou, Kazandjian, Kouretas, & Tahmazian, 2005; Eun & Shim, 1989). However, the information transmission across markets might not be only through returns but also through volatility (Baele, 2002; Bekaert & Harvey, 1997; Christiansen, 2003; Ng, 2000; Worthington & Higgs, 2004). It is argued that if two markets are integrated then any external shock in one market will not only affect the mean but also the variance of return in other markets. Understanding volatility spillover across markets is important because volatility is a measure of risk and helps in estimating the risk of internationally diversified portfolio. It is also important in executing hedging strategy, in asset allocation, and also in devising policies related to capital inflow in the market. The studies in this area consider the volatility spillover across markets in time-varying volatility framework. However, most of the studies have not used recent data and have either ignored the same day effect or not modeled the simultaneity. Hence there is a need to study these linkages empirically.

The purpose of this study is to explore the return and volatility spill overs across Asian (China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Pakistan, Singapore, and Taiwan), European (Germany, France and United Kingdom) and North American (Canada and United States) markets. In this study, firstly return spillover is modeled using VAR (15) that explains partial effect of one market on another. As VAR doesn’t model the same day effect,we further

model the return spillover after incorporating the same day effect of markets using VAR/AR in which returns of the markets that open/close before the market under examination, the same day returns are used as explanatory variables and those which open/close after, the one day lagged returns are used. For example, while modeling CAC and DAX, we take the same day returns of all the markets that open before them(Nikkei, Kospi, etc) and lagged returns of the markets that open after them (NASDAQ and S&P/ TSX 60). Lastly, volatility spillover is estimated using two-step ARGARCH model (Liu & Pan, 1997) and same day effect is also captured using the same method as used in return spillover. The paper contributes to the existing literature in several ways. First, we consider 15 markets including important markets of Asia, Europe and North America. These markets taken together span the complete geographical horizon as well as the time horizon. The trading hours of the markets chosen together span almost the whole day giving an opportunity to analyze fully the movement of information across the globe. Only when we take markets representing each geographical region and more importantly cover the whole time horizon, dominance of some important markets can be stated with some confidence. We also focused on taking more Asian countries as most of them are characterized asemerging markets and literature related to themis less. Most of the existing studies examine the inter-linkages only between five six markets and do not cover the complete time span. In such cases, we may see spillovers between two markets because some significant market may be missing which is affecting both these markets. VAR (15) gives us the partial effect often markets on each other. Second, our data consist often period (year 2000 through 2008) where most often Asian markets have gone through trade liberalization, considerable industrial deregulation, other structural reforms and export-led growth strategies. Also, Asian countries have attempted to increase cooperation and trade among themselves. Similarly in European markets context, the major change has taken place by the introduction of the EURO (1st Jan 1999). Where most of the work either looks at the effect of U.S. on Asian markets or on European markets, our work considers most often Asian, European and North American markets together for a period of 8 years. Third, we incorporate the same day effect while running the model for spillovers. In today's time when news and information travel from one country to another within a short time horizon, including the same day effect while modeling for any possible spillover effects between markets are necessary. Same day effect means incorporating the effect of the markets that open on the same day but ahead often other markets.

The market that opens before another market affects it and it's important to incorporate it in the model. In addition since there are markets that open simultaneously, we need to model them keeping in mind the simultaneity. Hence, AR/VAR with exogenous variables to incorporate the same day effect has been used here for such markets. To the best of our knowledge, both simultaneity and same day effect has not been modeled together in any paper. Fourth, we model the possible spillovers from emerging markets to developed markets. Previous studies in this area, especially in the context of emerging Asian markets, focused on the impact of developed markets on emerging Asian markets, inter- or intra-regional interdependencies between emerging markets, while controlling for the impact of developed markets. However, in the recent years, there is a distinct possibility of dynamic relationship between emerging and developed markets.

We find that the information flows from one market to another market as they open/close. Market that opens prior to the current market has a strong influence on it. The role of trading time in return and volatility spillovers through markets is shown by including the same day effect. This result is consistent with both return and volatility spillovers. Even after controlling for partial effects from other markets, the U.S. market influences most of the markets. We find that it's not only developed markets that influence the emerging markets. The emerging markets also affect many developed markets. In Asia, the Japanese, Singapore and Hong Kong markets dominate and in Europe, UK and German markets are more influential. The results found are also useful for other markets not included in the study as the results are generic. The other markets too are most likely going to be affected by markets that open/close prior to them and the U.S. market.

The rest of the paper is organized as follows. Section 2 presents a brief review of literature on the studies of return and volatility spillovers across the markets. The data and its descriptive statistics are provided in Section 3. Methodology employed for return spillovers is explained in Section 4. This section also reports the results of return spillovers. Section 5 describes the findings of volatility spillovers and discusses the results on volatility spillover. Final section summarizes and concludes.

2.Literature review

Interdependence among international markets has been studied in two broad contexts:

interdependence in returns and interdependence in volatility. Most of the studies have focused on developed markets especially interdependence among U.S., Japanese and major European markets. Some studies have also been done in the case of developed Asian and emerging market context in which interrelations among emerging markets (such as East Asia, Latin America, and the Middle East) and developed equity markets have been studied.

Liu and Pan (1997) studied the mean and volatility spillovers from U.S. and Japanese stock markets to four other Asian stock markets and found that the U.S. market is more influential than the Japanese market in transmitting returns and volatilities to the other four Asian markets. Ng (2000) studied volatility spillovers from Japan and U.S. market to pacific-basin stock markets. Alaganar and Bhar (2002) examined the information flow between dually listed Australian stocks' trades in Australia and U.S. using a bivariate GARCH model and found unidirectional information flow from U.S. market to Australian market. Baele (2002) investigated the time-varying nature of the volatility spillover from the U.S. (global effects) and the aggregate European stock markets (regional effects) into individual European stock markets. Christiansen (2003) examined mean and volatility spillover effects from both the U.S. and European markets into the individual European bond markets and found negligible mean-spillover but volatility spillover effect was substantial. Wongswan (2006) studied the information transmission from the U.S. and Japan to the Korean and Thai equity markets and concluded that there is a large and significant association between developed market and emerging market volatility at short time horizons.

In European countries' context, many authors examined the effect of the introduction of the EURO (1st Jan 1999) on European markets linkage and linkage between European and U.S. markets. Most of the studies found that linkages between European markets increased after the introduction of the EURO (Melle, 2003). However, the evidence for linkage between European and U.S. markets is not conclusive. Cheung and Westermann (2001) concluded that the spillover did not change between U.S and European market before and after the introduction of the EURO. While analyzing volatility spillover between U.S., UK and Japanese market using high frequency data, Veiga and McAleer (2003) found that volatility spillover took place from UK to the U.S. and Japan and from the U.S. to UK. Savva, Osborn, and Gill (2004) examined the spillover among U.S., German, UK and French markets using dynamic correlation framework and found that

European markets (only UK and German) are affected by the U.S. market. They also conclude that the correlation between European markets has increased after the introduction of the EURO. Bartram, Stephen, and Wang (2007) analyzed market linkages among Euro and non-Euro European countries using a general time-varying copula dependence model. They investigated the impact of the introduction of the EURO on dependence of equity markets in Europe and found that market dependence within the EURO area increased as a likely result of increased European integration only for some countries, like France, Germany, Italy, Netherlands and Spain. Syriopoulos (2007) investigated the short-run and long-run linkages between emerging and developed European stock markets and found that emerging markets co-integrated well with their developed counterparts.

In Asian markets context, Bekaert and Harvey (1997) analyzed the volatilities of emerging equity markets and found that in integrated markets global factors influence the volatility, whereas local factors affect the segmented markets. In, Kim, Yoon, and Viney (2001) studied the volatility transmission among Asian countries during the Asian Financial Crisis period from 1997 to 1998. They found reciprocal spillover between Hong Kong and Korea. Jang and Sul (2002) investigated the co-movement of Asian stock markets prior to, during and after the Asian Financial Crisis. They found that the co-movement among the Asian markets increased during the financial crisis period. Johnson and Soenen (2002) examined the degree of integration of 12 Asian equity markets with Japan and found that the equity markets of Australia, China, Hong Kong, Malaysia, New Zealand and Singapore are highly integrated with the stock market in Japan. Miyakoshi (2003) examined the magnitude of return and volatility spillovers from the Japanese and U.S. markets to the seven Asian equity markets using bivariate EGARCH model and found regional integration among Asian stock markets more than the effect of U.S. Bala and Premaratne (2004) investigated the volatility spillover to the Singapore stock market from that of Hong Kong, Japanese, U.S. and UK markets. They also found high degree of volatility co-movement between the Singapore market and Hong Kong, U.S., Japanese and UK markets. Worthington and Higgs (2004) found the presence of positive mean and volatility spillovers across nine Asian stock markets. Chuang, Lu, and Tswei (2007) investigated the volatility spillover among six East Asian markets by using VAR-BEKK framework. They found that the Japanese market is least susceptible to volatility

stimuli from other markets but, is most influential in transmitting volatility to the other East Asian markets. Dao and Wolters (2008) studied the volatility interdependence of four stock market indices, Dow Jones, Nikkei, Hang Seng and STI using a multivariate stochastic volatility model. They found that the volatilities of these indices moved together. Lee (2009) used bivariate GARCH model and examined the volatility spillover effects among six Asian countries. He found that there are statistically significant volatility spillover effects across the stock markets of these six countries.

3. Data and descriptive statistics of return on indices

The opening and closing GMT timings of the markets (local and GMT timings) are presented in Fig. 1. Table 1 gives both local and GMT timings. Daily opening and closing prices of these indices for the period of 1st January 2000 to 22nd February 2008 have been used in this study. Data of these indices have been taken from yahoo finance site3. Only days for which all the indices have value are taken, which results in 1441 data points for closing price series and 1369 values for opening prices. Daily close-to-close and open-to-open returns of the indices are calculated by taking the logarithm of ratio of price at time ‘t’ and price at time ‘t−1’. The descriptive statistics of the index returns are presented in Tables 2a and 2b.

4. Estimation of return spillover using vector autoregressive (VAR) model

As mentioned in the Introduction, we should model any spillover between two markets in returns after incorporating the partial effects ofother markets. It is likely that the same information would affect all the indices in a similar way and the correlations estimated through bivariate VAR4 model would be significant for all the indices and these may be misleading. For example, Japanese and Korean index open before other Asian markets and these markets may affect other markets like Singapore, Taiwan, or Hong Kong. Running a bivariate model of Indian market with Singapore or Taiwan or Hong Kong may show significant cross-correlation but possibly the effect is coming from Japan or Korea. To correct this problem, we estimated VAR model considering returns of all the indices. The VAR (15) model of index returns is as follows:

$$r_t = \delta + \sum_{i=1}^{p} \phi_i r_{t-i} + \varepsilon_t$$

where $r_t = \left(r_{1t}, r_{2t}, \ldots . r_{15t}\right)'$,

The partial cross-correlation is estimated through VAR (15) model and results are presented in Tables 3a and 3b. Table 3a explains the partial cross-correlation of close-to-close returns and Table 3b the partial cross-correlation of open-to-open returns. As expected, we found that one day lag of the NASDAQ, S&P/TSX 60, DAX, and FTSE returns are affecting the current period returns of most of the Asian and other countries. European (FTSE, CAC and DAX), U.S. and Canadian markets open/close after the other Asian markets, therefore any information (new/old) would be incorporated in these markets and would affect the next day open/close return of the indices. However, one day lagged open-to-open returns of some Asian indices such as Nikkei, KOSPI, STI, KLSE and Taiwan and Hang Seng also influence each other and other indices. It is important to note that European indices are mostly correlated with each other and are affected by NASDAQ lagged returns. In this analysis, the same day effect of return of indices is ignored.

To get a closer picture of information flow and importance of markets in information dissipation, we performed VAR/AR model with exogenous variables for index returns and incorporated the same day effect5 of index returns which open/close before the index under consideration. If indices open/close at the same time, we consider them as endogenous variables and estimate the parameters using VAR model, otherwise AR model of index returns is analyzed. Indices which open/ close before the index under examination, the same day returns of these indices are used as explanatory variable and those indices which open/ close after, the one day lagged returns are used as explanatory variable. For example, while modeling BSE 30 (Indian index) returns, the same day returns of Nikkei, KOSPI, STI, TSEC, KLSE, SSE, Hang Seng and JSX (these indices open/close before BSE 30) and one day lagged return of KSE, FTSE, CAC, DAX, NASDAQ, S&P/TSX 60 (these indices open/close after BSE 30) are considered as explanatory variable. In AR case, five lag lengths and one lag length in VAR model of the dependent variable is considered. In markets where opening/closing time is same, we have used VAR models with these markets as endogenous variables and other markets as exogenous variables. The VAR model with exogenous variables for the markets that open simultaneously is given below.

$$r_t = \delta + \sum_{i=1}^{p} \phi_i r_{t-i} + \sum_{1}^{k} \psi_{kt} r_{kt} + \sum_{1}^{1} \chi_{lt} r_{lt-1} + \varepsilon_t \tag{2}$$

where， $r_t = \left(r_{1t}, r_{2t}, \ldots . r_{jt}\right)'$,(1,.., j) are the indices that open simultaneously and modeled endogenously, k is the number of indices that open/close before the (1,.., j) indices, l is the number of indices that open/close after the (1,..,j).

For the markets that do not open simultaneously with any other market, we use AR model with exogenous variables as given below:

$$r_{it} = \alpha_i + \sum_{1}^{p} \beta_{it} r_{it-1} + \sum_{1}^{k} \chi_{kt} r_{kt} + \sum_{1}^{1} \chi_{it} r_{it-1} + \varepsilon_{it} \tag{3}$$

where, ‘k’ is the number of indices that open/close before the ith index and ‘l’ is the number of indices that open/close after the ith index.

We estimated the parameters for all 15 indices and for both open-to-open and close-to-close returns. Results of close-to-close and open-to-open returns of all indices are given in Tables 4a and4b respectively. Results of the VAR and AR models support the fact that the open-to-open or close-to-close returns of indices are mostly affected by indices which open/close just before them. However, it also indicates the strength ofs ome markets in transmitting the information through returns. Nikkei and KOSPI market open first (according to GMT) and a VAR model using Nikkei and KOSPI returns as endogenous variable and lag of other indices' return as explanatory variable is performed. It is found that the past returns (last day) of NASDAQ, S&PTCX DAX and CAC influence their returns. Just after them STI, TSEC and KLSE markets open and their returns are mostly affected by same day Nikkei and KOSPI returns. However, coefficient of one day past returns of NASDAQ is also significant for these markets. SSE return is affected by KLSE return only, where as Hang Seng return is influenced by other Asian markets (Nikkei, KOSPI, and STI) as well as European and U.S. markets (FTSE and NASDAQ) returns. Indian and Pakistan market open after other Asian markets. Pakistan index is only affected by KLSE, however, there is strong correlation between BSE 30 and KOSPI, STI Hang Seng and JKSE. Results of the Asian markets indicate that the information flows from Japan, Korea to Singapore, Taiwan, Malaysia to Hong Kong to India. Hong Kong market is also influenced by European markets. While analyzing the

European markets, we found that the FTSE return (which opens before DAX and CAC) is affected by same day returns of Asian markets such as Nikkei, STI and Hang Seng indices, and one day past returns of NASDAQ. It is important to note that many Asian markets open after Nikkei, STI and Hang Seng, but they do not affect FTSE returns. DAX and CAC are mostly influenced by FTSE market.

In Asian markets, DAX returns are only affected by Nikkei. NASDAQ returns are influenced mostly by same day DAX returns; however, Indian and Korean markets also affect the NASDAQ returns. Canadian market which opens/closes the last (according to GMT) is mostly affected by NASDAQ market. Similar pattern is found for both close-to-close and open-to-open returns.

It can be concluded from the analysis that the information flows from one market to another market as they open/close. However in Asia, Japanese, Singapore and Hong Kong markets are more influential than other markets. It also supports the fact that the correlation between European markets has increased after the introduction of the EURO (1st Jan 1999). Among the European markets, UK and German markets seems to be the most important markets. U.S. influences both Asian and European markets and the U.S. market comes out to be the most influential market (integrated with other influential Asian and European Market and affecting them).

5.Volatility spillover using AR-GARCH

It is often argued that the information flow across markets through returns (correlation in first moment) might not be significant and visible; however, they may have strong effect through volatility (correlation in second moment). Volatility has also been argued to be a better proxy of information by Clark (1973), Tauchen and Pitts (1983) and Ross (1989). In finding volatility spillover, we also considered the same day effect and estimated the partial coefficient of the parameters. In the first stage, we estimated the AR(1)-GARCH(1,1) model for each index and obtained the residuals from the mean equation.

$$r_{jt} = a + b_{j1} r_{jt-1} + \varepsilon_{jt}$$

where $\varepsilon_{jt} \mid \psi_{jt-1} \sim N\left(0, \sigma_{jt}^2\right)$ and

$$\sigma_{jt}^2 = \alpha_0 + \alpha_{j1}\varepsilon_{t-1}^2 + \beta_{j1}\sigma_{jt-1}^2 \tag{4}$$

r_{jt} is the return of the jth index at time t and ε_j is the error or unexpected return of the jth index. In the second stage, residuals are then used in the GARCH equation of the other indices as follows:

$$r_{jt} = a + b_{j1}r_{jt-1} + \varepsilon_{jt}$$

where $\varepsilon_{jt} \mid \psi_{jt-1} \sim N\left(0, \sigma_{jt}^2\right)$ and

$$\sigma_{jt}^2 = \alpha_0 + \alpha_{j1}\varepsilon_{t-1}^2 + \beta_{j1}\sigma_{jt-1}^2 + \sum_1^k \chi_{kt}\varepsilon_{kt}^2 + \sum_1^I \chi_{it}\varepsilon_{it-1}^2 \tag{5}$$

where, $\alpha_0 > 0, \alpha_{j1}, \beta_{j1} \geq 0, \alpha_{j1} + \beta_{j1} \leq 1$, ‘k’ is the number of indices open/ close before the jth index and ‘l’ is the number of indices which open/ close after jth index. For example, for modeling BSE 30 volatility, we used same day residuals of Nikkei, KOSPI, STI, TSEC, KLSE, SSE, Hang Seng and JSX (these indices open/close before BSE 30) and one day lagged residuals of KSE, FTSE, CAC, DAX, NASDAQ, S&P/TSX 60 (these indices open/close after BSE 30) as used in the GARCH equation.

We estimated the partial effect of indices and same day effect using AR-GARCH model and present the results in Tables 5a and5b.The results of AR (1)-GARCH(1,1) model to estimate volatility spillover indicate that significant volatility spillover takes place across Asia, Europe, U.S. and Canada. Similar to the result of return spillover, volatility of particular Index is mostly affected by the indices which open just before it. Significant volatility spillover takes place from U.S. market to Japan and Korea. Japanese and Korean markets affect most of the Asian and European markets. Singapore, Taiwan and Hong Kong market open/close after Japanese and Korean markets and significant spillover takes place from these markets to other Asian, European and U.S. markets. The partial effects of these markets are higher than Japan and Korea. This result is consistent in both close-to-close and open-to-open return series. UK market is mostly affected by Japanese, Singapore and Hong Kong market and affects France and German market volatility. Significant volatility spillover takes place from Korea, Singapore, Malaysia, Taiwan and Hong

Kong to U.S. market. It can be concluded that volatility spillover takes place from Japan and Korea to Singapore, Taiwan and Malaysia, to Hong Kong to UK, and Germany to U. S. to Japan and so on. Indian market is affected by other Asian Markets and significantly affects Pakistan, German and U.S. market.

6. Conclusions

This paper investigates return and volatility spillovers among 15 countries These countries and their representative stock index are India (BSE 30), France (CAC 40), Germany (DAX 30), United Kingdom (FTSE 100), Hong Kong (Hang Seng), Indonesia (JSX Composite), Malaysia (KLSE), Korea (KOSPI), Pakistan (KSE 100), United States (NASDAQ), Japan (Nikkei 225), China (SSE Composite), Singapore (STI), Canada (S&P/TSX 60) and Taiwan (TSEC). Both opening and closing prices were analyzed for the period of 1st January 2000 to 22nd February 2008. Our selection of countries accommodate all important markets along the time line which will help to investigate the information flow because of time difference or the effect of specific market on the other markets.

The main contributions of this paper are manifold. Most of the work in area of return and volatility spillovers uses VAR model up-to 5–6 variables (method used to calculate the effect of past return/volatility). The investigation of same day effect along with dynamic information spillover has been limited. However, it is important to use contemporaneous returns (volatility) when their opening and closing time are different (Kim, 2005; Lee, 2009). Generally, developed markets (U.S., Japan and European markets) are used as exogenous (control) variable. However in current scenario of economic (trade) and financial liberalization (FII and Dual listing), it is plausible that the emerging markets may also affect the developed markets. In this paper, firstly, vector autoregressive model in which all 15 indices are used to estimate the effect of one day lagged returns. Further to incorporate same day effect, we model VAR for markets that open/close simultaneously with exogenous variables being the markets that do not open with them. Same day returns are used of the markets that open/close before them and one day lagged returns of the markets that open after the mare used. For markets that do not open/close along with any other market, we model return spillover using AR model with same day returns of other markets that open/close before the current market and one day lagged returns of the markets that open/close

after the current market as exogenous variables. Lastly the contemporaneous (co-movements) and dynamic (causation) information spillover through volatility is estimated using AR-GARCH with same day effect.

From the results of VAR(15), it is found that most of the Asian indices are influenced by lagged returns of European and U.S. indices. This result is incomplete as VAR(15)models only lagged variables and as European and US indices open/close after all Asian indices, their effect becomes dominant. However, to see a clearer picture we include same day returns for indices that open prior to other indices. Results are different when we incorporate same day effect in VAR/AR model. We found that return spillover takes place from U.S. market to Japanese and Korean markets to Singapore and Taiwan markets to Hong Kong to European markets to U.S. and so on. However, some of the Asian markets like Japanese, Korean, Singapore, and Hong Kong markets show more influencing power than other Asian Markets. European Markets are mostly influenced by Japanese, Korean, Singapore, Hong Kong and U.S. markets. High correlation among European countries is also observed. U. S. market is influenced by both Asian and European markets. Volatility spillover is also analyzed through two-step AR-GARCH process to incorporate the same day effect in the model. We found similar results for volatility as in the case of return spillover.

In contrast to Ng (2000) results but similar to Miyakoshi (2003),we found greater regional influence among Asian markets than European and U.S. markets. Japanese market is affected by U.S. and European market and affects most of the Asian Markets. This finding is similar to the finding of Chuang et al. (2007) who analyzed six Asian markets including Japan and found that Japanese market is the least susceptible to volatility stimuli from other markets, but, is the most influential in transmitting volatility to the other East Asian markets. We found high degree of correlation among European indices namely FTSE, CAC and DAX, which support the similar finding of many studies (Bartram et al., 2007; Cheung &Westermann, 2001; Melle, 2003; Savva et al., 2004) that analyzed these indices after the introduction of the EURO.

This article can be extended by using high frequency data of the indices which will give finer results about price and volatility spillovers. This will be especially useful for markets that open together or have overlapping trading times.