Asian Academy *of* Management Journal *of* Accounting *and* Finance

AAMJAF Vol. 13, No. 1, 1–40, 2017

MANDATORY AUDIT FIRM ROTATION AND BIG4 EFFECT ON AUDIT QUALITY: EVIDENCE FROM SOUTH KOREA

Jong-seo Choi[1], Hyoung-joo Lim[2]* and Dafydd Mali[3]

[1] School of Business, Pusan National University,63-2, Pusan Daehak-ro, Keumjung-gu, 46241, Busan, South Korea
[2] School of Global Business Administration, Far East University, 76–32 Daehakgil, Gamgok-myeon, Eumseong-gun, Chungbuk, 369–700, South Korea
[3] College of Commerce and Economics, Kyungsung University, 309 Sooyoung-ro, 48434, Busan, South Korea

*Corresponding author: limhj@kdu.ac.kr

ABSTRACT

In South Korea, due to concurrent financial scandals, Korean legislators implemented two major audit policies in the 2000s; the mandatory audit "partner" rotation policy in 2000 and the mandatory audit "firm" rotation policy in 2006. The mandatory audit "firm" rotation policy was introduced as a mean to improve audit quality based on the auditor entrenchment hypothesis. In this paper, we compare the audit quality of firms subjected to mandatory audit "firm" rotation with two benchmark groups, a sample that adopted the policy voluntarily; the second group consists of the mandatory "firm" rotation sample in years prior, a period firms were subject to mandatory audit "partner" rotation. Using accrual-based measures as proxies for audit quality, we find evidence that audit quality of the mandatory rotation firm sample is lower compared to firms that voluntarily adopted the policy. Furthermore, we find evidence that audit quality of the mandatory rotation firm sample is lower compared to the mandatory audit partner firm sample. Additionally, we also find evidence that the mandatory audit firms rotation sample whose auditors were rotated from Non-Big4 to Big4 are generally associated with lower levels of abnormal accruals consistent with the argument that the audit quality of Big4 accounting firms is superior to Non-Big4 firms. Finally, longer audit tenure and switches to Big4 audit firms generally have a positive effect upon audit quality. These findings suggest that extended audit tenure improves audit quality due to accounting firm's

Publication date: 30 August 2017

To cite this article: Choi, J.-S., Lim, H.-J., & Mali, D. (2017). Mandatory audit firm rotation and Big4 effect on audit quality: Evidence from South Korea. *Asian Academy of Management Journal of Accounting and Finance, 13*(1), 1–40. https://doi.org/10.21315/aamjaf2017.13.1.1

To link to this article: https://doi.org/10.21315/aamjaf2017.13.1.1

accumulated client specific knowledge. Thus, our evidence suggests that the mandatory audit firm rotation policy did not have the desired effect in a Korean context.

Keywords: mandatory audit firm rotation, mandatory audit partner rotation, abnormal accruals, audit quality

INTRODUCTION

Public concern over instances of accounting fraud has increased due to major accounting scandals. A review of auditor behaviour from recent U.S. accounting scandals suggests auditors did not possess sufficient skepticism, objectivity or independence; hence, audit quality deteriorates with longer audit tenure (DeFond & Francis, 2005). Mandatory audit firm rotation has been considered as a policy with the potential to improve audit quality for decades. However, in the early 2000s, the Enron and the WorldCom financial scandals reignited the debate. Opponents of the mandatory audit firm rotation policy argue that auditing errors are more likely to occur in the initial years of the auditor-client relationship due to the loss of auditors' cumulative knowledge. On the other hand, proponents of the mandatory audit firm rotation policy argue that prolonged audit tenure negatively affects the auditor-client relationship because managers often have an opportunity to manage earnings when audit firms have an incentive to satisfy client's requests to retain an audit contract, which creates a basic conflict.

The Korean setting provides a unique opportunity to conduct empirical analysis on the effectiveness of the mandatory audit "firm" rotation policy on audit quality, a relatively rare policy internationally. Korea adopted the mandatory audit "firm" rotation policy because of concurrent financial scandals since 1997. In 2001, the Financial Supervisory Commission (FSC) mandated a three-year mandatory audit "partner" rotation policy in response to the Kia and Korean Air accounting scandals. In 2002, in the U.S., the Security and Exchange Commission (SEC) considered the mandatory audit "firm" rotation policy while enacting Sarbanes-Oxley Act (SOX), following major U.S. financial scandals to restore public confidence in the profession. However, based on the research conducted by the General Accounting Office, the SEC decided not to adopt the mandatory audit firm rotation policy. In 2003, the Financial Supervisory Service (the Korean regulator, hereafter FSS) proposed the controversial mandatory audit "firm" rotation policy because of the failure of SK global and Daewoo, two of Korea's largest conglomerates within the mandatory audit firm "partner" rotation period. Mandatory audit "firm" rotation was considered to be a more robust policy for reducing financial mismanagement and financial scandal compared to mandatory audit "partner" rotation by the Korean government, based on the auditor entrenchment hypothesis. The mandatory audit "firm" rotation policy was not adopted in the U.S. on the grounds the social cost would exceed the perceived benefits. The mandatory audit "firm" policy became fully effective in 2006 and was adopted on a firm by firm basis. The mandatory audit "firm" rotation policy mandated that firms replace their audit firm as a service provider, every six years. However, the mandatory audit "firm" rotation policy ended in 2010, lasting for only five years due to the adoption of IFRS and political pressure due to double regulation.

This analysis, to our knowledge, is one of the first empirical studies comparing the effect of mandatory audit "firm" rotation and "partner" rotation on audit quality. Previous mandatory auditor rotation studies suggest that there are significant costs that outweigh the benefits of a "fresh look" by a new audit firm (Johnson, Khurana, & Reynolds, 2002; Myers, Myers, & Omer, 2003; Blouin, Grein, & Rountree, 2007). Chi, Huang, Liao and Xie (2009) examine the effect of mandatory partner rotation on audit quality in Taiwan, employing absolute abnormal accruals as proxies for audit quality, and the earnings response coefficient as a proxy for perceived audit quality. They find no evidence that mandatory audit partner rotation enhances audit quality. Our study differs from Chi et al. (2009) by directly comparing the audit quality of firms that promulgate the mandatory audit "firm" policy after a period of mandatory audit "partner" rotation. Thus, Korea's unique regulatory system enables us to make inferences about which sample has the highest levels of audit quality, mandatory audit "partner" or "firm" rotation.

Kwon, Lim and Simnett (2014) analyse the effect of mandatory audit firm rotation on audit quality and audit fees before and after 2006, the period the audit firm rotation policy was adopted. They find that audit fees increase after 2006, but audit quality remains unaffected. Our study differs from Kwon, due to the fact we incorporate partitioning that allows us to capture audit quality based on managers varying levels of opportunity to manage earnings and audit firms' incentives to accommodate the managers in three-year policy periods, rather than before and after 2006. Our group of interests are firms subject to the mandatory audit firm rotation policy from 2006–2009. We compare this group with two benchmark groups. First, we compare the mandatory rotation sample with firms in the same sample period (2006–2009) which are not subject to the mandatory audit firm rotation policy; second, we compare the mandatory rotation sample with the firm itself in prior periods where the firms are subject to the mandatory partner rotation policy (2000–2008). We believe this partitioning adds robustness due to the fact that all firms did not adopt the mandatory audit firm rotation policy in 2006. In 2006, a manager's opportunity to manage earnings and an audit firm's incentives to accommodate managers vary dependent on the period of audit policy adoption (see Figure 1).

We conduct empirical tests to analyse the effect of the implementation of the mandatory audit firm rotation policy on audit quality. First, we use two measures of abnormal accruals as proxies for audit quality; the modified Jones model suggested by Dechow, Sloan and Sweeney (1995) and the performance-adjusted Jones model suggested by Kothari, Leone and Wasley (2005). Abnormal accruals are widely used in accounting literature as proxies for earnings and/or audit quality (Healy & Wahlen, 1999; Kothari, 2001; Myers et al., 2003; Chen, Lin, & Lin, 2008; Chi et al., 2009). We find evidence that the audit quality of the mandatory audit firm rotation sample is lower or indifferent, compared to the samples in the same sample period (2006–2009). Moreover, we find evidence that the audit quality of a firm in the mandatory audit firm rotation sample is lower or indifferent compared to earlier years under the mandatory partner rotation policy (2000–2008). Thus, we find evidence supporting the auditor expertise hypothesis that mandatory audit firm rotation does not enhance audit quality. The results are robust to various forms of additional analysis.

Secondly, we examine the relationship between audit quality and four different types of audit 'switch' for the mandatory audit firm rotation sample. Numerous studies find that Big4 auditors provide higher audit quality information compared to non-Big4 auditors (DeAngelo, 1981; Becker, DeFond, Jiambalvo, & Subramanyam, 1998; Khurana & Raman, 2004; Behn, Choi, & Kang, 2008). Consistent with the current literature, we find that levels of abnormal accruals decrease as firms are mandatorily rotated from non-Big4 to Big4 audit firms. Concurrently, we test the association between audit tenure and audit quality. Numerous studies find audit quality increases with audit tenure (Myers et al., 2003; Chi & Huang, 2005; Chi et al., 2009). Our results suggest that longer audit tenure has a positive effect on audit quality, consistent with previous findings.

This study is motivated by the varying policy decisions of the world's largest two economic regions, the U.S. and the European Union. In April 2014, the European Parliament approved a mandatory audit firm rotation policy, requiring European listed companies, banks and financial institutions to appoint a new audit firm every 10 years. However, in the U.S., the mandatory audit firm rotation policy, a policy suggested by the Public Company Accounting Oversight Board (PCAOB) was rejected by the U.S. House of Representatives. Therefore, our findings may be of interest to both groups of legislators. Our study makes several contributions. First, previous studies empirically examine the effect of a mandatory audit firm rotation policy and a mandatory audit partner rotation policy on audit quality in individual tests. However, we compare the audit quality of a mandatory audit "firm" rotation period with a mandatory audit "partner" rotation. Secondly, the majority of studies compare audit quality before and after legislation is introduced using a "before and after" calendar year approach. However, due to Korea's unique experiment with audit policy, we partition our sample to capture managers' opportunity to manage earnings and auditors' incentives to satisfy clients to retain an audit contract. This partitioning is necessary because audit firms and managers have different incentives based on the period of policy adoption. Thus, our partitioning captures an auditors' incentive to impair independence based on policy adoption period rather than calendar year. Thirdly, we consider the partial effect of audit switch type and audit tenure. Forth, our study extends previous Korean studies in several distinctive manners, including the use of two unique benchmark samples.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Institutional Setting

La Porta, Lopez-De-Silanes, Shleifer and Vishny (1997) find that the Korean economy can be considered comparable to developed countries; however, in the past, Korea's legal enforcement has been considered weak. Recent evidence suggests that South Korea's legislative infrastructure is improving. A report by the FTSE, the London Stock Exchange suggests that in most respects South Korea satisfies the definitions and standards of a developed market (Woods, 2013). Korea's economy has developed rapidly; however, financial scandals have necessitated Korea's experimentation with numerous audit policies. Numerous countries practice the mandatory audit partner rotation policy. The mandatory audit firm rotation policy is a legal requirement for only a small number of countries. For instance, firms in Italy and Brazil are required to rotate their audit firms every nine and five years respectively. The Korean setting is unique because the mandatory audit firm rotation policy, a policy which is rare internationally coexisted with the mandatory partner rotation policy because firms adopted both policies on an individual basis. The mandatory audit "partner" and "firm" rotation policies are significantly different with regards to the auditor-client relationship. The mandatory audit "partner" rotation policy allows a firm to retain the services of an audit firm under the supervision of another partner or affiliate. The mandatory audit "firm" rotation policy requires firms to change their audit company after a specified period. The mandatory audit "firm" and "partner" rotation policies differ in the sense that the relationship between clients and auditors are different after a "partner" and "firm" rotation. Mandatory audit "partner" rotation enables partners within the same audit firm to cooperate, hence audit firms are able maintain firm specific knowledge. The mandatory "firm" rotation is designed to promote auditor independence; however, increased auditor independence will almost certainly lead to a decrease in firm specific knowledge. Korea is the very first country to adopt the mandatory audit firm rotation policy after the high-profile accounting scandals and the passage of SOX. Thus, it is possible to empirically test the difference in audit quality between the mandatory audit firm rotation sample (2006–2009) and the audit quality of two benchmark groups (2000–2009), the mandatory audit "partner" group, and firms that adopt the policy on a voluntary basis. If accounting quality increases after mandatory audit "firm" rotation, the results would suggest that increased auditor independence has the desired effect, consistent with the auditor entrenchment hypothesis. If abnormal accrual increase or do not change after the adoption of the mandatory audit "firm" policy, the policy can be seen as having a negative effect on audit quality through the loss of firm specific knowledge attainable under the mandatory audit "partner" rotation policy, consistent with the auditor expertise hypothesis.

In 2003, the SSB (Securities Supervisory Board, the predecessor of FSC) of Korea promulgated a policy that required corporate entities to rotate their audit firm every six years on a mandatory basis (effective in 2006). This policy was introduced because of public distrust in the Korean external audit system due to auditing errors. Prior to 1982, Korea adopted an auditor designation "rule", whereby the regulatory body, SSB, assigned external auditors for all listed firms. In 1982, the Korean government introduced the free audit engagement "rule" because of increasingly interdependent capital markets and the international convergence of accounting standards. Thus, the decision of the Korean government to adopt the audit engagement rule in lieu of the mandatory designation system was designed to integrate the Korea's accounting system in-line with international accounting trends. Moreover, moral and ethical issues involving CPAs in the 1970s accelerated the repeal of the designation rule in 1981. The free audit engagement "rule" permitted a firm the right to independently choose an audit firm for the first time. Since firms were able to select their audit firm in 1982, the power of audit engagement negotiation moved from audit firms to client companies which impeded the protection of auditor independence. In 1997, the FSC promulgated two additional rules that require firms to retain auditors for three-years, and audit partner rotation after five years. In 2001, the FSC mandated a three-year mandatory partner rotation policy in response to the 1997 Asian financial crisis and the Kia and Korean Air accounting scandals. In 2003, investigators found that abnormally high levels of window dressing caused the collapse of Daewoo, one of the largest conglomerates in 1999. The incident damaged the reputation of Angin Deloitte, one of the largest audit firms in Korea, the Korean government and the accounting profession.

In 2003, a period the mandatory auditor partner rotation was being practiced, SK Global, another large Korean conglomerate overstated earnings by 1.5 trillion won. In 2003, the FSC announced that, on average, one of three domestic firms was committing accounting fraud, and seven of out ten Korean conglomerates, known as Chaebol, engaged in some kind of earnings manipulation. Thus, following a period of successive financial failures, Korean regulators were required to consider policies to improve audit quality and to increase public confidence in public auditing. In 2003, the FSC promulgated the mandatory audit firm rotation policy. The introduction of the mandatory audit firm rotation policy was influenced by the passage of SOX of 2002 in the U.S. and the establishment of PCAOB. In 2003, in the U.S., the PCAOB considered the adoption of the mandatory audit firm rotation policy, introduced by SOX. But the policy was not adopted in the U.S. on the grounds the social cost would exceed the perceived benefits. However, in Korea, consecutive accounting scandals compel legislators to adopt the mandatory audit firm rotation policy under the assumption of the auditor entrenchment hypothesis. The policy became effective in 2006 and lasted for five years until 2010. The FSC abolished mandatory audit firm rotation in 2010, with the adoption of IFRS (2009/3) and political pressure from the business community due to the additional cost of double regulation.

Our study is motivated by the varying policy decisions of the two world's largest economic regions, the U.S. and the EU. In 2011, in the U.S., the PCAOB proposed the introduction of the mandatory audit firm rotation policy despite opposition from audit firms and corporations. The PCAOB argue that the practice of the 5-year mandatory audit partner rotation policy was not sufficient to protect auditor independence. The PCAOB suggest that the mandatory audit firm rotation policy would increase audit quality through protected auditor independence, enhance objectivity and professional skepticism (PCAOB, 2011a). Later in 2011, the PCAOB issue a concept release explaining that mandatory audit firm rotation policy has the potential to increase investor confidence, audit quality and the quality of financial reporting (PCAOB, 2011b). However, in July 2013, the U.S. House of Representatives introduce legislation that would prevent the PCAOB from implementing the audit firm rotation policy.

Following the PCAOB's announcement in the U.S., the European Commission (EC) announced its intention to adopt the mandatory audit firm rotation policy (Dalton, 2011; Brunsden, 2011). Following the announcement, the European Union's agreement in December 2013 (EU 2013) contained requirements for the mandatory rotation of auditors after 10 years for public interest entities (PIEs). In April 2014, the European Parliament approved the mandatory audit firm rotation policy, requiring European listed companies, banks and financial institutions to appoint a new audit firm every 10 years. Thus, the two world's largest economic regions have considered implementing a mandatory audit firm rotation policy; however, both regions have made different policy decisions. Therefore, the effectiveness of the mandatory "audit partner" rotation policy and mandatory "audit firm" rotation policy as means to improve audit quality is an important empirical question left unanswered. Our findings may be of interest to regulators in the EU and the U.S. because Korea's experiments with audit policy changes offer unique evidence of how the mandatory audit firm rotation policy effects audit quality.

Literature Review

Whether or not extended audit firm period vitiates auditor independence or enhances audit quality is a recurring debate. Proponents of audit firm rotation, advocates of the audit entrenchment hypothesise argue that mandatory rotation prevents auditors from becoming closely aligned with managers, thus maintaining independence. Deis and Giroux (1992) review audit quality letters produced by a public audit agency and conclude that audit quality declines as tenure increases. Brody and Moscove (1998) suggest that mandatory audit firm rotation reduces the influence of firm's management on auditors and therefore can enhance audit quality. Ryan et al. (2001) report that extended audit tenure provides incentives for audit firms to retain their client's contract, thus audit quality can be negatively affected. Moreover, Casterella, Knechel and Walket (2002) argue that window dressing and audit failures occur more frequently as audit tenure is extended.

On the other hand, opponents of mandatory audit firm rotation, advocates of the audit expertise hypothesise state that a number of studies report that audit failures occur more often in the initial stage of an audit service (Peirre & Anderson, 1984; American Institute of Certified Public Accountants [AICPA], 1992; Arrunada & Paz-Ares, 1997; Johnstone & Bedard, 2004; Carcello & Nagy, 2004, Chen et al., 2008). Johnson et al. (2002) examine the relation between audit firm tenure and absolute abnormal accruals. They find absolute abnormal accruals are larger in short tenure (two to three years), than that of medium (four to eight years) and long tenures (nine or more years), suggesting deterioration in audit quality in the early years of tenure. Geiger and Raghunandan (2002) argue that auditors issue qualified audit opinions on business collapses more often when audit tenure is short. Myers et al. (2003) report that the magnitude of both absolute abnormal accruals and current accruals declines with longer audit tenure, suggesting that audit quality is positively associated with audit tenure.

Recent studies suggest that mandatory partner rotation does not have a positive effect on audit quality. Chi and Huang (2005) examine the effect of audit firm and partner tenure on earnings quality independently in the Taiwanese audit market using signed abnormal accruals as a proxy for earnings quality. They find lower earnings quality in the early years of audit firm and/or partner tenures as well as the later years of audit firm tenure. Carey and Simnett (2006) find a decline in audit quality, as proxied by the propensity to issue going concern opinions and the incidence of just beating earnings benchmarks. Chi et al. (2009) directly examine the effect of mandatory audit partner rotation in Taiwan and found no evidence that the policy enhances audit quality. However, mandatory audit firm rotation entails significantly higher costs to both client firms and auditors alike compared to mandatory audit partner rotation. Lennox, Wu and Zhang (2014) find evidence consistent with mandatory audit partner rotation improving audit quality in Chinese firms. They conjecture that a partner is motivated to clean up financial statements before handing them over to a new partner; moreover, a new partner brings in a fresh perspective.

Thus, the literature is mixed. In the early 1990s, the literature suggests that increased audit tenure has a negative effect on audit quality. However, the literature has not reached a consensus about the benefits of mandatory audit rotation. Kwon et al. (2014) is the first author to study the economic impact of the mandatory rotation policy initiative on audit quality, and the associated implications for audit fees in Korea. Their study takes a pre- and post calendar year approach to compare pre 2006 and post 2006 periods; long vs short term audit tenure and voluntary vs mandated firm rotation samples. Kwon et al. (2014) suggests that audit quality measured as abnormal discretionary accruals do not significantly change compared with pre-2006 long-tenure audit period and voluntary post rotation period. Audit fees in the post-regulation period for mandatorily rotated engagements are significantly larger than in the pre-regulation period, but are discounted compared to audit fees for post-regulation continuing engagements.

Hypothesis Development

We build on Kwon et al.'s (2014) argument through partitioning samples to capture managers' opportunity to manage earning and audit firms' incentives to accommodate managers to retain audit contracts. Kwon et al. (2014) find that audit quality is indifferent before and after 2006, the period the mandatory audit firm rotation policy was adopted. However, we hypothesise that managers' opportunity to manage earnings and auditors' incentives are different in specific policy periods. Figure 1 illustrates, in the first three-year period of the mandatory audit partner rotation policy, managers have an opportunity to manage earnings because audit firms have an incentive to retain their clients. In the second three-year period of mandatory audit partner rotation, audit firm firms will know in advance that their tenure will end on a given date. Therefore, managers have limited opportunity to manage earnings and audit firms have no incentive to retain audit contracts. After the second three-year mandatory audit partner rotation period expires, firms are either required to adopt the audit firm rotation policy voluntarily or on a mandatory basis. In this period, managers have limited opportunity to manage earnings and audit firms have no incentive to retain audit contracts. Thus, this unique context allows us to evaluate the effect of the mandatory audit firm rotation policy on audit quality. As discussed above, we believe it is highly unlikely the audit quality will remain unaffected in all periods because of managers' opportunity to manage earnings and audit firms' incentives in different periods. If the auditor expertise hypothesis is true, audit quality will be lower after the implementation of the mandatory audit firm rotation policy sample compared to other benchmark samples. If the auditor entrenchment hypothesis is true, audit quality will increase after the implementation of the mandatory audit firm rotation policy sample compared to other benchmark samples. Therefore, we develop the following hypothesis based on the discussions above.

> H1: The audit quality of the mandatory audit firm rotation sample will be different compared to the benchmark samples

Several studies have examined the relationship between audit firm "switch" type and audit quality. DeFond and Subramanyam (1998) find firms that a switch from Big6 to non-Big6 audit firms increase their level of abnormal accruals. Following DeAngelo (1981), numerous empirical studies find evidence suggesting that Big4 auditors provide higher quality audit information compared to Non-Big4 auditors (Becker et al., 1998; Khurana & Raman, 2004; Behn et al., 2008). Furthermore, organisations audited by large audit firms (Top 10 in China) are less likely to commit financial statement fraud (Lisic, Silveri, & Song, 2015). The literature provides three reasons why Big4 accounting firms have higher audit quality compared to Non-Big4. First, the income dependence of Non-Big4 auditors is higher than Big4, creating incentives for auditors to compromise their independence. Second, Big4 audit firms have higher incentives to retain their public image and reputation to avoid litigation risk (DeAngelo, 1981; Basu, Lee, & Jan, 2001). Third, Big4 auditors have better audit systems and professionals. In consideration of the "Big4's expertise", we classify 4 switch types (Big4 to Big4, Big4 to Non-Big4, Non-Big4 to Big4, Non-Big4 to Non-Big4) to test whether the Non-Big4 to Big4 switch type has a positive effect on audit quality. Based on the pervious literature, the audit quality of the sample that switch from Non-Big4 to

Big4 should increase. Hence, we develop the following hypothesis based on the discussions above.

> H2: The audit quality of the mandatory rotated audit firm sample will increase as firms are rotated from non-Big4 to Big4 audit firms.

RESEARCH DESIGN

Sample Selection

The sample consists of public firms listed on the KRX (Korea Stock-Exchange) market. All financial data, non-financial data, share price and audit tenure information are collected from the KIS-VALUE and the Data-Guide database systems. Figure 1 illustrates the major external audit policy changes to affect Korea from the 1980s. The auditor designation regime is replaced by the free audit engagement in 1982. After the Asian Financial Crisis, the FSC promulgate a 5-year audit partner rotation policy in 1997. In the same year, the mandatory auditor retention policy becomes obligatory, requiring firms to retain their external audit firms for at least three consecutive years. In 2001, the FSC implement the mandatory audit partner rotation policy, whereby audit partners are required to be rotated at least once every three years. The Korean regulatory authority introduces the policy of mandatory audit firm rotation in December 2003. The policy comes into effect from 2006 and ends in 2010 due to the introduction of IFRS and political pressure from accounting firms and corporate entities.

Firms adopted the mandatory audit firm rotation policies on a firm-by-firm basis. Therefore, to disentangle the effect of the mandatory partner rotation policy on audit quality from two benchmark samples, data is hand collected and firms are partitioned accordingly. Figure 1 illustrates the partitioning. The vertical partitioning illustrates if the firm sample is subject to the mandatory audit firm rotation sample (MROT). No mandatory rotation (NROT) sample firms are not subject to mandatory audit firm rotation. The horizontal partitioning captures managers varying levels of opportunity to manage earnings and audit firms' incentives to accommodate managers. We split the sample into three groups and two sub-groups over the sample, period 2000 to 2009. The first sample, the mandatory partner rotation sample (PROT henceforth) consists of firms subjected to the three-year mandatory partner rotation policy from 2000–2008. The PROT sample has been partitioned into two sub-samples, because auditors are likely to have different incentives in different periods. In PROT 1, the first three-year period of the mandatory partner rotation policy, auditors have an incentive to accommodate clients because an audit firm could potentially retain the business of the client under a different partner. In PROT 2, the second three-year period of the mandatory partner rotation policy, auditors have no incentive to accommodate clients because of the imminent introduction of the mandatory audit firm rotation which does not allow client retention. The PROT 1 and PROT 2 sample firms adopted the mandatory audit firm rotation policy (MROT).

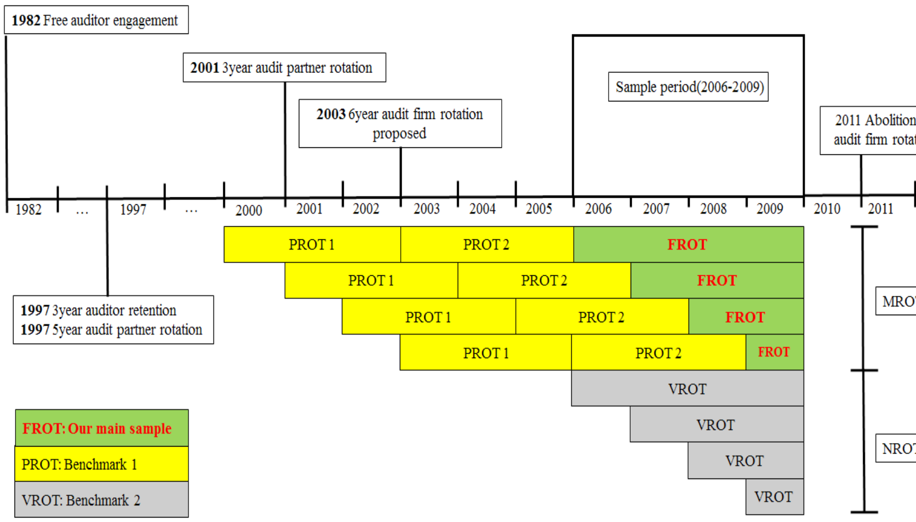

Figure 1. Major external audit policy changes, FROT sample and two benchmark samples

The second group of interests are organisations that voluntarily rotated their audit firms (VROT henceforth) from 2006–2009. VROT firms did not adopt the mandatory audit firm rotation (NROT). Our final group, our group of interests are firms that were required to adopt the mandatory audit firm rotation policy on obligatory basis (FROT henceforth) from 2006–2009. FROT firms are required to practice mandatory audit firm rotation (MROT). As depicted in Figure 1, period (PROT) 1 and 2 have a fixed-term of three years since listed firms are subject to the three-year mandatory auditor retention policy. Period 3 varies from 1 year to 4 years depending on the rotation year. For instance, for firms whose external auditors were mandatorily rotated in 2006, period 3 consists of 4 years (2006, 2007, 2008 and 2009); firms whose auditors were rotated in 2009, period 3 constitutes only one year (2009). The coexistence of both regimes during the period under consideration necessitates a careful decomposition of observations into target and benchmark samples. Given 0 is the period an audit firm is mandatorily rotated, PROT 1 indicates a three-year period from year –6 to year –4 and PROT 2 represents a three-year period from year –3 to year –1. Thus, we compare the FROT sample, the mandatory audit firm rotation sample with the benchmark groups specified above; the VROT sample consisting of firms that adopted the mandatory firm rotation policy voluntarily and PROT, two subsamples (PROT 1 and PROT 2) consisting of the FROT sample prior to the adoption of the mandatory audit firm rotation policy.

Table 1 specifies the sample selection process for FROT and PROT. The PROT group consists of FROT firms partitioned into specific time periods before the rotation to capture the effect of audit policies on audit quality. From 2000 to 2010, we identify 664 firms listed on the KRX market from the KIS-VALUE database after excluding financial institutions. We then exclude 154 firms with no financial data, 20 firms whose auditors were rotated in 2010 and firms listed on an overseas market (Overseas firms did not adopt audit rotation policies), which leaves 490 firms. Firms rotated in 2010 are excluded for following reasons. First, K-IFRS early adopters in 2010 are not subject to mandatory rotation. Second, the number of firms subjected to mandatory rotation in 2010 was relatively small (20 firms). Finally, auditors knew in advance the mandatory audit firm rotation policy would be replaced in 2010 which may affect manager's opportunity and auditors' incentives. There are 144 VROT firms which are not subject to the mandatory audit rotation policy because of early voluntary adoption of the audit firm rotation policy.

Table 1
Sample selection

Mandatory rotation samples between 2006 to 2009	Number of firms
Non-financial companies	664
No financial data and non-financial available	(154)
Mandatory rotation in 2010	(20)
Potential samples	490
Overseas listings	(12)
Firms not subject to mandatory rotation	(144)
Total samples (2006–2009)	334

Table 2 presents the distribution of our mandatory rotation sample. Panel A shows the number of mandatory rotation firms, classified by year and type. Among the total sample of 334 firms, the most frequent rotations occurred in 2009 (105 rotations, 31.44%) and the least number of rotations occurred in 2007 (58 rotations, 17.37%). With regard to audit firm switch type, Big4 to Big4 switch is the most frequent switch type (145 rotation types, 43.41%) and switching from Non-Big4 exceeds 20% of the total sample. Specifically, Non-Big4 to Non-Big4 and Non-Big4 to Big4 switches occur on 71 occasions (21.26%) and 85 occasions (25.46%) respectively. A Big4 to Non-Big4 switch occurs less than 10%. Panel B exhibits the number of audit firm rotations since the 3-year auditor retention rule became effective in 1997. 36.23% of firms rotate their auditors twice and the cumulative ratio of firms that rotated their auditors more than three times exceeds 40%. We notice that frequent auditor switching is a common practice in South Korea. From 2000–2010, only 20.06% of firms change their auditor once.

Panel C shows consecutive auditor retention periods prior to the regulation of mandatory audit firm rotation. We investigate from 1982, because 1982 is the year that the free audit engagement system became effective. Prior to 1982, under auditor designation rule, firms were not allowed to select audit firms. The results based on the investigation of auditor retention periods between 1982 and 2010 show that 8 years of audit tenure exceeds 50% and 10 years of auditor retention occupies nearly 80% (78.44%). On the other hand, firms that retain their audit firms for more than 20 years occupy 6.59%. The longest retention period appears to be 25 years. Finally, Panel D reports industry classification. Our samples are classified by industry using two digit KSIC codes. The metal industry has the highest number of observations in our sample (12.87%), followed by the electrical machinery industry (10.78%), chemistry (9.58%) and the service industry (8.08%). The table shows that the sample firms are indiscriminately distributed throughout various industries.

Table 2
Distribution of samples

Panel A: Number of Mandatory Rotation Firms by Year and Type

Number of samples by year			Number of samples by switch type		
Year	Number of Firm	Ratio (%)	Switch Type	Number of Firm	Ratio (%)
2006	71	21.26	Big4 to Big4	145	43.41
2007	58	17.37	Big4 to Non-Big4	33	9.88
2008	100	29.94	Non-Big4 to Big4	85	25.45
2009	105	31.44	Non-Big4 to Non-Big4	71	21.26
Total	334	100.00	Total	334	100.00

(*continued on next page*)

Table 2: (*continued*)

Panel B: Number of Auditor Rotations since Auditor Retention Regime

Number of Switches	Number of Firm	Ratio (%)	Cumulative Ratio (%)
1	67	20.06	20.06
2	121	36.23	56.29
3	96	28.74	85.03
4	44	13.17	98.20
5	6	1.80	100.00
Total	334	100.00	

Panel C: Consecutive Audit Tenure before Mandatory Audit Firm Rotation

Tenure	Number of Firm	Ratio (%)	Cumulative Ratio (%)
6 years	88	26.35	26.35
7 years	62	18.56	44.91
8 years	31	9.28	54.19
9 years	57	17.07	71.26
10 years	24	7.19	78.44
11 years	3	0.90	79.34
12 years	11	3.29	82.63
13 years	6	1.80	84.43
14 years	6	1.80	86.23
15 years	3	0.90	87.13
16 years	3	0.90	88.02
17 years	13	3.89	91.92
18 years	3	0.90	92.81
19 years	2	0.60	93.41
20 years	6	1.80	95.21
21 years	5	1.50	96.71
22 years	2	0.60	97.31
23 years	4	1.20	98.50
24 years	4	1.20	99.70
25 years	1	0.30	100.00
Total	334	100.00	

(*continued on next page*)

Table 2: (*continued*)

Panel D: Industry Classification

Industry	Number of sample	Percentage (%)	Industry	Number of sample	Percentage (%)
Fishing	5	1.50	Medicine and medical	25	7.49
Food and beverages	24	7.19	Electrical machinery	36	10.78
Non-metallic minerals	4	1.20	Construction	23	6.89
Textiles	18	5.39	Metal working	12	3.59
Pulp and paper	11	3.29	Distribution	20	5.99
Metal	43	12.87	Transport and storage	11	3.29
Service	27	8.08	Others	13	3.89
Computer	30	8.98			
Chemistry	32	9.58	Total	334	100.00

RESEARCH DESIGN

Abnormal accrual model

Numerous studies use proxies for audit quality other than accruals based measures, which include auditor litigation (Heninger, 2001), propensity to issue a going concern opinion and benchmark beating (Carey & Simnett, 2006). However, these proxies based on publically available information have the potential to be influenced by organisational behaviour associated with legitimacy theory. Previous studies often use earnings response coefficients (Ghosh & Moon, 2005). The large majority of studies use signed and absolute abnormal accruals as proxies for audit quality (Heninger, 2001; Johnson et al., 2002; Richardson, Tuna, & Wu, 2002; Myers et al., 2003; Chi & Huang, 2005; Piot & Janin, 2007; Chen et al., 2008; Chi et al., 2009). Chi and Huang (2005) examine the effect of audit firm and audit partner tenures, using signed abnormal accruals as a proxy for audit quality. Other studies also use absolute abnormal accruals since earnings can be managed either upward or downward on terms favourable to management (Chen et al., 2008; Chi et al., 2009).

We use both signed and absolute values of abnormal accruals as proxies for audit quality. In deriving measures of abnormal accruals; we rely on the modified Jones model suggested by Dechow et al. (1995) and the performance-adjusted

Jones model suggested by Kothari et al. (2005), since Kothari et al. (2005) find that the inclusion of the firm's prior year performance better explains earnings management. To estimate abnormal accruals, we estimate residuals from the cross-sectional model, positive deviations from the residual are considered earnings management, hence lower accruals quality. Samples are cross-sectionally matched by year and industry.

Dechow et al. (1995) model

$$TACC_{i,t}/Assets_{i,t-1} = \alpha_1 1/Assets_{i,t-1} + \alpha_2(\Delta REV_{i,t} - \Delta REC_{i,t})/Assets_{i,t-1} + \alpha_3 PPE_{i,t}/Assets_{i,t-1} + \epsilon_{i,t} \quad (1)$$

where,
$TACC_{i,t}$: total accruals,
$Assets_{i,t\text{-}1}$: total assets of year t-1,
$\Delta REV_{i,t}$: change in revenue,
$\Delta REC_{i,t}$: change in accounts receivable,
$PPE_{i,t}$: gross amount of property, plant and equipment.

Kothari et al. (2005) model

$$TACC_{i,t}/Assets_{i,t-1} = \alpha_1 1/Assets_{i,t-1} + \alpha_2(\Delta REV_{i,t} - \Delta REC_{i,t})/Assets_{i,t-1} + \alpha_3 PPE_{i,t}/Assets_{i,t-1} + \beta_4 ROA_{i,t-1} + \epsilon_{i,t} \quad (2)$$

$ROA_{i,t\text{-}1}$: Return on Asset in period t-1

In Equation (3), we examine whether the mandatory audit firm rotation policy is associated with higher levels of abnormal accruals. Our dependent variables, AQ 1–4 are signed and absolute values of abnormal accruals established in Equations (1) and (2). Our primary variable of interest is ROT, which is a dummy variable that indicates 1 if an observation belongs to the mandatory rotation sample (FROT), 0 if either of the two benchmark groups (PROT or VROT). A negative relation between ROT and abnormal accruals would suggest that the mandatory audit firm rotation improved audit quality, supporting auditor *entrenchment hypothesis*. A positive relation would suggest that the mandatory audit firm rotation decreased audit quality, consistent with longer audit tenures improving audit quality, and the auditor *expertise hypothesis*. Statistically insignificant results would suggest no affect.

$$AQ_{i,j,t(j=1,2,3,4)} = \gamma_0 + \gamma_1 ROT_{i,t} + \gamma_2 Size_{i,t} + \gamma_3 CFO_{i,t} + \gamma_4 MKBK_{i,t} + \gamma_5 Lev_{i,t} + \gamma_6 Grw_{i,t} + \gamma_7 Deficit_{i,t} + \gamma_8 LAGTACC_{i,t} + ID + YD + \epsilon_{i,t} \quad (3)$$

Dependent Variables:

AQ_1(*DAMJ*): Abnormal accruals calculated using the modified Jones model, suggested by Dechow et al. (1995)
AQ_2(*DAKO*): Abnormal accruals calculated using the performance adjusted model, suggested by Kothari et al. (2005)
AQ_3(*ABMJ*): Absolute value of DAMJ (ABMJ)
AQ_4(*ABKO*): Absolute value of DAKO (ABKO)

Variables of Interest:

ROT1 : Dummy variable that is 1 if mandatory rotation samples, 0 if benchmark 1 sample (PROT)
ROT2 : Dummy variable that is 1 if mandatory rotation samples, 0 if benchmark 2 sample (VROT)

Control Variables:

Size : Natural logarithm of total assets
CFO : Cashflow from operations
MKBK : Market value to book value ratio
Lev *:* Debt ratio
Grw : Sales growth
Deficit : Dummy variable that is 1 if a firm experienced a loss, 0 otherwise
LAGTACC: Total accruals in previous year
ID : Industry fixed effect
YD : Year fixed effect

To demonstrate the validity of our model, and to increase the robustness of our findings; first, we identify the key determinants for abnormal accruals from previous literature (our main audit quality proxy) that include firm size, firm performance, business risk, firm growth, market opportunity, previous accruals effect, and financial loss. Second, we consider several potential proxies for each determinant, for instance ROA, ROE, ROS, and CFO as a proxy for firm performance. Finally, we select the best proxy for each category using scatter plot and correlation coefficients that best explain our dependent variable. To control for the effect of outliers, all variables are winsorised at top and bottom 1% level before the model specification process. Table 3 illustrates operational definitions of all the variables considered for this study.

First, we control for *Size*, defined as the natural logarithm of market value. We expect abnormal accruals for larger firms to be lower following the political cost hypothesis. However, previous earnings management studies report mixed signs with respect to size variables. Second, we include CFO, since a negative relation has been documented between accruals and cashflow from operations (Dechow, 1994; Sloan, 1996). Third, we include MKBK (market value to book value ratio) to control for variations in firms' investment opportunity sets. Fourth, we include additional incentives to manage earnings such as Lev (debt ratio), and Grw (sales growth). Finally, we include a dummy variable for instances of loss reporting (Deficit) and (LAGTACC) controlling for the reversal effect of prior accruals (Ashbaugh, LaFond, & Mayhew, 2003). We do not include a variable to control for audit firm size since the switch type is tested separately.

Table 3
Model specification and variable definitions

Variables	Proxies	Definitions	Selected
Audit quality (DV)	DAMJ	Abnormal accruals computed from the modified Jones model, suggested by Dechow et al. (1995)	√
	DAKO	Abnormal accruals computed from the performance adjusted model, suggested by Kothari et al. (2005)	√
	ABMJ	Absolute value of DAMJ (ABMJ)	√
	ABKO	Absolute value of DAKO (ABKO)	√
Main Variables of Interest			
Effect of MAFR 1	ROT1 (FROT vs PROT)	Dummy variable that is 1 if mandatory rotation samples, 0 if benchmark 1 sample (PROT)	√
Effect of MAFR 2	ROT2 (FROT vs VROT)	Dummy variable that is 1 if mandatory rotation samples, 0 if benchmark 2 sample (VROT)	√
Additional Test Variables			
Effect of switch type	Switch type	Dummy variable that is one if Non-Big4 to Big4 switch type, 0 otherwise	√
Effect of audit tenure	Audit	Audit tenure length	√
Control Variables			
Firm Size	Size 1	Natural logarithm of total previous year total assets	√
	Size 2	Natural logarithm of market capitalisation	
Firm Performance	ROE	Return on Equity	
	ROS	Return on Sales	
	ROA	Return on Assets	

(*continued on next page*)

Table 3: (*continued*)

Variables	Proxies	Definitions	Selected
	CFO	Cash flow from operation/TA at time *t*-1	√
Firm Risk	Lev	Total liabilities/Total owners' equity	√
	Borrowings	Total borrowings/TA at time *t*-1	
	CF to lev	Cash flow to leverage ratio	
	CF to borrowings	Cash flow to borrowings ratio	
Firm Growth	Asset growth	(TA at time t/TA at time *t*-1)-1	
	OE growth	(OE at time t/OE at time *t*-1)-1	
	Sales growth	(Sales at time t/Sales at time *t*-1)-1	√
	OI_growth	(OI at time t/OI at time *t*-1)-1	
Other Determinants of DA			
Market opportunity	MKBK	Market to Book ratio	√
Effect of previous accruals	TACC	NI at time *t*-1 – CFO at time *t*-1	√
Loss firms	Deficit	Dummy variable that is one if a firm experienced loss, 0 otherwise	√

EMPIRICAL RESULTS

Descriptive Statistics

Table 4 presents descriptive statistics for our dependent variables. Panel A reports descriptive statistics and results of mean (median) difference tests of the mandatory rotation samples (FROT) versus two benchmark samples (PROT and VROT). First, we compare the mandatory rotation sample with itself in prior years. In the difference test, besides DAMJ, all accrual variables show significantly positive (+) signs for the FROT sample suggesting that abnormal accruals increased after the rotation period (compared to PROT). Likewise, abnormal accruals for FROT are generally larger than that the VROT sample. Thus, the univariate analysis suggest that the mandatory rotation sample has lower audit quality compared to the audit partner rotation policy sample firms, and firms that adopted the mandatory audit firm rotation voluntarily.

Table 4
Descriptive statistics

Panel A: Mandatory rotation and benchmark samples

	Mandatory firms						Diff test	VROT (3)			Diff tests
Variables	PROT (1)			FROT (2)			(2)-(1)				(2)-(3)
	Mean (Med)	Min (Max)	SD	Mean (Med)	Min (Max)	SD	*t* (*z*)	Mean (Med)	Min (Max)	SD	*t* (*z*)
DAMJ	0.02 (0.02)	–0.755 (1.51)	0.12	0.037 (0.03)	–1.47 (0.74)	0.14	1.57 (1.48)	–0.01 (–0.00)	–0.41 (0.49)	0.09	1.56 (1.49)
DAKO	0.01 (0.00)	–0.49 (1.62)	1.04	0.006 (0.01)	–1.412 (0.56)	0.02	2.24** (1.88)*	–0.00 (0.00)	–0.19 (0.17)	0.04	1.90* (1.82)*
ABMJ	0.01 (0.00)	0.00 (3.75)	0.15	0.10 (0.07)	0.000 (0.93)	0.12	2.57* (1.86)*	0.03 (0.04)	–1.12 (0.56)	0.12	3.46*** (2.53)**
ABKO	0.06 (0.03)	0.00 (1.66)	5.19	0.07 (0.04)	0.000 (0.556)	0.08	2.11** (2.42)**	0.02 (–0.00)	–15.41 (14.74)	1.92	2.15** (1.85)*
Obs.		1487			573				839		

Panel B: Mandatory rotation sample by sub-periods

	PROT1			PROT2			FROT		
	Mean (Med)	Min (Max)	SD	Mean (Med)	Min (Max)	SD	Mean (Med)	Min (Max)	SD
DAMJ	0.024 (0.015)	–0.503 (3.743)	0.193	0.026 (0.031)	–1.088 (0.493)	0.118	0.037 (0.029)	–1.471 (0.736)	0.147
DAKO	0.013 (0.027)	–0.429 (1.266)	0.108	0.014 (0.011)	–1.088 (0.354)	0.092	0.061 (0.013)	–1.412 (0.556)	0.015
ABMJ	0.086 (0.058)	0.013 (1.743)	0.111	0.084 (0.064)	0.000 (0.865)	0.083	0.104 (0.065)	0.000 (0.926)	0.119
ABKO	0.067 (0.046)	0.000 (1.266)	0.072	0.059 (0.043)	0.000 (0.429)	0.061	0.065 (0.042)	0.000 (0.556)	0.075
Obs.		743			744			573	

(*continued on next page*)

Table 4: (*continued*)

Panel C: Difference test between sub-periods (two-tailed *t*-test)			
	FROT vs PROT2	FROT vs PROT1	PROT2 vs FROT & PROT1
DAMJ	0.011 (1.49)	0.013 (1.37)	–0.003 (–0.47)
DAKO	0.007 (1.35)	0.017 (2.80)***	–0.002 (–0.43)
ABMJ	0.014 (2.67)***	0.011 (1.91)*	–0.007 (–1.60)
ABKO	0.011 (2.90)***	0.003 (0.82)	–0.009 (–1.76)*
Obs.	1317	1316	2060

Panel D: Pearson correlation of key variables					
	1. ROT	2. DAMJ	3. DAKO	4. ABMJ	5. ABKO
1. ROT	1				
2. DAMJ	0.051*	1			
3. DAKO	0.069	0.469***	1		
4. ABMJ	0.056**	0.3358***	0.192***		
5. ABKO	0.046**	0.0152*	0.0153**	0.661***	1

Notes: PROT = Mandatory audit partner rotation; FROT = Mandatory audit firm rotation; VROT = Voluntarily rotation ; SD = Standard deviation; DAMJ = Discretionary Accruals from Modified Jones model; DAKO = Discretionary Accruals from Kothari model ; ABMJ = Absolute value of DAMJ ; ABKO = Absolute value of DAKO ; Obs = Observations

In Panel B, we further partition PROT into two sub periods; PROT 1 (year –6 to year –4), PROT 2 (year –3 to year –1) when the rotation year is set to 0, and compare these samples with FROT (year +1 to year +4). In PROT 1, managers have an opportunity to manage earnings because audit firms have an incentive to retain their clients. In PROT 2, audit firm firms will know in advance that their tenure will end on a given date. Therefore, the managers of the PROT 2 sample have a limited opportunity to manage earnings and audit firms have no incentive to retain audit contracts. The managers of the FROT sample also have limited opportunity to manage earnings and audit firms have no incentive to retain audit contracts. The mean level of abnormal accruals, computed from both the modified Jones model and the performance adjusted model show an increase in the FROT sample. For instance, the mean of DAMJ increases from 0.024 to 0.026 to 0.037 over the three periods. The mean of DAKO is higher in the FROT sample (0.061) compared to prior periods (0.013) in PROT 1 and (0.014) in PROT 2. Thus, our results support the expertise hypothesis based on two factors. First, the levels of abnormal accruals increase in the FROT sample compared to PROT 2, a period when managers' opportunity and auditor firms 'incentives were similar. Secondly, the levels of abnormal accruals for the FROT sample is higher compared to PROT 1, a period when managers had an opportunity to manage earnings and auditors had an incentive to retain an audit contract. The results obtained from absolute values of abnormal accruals are qualitatively similar to afore-mentioned results, albeit with slight differences. For example, the mean of ABMJ is the highest in the FROT sample (0.104); the ABMJ average during PROT 2 (0.084) is slightly lower compared to PROT 1 (0.086). The mean of ABKO in PROT 1 (0.067) is lower than other samples. However, FROT exhibits a slightly higher ABKO average compared to PROT 2.

Panel C presents a difference analysis among different periods. The second and third columns compare FROT sample with PROT 2 and PROT 1 respectively. Although there are no statistically significant differences found in signed abnormal accruals between FROT and PROT 2, the absolute values of FROT appear to be larger. In comparison between FROT and PROT 1, DAKO and ABMJ show significant positive signs whereas DAMJ and ABKO do not. Thus, the data suggests that abnormal accruals, whether signed or absolute value based, tend to increase after the audit firm was rotated on a mandatory basis. The final column exhibits a difference test between period 2 (PROT 2) and, period 1 (PROT 1) and 3 (FROT). In period 2, auditors know in advance that they will be rotated mandatorily due to policy change, thus are less likely to have incentives to impair their independence. However, the results show that all abnormal accruals are not significantly different besides ABKO. Panel D outlines the results of Pearson correlation analysis among key variables. Our main variable, ROT, is generally significantly correlated with all accrual variables suggesting positive linear correlations between poor audit quality and mandatory audit firm rotation.

Multivariate Analysis: Abnormal Accruals

Our results from OLS regressions using abnormal accrual measures as dependent variables are presented in Table 5. Panel A reports our findings comparing the FROT and sample with itself in prior years (PROT). Panel B reports our findings comparing the FROT sample with the sample that voluntarily rotated their audit firm (VROT). Panel A shows the coefficients for ROT, a dummy variable that is one if an FROT firm, 0 otherwise (PROT) are significantly positive (0.031 and 0.028) using absolute abnormal accruals (ABMJ and ABKO). The results suggest that the magnitude of abnormal accruals increases when auditors are mandatorily rotated. The coefficients are not significant for signed abnormal accruals (DAMJ and DAKO). We interpret that audit quality of firms that experience mandatory audit firm rotation is lower after the rotation compared to previous periods. Panel B shows that when the FROT sample is compared with the VROT sample, a sample consisting of firms not subject to the mandatory rotation policy, the ROT coefficients positive. The absolute value of abnormal accruals (ABMJ and ABKO) are significantly positive (0.019 and 0.026) suggesting that the level of abnormal accruals is higher for the sample that was mandated to rotate their auditors compared to the sample that adopted the policy voluntarily. The results are consistent with arguments made by opponents of the mandatory audit firm rotation, supporting the auditor expertise perspective. Our results are largely consistent with previous research suggesting that accounting failures and errors are likely to occur more frequently during the early stages following an audit firm change (Peirre & Anderson, 1984; Cercello & Nagy, 2004).

With respect to the control variables, we find that *Size* is generally positively associated with abnormal accruals, suggesting that larger firms use more abnormal accruals to manage earnings, inconsistent with political cost hypothesis. The *CFO* variable controlling for firm performance is positively associated with all dependent variables suggesting that firms with better performance use less abnormal accruals, consistent with findings in Dechow (1994) and Sloan (1996). *MKBK*, controlling for investment opportunity reveal inconsistent results. *Lev*, which controls for firm risk is generally positively associated with abnormal accruals, suggesting that firms with high debt ratios use abnormal accruals to increase reported earnings. Moreover, the *Grw* variable controlling for growth of firms is positively associated with abnormal accruals. In addition, the *Deficit* coefficient controlling for deficit firms and *LAGTACC* controlling for the reversal effect of prior accruals are generally significantly positive. Year fixed and industry effects are estimated.

Table 5
Abnormal accruals and mandatory audit firm rotation

Model : $AQ_{i,j,t(j=1,2,3,4)} = \gamma_0 + \gamma_1 ROT_{i,t} + \gamma_2 Size_{i,t} + \gamma_3 CFO_{i,t} + \gamma_4 MKBK_{i,t} + \gamma_5 Lev_{i,t} + \gamma_6 Grw_{i,t} + \gamma_7 Deficit_{i,t} + \gamma_8 LAGTACC_{i,t} + ID + YD + \epsilon_{i,t}$

	Panel A: FROT vs PROT				Panel B: FROT vs VROT			
	DAMJ	DAKO	ABMJ	ABKO	DAMJ	DAKO	ABMJ	ABKO
Intercept	0.162 (3.75)***	0.135 (2.11)**	0.352 (3.24)***	0.172 (2.69)***	0.221 (0.51)	0.348 (1.78)*	0.108 (3.52)***	0.327 (1.52)
ROT	0.006 (0.72)	0.009 (1.62)	0.031 (2.24)**	0.028 (2.73)***	0.042 (2.29)**	0.003 (1.64)	0.019 (2.76)***	0.026 (3.23)***
Size	0.026 (3.73)***	0.014 (4.73)***	0.008 (1.98)**	0.012 (2.31)**	0.006 (1.68)	0.002 (1.27)	0.003 (1.82)*	0.004 (2.42)**
CFO	–0.623 (–5.67)***	–0.627 (–19.28)***	–0.381 (–16.58)***	–0.029 (–12.68)***	–0.531 (–4.73)***	–0.525 (–23.64)***	–0.154 (–9.64)***	–0.026 (–1.87)*
MKBK	0.014 (1.72)*	0.006 (1.81)*	0.016 (2.94)***	0.015 (3.96)***	0.004 (1.21)	0.004 (0.34)	0.004 (1.91)*	0.008 (3.21)***
Lev	0.082 (1.51)	0.004 (2.46)**	0.005 (5.27)***	0.004 (3.45)***	0.002 (1.57)	0.008 (4.35)***	0.007 (6.57)***	0.005 (4.76)***
Grw	0.026 (2.16)**	0.033 (3.18)***	0.027 (3.68)***	0.017 (2.96)***	0.019 (2.37)**	0.023 (3.72)***	0.022 (2.86)***	0.016 (2.57)**
Deficit	0.142 (16.64)***	0.122 (26.87)***	0.004 (0.72)	0.028 (6.14)***	0.123 (12.37)***	0.032 (18.72)***	0.014 (2.41)**	0.024 (4.87)***
LAGTACC	0.031 (0.73)	0.082 (5.14)***	0.067 (3.14)***	0.027 (3.26)***	0.031 (7.51)***	0.014 (4.53)***	0.006 (1.83)*	0.004 (1.95)*
ID YD	Included	Included	Included	Included	Included	Included	Included	Included
Adj.R^2	0.3084	0.3627	0.2459	0.2467	0.2898	0.3214	0.1874	0.1957
F value	38.76***	29.49***	28.76***	23.54***	92.54***	181.52***	39.54***	42.51***
Obs.	2060	2060	2060	2060	1412	1412	1412	1412

The Effect of Auditor Switch Type and Audit Tenure

Our analysis suggests that the mandatory audit firm rotation policy is not effective in enhancing audit quality. The results show that the level of abnormal accruals increase after a firm adopts the mandatory audit firm rotation; firms that voluntarily adopted the policy have lower levels of abnormal accruals compared to firms that adopted the policy on a mandatory basis. Existing studies that examine the relation between audit switches and audit quality almost exclusively focus on audit firm tenure. Previous research suggests that the audit quality of Big4 firms is higher than Non-Big4 firms. To add robustness to our initial findings, we examine the expertise hypothesis by testing if the audit quality of Big4 firms is higher than Non-Big4 firms. In order to test the effect of switch type, we identify four auditor switch types: Big4 to Big4, Big4 to Non-Big4, Non-Big4 to Big4, and Non-Big4 to Non-Big4. We calculate the relation between audit switch types with a switch dummy variable that takes the value of one if switch type is from Non-Big4 to Big4 or 0 otherwise.

Moreover, to add further robustness to our initial findings, we consider the effect of audit firm tenure. Over the past decade, archival literature finds evidence that audit quality increases in extended audit tenure (Myers et al., 2003; Chi & Huang, 2005; Chi et al., 2009). We attempt to test the robustness of our findings by including audit tenure length. We include the *audit* variable representing the length of audit tenure prior to the mandatory audit firm rotation policy. The audit tenure length ranges from 6 years to 25 years for the FROT sample and the 6-years tenure represents the PROT period. Moreover, we include the audit*ROT as a control. Our model to test the effect of switch type and audit tenure is estimated by the following model:

$$AQ_{i,j,t(j=1,2,3,4)} = \gamma_0 + \gamma_1 ROT1/2_{i,t} + \gamma_2 Audit_{i,t} + \gamma_3 Switch_{i,t} + \gamma_4 ROT * Audit + \gamma_5 ROT * Switch + \gamma_6 Size_{i,t} + \gamma_7 CFO_{i,t} + \gamma_8 MKBK_{i,t} + \gamma_9 Lev_{i,t} + \gamma_{10} Grw_{i,t} + \gamma_{11} Deficit_{i,t} + \gamma_{12} LAGTACC_{i,t} + ID + YD + \epsilon_{i,t} \quad (4)$$

Additional Variable:
Switch : Dummy variable that is one if Non-Big4 to Big4 switch type, 0 otherwise
Audit : Audit tenure length

Variables of Interest:
ROT1*Switch
ROT2*Switch

Table 6 illustrates our findings for the switch type effect and audit tenure. Panel A represents the results for the FROT sample versus the PROT sample. ROT, a dummy variable taking a value of 1 if a firm mandatorily rotated their audit firm or 0 otherwise. (PROT) shows that the level of absolute value of abnormal ABMJ and ABKO is higher (0.027 and 0.021) compared to PROT sample firms, suggesting FROT sample firms have higher levels of abnormal accruals compared to the PROT sample. However, the interaction term *ROT*switch*, our main variable of interest shows a significantly negative coefficient suggesting that abnormal accruals are smaller when auditors are rotated from Non-Big4 to Big4. The partial effect of a Big4 accounting firm on audit quality is –0.021 for ABMJ and –0.016 for ABKO. The Audit coefficient representing audit tenure, *audit* is statistically negative for abnormal accruals (–0.003 ABMJ and –0.004 ABKO) suggesting that increased audit tenure has a positive effect on audit quality, consistent with previous findings (Chi & Huang, 2005; Carey & Simnett, 2006; Chi et al., 2009). However, the interaction term *ROT*Audit* shows a significant positive sign for ABMJ and ABKO despite insignificant signed abnormal accruals, suggesting that audit quality deteriorates when audit firms are mandatorily rotated after a period of 6 years, supporting the auditor expertise hypothesis. After controlling for audit tenure effect, the results for *ROT*switch* suggest that the mandatory audit firm rotation sample firms that switched from Non-Big4 to Big4 auditors have lower level of abnormal accruals.

Table 6
Audit tenure and Switch type effect (Accrual-based Measure)

Model :

$$AQ_{i,j,t(j=1,2,3,4)} = \gamma_0 + \gamma_1 ROT1_{i,t} + \gamma_2 Audit_{i,t} + \gamma_3 Switch_{i,t} + \gamma_4 ROT1 * Audit + \gamma_5 ROT * Switch + \gamma_6 Size_{i,t} + \gamma_7 CFO_{i,t} + \gamma_8 MKBK_{i,t} + \gamma_9 Lev_{i,t} + \gamma_{10} Grw_{i,t} + \gamma_{11} Deficit_{i,t} + \gamma_{12} LAGTACC_{i,t} + ID + YD + \epsilon_{i,t}$$

Panel A: FROT vs PROT

	DAMJ	DAKO	AB_MJ	AB_KO
Intercept	0.172 (2.85)***	–0.034 (–0.12)	0.3647 (8.2)***	0.0862 (2.85)***
ROT1	0.008 (0.59)	0.009 (1.37)	0.027 (2.53)**	0.021 (2.68)***
Audit	–0.001 (–1.60)	–0.005 (–1.84)*	–0.003 (2.06)**	–0.004 (–2.15)**
Switch	–0.005 (–0.79)	–0.003 (–0.76)	–0.008 (–1.93)**	–0.006 (–1.98)**
ROT1*Audit	0.001 (0.08)	0.006 (0.99)	0.001 (2.16)**	0.008 (2.01)**
ROT1*Switch	–0.012 (–1.07)	–0.007 (–0.99)	–0.021 (–1.87)*	–0.016 (–1.85)*
ROT2				
ROT2*Audit				
ROT2*Switch				
Size	0.025 (3.44)***	0.014 (4.73)***	0.009 (2.13)**	0.007 (2.22)**
CFO	–0.722 (–13.98)***	–0.724 (–17.78)***	–0.241 (–10.54)***	–0.027 (–11.66)***

(*continued on next page*)

Table 6: (*continued*)

Model :

$$AQ_{i,j,t(j=1,2,3,4)} = \gamma_0 + \gamma_1 ROT1_{i,t} + \gamma_2 Audit_{i,t} + \gamma_3 Switch_{i,t} + \gamma_4 ROT1 * Audit + \gamma_5 ROT * Switch + \gamma_6 Size_{i,t} + \gamma_7 CFO_{i,t} + \gamma_8 MKBK_{i,t} + \gamma_9 Lev_{i,t} + \gamma_{10} Grw_{i,t} + \gamma_{11} Deficit_{i,t} + \gamma_{12} LAGTACC_{i,t} + ID + YD + \epsilon_{i,t}$$

Panel A: FROT vs PROT

	DAMJ	DAKO	AB_MJ	AB_KO
MKBK	0.015	0.005	0.012	0.016
	(1.53)	(1.83)*	(2.86)***	(5.32)***
Lev	0.095	0.002	0.005	0.003
	(2.34)**	(3.03)***	(5.16)***	(4.55)***
Grw	0.023	0.023	0.023	0.016
	(2.27)**	(5.21)***	(3.46)***	(3.43)***
Deficit	0.121	0.118	0.004	0.031
	(13.39)***	(29.57)***	(0.64)	(7.01)***
LAGTA	0.027	0.079	0.059	0.058
	(0.63)	(6.11)***	(3.06)***	(4.15)***
ID YD	Included	Included	Included	Included
Adj. R^2 (%)	0.3120	0.3771	0.2251	0.2095
F value	34.75***	27.26***	23.65***	20.49***
Obs.	2060	2060	2060	2060

(*continued on next page*)

Panel B represents the results for the FROT sample versus the VROT sample. Our primary variable of interest, *Mand*Switch* shows significantly negative signs for all the absolute value dependent variables (–0.029 and –0.012). This suggests that the positive sign of ROT was reversed to a negative coefficient due to the effect of Non-Big4 to Big4 switch type indicating the size of abnormal accruals generally decreased when auditors are mandatorily rotated from Non-Big4 to Big4 compared to other switch types. Our variable of interest with regards to audit quality is increasing with audit tenure. *Mand*Audit* is statistically insignificant, suggesting that the positive effect of longer audit tenure has dissipated due to the mandatory audit firm rotation. In summary, in our comparisons between PROT (VROT) and FROT, we find that audit quality generally increases when a company switches from a Non-Big4 to a Big4 accounting firm after controlling for the effect of audit tenure and other key determinants.

Table 6: (*continued*)

Model :

$$AQ_{i,j,t(j=1,2,3,4)} = \gamma_0 + \gamma_1 ROT2_{i,t} + \gamma_2 Audit_{i,t} + \gamma_3 Switch_{i,t} + \gamma_4 ROT2 * Audit + \gamma_5 Mand * Switch + \gamma_6 Size_{i,t} + \gamma_7 CFO_{i,t} + \gamma_8 MKBK_{i,t} + \gamma_9 Lev_{i,t} + \gamma_{10} Grw_{i,t} + \gamma_{11} Deficit_{i,t} + \gamma_{12} LAGTACC_{i,t} + ID + YD + \epsilon_{i,t}$$

Panel B: FROT vs PROT

	DAMJ	DAKO	AB_MJ	AB_KO
Intercept	0.205 (0.45)	0.673 (2.67)***	0.2145 (5.34)***	0.349 (1.45)
ROT1				
Audit	–0.012 (–2.51)**	–0.008 (–1.81)*	–0.011 (–2.52)**	–0.009 (–2.30)**
Switch	–0.019 (–1.99)**	–0.012 (–2.38)**	–0.031 (–3.67)***	–0.014 (–2.76)***
ROT1*Audit				
ROT1*Switch				
ROT2	0.037 (5.29)***	0.002 (1.51)	0.021 (3.19)***	0.037 (6.20)***
ROT2*Audit	0.001 (0.66)	0.001 (1.24)	0.003 (1.11)	0.002 (1.20)
ROT2*Switch	–0.027 (–1.47)	–0.021 (–1.65)	–0.029 (–2.27)**	–0.012 (–2.05)**
Size	0.004 (1.57)	0.001 (1.08)	0.004 (1.71)*	0.003 (2.31)**
CFO	–0.564 (–23.66)***	–0.561 (–22.35)***	–0.172 (–8.16)***	–0.024 (–1.91)*
MKBK	0.004 (1.35)	0.005 (0.26)	0.005 (1.84)*	0.008 (4.99)***
Lev	0.003 (2.57)**	0.004 (6.41)***	0.005 (5.88)***	0.004 (7.75)***
Grw	0.017 (2.71)***	0.016 (4.67)***	0.016 (2.94)***	0.009 (2.88)***
Deficit	0.111 (17.54)***	0.091 (23.85)***	0.012 (2.31)	0.021 (6.38)***
LAGTA	0.029 (8.68)***	0.007 (3.80)***	0.005 (1.83)*	0.007 (2.41)**
ID YD	Included	Included	Included	Included
Adj. R^2 (%)	0.2724	0.3450	0.1662	0.1249
F value	90.90***	196.46***	18.26***	34.66***
Obs.	1412	1412	1412	1412

ADDITIONAL ANALYSIS

Sub-Periods Comparison

Our sample is partitioned into three periods, period 1 corresponding to year –6 to year –4, period 2 corresponding to year –3 to year –1, and period 3 corresponding to year +1 to year +4, when the rotation year is set to 0. Under the three-year auditor retention regime, firms are required to retain their external auditors for at least three-years. Therefore, in period 1 (PROT 1), auditors may impair their independence since they may wish to renew a contract for another 3 years. In period 2 (PROT 2), audit firms are less likely to impair their independence since they know in advance that their contract will end on a given date due to the mandatory rotation regime. For brevity, we combine PROT 1 and PROT 2 as PROT in the main analysis because of similar results in table 3 (Panel B and C). For robustness, we perform additional analysis to test whether audit quality is affected by managers' opportunity to manage earnings and an audit firms' incentives to retain clients in different periods. We empirically test the PROT 1 and PROT 2 samples separately. Using Equation (1), we find that the coefficients for ROT are generally insignificant (besides DAKO), suggesting that audit quality of the FROT sample is indistinguishable from that of PROT 1 (untabulated). For the FROT versus PROT 2 regression, the absolute value of abnormal accruals appears to be positively correlated with ROT, suggesting that the magnitude of abnormal accruals is larger after firm rotation compared to PROT 2. Finally, for the three-way comparisons between PROT 2, FROT and PROT 1, the coefficients of ROT are generally insignificant; suggesting that audit the quality of PROT 2 is indifferent to other periods. These results are consistent with our previous finding, represented by PROT, (the PROT 1 and PROT 2 sample combined) that the mandatory audit rotation policy does not enhance audit quality using abnormal accruals.

Alternative Measure of Audit Quality

We use an alternative measure of audit quality proposed by Dechow and Dichev (2002). Dechow and Dichev (2002) propose a measure of accruals quality determined by the extent to which working capital accruals map into operating cash flow realisations. To investigate whether our previous results in our main analysis (Kothari and modified Jones model) are robust to the alternative measure of audit quality suggested Dechow and Dichev, we run regression model (3) replacing the abnormal accrual variables with the newly computed signed and absolute value of abnormal accruals as the dependent variable. This alternative test yields practically identical results. Untabulated results provide insignificant and significantly positive relations between accrual measures and the ROT variable for signed abnormal accruals and absolute value of abnormal accruals respectively.

Positive and Negative Accruals

The explanation for no significant association between ROT and signed abnormal accrual variables may be due to the fact that positive accruals and negative accruals are offset against each other. Myers et al. (2003) argue that regulators are not solely concerned with the dispersion in accruals, but they are also concerned about the distortion in earnings due to inappropriate income-increasing or income-decreasing accruals. Earnings can either be managed upward (income-increasing) or downward (income-decreasing) on terms favorable to management. Myers et al. (2003) and Chi et al. (2009) also separate absolute abnormal accruals into positive and negative accruals. Following these studies, we identify positive and negative abnormal accruals to test whether new auditors restrict extreme income-increasing and/or decreasing activities. Previous studies posit that ordinary least squares (OLS) estimates can be considered biased in a truncated sample; therefore, we estimate a ML (maximum likelihood) truncated regression, consistent with previous studies (Greene, 2000; Myers et al., 2003; Chi et al., 2009). In untabulated results, we find mixed results. Specifically, for income-increasing accruals from DAMJ, the coefficient for ROT is significantly positive (0.006, z = 2.69) for FROT versus PROT comparison, suggesting that the FROT sample do not constrain extremely positive accruals compared to the PROT sample. Second, for income-decreasing accruals from DAMJ, the coefficient for ROT is insignificant (0.001, z = 0.20) for the FROT versus PROT comparison, suggesting that the audit quality of the FROT sample is indistinguishable from that of itself in prior years. All the coefficients for ROT for the FROT versus VROT comparison appear to be insignificant, again suggesting that there is no evidence supporting that the mandatory rotation regime enhances audit quality. The results from the DAKO partitions are consistent with above findings.

Alternative Tenure Proxies

We find a significant relationship between *Audit* (length of tenure) and the dependent variables, consistent with previous findings. As a further sensitivity analysis, the *Audit* variable was replaced by two additional dummy variables. The two dummy variables are audit tenure length of greater than 9 and 10 years in respective regressions. In these regressions, *Audit* is a dummy variable that takes the value of one if the length of audit tenure is greater than 9 years (10 years), 0 otherwise. Since our FROT sample has at least 6 years of prior audit tenure under the mandatory audit firm rotation policy, we intend to test whether longer audit tenure prior to mandatory audit firm rotation affects audit quality following the auditor expertise hypothesis. Considering the cumulative percentage of six to eight years category of audit tenure before the rotation occupies 54.19% (See Panel C in Table 3), we compare our FROT sample with up to 8 years of previous audit tenure, with firms with more than 9 years (10 years) of previous audit tenure. Untabulated results are generally consistent with earlier results based on the accrual models. We find that the coefficients for Audit*ROT using absolute value of abnormal accruals are significantly positive at 5% (10%) for ABMJ (ABKO) in the FROT versus PROT regression. Despite the coefficients for *Audit*ROT* using signed abnormal accruals being positive, they appear to be insignificant. For the FROT versus VROT comparison, all the coefficients for *Audit*ROT* are positive but only significant using DAKO and ABKO as the dependent variables. In summary, abnormal accruals after the rotation are generally larger when length of previous audit tenure is longer. These findings suggest that the length of audit tenure has positive effect on audit quality, consistent with prior findings (Myers et al., 2003).

Real Earnings Management Metrics

Real earnings management (REM) is considered a deviation from 'normal' business practices to achieve a particular earning level (Roychowdhury, 2006). Management may use a combination of real earnings management and abnormal accruals as tools to manage their reported earnings. Alternatively, a firm may choose between the two earnings management mechanisms using the technique that is less costly to them (Mali & Lim, 2016). Zang (2012) reports the decision to engage in real earnings management or abnormal accruals earnings management is dependent on a firm's relative cost. By employing REM measures as dependent variables, we test whether firms subject to mandatory audit firm rotation are more likely to engage in opportunistic earnings management using REM after rotation. If the audit entrenchment hypothesis is true, client firms may have an incentive to engage in REM since audit firms' incentives to accommodate clients to retain contracts would cease.

We rely on prior studies to develop our proxies for real earnings manipulation. We combine the three individual measures established by Roychowdhury (2006). A positive deviation from the sample's normal level of real activities is considered real earnings management (the residual from one of the three estimation models). A negative deviation is interpreted as earnings management for our production cost measure (Prod). A positive deviation is interpreted as upward earnings management based on CFO and discretionary expenses (SGA). We combine the three individual measures to calculate two comprehensive metrics of REM activities, as suggested by Cohen and Zarowin (2010). We multiply abSGA and abCFO by minus 1 to interpret positive values as positive earnings management and include both measures as the dependent variable in Equation (3).

$$TRM1 = abProd + abSGA*(-1) \quad (5)$$

$$TRM2 = abCFO*(-1) + abSGA*(-1) \quad (6)$$

where,
abCFO : Abnormal CFO is calculated using the Roychowdhury model (2006)
abProd : Abnormal production cost is calculated using the Roychowdhury model (2006)
abSGA : Abnormal discretionary expenses is calculated using the Roychowdhury model (2006).

Untabulated results show mixed signs for REM proxies in both comparisons, FROT versus PROT and FROT versus VROT. However, we do not observe a significant relationship between REM and audit policy. Thus, we conclude that the mandatory audit firm rotation policy has no effect on real earnings management.

Test for Predictive Validity

The main objective of our study is to examine the marginal effect of the mandatory audit firm rotation policy on audit quality. Therefore, for robustness, we establish our model's key determinants based on previous abnormal accrual and audit quality literature. To test the accuracy of our results, and to confirm the reliability of our findings, we use the cross validation technique to test the predictive validity of our model. First, we partition our entire sample into two data sets; training (60%) and holdout (40%) samples. Next, using the training sample, we conduct a stepwise regression and only include variables where the student *t*-value is greater than 2.00 (Woodside, 2013). As a result, we drop some redundant *t* predictors, overall the $adj\text{-}R^2$ increases. We repeat this process for every analysis determinant in this study to find the optimal model. Third, we test the newly specified model from the training sample, against the holdout sample. Finally, we test the predictive validity of the model using leave-one-out cross validation (a method to assess how the results of an empirical analysis will generalise to an independent data set).

We show the results of our earnings management models in Table 7. In short, the results are qualitatively unchanged. The root mean square residual (RMR) of the holdout sample, where zero RMR indicates a perfect fit ranges from 0.06 to 0.11 (slightly higher than the training sample). The mean absolute percentage error (MAPE), where zero MAPE is a perfect fit, ranges from 0.06 to 0.14 (a little different to the training sample), suggesting that the models have a reasonably high predictive and explanatory power. Our results consistently suggest that audit quality of the mandatory rotation firm sample is lower or indifferent compared to the two benchmark samples. Moreover, non-big4 to big4 switches and audit tenure generally have a positive effect on audit quality.

Table 7
Test for predictive validity

Panel A: Earnings Management Model 1								
	Training Sample (60%)				Holdout Sample (40%)			
FROT vs PROT	DAMJ	DAKO	AB_MJ	AB_KO	DAMJ	DAKO	AB_MJ	AB_KO
ROT	0.01 (1.28)	0.01 (1.31)	0.01 (2.49)**	0.01 (2.19)**	0.01 (1.77)*	0.01 (1.54)	0.01 (1.93)**	0.01 (1.90)*
Obs.	1243	1243	1243	1243	817	817	817	817
Predictive Validity								
RMSE	0.08	0.07	0.07	0.06	0.10	0.09	0.09	0.07
MAE	0.06	0.05	0.05	0.04	0.07	0.06	0.06	0.05
FROT vs VROT								
ROT	0.02 (1.60)	0.01 (1.17)	0.03 (2.07)**	0.03 (3.91)***	0.02 (1.34)	0.03 (0.42)	0.03 (1.81)*	0.05 (3.93)***
Obs.	728	728	728	728	684	684	684	684
Predictive Validity								
RMSE	0.12	0.08	0.11	0.06	0.11	0.10	0.09	0.08
MAE	0.08	0.06	0.07	0.04	0.08	0.07	0.06	0.06
Panel B:Earnings Management Model 2								
FROT vs PROT	DAMJ	DAKO	AB_MJ	AB_KO	DAMJ	DAKO	AB_MJ	AB_KO
ROT1	0.01 (0.47)	0.02 (1.74)*	0.02 (1.73)*	0.02 (1.96)*	0.00 (0.13)	0.02 (1.73)*	0.04 (2.30)**	0.02 (1.65)
Audit	–0.00 (–0.92)	–0.00 (–1.08)	–0.00 (–2.67)**	–0.00 (2.41)**	–0.00 (–1.42)	–0.01 (–1.79)*	–0.00 (–2.47)**	–0.00 (–2.21)**
Switch	–0.01 (–1.27)	–0.00 (–1.06)	–0.00 (–2.10)**	–0.01 (–1.83)*	–0.01 (–0.72)	–0.02 (–1.59)	–0.01 (–2.34)**	–0.01 (–1.59)
ROT1*Audit	0.00 (0.21)	0.00 (1.01)	0.00 (2.24)**	0.00 (1.60)	0.00 (0.51)	0.01 (0.55)	0.02 (1.78)*	0.01 (1.71)*
ROT1*Switch	–0.02 (–1.23)	–0.01 (–0.90)	–0.02 (–2.02)**	–0.01 (–1.75)*	–0.01 (–0.70)	–0.01 (–0.88)	–0.01 (–1.71)*	–0.01 (–1.75)*
Predictive Validity								

(*continued on next page*)

Table 7: (*continued*)

FROT vs PROT	DAMJ	DAKO	AB_MJ	AB_KO	DAMJ	DAKO	AB_MJ	AB_KO
RMSE	0.08	0.07	0.07	0.06	0.10	0.08	0.08	0.07
MAE	0.06	0.05	0.05	0.04	0.07	0.06	0.06	0.05
FROT vs VROT								
ROT2	0.05 (2.52)***	0.01 (1.47)	0.01 (2.36)**	0.05 (3.05)***	0.03 (1.72)*	0.03 (0.77)	0.01 (2.35)**	0.03 (1.94)*
Audit	–0.04 (–0.84)	–0.02 (–0.69)	–0.01 (–1.75)*	–0.01 (–0.36)	–0.00 (–0.52)	–0.02 (–0.29)	–0.01 (–1.93)*	–0.01 (–1.38)
Switch	–0.03 (–0.97)	–0.02 (–0.16)	–0.08 (–3.71)***	–0.02 (–1.36)	–0.02 (–0.68)	–0.02 (–0.47)	–0.03 (–1.02)	–0.01 (–0.25)
ROT2*Audit	0.03 (0.65)	0.03 (0.84)	0.01 (1.42)	0.02 (0.82)	0.01 (0.45)	0.03 (0.34)	0.01 (1.57)	0.01 (1.16)
ROT2*Switch	–0.04 (–1.41)	–0.02 (–0.83)	–0.09 (–3.66)***	–0.01 (–1.73)*	–0.01 (–1.14)	–0.01 (–0.43)	–0.05 (–2.36)**	–0.03 (–2.12)**
Predictive Validity								
RMSE	0.12	0.08	0.11	0.06	0.11	0.10	0.09	0.08
MAE	0.08	0.06	0.07	0.04	0.08	0.07	0.06	0.06

CONCLUSION

In this study, we investigate the effect of the mandatory audit firm rotation policy on audit quality using a Korean sample from 2000 to 2009. In Korea, a six-year mandatory audit firm rotation policy was introduced in 2006 on a firm-by-firm basis and was repealed in 2010. Our study is motivated by the uniqueness of the short-lived Korean experiment as well as the current debate surrounding the effectiveness of mandatory audit firm rotation, recently rekindled in the U.S. and Europe. The arguments in favor of the policy are based on the belief that longer audit tenure impairs audit quality. The Korean experience is a rare experiment, which lasted only for five years. We attempt to take advantage of Korea's case to examine the relationship between the mandatory audit rotation policy and audit quality.

Using accrual-based measures, we conduct a series of empirical tests to determine the association between the implementation of the mandatory audit firm rotation policy and changes in the level of audit quality. We find evidence suggesting that the audit quality of the mandatory rotation firms in post turnover period is generally lower relative to prior periods (mandatory audit partner rotation) or audit quality is indifferent. The results are consistent when audit quality of the mandatory sample is compared with that of firms not subject to the mandatory audit rotation policy in the same sample period. A 'fresh view' and increased auditor independence under the mandatory audit firm rotation policy was expected to increase audit quality in South Korea. However, using abnormal accruals, audit quality is found to be higher under the mandatory audit partner policy. Our results suggest that the loss of firm specific knowledge after the adoption of the mandatory audit firm rotation period has led to a decrease in accounting quality compared to partner rotation periods, periods partners are able to cooperate. Previous studies have focused on the effect of audit quality after the implementation of the mandatory audit partner rotation or mandatory audit firm rotation using a before and after approach. However, our paper is the first to compare the mandatory audit partner and mandatory audit firm rotation policies. Our results suggest that the mandatory audit firm rotation does not perform its intended purpose to enhance audit quality. Moreover, in some instances, audit quality decreases compared to periods of mandatory audit partner rotation. We also find that the mandatory audit firms rotation sample whose auditors were rotated from Non-Big4 to Big4 are generally associated with lower levels of abnormal accruals due to the audit quality superiority of Big4 audit firms compared to Non-Big4. Finally, we find evidence that longer audit tenure has a positive effect upon audit quality.

Regulatory authorities should proceed with caution when considering the advantages of mandatory audit firm rotation as a policy with the potential to improve audit quality and auditor independence. We provide evidence supporting the auditor expertise in the Korean setting. The data suggests that mandatory audit firm rotation, a policy based on the auditor entrenchment hypothesis is not effective in enhancing audit quality. Given the substantial additional costs associated with changing an audit firm and the negative effect on audit quality after the adoption of the policy, we believe the policy is not justified.

Our study, to our knowledge, is one of the first to directly compare the effectiveness of mandatory audit firm rotation policy and the mandatory audit partner rotation policy. We note that accounting standards and other regulatory systems before the adoption of IFRS in Korea are similar to the U.S. Therefore, we believe that our findings could provide useful implications for policy makers in the U.S. and European countries wherein the mandatory audit firm rotation policy is emerging to be a controversial issue.

However, our study may have some limitations. We focus on the impact of the mandatory audit firm rotation policy on audit quality using abnormal accruals as proxies for audit quality. Whilst an extensive literature finds abnormal accruals to be a plausible proxy for audit quality, the proxy is not free from 'noise' (Chi et al., 2009). Also, we do not directly control for the mandatory audit partner period using a dummy variable approach specifically due to the data unavailability. However, our approach, dividing our mandatory audit firm rotation samples into two different periods in which firms have different incentives to satisfy client's requirements to retain an audit contracts offer an unique insight, and adds additional robustness. Moreover, since our investigation is based on a unique institutional setting, our findings may not be readily generalisable to other nations with different legal and regulatory environments. In addition, the research period was short and overlapped the final crisis. However, despite these limitations, overall our results provide consistent evidence supporting the auditor expertise hypothesis, that the mandatory audit rotation policy did not improve audit quality in a Korean context.

REFERENCES

American Institute of Certified Public Accountants (AICPA). (1992). *Statement of position regarding mandatory rotation of audit firms of publicly held companies*. New York: Author.

Arrunada, B., & Paz-Ares, C. (1997). Mandatory rotation of company auditors: A critical examination. *International Review of Law and Economics*, *17*(1), 31–61. https://doi.org/10.1016/S0144-8188(96)00063-4

Ashbaugh, H., LaFond, R., & Mayhew, B. W. (2003). Do non-audit services compromise independence? Further evidence. *The Accounting Review, 78*(3), 611–639. https://doi.org/10.2308/accr.2003.78.3.611

Basu, S., Lee, S. H., & Jan, C. L. (2001). *Differences in conservatism between big eight and non-big eight auditors*, (Working Paper). Emory University, Atlanta, Georgia.

Becker, C., DeFond, M., Jiambalvo, J., & Subramanyam, K. R. (1998). The effect of audit quality on earnings management. *Contemporary Accounting Research, 15*(1), 1–24. https://doi.org/10.1111/j.1911-3846.1998.tb00547.x

Behn, B., Choi, J. H., & Kang, T. (2008). Audit quality and properties of analyst earnings forecasts. *The Accounting Review, 83*(2), 327–359. https://doi.org/10.2308/accr.2008.83.2.327

Blouin, J., Grein, B., & Rountree, B. (2007). An analysis of forced auditor change: The case of former Arthur Andersen clients. *The Accounting Review, 82*(3), 621–650. https://doi.org/10.2308/accr.2007.82.3.621

Brody, R. G., & Moscove, S. A. (1998). Mandatory auditor rotation. *National Public Accountant, 48*(5), 32–35.

Brunsden, J. (2011). *EU seeks to split big four auditing firms in rule overhaul*. New York, NY: Bloomberg. 5 December.

Carcello, J. V., & Nagy, A. L. (2004). Audit firm tenure and fraudulent financial reporting. *Journal of Practice and Theory, 23*(2), 55–69. https://doi.org/10.2308/aud.2004.23.2.55

Carey, P., & Simnett, R. (2006). Audit partner tenure and audit quality. *The Accounting Review, 81*(3), 653–676. https://doi.org/10.2308/accr.2006.81.3.653

Casterella, J., Knechel, W. R., & Walket, P. S. (2002). *The relationship of audit failures and auditor tenure* (Working Paper). University of Florida.

Chen, C., Lin, C., & Lin, Y. (2008). Audit partner tenure, audit firm tenure, and discretionary accruals: Does long auditor tenure impair earnings quality? *Contemporary Accounting Research, 25*(2), 415–445. https://doi.org/10.1506/car.25.2.5

Chi, W., & Huang, H. (2005). Discretionary accruals, audit-firm tenure and audit-partner tenure: Empirical evidence from Taiwan. *Journal of Contemporary Accounting and Economics, 1*(1), 65–92. https://doi.org/10.1016/S1815-5669(10)70003-5

Chi, W., Huang, H., Liao, Y., & Xie, H. (2009). Mandatory audit partner rotation, audit quality, and market perception: Evidence from Taiwan. *Contemporary Accounting Research, 26*(2), 329–358. https://doi.org/10.1506/car.26.2.2

Cohen, D., & Zarowin, P. (2010). Accrual-based and real earnings management activities around seasoned equity offerings. *Journal of Accounting and Economics, 50*(1), 2–19. https://doi.org/10.1016/j.jacceco.2010.01.002

Dalton, M. (2011). *EU Proposes overhaul to audit rules*. New York, NY: The Wall Street Journal, 1 December.

DeAngelo, L. E. (1981). Auditor size and audit quality. *Journal of Accounting and Economics, 3*(3), 183–199. https://doi.org/10.1016/0165-4101(81)90002-1

Dechow, P. M. (1994). Accounting earnings and cash flows as measures of firm performance: The role of accounting accruals. *Journal of Accounting and Economics, 18*(1), 3–42. https://doi.org/10.1016/0165-4101(94)90016-7

Dechow, P. M., Sloan, R. G., & Sweeney, A. P. (1995). Detecting earnings management. *The Accounting Review, 70*(2), 193–225.

Dechow. P. M., & Dichev, I. (2002). The quality of accruals and earnings: The role of accrual estimation error. *The Accounting Review, 77*(4), 35–59. https://doi.org/10.2308/accr.2002.77.s-1.35

DeFond, M. L., & Francis, J. R. (2005). The audit research after Sarbanes-Oxley. *Journal of Practice & Theory, 24*(Supplement), 5–30.

DeFond, M. L., & Subramanyam, K. R. (1998). Auditor choice and discretionary accruals. *Journal of Accounting and Economics, 25*(1), 35–67. https://doi.org/10.1016/S0165-4101(98)00018-4

Deis, D. R., & Giroux, G. A. (1992). Determinants of audit quality in the public sector. *The Accounting Review, 67*(3), 462–479.

Geiger, M., & Raghunandan, K. (2002). Auditor tenure and audit report failure. *Auditing*: *A Journal of Theory and Practice*, *21*(1), 67–78. https://doi.org/10.2308/aud.2002.21.1.67

Ghosh, A., & Moon, D. (2005). Auditor tenure and perceptions of audit quality. *The Accounting Review, 80*(2), 585–612. https://doi.org/10.2308/accr.2005.80.2.585

Greene, W. H. (2000). *Econometric analysis*. Englewood Cliffs, NJ: Prentice Hall.

Healy, P., & Wahlen, J. (1999). A review of the earnings management literature and its implications for standard setting. *Accounting Horizons, 13*(4), 365–383. https://doi.org/10.2308/acch.1999.13.4.365

Heninger, W. (2001). The association between auditor litigation and abnormal accruals. *The Accounting Review, 76*(1), 111–126. https://doi.org/10.2308/accr.2001.76.1.111

Johnson, V., Khurana, I., & Reynolds, J. (2002). Audit-firm tenure and the quality of financial reports. *Contemporary Accounting Research, 19*(4), 637–660. https://doi.org/10.1506/LLTH-JXQV-8CEW-8MXD

Johnstone, K., & Bedard, J. (2004). Audit firm portfolio management decisions. *Journal of Accounting Research, 42*(4), 659–690. https://doi.org/10.1111/j.1475-679X.2004.00153.x

Khurana, I., & Raman, K. (2004). Litigation risk and the financial reporting credibility of Big 4 versus non-Big 4 audits: Evidence from Anglo-American countries. *The Accounting Review, 79*(2), 473–495. https://doi.org/10.2308/accr.2004.79.2.473

Kothari, S., Leone, A., & Wasley, C. (2005). Performance matched discretionary accruals measures. *Journal of Accounting and Economics, 39*(1), 163–197. https://doi.org/10.1016/j.jacceco.2004.11.002

Kothari, S. P. (2001). Capital markets research in accounting. *Journal of Accounting and Economics, 3*(1–3), 105–231. https://doi.org/10.1016/S0165-4101(01)00030-1

Kwon, S. A., Lim, Y., & Simnett, R. (2014). The effect of mandatory audit firm rotation on audit quality and audit fees: Empirical evidence from the Korean audit market. *Auditing: A Journal of Practice & Theory, 33*(4), 167–196. https://doi.org/10.2308/ajpt-50814

La Porta, R., Lopez-De-Silanes, F., Shleifer, A., & Vishny, R. W. (1997). Legal determinants of external finance. *Journal of Finance, 52*(3), 1131–1150. https://doi.org/10.1111/j.1540-6261.1997.tb02727.x

Lennox, C. S., Wu, X., & Zhang, T. (2014). Does mandatory rotation of audit partners improve audit quality? *The Accounting Review, 89*(5), 1775–1803. https://doi.org/10.2308/accr-50800

Lisic, L. L., Silveri, S., & Song, Y. (2015). Accounting fraud, auditing, and the role of government sanctions in China. *Journal of Business Research, 68*(6), 1186–1195. https://doi.org/10.1016/j.jbusres.2014.11.013

Mali, D., & Lim, H. J. (2016). Do firms engage in earnings management to improve credit ratings? Evidence from KRX bond issuers. *Korea Corporation Management Review, 23*(1), 39–61.

Myers, J., Myers, L., & Omer, T. (2003). Exploring the term of auditor-client relationship and the quality of earnings: A case for mandatory auditor rotation? *The Accounting Review, 78*(3), 779–799. https://doi.org/10.2308/accr.2003.78.3.779

Public Company Accounting Oversight Board (PCAOB). (2011a). *PCAOB to consider concept release on auditor independence and audit firm rotation*. PCAOB Press Release. Washington, DC: U.S. Public Company Accounting, 11 August.

PCAOB. (2011b). *Concept release on auditor independence and audit firm rotation: Notice of roundtable*. PCAOB Release No. 2011–006. Washington, DC: U. S. Public Company Accounting Oversight Board, 11 August.

Peirre, K., & Anderson, J. A. (1984). An analysis of the factor associated with lawsuits against public accountants. *The Accounting Review, 59*(2), 242–263.

Piot, C., & Janin, R. (2007). External auditors, audit committees and earnings management in France. *European Accounting Review*, *16*(2), 429–454. https://doi.org/10.1080/09638180701391030

Richardson, S., Tuna, I., & Wu, M. (2002). *Predicting earnings management: The case of earnings restatements*. (Working paper). University of Pennsylvania.

Ryan, S. G., Herz, R. H., Iannaconi, T. E., Maines, L. A., Palepu, K., Schrand, C. M., Skinner, D. J., & Vincent, L. (2001). SEC auditor independence requirements: AAA Financial Accounting Standards Committee. *Accounting Horizons, 15*(4), 373–386. https://doi.org/10.2308/acch.2001.15.4.373

Roychowdhury, S. (2006). Earnings management through real activities manipulation. *Journal of Accounting and Economics, 42*(3), 335–370. https://doi.org/10.1016/j.jacceco.2006.01.002

Sloan, R. (1996). Do stock prices fully reflect information in accruals and cash flows about future earnings? *The Accounting Review, 71*(7), 289–315.

Woods, C. (2013). *Classifying South Korea as a developed market* (White Paper Report). FTSE Publications. Retrieved from http://www.ftse.com/products/downloads/FTSE_South_Korea_Whitepaper_Jan2013.pdf

Woodside, A. G. (2013). Moving beyond multiple regression analysis to algorithms: Calling for adoption of a paradigm shift from symmetric to asymmetric thinking in data analysis and crafting theory. *Journal of Business Research, 66*(4), 463–472. https://doi.org/10.1016/j.jbusres.2012.12.021

Zang, A. (2012). Evidence on the tradeoff between real activities manipulation and accrual based earnings management. *The Accounting Review, 87*(2), 675–703. https://doi.org/10.2308/accr-10196

ASIAN ACADEMY *of*
MANAGEMENT JOURNAL
of ACCOUNTING
and FINANCE

AAMJAF Vol. 13, No. 1, 41–62, 2017

GENDER DIVERSITY AND FIRMS' FINANCIAL PERFORMANCE IN MALAYSIA

Irean Yap Lee-Kuen, Chan Sok-Gee and Rozaimah Zainudin*

Faculty of Business and Accountancy, University of Malaya, 50603 Kuala Lumpur, Malaysia

*Corresponding author: rozaimah@um.edu.my

ABSTRACT

This study aims to investigate the relationship between gender diversity in a firm's board of directors and financial performance of firms listed on Bursa Malaysia for the period between 2009 and 2013. Using unbalanced panel data analysis, we tested whether gender diversity in the boardroom may influence the firm's performance, as measured by Tobin's Q. We employed four different proxies for gender diversity (the dummy variable for women, the percentage of women on the board, the Blau index, and the Shannon index) to provide a more comprehensive measure of gender diversity. This study suggests that a higher degree of female representation on the board increases a firm's financial performance. Positive discrimination favouring female boardroom appointment is therefore likely to persist as a feature of the corporate governance landscape in Malaysia.

Keywords: gender diversity, board of directors, firm performance, corporate governance, Shannon index, Blau index, panel data, Malaysia, board composition, female representation

INTRODUCTION

Following the collapse of high-profile firms such as Enron in 2001 and WorldCom in 2002, good corporate governance practices have been considered crucial and are now recognised as being among the driving forces sustaining a firm's growth in the long run. The corporate collapses of the last decade happened due to a lack of

Publication date: 30 August 2017

To cite this article: Yap, I. L.-K., Chan S.-G., & Zainudin, R. (2017). Gender diversity and firms' financial performance in Malaysia. *Asian Academy of Management Journal of Accounting and Finance, 13*(1), 41–62. https://doi.org/10.21315/aamjaf2017.13.1.2

To link to this article: https://doi.org/10.21315/aamjaf2017.13.1.2

corporate monitoring in the firms, which leads to significant agency problems in the management and the board of directors. This has resulted in an interest in looking at board composition in terms such as the percentage of independent directors, the diversity of the directors in terms of gender, education, experience, and age, and the networking of the directors. This is crucial as a better mix of directors offers greater perspective in decision-making processes (Randøy, Thomsen, & Oxelheim, 2006). In addition, Campbell and Minguez-Vera (2008) have also pointed out that ethnic and gender diversity among directors provides new and better perspectives and, hence, enhanced performance of the firm.

The corporate governance codes of conduct from both developed and developing countries (Norway, Italy, France, Malaysia, and other) have begun to impose gender quota systems as an initial measure to increase board diversity (Oba & Fodio, 2013). This system has received positive feedback in European countries, where the number of women on corporate boards has increased to over 40% (Corkery & Taylor, 2012). Nevertheless, in developing countries such as Malaysia, the corporate boardroom is still skeptical of policies that increase the percentage of women directors in the corporate boardroom. This is due to Asian cultural differences, according to which women in Asia are expected to have sole responsibility for family and household duties (see Chan & Lee, 1994; Omar & Davidson, 2001). This cultural difference may limit Asian women from advancing to higher positions in the workforce and may thus lead boards to see little evidence that gender imbalance affects firm performance. Due to the low number female directors in Malaysia, the Prime Minister has further urged that the incidence of female board members at government-linked companies and all listed firms be raised to 30% by 2016.

The value of including women in the corporate boardroom is debatable in terms of policy implication. This is because empirical evidence of the contribution of women directors on firm performance is still unclear. Greater gender diversity on the board tends to generate more conflicting opinions, thus leading to inefficient and ineffective decision making, which can reduce the firm's performance (Campbell & Minguez-Vera, 2008). Firms also incur higher costs associated with collective decision-making given a diversified board (Daunfeldt & Rudholm, 2012). In fact, mixed evidence has been reported in countries that have official gender quota systems (such as Norway, Italy, and France), with the consensus of evidence failing to find any relationship between gender diversity and firm performance (Daufeldt & Rudholm, 2012; Rose, 2007). Smith, Smith and Verner (2006), on the other hand, found only a weak negative relationship between gender diversity and firm performance.

Yet empirical studies also suggest the importance of gender diversity in producing a better perspective, and hence contributing to better financial performance (Dobbin & Jung, 2011; Gul, Hutchinson & Lai, 2013; Marinova, Plantenga & Remery, 2010; Rose, 2007). In a similar vein, Dezsö and Ross (2012), Rose (2007) and Smith et al. (2006) also found that gender diversity was positively related to the firm's performance in emerging economies. This is consistent with the studies of Barnett, Morley and Piterman (2010), Carter, Simkins, and Simpson (2003), and Shrader, Blackburn, and Iles (1997), which found that gender diversity leads to better financial performance in firms.

Consequently, it is questionable whether legislation is a good way to facilitate greater board gender diversity, as mixed results have been found regarding the contribution of women directors to the corporate boardroom. This is especially crucial for developing nations that try to implement the gender quota system, which may affect the performance of the firms in the long run. In this case, we aim to study the effect of gender diversity in the board of directors on financial performance among Malaysian public listed firms. We have selected Malaysia as the sample for our study because the participation rate of women in the corporate boardroom has remained below 10% even four years after the 2011 enforcement of the rule requiring that Malaysian boards of directors be composed of at least 30% women. It is this important to ascertain the performance of the public listed companies in Malaysia is not affected with the inclusion of female directors in corporate boardrooms in order to convince stakeholders and to fulfill the public policy.

Malaysia has also been selected because it represents the Asian region well in terms of cultural diversity, which serves as the main avenue for such study to be conducted. Further, to enrich our model estimations, we used multiple proxies for gender diversity, including the Blau index of diversity (BLAU), a dummy for woman on the board of directors (DWOMEN), the Shannon index of diversity (SHANNON), and the percentage of women on board of directors (PWOMEN) by controlling the firms' debt level, return on assets, and firm size. Our study differs from earlier studies in the context of Malaysia. In comparison with the study by Taghizadeh and Saremi (2013), we have conducted a more robust estimation in our gender diversity and firm financial performance investigation. We have used Tobin's Q as our firm's financial performance proxy, while their study only used ROA and ROE. Furthermore, we have applied multiple proxies for our gender diversity measurement (BLAU, DWOMEN, SHANNON, and PWOMEN) while they focused only on the percentage of women on board of directors. Additionally, in comparison with the study of Johl, Kaur and Cooper (2015) which was focused on examining the effect of board characteristics on a firm's ROA, our analysis attempts to identify how gender diversity affects a firm's financial performance. Based on our findings, we found that gender diversity on the boards of Malaysian public listed firms is positively related to the firm's financial performance. This provides further support of the implementation of the gender quota policy in the country, which aims to increase the performance and long-term survivability of the firms in the more complex business world of the future.

This remainder of the paper is structured as follows: The next section describes the empirical evidence related to gender diversity and firm financial performance in various countries. We then explain the development of the hypothesis in the subsequent section. This is followed by a discussion of the data and estimation models applied in the analysis. Next is a discussion of the empirical results and finally, the conclusion.

LITERATURE REVIEW

The topic of board composition is a growing area of study and one of the most important variables is the presence of women directors on the board and its relationship with firm performance. Research in this area has been prompted by the growing concern that women continue to be underrepresented on corporate boards in most countries of the world. Although the relationship between board gender diversity and firm performance is one of the focuses of related studies, the empirical evidence is inconclusive. A great amount of attention has been paid to analysing the relationship within mature economies such as the United States and Scandinavia, with only a handful studies have been performed using data from emerging economies. However, the evidence in these is also mixed. Campbell and Minguez-Vera (2008) suggest that these differences may be due to data collected from different countries having different board systems and due to different study periods. Other than the geographical region, different estimation methods and unobserved factors may affect the results. In addition, these differences may also be characterised by different cultural, legal, social, and economic environments in which the firms are operating.

Studies of the impact of gender diversity in Asian regions and in developing countries are relatively scant because of skepticism about including female directors in the corporate boardroom. Johl, Kaur and Cooper (2015) have studied the impact of board characteristics and firm performance of 700 public listed firms in Malaysia for the year 2009. They found that women's participation is positively related to the return on assets. This is consistent with the work of Taghizadeh and Saremi (2013); their study examined 150 public listed firms in Malaysia using data from 2008. Similar results have been found by Fan (2012) for the firms listed on the main board of Singapore Exchange; Fan found that gender diversity increases the firm's value as measured by Tobin's Q. Nevertheless, Marimuthu and Kolandaisamy (2009) as well as Shukeri, Shin, and Shaari (2012) found no relationship between gender diversity and firm performance for 300 listed firms on Bursa Malaysia.

In addition, factors such as ethnicity and educational background also influence the performance of the board. This may be because gender diversity provides different perspectives and thought, as well as commitments in terms of time, unity, and collegiality, which can contribute positively to the firm's performance (Barnett et al., 2010). In fact, Jhunjhunwala and Mishra (2012), using data from 30 firms' data listed in Sensex, found that board diversity in terms such as gender, age, tenure, nationality, educational background, and working experience does not contribute to the firm's performance.

On the other hand, empirical studies on the contribution of female directors in the United States are rather positive. Erhardt, Werbel, and Shrader (2003) study the relationship between board diversity measured as the percentage of women and as female minority on board of directors and firm performance of 127 large American firms. They found that a diverse board positively affects the firm's performance measure in terms of return on assets and return on investment. This is supported by the study of Carter et al. (2003), where board diversity was found to positively relate to the firm's value.

Adams and Ferreira (2009) and Farrell and Hersch (2005) suggest that successful firms are more likely to recruit women to top management. They found that female directors have significant impact on board input and firm profitability, as well as on the value of the firm, which supports the results of Shrader et al. (1997) regarding 200 firms listed in the *Wall Street Journal*.

In addition, Stigring and Lyxell (2011) also found a positive relationship between gender diversity and firms' profitability level as measured by the return on assets and return on equity. Nevertheless, their study failed to take into account the endogeneity problems and the causal relationship between gender diversity and firm performance, as highlighted by Dobbin and Jung (2011). Srinidhi, Gul and Tsui (2011) found that a higher number of female directors leads to higher earning quality, even after considering the endogeneity problems highlighted above. This is also supported by Dezsö and Ross (2012) in their analysis of 1500 firms listed in S&P. Gul et al. (2013) further suggest that a positive relationship between gender diversity on the board and analysts' earnings forecast accuracy for 2200 firms listed in the United States. This clearly shows the importance of gender diversity in the United States.

In European and Scandinavia countries, the relationship of the gender diversity and various firm's performance measures (return on assets, return on equity, and Tobin's Q) are rather weak. Bianco, Ciavarella and Signoretti (2011), Daunfeldt and Rudholm (2012), Marinova et al. (2010), Randøy et al. (2006), Rose (2007), Schwizer, Soana and Cucinelli (2012), and Stigring and Lyxell (2011) all failed to identify any significant relationship between gender diversity and a firm's performance measures. Luckerath-Rovers (2011) found that firms with female directors performed better in their study of 116 Dutch firms listed on the Amsterdam Euronext Stock Exchange. However, Ahern and Dittmar (2006) found that the stock prices of Norwegian firms declines with the appointment of women directors to fulfill the gender quota system.

As the results are still mixed in terms of the contribution of gender diversity, especially in developing nations, we have further extended the study by analysing the gender diversity with different proxies (the Blau index of diversity, a dummy for women on the board of directors, the Shannon index of diversity, and the percentage of women on board of directors) to confirm the contribution of women's participation in corporate boardrooms. The use of different proxies is important to tap into developing markets such as Malaysia, as the percentage of woman directors may be low or insignificant; hence the use of different indexes to capture the lower representation.

Hypotheses Development

The relationship between gender diversity in the corporate boardroom and firm performance can be explained using the resource-based theory. According to resource-based theory, gender diversity in an organisation is view as an intangible and socially complex resourced that provides firms with sustainable competitive advantage (Grant, 1991; Barney, 2001). This is because gender diversity increases creativity and innovation in firms which is considered as valuable, rare, inimitable and non-replaceable. This is supported by Carter et al. (2003), Erhardt et al. (2003) and Stigring and Lyxell (2011) that found greater gender diversity in the boardroom may positively influence a firm's financial performance (Carter et al., 2003; Erhardt et al., 2003; Stigring & Lyxell, 2011). The resource-based theory highlights the importance of the female directors in the corporate boardrooms because it contributes to better synergy from the interaction of male and female directors as a source of competitive advantage. In this context, female directors are able to provide different perspectives and improve in decision-making processes

(Campbell & Minguez-Vera, 2008) and therefore contribute positively toward firms' performance. Besides, a study by Srinidhi et al. (2011) reveals several mechanisms through which female representation on the board of directors may improve the firm's earning quality, through expansion of scope in discussion and decision making in the board. In addition, women are said to exhibit greater diligence in monitoring and to demand greater accountability for managers' performance. In this case, female directors could improve board oversight and therefore improve earnings quality.

On the other hand, agency theory focuses on the relationship between the shareholder and manager relationship. The theory suggests that higher gender diversity creates a better control mechanism between the boards and management via enhancing boardroom independence and better monitoring system. Besides, female directors are able to improve firms' earning quality through the reduction of opportunistic earnings management, because women directors are said to be less tolerant of opportunistic behaviour (Srinidhi et al., 2011), hence reduces the conflict between the boards and the managers.

Consequently, gender diversity on the board sends a positive signal to the market that the organisation focuses more on corporate governance and that the company is doing well, thus improving the firm's reputation. Larkin, Bernardi and Bosco (2012) indicates that interaction between the firm's recognition and multiple female board directors is associated with higher overall returns and lower negative returns for stockholders, as measured by market prices of the firm's common stock. We therefore expect that there is a positive and significant relationship between board gender diversity and firm financial performance.

We measure the degree of female representation on the board of directors using a dummy variable for women on the board, the percentage of women on the board, the Blau index of diversity, and the Shannon index of diversity. The use of the Blau and Shannon indices is particularly useful in our study, because they take into account the number of gender categories, as well as the distribution of board members between them. The Blau index is calculated as $1-\sum_{i=1}^{n} P_i^2$ where P_i is the percentage of board members in each category and n is the total number of board members. The Blau index for gender diversity thus lies between 0 and 0.5, with a value of 0.5 indicating that the board consists of an equal number of men and women.

On the other hand, the Shannon index is calculated as $-\sum_{i=1}^{n} P_i$ where P_i and n have the same meanings as in the case of the Blau index. The larger the Shannon index, the more diversified is the corporate board structure; in our case, the more diverse in terms of gender. The Blau and Shannon indices both measure diversity, though the Shannon index is more sensitive to small changes in the gender composition of boards, given that it is calculated as a logarithm of gender diversity (Campbell & Minguez-Vera, 2008). The use of both indices allows us to check for consistency and robustness in the results. In this case, a similar hypothesis is developed as for female representation, because greater gender diversity may lead to more imagination in company strategies and hence in better firm performance. Besides, diversity may also improve the decision making of firms from different perspectives due to differences in the cognitive levels of males and females. Based on this discussion, we propose the following hypotheses:

> H1: There is a significant positive relationship between female representation on the board of directors and the firm's financial performance.
>
> H2: There is a significant positive relationship between gender diversity (measured by the Blau and Shannon indices) and a firm's financial performance.

METHODOLOGY

We used unbalanced panel data analysis based on generalised least square (GLS) to ascertain the relationship between women directors and firm performance. The use of GLS estimation helps to take into account the unobserved heterogeneity that would result in bias. The impact of gender diversity on firm performance is estimated using Equation (1):

$$Q_{it} = \beta_0 + \beta_1 WOMEN_{it} + \beta_2 LEVER_{it} + \beta_3 ROA_{it} + \beta_4 SIZE_{it} + \eta_I + \varepsilon_{it} \quad (1)$$

where Q_{it} represents Tobin's Q value for firm i at time t, $WOMEN_{it}$ is female representation on board of directors for firm i at time t (measured by the four alternative variables: the dummy variable for women, the percentage of women on the board of directors, the Blau index, and the Shannon index). $LEVER_{it}$ is the debt level for firm i at time t, and ROA_{it} is the return on assets for firm i at time t; $SIZE_{it}$ denotes the firm's size for firm i at time t and η_I represents unobservable heterogeneity.

We employ the pooled ordinary least square (POLS) model in conjunction with the fixed effect model (FEM) and the random effect model (REM) for more robust estimations. The Breusch–Pagan Lagrange Multiplier is used to decide the appropriateness of the random effects estimation over the normal OLS estimation. The rejection of null in the LM test shows the existence of heterogeneity in the variables, meaning that the use of OLS may not be appropriate. We then proceed to perform the Hausman test to identify whether a correlation between unobservable heterogeneity and the explanatory variables exists. This test is used to test the correlation between the unique errors (U_i) and the regressors. The rejection of the null hypothesis favors the fixed effect model in which unobserved heterogeneity and explanatory variables exist (Campbell & Minguez-Vera, 2008).

Data and Sample

Panel data analysis is employed to examine the relationship between board gender diversity and firm performance. The sample consists of nonfinancial firms listed on the FTSE Bursa Malaysia Top 100 Index for the period between 2009 and 2013. We used a five-year period to mitigate any potential sample bias due to changes from KLCI to FTSE Bursa Malaysia KLCI. Due to data constraints, we were only able to collect a sample of 76 nonfinancial firms and use 336 observations for the estimation process. The identities of directors were obtained from the firms' annual reports. From these reports, the number of board members is calculated. Accounting data, such as the book value of debt, the book value of total assets, and the return on assets were obtained from Bloomberg. Similarly, the number of shares and share prices were also obtained from Bloomberg.

Variables Definition

We use Tobin's Q as a proxy of firm value to measure the firm's financial performance. Tobin's Q is calculated using the sum of the market value of stock and the book value of debt divided by the book value of total assets. We employed Tobin's Q in our study because it reflects the market's expectation of the firm's competitive advantage. Unlike accounting data that reflects only past performance, Tobin's Q is more forward looking and portrays a firm's future prospect, given the superiority of managerial control. Firms with a high Tobin's Q of more than 1.00 have better investment opportunities, higher growth potential, and shows indications that management has performed well with its assets (Wolfe & Sauaia, 2003). Firms with Tobin's Q ratio of less than 1.00 are associated with poor utilisation of available resources (Campbell & Minguez-Vera, 2008).

We employed different proxies to measure gender diversity. This includes the use of the dummy variable for women (DWOMEN), the percentage of women on the board (PWOMEN), the Blau index, and the Shannon index. The use of various measures enables more comprehensive analysis of female representation in the corporate boardroom. The Blau index is measured as $1-\sum_{i=1}^{n} P_i^2$, where P_i is the percentage of board members in each category and *n* is the total number of board members. The values of the Blau index range from 0 to a maximum of 0.5. The maximum value of 0.5 occurs when the firm has an equal number of men and women on the board of directors. On the other hand, the Shannon index is calculated as $\sum_{i=1}^{n} P_i InP_i$, where P_i and *n* are similarly the percentage of board members in each category and the total number of board members. The values for the Shannon index range from 0 to a maximum of 0.69. The maximum value of 0.69 occurs when both males and females are present in equal proportions and diversity is thus maximised. The advantage of the Blau and Shannon indices is that they take into account the number of gender categories as well as the evenness of the distribution of the board members among them. The Shannon index is also more sensitive to small differences in the gender composition of boards, given that it is a logarithm of total assets (Campbell & Minguez-Vera, 2008). Besides these indices, we also resort to conventional measures of female representation by using the dummy variable for women representing the firm (i.e., when there is at least one woman on the board) and also the size of the female representation in the boardroom as the percentage of women on the board of directors. Board gender diversity is expected to have a positive and significant relationship with firm financial performance, given that there are various benefits for appointing women to the boardroom, as discussed above.

Several control variables have also been adopted from the study of Campbell and Minguez-Vera (2008). Among these are the *debt level* (*LEVER*, the ratio of total debt to total assets), the return on assets (ROA), and the *firm size* (*SIZE*, the natural logarithm of total assets). The debt level (*LEVER*) is used as a control variable because a firm's debt policy is considered to be significant decision that influences the firm's value (Sadeghian, Latifi, Soroush, & Aghabagher, 2012). The debt level is expected to have a positive and significant relationship with Tobin's Q, since debt is an efficient mechanism for reducing the agency problem and therefore for increasing the firm's financial performance (Campbell & Minguez-Vera, 2008). The return on assets (ROA) is used as a control variable because it is an indicator of the firm's ability to produce income for its shareholders (Carter, D'Souza, Simkins, & Simpson, 2010). The return on assets is also expected to have positive and significant relationship with Tobin's Q, since more profitable firms tend to have higher value. Firm size (*SIZE*) is often used as a control variable in the analysis of firm financial performance and several studies have shown that asset size is related to Tobin's Q (Yermack, 1996). The firm size is expected to be positively and significantly related to Tobin's Q, since larger firms have greater competitive power (Dogan & Yildiz, 2013) and also enjoy the advantage of economies of scale.

Descriptive Statistics

The statistical characteristics for the tested variables are summarised in Table 1. Based on this, we see that Tobin's Q has a mean value of 1.94. This value is close to the value obtained by Hillier and McColgan (2001) for the UK market (1.96), by Demsetz and Villalonga (2001) for the US market (1.10), and by Campbell and Minguez-Vera (2008) for the Spanish market (1.64). Firms with a Tobin's Q value of more than 1.00 have better investment opportunities, have higher growth potential, and have a management that has managed the assets well.

The mean value for DWOMEN, which represents the percentage of firms with at least one or more women on the board of directors, is 0.54. In other words, approximately 54% of Malaysian public listed firms have one or more women on board, compared to 70% of US firms, as reported by Farrell and Hersch (2005). Surprisingly, the percentage of Malaysian firms having one or more female directors is higher than in the Spanish market, where the value is 23.7%, as reported by Campbell and Minguez-Vera (2008).

The mean percentage of women on the board of directors, PWOMEN, is 8.61%. This is higher than the value of 7.5% disclosed by Tan Sri Zarinah of the Securities Commission (SC), according to a report by The Edge Financial Daily (2011). Bernama (2013) reported that 8.7% of the directors on Malaysian boards are women, which is consistent with the result reported in Table 3.1. In the US market, Carter et al. (2003) reported a value of 9.6%, while The Catalyst (2004) reported a value of 10.2%. The mean percentage of female directors on the boards of Malaysian listed firms is much higher than in Spain. Campbell and Minguez-Vera (2008) reported a value of only 3.28% in the Spanish market. According to PR Newswire (2011), Malaysia has the highest percentage of female non-independent nonexecutive directors in the Asia Pacific. These female directors on the boards of Malaysian firms are likely to be family members.

The mean values for the BLAU and SHANNON indices are 0.14 and 0.23 respectively, which compare to the values of 0.05 and 0.09 reported by Campbell and Minguez-Vera (2008) in Spain. The results indicate that the board gender diversity in Malaysia is greater than that in Spain. The incorporation of women into the workplace has been slower in Spain than in other developed countries. This could be due to its traditionally deep-rooted societal attitudes towards the role of women (Campbell & Minguez-Vera, 2008). Although Malaysian firms tend to outperform Spanish firms, the level of board gender diversity is far below the perfect diversity score, which is 0.5 for Blau and 0.69 for Shannon. A perfect Blau index of 0.5 indicates that the firm has an equal balance of men and women on the board of directors, while a Shannon index of 0.69 means that the firm has maximised the number of women on the board of directors.

The mean value of the leverage variable *LEVER* is 44%; this can be compared to the value of 19% reported by Demsetz and Villalonga (2004) in the US and to the value of 38% reported by Campbell and Minguez-Vera (2008) in Spain. Although highly leveraged firms may be at risk of bankruptcy if they are unable to make repayment on their debts, high leverage is not necessarily bad. According to the agency cost hypothesis, an increase in leverage may reduce agency costs and increase firm value by encouraging managers to act more in the interest of the shareholders (Grossman & Hart, 1982) through a variety of mechanisms, including the monitoring of activities by debt holders, the threat of liquidation (which would affect the managers' reputation and salaries), the pressure to generate cash flow for the payment of interest expenses and, finally by curtailing overinvestment (reviewed by Zhang & Li, 2008).

The mean value of the return on assets ROA is 9.14%, while the mean value of the firm's size (taking the natural log of total assets) was found to be 22.31.

Table 1
Descriptive statistics

Variables	Mean	Median	Minimum	Maximum	Standard Deviation	Skewness	Kurtosis
Q	1.9375	1.3457	0.4998	13.9825	1.7978	3.5732	18.5832
DWOMEN	0.5357	1.0000	0.0000	1.0000	0.4995	-0.1432	1.0205
PWOMEN	0.0861	0.0833	0.0000	0.4444	0.0954	0.9623	3.7175
BLAU	0.1392	0.1528	0.0000	0.4938	0.1426	0.4186	1.8911
SHANNON	0.2274	0.2868	0.0000	0.6870	0.2232	0.1800	1.4619
LEVER	0.4346	0.4275	0.0326	1.3698	0.2032	0.4620	3.8341
ROA	0.0914	0.0642	-0.2023	0.5847	9.0432	2.3143	10.6035
SIZE	22.3050	22.2409	19.4538	25.3187	1.3589	0.0995	2.1504

Notes: Q (approximation of Tobin's Q), DWOMEN (binary variable that takes a value of 1 where there is at least one woman on the board of directors, and 0 otherwise), PWOMEN (percentage of women on the board of directors), BLAU (Blau index of diversity), SHANNON (Shannon index of diversity), LEVER (total debt over total assets), ROA (return on assets), SIZE (logarithm of the book value of the total assets of the firm).

Correlation Coefficients

Table 2
Correlation coefficients between gender diversity proxies and other variables

Panel 1 : DWOMEN				
Correlation	DWOMEN	LEVER	ROA	SIZE
DWOMEN	1			
LEVER	0.0935	1		
ROA	–0.1296	–0.096	1	
SIZE	0.1153	0.3201	–0.4618	1
Panel 2 : PWOMEN				
Correlation	PWOMEN	LEVER	ROA	SIZE
PWOMEN	1			
LEVER	0.0763	1		
ROA	–0.1441	–0.096	1	
SIZE	0.1512	0.3201	–0.4618	1
Panel 3 : Blau Index				
Correlation	BLAU	LEVER	ROA	SIZE
BLAU	1			
LEVER	0.0899	1		
ROA	–0.1415	–0.096	1	
SIZE	0.147	0.3201	–0.4618	1
Panel 4: Shannon Index				
Correlation	SHANNON	LEVER	ROA	SIZE
SHANNON	1			
LEVER	0.095	1		
ROA	–0.1408	–0.096	1	
SIZE	0.1394	0.3201	–0.4618	1

Notes: DWOMEN (binary variable that takes a value of 1 where there is at least one woman on the board of directors, and 0 otherwise), PWOMEN (percentage of women on the board of directors), BLAU (Blau index of diversity), SHANNON (Shannon index of diversity), LEVER (total debt over total assets), ROA (return on assets), SIZE (logarithm of the book value of the total assets of the firm).

Severe multicollinearity occurs when two explanatory variables are significantly related in the sample. When explanatory variables are highly correlated, it becomes difficult to estimate the coefficients accurately. As a rule of thumb, multicollinearity is a concern if the absolute value of simple correlation coefficients exceeds 0.80 (Studenmund, 2011). The results presented in Table 2 show that the independent variables (DWOMEN, PWOMEN, the Blau index and the Shannon index) are not highly correlated with the other explanatory variables, which are the control variables (LEVER, ROA and SIZE).

RESULTS AND DISCUSSION

The results of the study are presented in Table 3. Estimation is carried out using the pooled ordinary least square (POLS) model, the fixed effect model, and the random effect model. The results of all models are presented for comparison. The Hausman test, the Breusch–Pagan Lagrange Multiplier test, and the *F*-test are performed to determine which of the pooled ordinary least square model, fixed effect model, and random effect model is more appropriate. The results indicate that the fixed effect model is more appropriate. The results for the fixed effect model are therefore analysed and discussed.

The results of the Breusch–Pagan Lagrange Multiplier test in Table 3 show that the null hypothesis is rejected and the random effect model is more appropriate over the pooled ordinary least square model. Similarly, the *F*-test results indicate that the fixed effect model is more appropriate than the pooled ordinary least square model. When the random effect model is compared to the fixed effect model using the Hausman test, the null hypothesis is rejected; the fixed effect model is thus employed for analysis and discussion.

The results in Table 3 show that the performance of firms with female directors does not differ significantly from that of firms without female directors. However, based on Table 3, our hypotheses H1 and H2 are fully supported, where Tobin's Q and three proxies (BLAU, SHANNON, and PWOMEN) are statistically highly significant. Our findings suggest that a higher percentage of women directors in the corporate boardroom increases the firm's value. This is consistent with the study of Johl et al. (2015), which found that the participation of women was positively related to the return on assets for 700 public listed firms in Malaysia. Similarly, Taghizadeh and Saremi (2013) also found that female directors contribute positively to the performance of 150 public listed firms in 2008. The results are also consistent with studies found in the US, where female directors have been found to improve the firm's profitability (Adams & Ferreira, 2009; Erhardt et al., 2003; Farrell & Hersch, 2005; Stigring & Lyxell, 2011) and value (Srinidhi et al., 2011).

Table 3
Estimation results for women director on firm's Tobin's Q

	Dependent Variable - Tobin's Q			
Variable	Model 1	Model 2	Model 3	Model 4
Constant	6.6279 (3.8107)	8.5999 (3.7747)	8.4503 (3.7839)	8.0489 (3.7940)
DWOMEN	0.2499 (0.1635)	–	–	–
PWOMEN	–	3.1716*** (0.8985)	–	–
BLAU	–	–	1.9788*** (0.5917)	–
LEVER	3.6450*** (0.7217)	3.6193*** (0.7072)	3.6318*** (0.7089)	3.6333*** (0.7121)
ROA	0.1060*** (0.0118)	0.1067*** (0.0116)	0.1064*** (0.0116)	0.1061*** (0.0117)
SIZE	–0.3308* (0.1719)	–0.4252** (0.1703)	–0.4187** (0.1708)	–0.3997** (0.1713)
Model fit:				
R-squared	0.6693	0.6455	0.6477	0.6525
Redundant fixed effect	5.02***	5.30***	5.24***	5.17***
BP-LM test	86.20***	91.26***	90.46***	89.33***
Hausman test	36.35***	39.52***	39.09***	38.24***

Notes: *, **, *** Denote significance at the 10%, 5% and 1% levels, respectively. Standard errors are reported in parenthesis. Tobin's Q (sum of market value of stock and book value of debt divided by book value of total assets), DWOMEN (binary variable that takes a value of 1 where there is at least one woman on the board of directors, and 0 otherwise), PWOMEN (percentage of women on the board of directors), BLAU (Blau index of diversity), SHANNON (Shannon index of diversity), LEVER (total debt over total assets), SIZE (logarithm of the book value of the total assets of the firm), ROA (return on investment).

In addition, we found that both the Blau and Shannon indices are positively related to the firm's Tobin's Q, with statistical significance at the 1% significance level. This confirms that female representation in the board of directors enhances the firm's value and suggests that a mixture of men and women is important to forming a stronger board that boosts the firm's performance. This may be due to greater gender diversity offering a broader perspective in terms of decision making, as the directors come from different demographic backgrounds. This is supported by studies in gender diversity, where higher female representation contributes to higher quality decisions, to increases in creativity and innovation (Cox & Blake, 1991; Westphal & Milton, 2000), and to enhancing problem-solving ability (Miller, Burke, & Glick, 1998). In addition, the differences of the women's demographic background as compared to men offers variety in terms of personality, communication style, educational background, career experience, and expertise (Liao, Luo, & Tang, 2015), which contribute to a wider perspective in decision making and strategic planning. This contributes positively to the firms' value and hence increases their competitive advantage. According to Kramer, Maguire, Brewer, Chmielewski, Kishner and Krugman (2007), women demonstrate a strong collaborative leadership style that promotes win-win situations at the board table, which can enhance the firm's decision-making process.

The results of Table 3 also indicate that higher leverage increases the firm value and that this is statistically significant at the 1% significance level for all the models. This is consistent with the study of Grossman and Hart (1982), who suggested that higher leverage encourages managers to act in the interest of shareholders and hence to reduce the agency problem. This is because managers are now not answerable only to the shareholders, but also to the creditors, to whom they must pay off their long-term obligations. This will eventually reduce the motivation of managers to engage in risky activities, thus increasing the firm's value. In addition, Signaling Theory suggests that firms signal their quality with an optimal combination of dividends and leverage. In this case, signals of high leverage to the investors can suggest an optimistic future and a higher quality firm. Modigliani and Miller's theorem also asserts that firms are capable of increasing their value by taking on additional debt, because it could give advantage in terms of tax savings.

The results indicate that the return on assets is positively related to firm value at the 1% significance level. This is consistent with the expectation that higher profits help to increase the firm's value. According to Haugen and Baker (2010), the greater the profitability of a firm, the greater the distribution of earnings to the shareholders, and therefore the greater the expected value of the firm. The return on assets is crucial because it indicates the efficiency of the management in managing the assets, and is hence a positive measure of firm value (Chen, Chen, Lobo, & Wang, 2011).

On the other hand, we found that firm size is negatively related to firm value. This contradicts the expectation that larger firms have greater competitive power and are more likely to enjoy economies of scale and greater bargaining power than clients and suppliers (Serrasqueiro & Paulo, 2008). Our results are consistent with the study by Campbell and Minguez-Vera (2008). This finding implies that a firm will exhibit decreasing returns with scale because when it reaches an optimal size, its growth rate will decrease, affecting in turn the firm's value.

CONCLUSION

Previous studies have suggested that gender diversity in the boardroom tends to lead to better financial performance on the part of the firm. This scenario may be different in Asia, where gender diversity may not increase a firm's performance. To determine if this is the case, we investigated the effects of gender diversity on firms' financial performance in Malaysia. Unlike previous researchers, we used nonfinancial firms listed on Bursa Malaysia for the period spanning from 2009 to 2013. Using the pooled ordinary least square model, the fixed effect model, and the random effect model, we tested whether gender diversity in the boardroom influences a firm's performance. In our estimation models, we include Tobin's Q as our dependent variable and four different proxies for gender diversity (the dummy variable for women, the percentage of women on the board, the Blau index, and the Shannon index), controlling with the firm's debt level, return on assets and size.

Based on our results, we failed to find any relationship between the presence of women on board and firm performance. However, the percentage of women on the board, the Blau index, and the Shannon index were positively and significantly related to firm performance. This suggests that the mere fact of there being at least one female on the board has no impact on firm performance, but a higher degree of female representation does increase the firm's financial performance. This may reflect the fact that the presence of female directors on the board generates a greater market expectation of the firm's competitive advantages, which are reflected by an increase in the value of the firm, as suggested by Tobin's Q. This is because a greater representation of women is expected to contribute a different perspective, as well as more comprehensive thinking in the decision-making process, which is crucial for firms' strategic decision making and for ensuring their long-term performance. This could be due to the socialisation process whereby unconventional female directors adopt the behavior and norms of conventional male directors to be recognised by top decision makers (Rose, 2007). Consequently, the advantages of having females on the board of directors are not reflected in the measure of firm performance and, as a result, positive discrimination favoring female boardroom appointment is likely to persist as a feature of the corporate governance landscape in Malaysia. Consistent with the literature, we infer that the debt level and return on assets of a firm are significantly positively correlated with firm financial performance, while firm size is significantly negatively correlated with it.

One limitation of this study is that the results are valid only for Malaysian firms and cannot be generalised to firms in other countries, which may have different legal and cultural attributes. Malaysia may suffer from the weak corporate governance common to many developing countries. Therefore, it is important to determine the strength of corporate governance in Malaysia and its association with the relationship between board gender diversity and firm performance. It is also unclear whether the appointment of female directors in Malaysian firms is socially motivated. Malaysian firms have high levels of family ownership, and so it is unclear whether board members are nominated by family members so as to permit continuity of the family business. To address these issues, future research needs to account for corporate governance and the family ownership structure in the estimation model.

REFERENCES

Adams, R. B., & Ferreira, D. (2009). Women in the boardroom and their impact on governance and performance. *Journal of Financial Economics, 94*(2), 291–309. https://doi.org/10.1016/j.jfineco.2008.10.007

Ahern, K. R., & Dittmar, A. K. (2012). The changing of the boards: The impact on firm valuation of mandated female board representation. *The Quarterly Journal of Economics, 127*(1), 137–197.

Barnett, N., Morley, K., & Piterman, H. (2010). *Gender agenda: Unlocking the power of diversity in the boardroom*. Insyc Surveys and Gender Worx. Retrieved from http://women.govt.nz/sites/public_files/Insync%20gender%20agenda%202010_0.pdf

Barney, J. (2001). Is the resource-based 'view' a useful perspective for strategic management research? Yes. *Academic of Management Review*, *2*(1), 41–56.

Bernama (2013). Malaysia has more women in boardroom than Singapore. Retrieved from http://www.freemalaysiatoday.com/category/business/2013/11/14/malaysia-has-more-women-in-boardroom-than-singapore/

Bianco, M., Ciavarella, A., & Signoretti, R. (2011). *Women on boards in Italy*. (CONSOB Working paper number 70), 7–44. https://doi.org/10.2139/ssrn.1945855

Campbell, K., & Minguez-Vera, A. (2008). Gender diversity in the boardroom and firm financial performance. *Journal of Business Ethics, 83*(3), 435–451. https://doi.org/10.1007/s10551-007-9630-y

Carter, D. A., D'Souza, F., Simkins, B. J., & Simpson, W. G. (2010). The gender and ethnic diversity of US boards and board committees and firm financial performance. *Corporate Governance: An International Review, 18*(5), 396–414. https://doi.org/10.1111/j.1467-8683.2010.00809.x

Carter, D. A., Simkins, B. J., & Simpson, W. G. (2003). Corporate governance, board diversity, and firm value. *Financial Review, 38*(1), 33–53. https://doi.org/10.1111/1540-6288.00034

Chan, A., & Lee, J. (1994). Women executives in a newly industrialized economy: The Singapore scenario. In N. J. Adler & D. N. Izraeli (Eds.), *Competitive frontiers: woman managers in a global economy* (pp. 127–142). Oxford: Blackwell Publishers.

Chen, H., Chen, J. Z., Lobo, G., & Wang, Y. (2011). Effects of audit quality on earnings management and cost of equity capital: Evidence from China. *Contemporary Accounting Research, 28*(3), 892–925. https://doi.org/10.1111/j.1911-3846.2011.01088.x

Corkery, J. F., & Taylor, J. F. (2012). The gender gap: A quota for women on the board. *Corporate Governance eJournal*. Retrieved from http://epublications.bond.edu.au/cgi/viewcontent.cgi?article=1026&context=cgej

Cox, T. H., & Blake, S. (1991). Managing cultural diversity: Implications for organisational competitiveness. *The Executive, 5*(3), 45–56. https://doi.org/10.5465/AME.1991.4274465

Daunfeldt, S. O., & Rudholm, N. (2012). *Does gender diversity in the boardroom improve firm performance?* (HUI working papers no. 60). HUI Research.

Demsetz, H., & Villalonga, B. (2001). Ownership structure and corporate performance. *Journal of Corporate* Finance, *7*(3), 209–233. https://doi.org/10.1016/S0929-1199(01)00020-7

Dezsö, C. L., & Ross, D. G. (2012). Does female representation in top management improve firm performance? A panel data investigation. *Strategic Management Journal, 33*(9), 1072–1089. https://doi.org/10.1002/smj.1955

Dobbin, F., & Jung, J. (2010). Corporate board gender diversity and stock performance: The competence gap or institutional investor bias. *North Carolina Law Review, 89*(3), 809–838.

Dogan, M., & Yildiz, F. (2013). The impact of the board of directors' size on the bank's performance: Evidence from Turkey. *European Journal of Business and Management, 5*(6), 130–140.

Erhardt, N. L., Werbel, J. D., & Shrader, C. B. (2003). Board of director diversity and firm financial performance. *Corporate Governance: An International Review, 11*(2), 102–111. https://doi.org/10.1111/1467-8683.00011

Fan, P. S. (2012). Is board diversity important for firm performance and board independence? An exploratory study of Singapore listed companies. MAS Staff Paper No. 52, The Monetary Authority of Singapore (MAS).

Farrell, K. A., & Hersch, P. L. (2005). Additions to corporate boards: The effect of gender. *Journal of Corporate Finance, 11*(1–2), 85–106. https://doi.org/10.1016/j.jcorpfin.2003.12.001

Grant, R. M. (1991). The resource-based theory of competitive advantage: Implications for strategy formulation. *California Management Review*, *33*(3), 114–135. https://doi.org/10.2307/41166664

Grossman, S. J., & Hart, O. D. (1982). Corporate financial structure and managerial incentives. In J. J. McCall (Ed.), *The economics of information and uncertainty* (pp. 107–140). Chicago: University of Chicago Press.

Gul, F. A., Hutchinson, M., & Lai, K. M. (2013). Gender-diverse boards and properties of analyst earnings forecasts. *Accounting Horizons, 27*(3), 511–538. https://doi.org/10.2308/acch-50486

Haugen, R. A., & Baker, N. L. (2010). Case closed. In J. B. Guerard, Jr. (Ed.), *Handbook of Portfolio* Construction (pp. 601–619). USA: Springer. https://doi.org/10.1007/978-0-387-77439-8_23

Hillier, D., & McColgan, P. (2001). *Insider ownership and corporate value: An empirical test from the United Kingdom corporate sector*. Financial Management Association (FMA) Meeting, Paris.

Jhunjhunwala, S., & Mishra, R. K. (2012). Board diversity and corporate performance: The Indian evidence. *The IUP Journal of Corporate Governance, 11*(3), 71–79.

Johl, S. K., Kaur, S., & Cooper, B. J. (2015). Board characteristics and firm performance: Evidence from Malaysian public listed firms. *Journal of Economics, Business and Management, 3*(2), 239–243.

Kramer, M., Maguire, P., Brewer, B., Chmielewski, L., Kishner, J., & Krugman, M. (2007). Nurse manager support: what is it? Structures and practices that promote it. *Nursing Administration Quarterly, 31*(4), 325–340. https://doi.org/10.1097/01.NAQ.0000290430.34066.43

Larkin, M. B., Bernardi, R. A., & Bosco, S. M. (2012). Corporate reputation, board gender diversity and market performance. *International Journal of Banking and Finance, 9*(1), 126.

Liao, L., Luo, L., & Tang, Q. (2015) Gender diversity, board independence, environmental committee and greenhouse gas disclosure. *The British Accounting Review, 47*(4), 409–424. https://doi.org/10.1016/j.bar.2014.01.002

Lückerath-Rovers, M. (2011). Women on board and firm performance. *Journal of Management & Governance, 17*(2), 491–509.

Marimuthu, M., & Kolandaisamy, I. (2009). Ethnic and gender diversity in board of directors and their relevance to financial performance of Malaysian companies. *Journal of Sustainable Development, 2*(3), 139–148. https://doi.org/10.5539/jsd.v2n3p139

Marinova, J., Plantenga, J., & Remery, C. (2010). Gender diversity and firm performance: Evidence from Dutch and Danish boardrooms. *Tjalling C. Koopmans Institute Discussion Paper Series, 10*, 1–28.

Miller, C. C., Burke, L. M., & Glick, W. H. (1998). Cognitive diversity among upper-echelon executives: Implications for strategic decision processes. *Strategic Management Journal, 19*(1), 39–58. https://doi.org/10.1002/(SICI)1097-0266(199801)19:1<39::AID-SMJ932>3.0.CO;2-A

Oba, V. C., & Fodio, M. I. (2013). Boards' gender mix as a predictor of financial performance in Nigeria: An empirical study. *International Journal of Economics and Finance, 5*(2), 170–178. https://doi.org/10.5539/ijef.v5n2p170

Omar, A., & Davidson, M. J. (2001). Women in management: a comparative cross-cultural overview. *Cross Cultural Management: An International Journal*, *8*(3/4), 35–67. https://doi.org/10.1108/13527600110797272

PRNewswire (2011). Demand for female directors on Asia Pacific boards remains high, but representation is still low. Retrieved from http://www.prnewswire.co.uk/news-releases/demand-for-female-directors-on-asia-pacific-boards-remains-high-but-representation-is-still-low-according-to-kornferry-gender-board-diversity-study-156772865.html

Randøy, T., Thomsen, S., & Oxelheim, L. (2006). *A Nordic perspective on corporate board diversity*. (Working paper), Nordic Innovation Centre, Oslo.

Rose, C. (2007). Does female board representation influence firm performance? The Danish evidence. *Corporate Governance: An International Review, 15*(2), 404–413. https://doi.org/10.1111/j.1467-8683.2007.00570.x

Sadeghian, N. S., Latifi, N. N., Soroush, S., & Aghabagher, Z. T. (2012). Debt policy and corporate performance: Empirical evidence from Tehran Stock Exchange companies. *International Journal of Economics and Finance, 4*(11), 217–224. https://doi.org/10.5539/ijef.v4n11p217

Schwizer, P., Soana, M., & Cucinelli, D. (2012). The relationship between board diversity and firm performance: The Italian evidence. Retrieved from http://www.adeimf.it/new/images/stories/Convegni/Novara/Soana_Schwizer_Cucinelli_Board_diversity.pdf

Serrasqueiro, Z. S., & Paulo, M. N. (2008). Performance and size: Empirical evidence from Portuguese SMEs. *Small Business Economics, 31*(2), 195–217. https://doi.org/10.1007/s11187-007-9092-8

Shrader, C. B., Blackburn, V. L., & Iles, P. (1997). Women in management and firm financial performance: An exploratory study. *Journal of Managerial Issues, 9*(3), 355–372.

Shukeri, S. N., Shin, O. W., & Shaari, M. S. (2012). Does board of director's characteristics affect firm performance? Evidence from Malaysian public listed companies. *International Business Research, 5*(9), 120–129. https://doi.org/10.5539/ibr.v5n9p120

Smith, N., Smith, V., & Verner, M. (2006). Do women in top management affect firm performance? A panel study of 2,500 Danish firms. *International Journal of Productivity and Performance Management, 55*(7), 569–593. https://doi.org/10.1108/17410400610702160

Srinidhi, B., Gul, F. A., & Tsui, J. (2011). Female directors and earnings quality. *Contemporary Accounting Research, 28*(5), 1610–1644. https://doi.org/10.1111/j.1911-3846.2011.01071.x

Stigring, C., & Lyxell, F. (2011). Is there a business case for gender diversity? *Industriell och Finansiell Ekonomi*, *10/11*(44), 1–26.

Studenmund, A. H. (2011). *Using econometrics: A practical guide* (6th ed.). Upper Saddle River, NJ: Pearson Education.

Taghizadeh, M., & Saremi, S. (2013). Board of directors and firms performance: Evidence from Malaysian public listed firm. *International Proceedings of Economics Development and Research, 59*, 178–182.

The Edge Financial Daily. (2011), Higher female participation in new corporate governance blueprint. Retreived from http://www.theedgemarkets.com/article/higher-female-participation-new-corporate-governance-blueprint

The Catalyst (2004). Retrieved from http://www.catalyst.org

Westphal, J. D., & Milton, L. P. (2000) How experience and network ties affect the influence of demographic minorities on corporate boards. *Administrative Science Quarterly, 45*(2), 366–398. https://doi.org/10.2307/2667075

Wolfe, J., & Sauaia, A. C. A. (2003). The Tobin Q as a company performance indicator. *Developments in Business Simulation and Experiential Learning, 30*, 155–159.

Yermack, D. (1996). Higher market valuation of companies with a small board of directors. *Journal of Financial Economics, 40*(2), 185–211. https://doi.org/10.1016/0304-405X(95)00844-5

Zhang, H., & Li, S. (2008). *The impact of capital structure on agency costs: Evidence from UK public companies*. Unpublished PhD dissertation, Queens University of Technology, Brisbane, Australia.

ASIAN ACADEMY *of* MANAGEMENT JOURNAL *of* ACCOUNTING *and* FINANCE

AAMJAF Vol. 13, No. 1, 63–82, 2017

AN EMPIRICAL EVALUATION OF HEDGE FUND MANAGERIAL SKILLS USING BAYESIAN TECHNIQUES

John Weirstrass Muteba Mwamba

School of Economics
University of Johannesburg, Auckland Park Campus,
Corner University Road and Kingsway Avenue
Auckland Park, Johannesburg South Africa

E-mail: johnmu@uj.ac.za

ABSTRACT

This paper makes use of the Bayesian method to evaluate hedge fund managers' selectivity, market timing and outperformance skills separately, and investigates their persistence from January 1995 to June 2010[1]. We divide this sample period into four overlapping sub-sample periods that contain different economic cycles. We define a skilled manager as a manager who can outperform the market in two consecutive sub-sample periods. We employ Bayesian linear CAPM and Bayesian quadratic CAPM to generate skill coefficients during each sub-sample period. We found that fund managers who possess selectivity skills can outperform the market at 7.5% significant level if and only if the economic conditions that governed the financial market during the period between sub-sample period2 and sub-sample period3 remain the same.

Keywords: selectivity, outperformance and market timing skills, Bayesian quadratic CAPM, priors, posteriors, beliefs

INTRODUCTION

In this paper, we investigate the persistence of fund managers' selectivity, market timing and outperformance skills during different economic cycles. This persistence analysis constitutes in itself a due diligence requirements that investors need to consider before including hedge funds in their portfolios for diversification

Publication date: 30 August 2017

To cite this article: Muteba Mwamba, J. W. (2017). An empirical evaluation of hedge fund managerial skills using Bayesian techniques. *Asian Academy of Management Journal of Accounting and Finance, 13*(1), 63–82. https://doi.org/10.21315/aamjaf2017.13.1.3

To link to this article: https://doi.org/10.21315/aamjaf2017.13.1.3

purposes. We implement a Bayesian regression in order to overcome what is termed as estimation risk in traditional frequentist regression based performance analysis. We consider a set of returns on monthly hedge fund indices from January 1995 to June 2010 provided by Hedge Fund Research Inc. (HFRI). Appendix A exhibits the labels of 26 investment styles used in this paper. Following Capocci and Hübner (2004) hedge fund data starting after 1994 are more reliable and do not contain any survivorship bias. We divide our sample period into four overlapping sub-sample periods that include different economic cycles such as the 1998 Japanese crisis, the Dotcom bubble, the 2001 South African currency crisis, and the 2008–2009 sub-prime crisis. Our aim is not to identify crisis dates that are already known by average informed investors, but instead to assess the effectiveness of these investment styles during different economic cycles.

The subdivision of our entire sample into four sub-sample periods follows Capocci and Hübner (2004) who use the Russell 3000 as the benchmark index to represent the market portfolio, and consider March 2000 as a separation date between sub-sample period1 (before March 2000) and sub-sample period2 (after March 2000). We extend their idea to include two more sub-sample periods in our study; sub-sample period3; spanning January 2003 and January 2007, and sub-sample period4; spanning February 2007 and June 2010. The subdivision of the sub-sample periods is intended to include different economic cycles in our study in such a way that the results are not affected by generally upward market trend as discussed by Ennis and Sebastian (2003).

The analysis of the persistence of posterior performance measures reveals that at very low significance level (1% or lower) fund managers do not exhibit any skill persistence. Outperformance skill as measured by the Jensen alpha is found at 2.5% or higher during sub-sample period1 to sub-sample period2, and between sub-sample period2 and sub-sample period3 (at 7.5% or higher). However at 5% or lower we found evidence of neither selectivity skills nor market timing skills (at 7.5% or lower) among all fund managers. The lack of market timing at lower significance level can be explained by the difficulties that many fund managers have to forecast future direction of markets and thereby invest heavily in assets that would outperform the benchmark.

In general our results show a relatively low evidence of market outperformance due to both selectivity and market timing skills (at 10% or higher) among hedge fund managers before the sub-prime crisis. We use simultaneously three different techniques: the contingence table, the chi-square test and the cross-sectional regression. The results obtained with all three techniques reinforce previous findings by Agarwal and Naik (2000) and Hwang and Salmon (2002) who found relatively small evidence for market outperformance.

Many studies on hedge fund performance carried out exclusively during upward (downward) market trends only, have led to contradictory conclusions. Considering only one period framework for their study, Brown, Goetzman and Ibbotson (1999), and Kosowski, Naik and Teo (2007) find hardly any evidence of the existence of differential managers' skills; whereas, Agarwal and Naik (2000) and Hwang and Salmon (2002) in a two-period framework analysis find evidence of managers' skills in hedge fund performance. Furthermore, using two periods as well as multi-periods framework analyses, Capocci and Hübner (2004) argue that managers' skills can be found among average performers.

Moreover, most hedge funds' performance analysis assumes that the historical return distribution is normal and that risk is represented by the historical standard deviation (Sharpe, 1966, Treynor, 1965). Since the distribution of future expected returns is unknown, at least precisely, we argue that using historical parameters of the returns distribution such as the mean and the standard deviation generates some estimation risk that needs to be taken into account. Contrarily to the work done by Ackerman, McEnally and Ravenscraft (1999), and Brown et al. (1999) (who use frequentist single-factor model); and Liang (1999); and Agarwal and Naik (2000) (who employ a frequentist multi-factor model); this paper overcomes the problem of estimation risk by making use of the Bayesian linear as well as non-linear CAPM to generate the estimates of the selectivity, market timing and outperformance skill coefficients.

METHODOLOGY

Outperformance Skill

The Jensen's alpha (Jensen, 1968) is the simplest and one of the most widely used measure of outperformance skill in practice. Jensen's alpha, α_i^J calculates the performance of a portfolio by measuring the deviation of a portfolio's returns from the securities market line as follows:

$$r_{it} - r_f = \alpha_{it}^J + \beta_i (r_{mt} - r_f) + \varepsilon_{it} \quad (1)$$

where $r_{it}, r_f, r_{mt}, \beta_i, r_{it} - r_f$, and $r_{mt} - r_f$ represent the returns of the main investment style *i*, the risk free rate, the market returns at time *t* , the systematic risk of the main investment style, the excess returns on investment style *i* , and the risk premium respectively. This model is based on the assumption that markets are efficient in the famous Fama (1984) efficient market hypothesis context. In this context, all market participants have the same beliefs about asset prices, which presumably suggest no mispricing in the market; that is, the Jensen's alpha and beta in (1) are statistically equal to zero and one respectively.

A fund manager with outperformance skills attempts to exploit any mispricing that occurs in the market, thereby generating a certain value of alpha statistically different from zero. Where the value of alpha is positive (negative) it is a signal that the investment style whose rate of returns is r_{it} ; is underpriced (overpriced) and the fund manager would gain from the strategy if s/he takes a long (short) position.

Selectivity and Market Skills

The Treynor and Mazuy (1966) measure is a performance measure for hedge fund managers' selectivity and market timing skills. If a fund manager is able to time the market and forecast correctly future market trends, then the returns on his managed portfolio will not be linearly related to the market return. This is because the manager will have to gain more than the market does when the market return is forecast to rise and he will lose less than the market does when the market is forecast to fall. Hence, his portfolio returns will be a concave function of the market returns. Of the form:

$$r_{it} - r_f = \alpha_i + \beta_{1i}(r_{mt} - r_f) + \beta_{2i}(r_{mt} - r_f)^2 + \varepsilon_{it} \quad (2)$$

Admati, Bhattacharya, Pfleiderer and Ross (1986) suggest that α_i in Equation (2) can be interpreted as the selectivity skill and the $E[\beta_{2i}(r_{mt} - r_f)^2]$ as the market timing skill.

Estimation of Outperformance, selectivity and market timing (Equations 1 and 2) is done using Bayesian regression. The benefit of using the Bayesian regression over frequentist regression is straight forward; Bayesian regression overcomes estimation risk induced by using the parameters of historical return distribution as such the standard deviation to represent risk.

Bayesian Estimation

Equations (1) and (2) can be rewritten in a closed form as follows:

$$y_i = \alpha + \sum_{k=1}^{n} \beta_k x_{ki} + e_i \quad (3)$$

where $k = 1$ or 2, $x_1 = (r_{mt} - r_f)$ for $k = 1$ or $x_2 = (r_{mt} - r_f)^2$ for $k = 2$, $y_i = r_{it} - r_f$ and $x_{ki}, \alpha, \beta_k, e_i$ represent the alpha, sensitivity of x_{ki} to changes in y_i and the disturbance term respectively. This Equation (3) nests a linear and quadratic CAPM model for $k = 1$ and $k = 2$ respectively.

The vector of parameters to be estimated is either $\mathrm{B} = (\alpha, \beta_1)$ for a linear CAPM or $\mathrm{B} = (\alpha, \beta_1, \beta_2)$ for a quadratic CAPM and the error variance σ^2 respectively.

We set up a Bayesian regression model with diffuse improper priors as follows: firstly we construct a multivariate prior distribution $\prod(\mathrm{B}, \sigma^2)$ of the parameter vectors to be estimated. Secondly; based on the observed investment style returns we derive the likehood function $L(\mathrm{B}, \sigma^2 / \mathrm{Y}, \mathrm{X})$ where Y, X are the excess returns on investment style i, and the vector of risk premiums respectively. Thirdly the posterior distribution of the parameter vectors is obtained by multiplying the prior and the likelihood function i.e. $\mathrm{p}(\mathrm{B}, \sigma^2 / \mathrm{Y}, \mathrm{X}) \propto \mathrm{L}(\mathrm{B}, \sigma^2 / \mathrm{Y}, \mathrm{X}) \prod(\mathrm{B}, \sigma^2)$.

Lastly numerical values of estimated parameters are obtained by simulating from the posterior distribution using a Monte Carlo simulation method known as the Gibbs sampler.

The joint diffuse improper prior distribution of B and σ^2 that we use is given by

$$\prod(\mathrm{B}, \sigma^2) \propto \frac{1}{\sigma^2} \tag{4}$$

Following Muteba Mwamba (2012) the likelihood function is a multivariate normal distribution of the form:

$$L(\mathrm{B}, \sigma / \mathrm{Y}, \mathrm{X}) = (2\pi\sigma^2)^{-n/2} \exp\left\{-\frac{1}{2\sigma^2}(\mathrm{Y} - \mathrm{XB})'(\mathrm{Y} - \mathrm{XB})\right\} \tag{5}$$

Posterior distributions are obtained by multiplying Equations (4) and (5). The posterior distribution of B condition on σ^2 is a multivariate normal distribution;

$$p(\mathrm{B}/\mathrm{Y}, \mathrm{X}, \sigma^2) = \mathrm{N}(\hat{\mathrm{B}}, (\mathrm{X'X})^{-1}\sigma^2) \tag{6}$$

where $\hat{\mathrm{B}}$ is the OLS estimator of B and $(\mathrm{X'X})^{-1}\sigma^2$ is the covariance matrix of $\hat{\mathrm{B}}$. The unconditional posterior distribution of σ^2 is an inverted χ^2:

$$p(\sigma^2 / \mathrm{Y}, \mathrm{X}) = \mathrm{Inv} - \chi^2(N - K, \hat{\sigma}^2) \tag{7}$$

where $\hat{\sigma}^2$ is the OLS estimator of σ^2. The unconditional posterior distribution of B is known to be a multivariate Student's t-distribution:

$$p(\mathrm{B/Y,X}) \propto ((\mathrm{n}-k) + (\mathrm{B}-\hat{\mathrm{B}})' \frac{\mathrm{X'X}}{\hat{\sigma}^2} (\mathrm{B}-\hat{\mathrm{B}})^{-n/2} \quad (8)$$

We simulate the posterior distributions in Equations (7) and (8) to obtain σ^2 and B respectively using the Gibbs Sampler[2].

Performance Analysis

Once the outperformance, selectivity and market timing coefficients (Equations 1 and 2) are estimated with the Bayesian regression model; we proceed with the performance analysis of these posterior coefficients in a two-period framework. Three techniques are used for this purpose: contingency table, Chi-square test and cross sectional auto-regression.

Two-Period Tests of Performance Persistence

We basically use two-period persistence in performance methodologies. Our aim is to find out whether the fund manager can outperform the market in two consecutive sub-sample periods. i.e. from sub-sample period1 to sub-sample period2; from sub-sample period2 to sub-sample period3; or from sub-sample period3 to sub-sample period4. In fact, we want to find out whether fund managers have skills to beat the market during consecutive different economic cycles.

Three different measures of skills are used; the outperformance, the selectivity skills and the market timing skills. We refer to selectivity skills as the ability to select investments that will outperform the benchmark, and market timing skills as the ability to forecast the future direction of security markets. The existence of persistence in skills over a long period will be evidence that the manager can outperform the market continuously. We therefore define a fund manager as a winner if the investment style that he uses generates a performance measure (i.e. Jensen's alpha or selectivity or market timing) that is higher than the median of all the managers' performance measure that use the same strategy; and a loser otherwise.

Contingency Table

For two-period tests of persistence performance, we use a contingency table of winners and losers. Persistence in this context relates to fund managers that are winners in two consecutive periods (from sub-sample period1 to sub-sample period2 or from sub-sample period2 to sub-sample period3 or from sub-sample period3 to sub-sample period4) denoted by WW, or losers in two consecutive periods, denoted LL. Similarly, winners in the first period and losers in the second period are denoted by WL, and LW denoted the reverse. We use both the cross product ratio (CPR) proposed Christensen (1990) and the Chi-square test statistics to detect the persistence in performance of fund managers. The CPR is given by:

$$CPR = \frac{(WW * LL)}{(WL * LW)} \quad (9)$$

The CPR captures the ratio of the funds which show persistence in performance to the ones which do not. Under the null hypothesis of no persistence in performance, the CPR is equal to one. This implies that each of the four categories denoted by WW, WL, LW, LL represent 25% of all funds. To make a decision about the rejection of the null hypothesis, we make use of the Z-statistic given by:

$$\text{Z - statistic} = \frac{\text{Ln}(\text{CPR})}{\sigma_{\text{Ln(CPR)}}} \quad (10)$$

$$\text{where} \quad \sigma_{Ln(CPR)} = \sqrt{\frac{1}{WW} + \frac{1}{WL} + \frac{1}{LW} + \frac{1}{LL}} \quad (11)$$

For example, a Z-statistic greater than 1.96 indicates evidence of the presence of significant persistence in performance at a 5% confidence level[3].

Chi-Square Test Statistics

The Chi-square test statistic is used to compare the distribution of observed frequencies for the four categories WW, WL, LW, and LL, for each fund manager with the expected frequency distribution. Studies carried out in persistence performance using chi-square test statistics (Carpenter & Lynch, 1999; Park & Staum, 1998) reveal that the chi-square test based on the numbers of winners and losers is well specified, powerful and more robust compared to other test methodologies, as it deals carefully with the presence of survivorship bias. Following Agarwal and Naik (2000) the chi-square test statistic is given by:

$$\chi^2_{Cal} = \frac{(WW - D_1)^2}{D_1} + \frac{(WL - D_2)^2}{D_2} + \frac{(LW - D_3)^2}{D_3} + \frac{(LL = D_4)^2}{D_4} \quad (12)$$

$$\text{where}\begin{cases} D_1 = \dfrac{(WW+WL)*(WW+LW)}{N} \\ D_2 = \dfrac{(WW+WL)*(WL+LL)}{N} \\ D_3 = \dfrac{(LW+LL)*(WW+LW)}{N} \\ D_4 = \dfrac{(LW+LL)*(WL+LL)}{N} \end{cases}$$

We compare this statistic to the critical value of chi-square at 1%, 2.5%, 5%, 7.5% and 10% with degree of freedom equal to one.

Cross-sectional Auto-Regression

We double check our persistence analysis by making use of a cross-sectional autoregressive regression of the form:

$$\text{Perf}_t = a + b\text{Perft}_{-1} + u_t \qquad (14)$$

where Equation (14) represents the relationship between performance parameter (i.e. outperformance or selectivity or market timing) during sub-sample period *t* and that of previous sub-sample period *t*–1. If the coefficient of a parameter in previous sub-sample periods is positive and statistically significant, it is an indication of persistence in two consecutive sub-sample periods.

EMPIRICAL RESULTS

We use all 26 investment styles and run 26 Bayesian linear CAPM models using Equation (1) to obtain the outperformance skill. The Russell 3000 index is used as proxy for the market portfolio while the three-month US Treasury Bill is used as a proxy for the risk-free asset. We also run 26 other Bayesian quadratic CAPM models using Equation (2) to obtain selectivity and market timing posterior coefficients. Once these skill coefficients are estimated, three techniques are used to investigate the persistence in performance. The skill posterior coefficients as well as the winners/losers results for each sub-sample period are shown in Tables 7, 8, 9, 10, 11 and 12 in Appendix B.

To investigate the persistence of each manager's skill we use three different techniques namely the contingence table, the Chi-square test and the cross-section regression analysis. Using the contingence table we first compute the Z-statistic for each manager's skill during the same sub-sample period. The Z-statistic values for each skill are exhibited in Table 1.

Table 1
Posterior Z-statistic

	P1–P2	P2–P3	P3–P4
Outperform	2.5306	1.8342	1.0722
Selectivity	0.2780	0.2780	1.8342
Timing	1.7723	-0.1000	0.1604

These statistic values are compared with their critical value drawn from a standard normal distribution at a different level of significance. Whenever the Z-statistic value is greater than its critical value it is an indication of the presence of a given skill. Table 2 summarises the persistence analysis at different significance levels.

Table 2
Posterior performance persistence with contingence table

α	1%	2.50%	5%	7.50%	10%
Z(1–α/2)	2.5758	2.2414	1.9600	1.7805	1.6449
Outperform	no skill	skill 1–2	skill 1–2	skill 1–2 & 2–3	skill 1–2 & 2–3
Selectivity	no skill	no skill	no skill	skill 2–3	skill 2–3
Timing	no skill	no skill	no skill	no skill	skill 1–2

Table 2 shows that there is no evidence of any fund managers' skill at 1% significance level. However, at 2.5% and 5% significance level we found great evidence of outperformance skill during sub-sample period1 and sub-sample period2. Notice that this market outperformance is not due to selectivity or market timing skills; therefore it would be due to luck only. At 7.5% or higher significance level we find enough evidence of market outperformance in hedge fund managers between sub-sample period1 and sub-sample period3. This market outperformance is due to luck between sub-sample period1 and sub-sample period2; and to selectivity skill during sub-sample period2 to sub-sample period3. Market timing skill explains this market outperformance only at 10% significance level during sub-sample period1 and sub-sample period2. These results emphasise major difficulties that have fund managers to accurately time the market.

We secondly use the chi-square technique and compute the chi-square statistic value for each manager's skill.

Table 3
Posterior chi-square statistic

	P1–P2	P2–P3	P3–P4
Outperform	7.2284	3.5536	1.1699
Selectivity	0.0774	0.0774	3.5536
Timing	3.3462	0.010	0.0258

These statistic values are thereafter compared with their critical values drawn from the chi-square distribution at different significance level. The null hypothesis tested here is that there is "no skill" in fund managers. Table 4 summarises the persistence of each manager's skill.

Table 4
Posterior persistence performance with chi-square technique

α	1%	2.50%	5%	7.50%	10%
CHI α	6.6349	5.0239	3.8415	3.1701	2.7055
Outperform	skill 1–2	skill 1–2	skill 1–2	skill 1–2 & 2–3	skill 1–2 & 2–3
Selectivity	no skill	no skill	no skill	skill 2–3	skill 2–3
Timing	no skill	no skill	no skill	skill 1–2	skill 1–2

Table 4 reports the same results as Table 2 with the only difference that market timing explains the overall market outperformance at 7.5% or higher (instead of 10% as reported in Table 2) during sub-sample period1 and sub-sample period2.

Lastly, the cross-section regression technique is used to investigate the robustness of these managers' skill persistence. We regress current period performance parameters on previous parameters. Whenever the coefficient of the previous parameter is positive and statistically significant we conclude that there is persistence in performance between the two consecutive periods. Table 5 highlights the regression results.

Table 5
Posterior cross-section regression coefficients

Period	1–2	2–3	3–4
Outperform	–0.155 (0.305)	0.573(0.0003)	0.138(0.4065)
Selectivity	–0.292 (0.148)	0.520(0.0001)	0.958(0.3437)
Timing	0.108 (0.141)	0.272(0.0526)	0.205(0.061)

Again Table 5 reinforces previous results; market outperformance is due to selectivity rather than market timing skill during sub-sample period2 and sub-sample period3. No evidence of market outperformance due to timing skill is found among these fund managers (regression results at 5% only).

CONCLUSION

This paper aimed at investigating the persistence of hedge fund managerial skills. The main objective was to determine whether fund managers can outperform the market during different economic market trends. In other words, the paper attempted to answer the question of whether fund managers can outperform the market consistently in both bear and bull markets. For this purpose, monthly returns (net of fees) on hedge fund indices were collected from HFR for the period between January 1995 and June 2010. We divided our entire sample into four overlapping sub-samples to see whether skilled fund manager would consistently outperform the market in these different sub-sample periods. Based on the efficient market hypothesis as a prediction model we assume that the market is efficient and that fund managers cannot outperform it.

Using the Gibbs sampler with 21 thousand simulations; our results exhibited in Table 6, show that fund managers have skills to outperform the market during sub-sample period1 through sub-sample period3. This market outperformance is due to market timing skill during sub-sample period1 and sub-sample period2, and to selectivity skill during sub-sample period2 through sub-sample period3.

Table 6
Persistency per sample period

		Sub-sample
Contingence	Outperform	P1–P2; P2–P3
	Selectivity	P2–P3
	Timing	P1–P2
Chi-square	Outperform	P1–P2; P2–P3
	Selectivity	P2–P3
	Timing	P1–P2
Regression	Outperform	P2–P3
	Selectivity	P2–P3
	Timing	None

These results contradict the EMH paradox and show that fund managers who possess selectivity skills can outperform the market at 7.5% significant level if and only if the economic conditions that governed the financial market during the period between sub-sample period2 and sub-sample period3 remain constant i.e. fast domestic growth coupled with low interest rates.

NOTES

1. Due to data availability, we were able to get data only up to 2010.
2. See Geman and Geman (1984) for more details.
3. See Kat and Menexe (2003) and De Souza and Gokcan (2004).

REFERENCES

Ackerman, C., McEnally, R., & Ravenscraft, D. (1999). The performance of hedge funds: Risk, return, and incentives. *Journal of Finance, 54*(3), 833–874. https://doi.org/10.1111/0022-1082.00129

Admati, A., Bhattacharya, S., Pfleiderer, P. & Ross, S. A. (1986). On timing and selectivity. *Journal of Finance, 41*(3), 715–730. https://doi.org/10.1111/j.1540-6261.1986.tb04536.x

Agarwal, V., & Naik, N. Y. (2000). Multi-period performance persistence analysis of hedge funds. *Journal of Financial and Quantitative Analysis*, *35*(3), 327–342. https://doi.org/10.2307/2676207

Brown, S. J., Goetzman, W. N., & Ibbotson, R. G. (1999). Offshore hedge funds: Survival and performance 1989–1995. *Journal of Business*, *72*(1), 91–118. https://doi.org/10.1086/209603

Capocci, D., & Hübner, G. (2004). An analysis of hedge fund performance. *Journal of Empirical Finance, 11*, 55–89. https://doi.org/10.1016/j.jempfin.2002.12.002

Carpenter, J. N., & Lynch, W. A. (1999). Survivorship bias and attrition effects in measures of performance persistence. *Journal of Financial Economics, 54*(3), 337–374. https://doi.org/10.1016/S0304-405X(99)00040-9

Christensen, R. (1990). *Log-linear models.* New York: Springer. https://doi.org/10.1007/978-1-4757-4111-7

De Souza, C., & Gokcan, S. (2004). Hedge fund investing: A quantitative approach to hedge fund manager selection and de-selection. *Journal of Wealth Management*, *6*(4), 52–73. https://doi.org/10.3905/jwm.2004.391058

Ennis, R. M., & Sebastian, M. D. (2003). A critical look at the case for hedge funds. *Journal of Portfolio Management, 29*(4), 103–112. https://doi.org/10.3905/jpm.2003.319899

Fama, E. F. (1984). The information in term structure. *Journal of Financial Economics, 13*(4), 509–528. https://doi.org/10.1016/0304-405X(84)90013-8

Geman, S. & Geman, D. (1984). Stochastic relaxation, Gibbs distributions and the Bayesian restoration of images. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 6*, 721–741. https://doi.org/10.1109/TPAMI.1984.4767596

Hwang, S. & Salmon, M. (2002). An analysis of performance measures using copulae. In Knight, J., & Satchell, S. (Eds.), *Performance measurement in finance* (pp. 160–197), Oxford: Butterworth-Heinemann.

Jensen, M. (1968). The performance of mutual funds in the period 1945–1946. *Journal of Finance*, *23*(2), 389–416. https://doi.org/10.1111/j.1540-6261.1968.tb00815.x

Kat, H. M., & Menexe, F. (2003). *Persistence in hedge fund performance: The true value of a track record.* Working Paper, City University, London.

Kosowski, R., Naik, N. Y., & Teo, M. (2007). Do hedge funds deliver Alpha? A Bayesian and Bootstrap analysis. *Journal of Financial Economics*, *84*(1), 229–264. https://doi.org/10.1016/j.jfineco.2005.12.009

Liang, B. (1999). On the performance of hedge funds. *Financial Analyst Journal*, *55*(4), 72–85. https://doi.org/10.2469/faj.v55.n4.2287

Muteba Mwamba, J. W. (2012). Implementing a robust market risk model for South African equity markets: A peak-over threshold approach. *South African Journal of Economics*, *80*(4), 459–472.

Park, J. M., & Staum, J. C. (1998). *Performance persistence in alternative investment*. Working Paper, Paradigm Capital Management, Inc.

Sharpe, W. (1966). Mutual fund performance. *Journal of Business*, *39*(1), 119–138. https://doi.org/10.1086/294846

Treynor, J. L. (1965). How to rate management of investment funds. *Harvard Business Review*, *43*, 63–75.

Treynor, J. L. & Mazuy, F. (1966). Can mutual funds outguess the market? *Harvard Business Review, 44*, 131–136.

APPENDIX A

List of Labels

The labels of investment styles used throughout the paper.

1. **ED:** HFRI Event-Driven (Total) Index
    - HFRI ED: Distressed/Restructuring Index: **ED_RES**
    - HFRI ED: Merger Arbitrage Index: **ED_MA**
    - HFRI ED: Private Issue/Regulation D Index: **ED_PVT**
2. **EH:** HFRI Equity Hedge (Total) Index:
    - HFRI EH: Equity Market Neutral Index: **EH_EMN**
    - HFRI EH: Quantitative Directional: **EH_QUANT**
    - HFRI EH: Sector - Energy/Basic Materials Index: **EH_ENERG**
    - HFRI EH: Sector - Technology/Healthcare Index: **EH_TECH**
    - HFRI EH: Short Bias Index: **EH_SBIAS**
3. **EM:** HFRI Emerging Markets (Total) Index:
    - HFRI Emerging Markets: Asia ex-Japan Index: **EM_ASIA-JP**
    - HFRI Emerging Markets: Global Index: **EM_GLOBAL**
    - HFRI Emerging Markets: Latin America Index: **EM_LAT_AM**
    - HFRI Emerging Markets: Russia/Eastern Europe Index: **EM_EAST-EU**
4. **FoF:** HFRI Fund of Funds Composite Index:
    - HFRI FOF: Conservative Index: **FoF_CONSV**
    - HFRI FOF: Diversified Index: **FoF_DIVERS**
    - HFRI FOF: Market Defensive Index: **FoF_MKT-DFENS**
    - HFRI FOF: Strategic Index: **FoF_STRATG**
5. **FWC:** HFRI Fund Weighted Composite Index:
    - HFRI Fund Weighted Composite Index CHF: **FWC_CHF**
    - HFRI Fund Weighted Composite Index EUR: **FWC_EUR**
    - HFRI Fund Weighted Composite Index GBP: **FWC_GBP**
    - HFRI Fund Weighted Composite Index JPY: **FWC_JPY**

6. **MCRO:** HFRI Macro (Total) Index:
   - HFRI Macro: Systematic Diversified Index: **MCRO_SYST-DIV**
7. **RV:** HFRI Relative Value (Total) Index:
   - HFRI RV: Fixed Income-Asset Backed: **RV_FIAB**
   - HFRI RV: Fixed Income-Convertible Arbitrage Index: **RV_FICA**
   - HFRI RV: Fixed Income-Corporate Index: **RV_FICORP**
   - HFRI RV: Multi-Strategy Index: **RV_MSTRAT**
   - HFRI RV: Yield Alternatives Index: **RV_YEILDA**

APPENDIX B

The Bayesian Estimation

The Jensen alpha, the Treynor and Mazuy selectivity and timing skills:

Table 7
Posterior outperformance skill

	Period 1	Period 2	Period 3	Period 4
ED_RES	1.248	4.0178	–2.5425	1.0417
ED_MA	1.4147	3.935	–3.214	1.0736
ED_PVT	3.16	3.3281	–2.9835	0.06922
EH_EMN	1.322	3.92	–3.3072	0.6969
EH_QUANT	1.2228	3.9854	–3.244	0.9912
EH_ENERG	2.2134	4.5321	–2.4139	1.2346
EH_TECH	2.2239	3.0759	–3.546	1.444
EH_SBIAS	1.517	4.347	–3.207	0.3229
EM_ASIA_JP	0.3156	3.3237	–2.575	1.6126
EM_GLOBAL	0.1285	3.752	–2.6925	1.4088
EM_LAT_AM	0.5334	3.8591	–2.7503	1.5566
EM_EAST_EU	0.3702	5.7529	–1.3025	1.0322
FoF_CONSV	1.2838	3.7451	–3.198	0.688
FoF_DIVERS	0.9787	3.5669	–3.2023	0.7436
FoF_MKT_DFENS	1.1297	4.0162	–3.3682	1.1143
FoF_STRATG	1.085	3.5086	–3.159	0.7746
FWC_CHF	1.004	3.7648	–3.264	0.9605

(*continued on next page*)

Table 7: (*continued*)

	Period 1	Period 2	Period 3	Period 4
FWC_EUR	2.6339	3.905	–3.1198	1.0539
FWC_GBP	1.3807	3.9846	–2.9473	1.1132
FWC_JPY	0.8741	3.5563	–3.3251	0.9313
MCRO_SYST_DIV	1.5046	3.9258	–3.2543	1.2655
RV_FIAB	1.2995	4.4361	–2.9079	1.3871
RV_FICA	1.4947	4.3177	–3.278	1.4658
RV_FICORP	0.9012	3.7697	–2.8449	1.0499
RV_MSTRAT	1.1197	4.1141	–3.0372	1.0243
RV_YEILDAT	0.7561	4.3275	–3.0203	0.7972

Table 8
Posterior selectivity skill

	Period 1	Period 2	Period 3	Period 4
ED_RES	0.4295	1.4314	–0.3176	0.9008
ED_MA	0.3744	1.0415	–0.7369	0.9047
ED_PVT	2.0792	0.3669	–0.2644	0.8204
EH_EMN	0.2352	0.7802	–0.9527	0.5187
EH_QUANT	0.5581	1.0809	–0.9245	0.8189
EH_ENERG	1.1334	0.2148	–0.5451	0.8407
EH_TECH	2.0245	0.0508	–1.0376	1.085
EH_SBIAS	–0.0396	1.6598	–0.978	0.5382
EM_ASIA_JP	–0.5133	0.8136	–0.0945	1.1605
EM_GLOBAL	–0.3389	1.1158	–0.4861	1.2368
EM_LAT_AM	0.1711	0.7678	–0.5528	1.1189
EM_EAST_EU	0.4485	3.5233	1.4334	0.9165
FoF_CONSV	0.3244	0.796	–0.8203	0.6002
FoF_DIVERS	0.1707	0.6352	–0.8166	0.555
FoF_MKT_DFENS	0.1826	0.6081	–0.738	1.082
FoF_STRATG	0.3181	0.5884	–0.7957	0.6208
FWC_CHF	0.195	0.7706	–0.9247	0.7684
FWC_EUR	1.8849	0.9096	–0.7815	0.8714
FWC_GBP	0.5664	0.9856	–0.616	0.9546
FWC_JPY	0.0541	0.5584	–0.9867	0.6909

(*continued on next page*)

Table 8: (*continued*)

	Period 1	Period 2	Period 3	Period 4
MCRO_SYST_DIV	0.6073	0.4472	–0.7961	1.38
RV_FIAB	0.2462	1.6528	–0.6331	1.2336
RV_FICA	0.4347	1.4624	–0.8276	0.9565
RV_FICORP	–0.0583	0.9674	–0.5946	1.026
RV_MSTRAT	0.133	1.1201	–0.7192	0.7642
RV_YEILDAT	–0.1645	1.1605	–0.4647	0.6

Table 9
Posterior market timing skill

	Period 1	Period 2	Period 3	Period 4
ED_RES	0.043	0.0422	–0.0549	0.0018
ED_MA	0.0547	0.0472	–0.0611	0.0022
ED_PVT	0.0568	0.0484	–0.067	–0.0024
EH_EMN	0.0571	0.0513	–0.0581	0.0024
EH_QUANT	0.0348	0.0474	–0.0572	0.0023
EH_ENERG	0.0565	0.0705	–0.0463	0.0057
EH_TECH	0.0101	0.0493	–0.0619	0.0052
EH_SBIAS	0.0817	0.0437	–0.055	0.0038
EM_ASIA_JP	0.0435	0.0409	–0.0612	0.0066
EM_GLOBAL	0.0244	0.043	–0.0545	0.0022
EM_LAT_AM	0.0187	0.0504	–0.0543	0.0064
EM_EAST_EU	–0.0048	0.0362	–0.0675	0.0012
FoF_CONSV	0.0504	0.0482	–0.0587	0.0009
FoF_DIVERS	0.0424	0.0479	–0.0588	0.0025
FoF_MKT_DFENS	0.0498	0.0557	–0.0649	0.0001
FoF_STRATG	0.0402	0.0477	–0.0583	0.002
FWC_CHF	0.0425	0.0489	–0.0577	0.0026
FWC_EUR	0.0393	0.0489	–0.0577	0.0024
FWC_GBP	0.0428	0.049	–0.0575	0.002
FWC_JPY	0.0431	0.0489	–0.0577	0.0033
MCRO_SYST_DIV	0.0471	0.0568	–0.0606	–0.0023
RV_FIAB	0.0553	0.0454	–0.0561	0.002
RV_FICA	0.0557	0.0466	–0.0605	0.0075

(*continued on next page*)

Table 9: (*continued*)

	Period 1	Period 2	Period 3	Period 4
RV_FICORP	0.0504	0.0457	–0.0555	–0.0001
RV_MSTRAT	0.0519	0.0489	–0.0572	0.0036
RV_YEILDAT	0.0484	0.0517	–0.063	0.0026

The series of winners and losers for each skill are shown below.

Table 10
Posterior winners/losers for outperformance skill

	Period 1	Period 2	Period 3	Period 4
ED_RES	L	W	W	W
ED_MA	W	W	L	W
ED_PVT	W	L	W	L
EH_EMN	L	L	L	L
EH_QUANT	L	W	W	W
EH_ENERG	W	W	W	W
EH_TECH	W	L	L	W
EH_SBIAS	W	W	W	L
EM_ASIA_JP	L	L	W	W
EM_GLOBAL	L	L	L	L
EM_LAT_AM	W	W	L	W
EM_EAST_EU	W	W	W	L
FoF_CONSV	W	W	W	L
FoF_DIVERS	L	L	L	L
FoF_MKT_DFENS	W	W	L	W
FoF_STRATG	L	L	W	W
FWC_CHF	L	L	L	L
FWC_EUR	W	W	W	W
FWC_GBP	W	W	W	W
FWC_JPY	L	L	L	L
MCRO_SYST_DIV	W	W	W	W
RV_FIAB	W	W	W	W
RV_FICA	W	W	L	W
RV_FICORP	L	L	W	W
RV_MSTRAT	W	L	L	L
RV_YEILDAT	L	W	W	L

Table 11
Posterior winners/losers for selectivity skill

	Period 1	Period 2	Period 3	Period 4
ED_RES	W	W	W	W
ED_MA	L	W	L	W
ED_PVT	W	L	W	L
EH_EMN	L	W	W	L
EH_QUANT	W	W	W	W
EH_ENERG	W	L	W	W
EH_TECH	W	L	L	W
EH_SBIAS	L	W	L	L
EM_ASIA_JP	L	L	W	W
EM_GLOBAL	L	W	L	W
EM_LAT_AM	W	L	L	L
EM_EAST_EU	W	W	W	L
FoF_CONSV	W	W	L	L
FoF_DIVERS	L	W	L	L
FoF_MKT_DFENS	L	L	W	W
FoF_STRATG	W	L	W	W
FWC_CHF	L	L	L	L
FWC_EUR	W	W	W	W
FWC_GBP	W	W	W	W
FWC_JPY	L	L	L	L
MCRO_SYST_DIV	W	W	W	W
RV_FIAB	W	W	W	W
RV_FICA	W	W	L	W
RV_FICORP	L	L	W	W
RV_MSTRAT	W	L	L	L
RV_YEILDAT	L	W	W	L

Table 12
Posterior winners/losers for market timing skill

	Period 1	Period 2	Period 3	Period 4
ED_RES	L	L	W	W
ED_MA	W	W	W	W
ED_PVT	W	W	L	L
EH_EMN	W	W	L	L
EH_QUANT	L	L	W	L
EH_ENERG	W	W	W	W
EH_TECH	L	W	L	W
EH_SBIAS	W	L	W	W
EM_ASIA_JP	W	L	L	W
EM_GLOBAL	W	W	W	L
EM_LAT_AM	L	W	W	W
EM_EAST_EU	L	L	L	L
FoF_CONSV	W	W	W	L
FoF_DIVERS	L	L	L	W
FoF_MKT_DFENS	W	W	L	L
FoF_STRATG	L	L	W	W
FWC_CHF	L	W	W	W
FWC_EUR	L	W	W	L
FWC_GBP	W	W	W	L
FWC_JPY	W	W	W	W
MCRO_SYST_DIV	W	W	W	W
RV_FIAB	W	L	W	L
RV_FICA	W	W	L	W
RV_FICORP	L	L	W	L
RV_MSTRAT	W	W	W	W
RV_YEILDAT	L	W	L	W

Asian Academy *of* Management Journal *of* Accounting *and* Finance

AAMJAF Vol. 13, No. 1, 83–111, 2017

INSTRUMENTAL-VARIABLE ESTIMATION OF BANGKOK-WEATHER EFFECTS IN THE STOCK EXCHANGE OF THAILAND

Anya Khanthavit

Faculty of Commerce and Accountancy
Thammasat University, Bangkok, Thailand

E-mail: akhantha@tu.ac.th

ABSTRACT

The incorrect fixed-effect assumption, missing-data problem, omitted-variable problem, and errors-in-variables (EIV) problem are estimation problems that are generally found in studies on weather effects on asset returns. This study proposes an approach that can address these problems simultaneously. The approach is demonstrated by revisiting the effects on the Stock Exchange of Thailand. The sample shows daily data from 2 January 1991 to 30 December 2015. Artificial Hausman instrumental-variable regressions successfully improve the quality of the analyses for ordinary least squares regressions when significant EIV problems are identified and the regression results in a conflict. The study finds significant air pressure and rainfall effects and empirically shows that the temperature effects reported by previous studies were induced by the fixed-effect assumption and are therefore incorrect.

Keywords: instrumental-variable estimation, artificial Hausman regression, weather effects, model misspecification, Thai stock returns

INTRODUCTION

Good or bad weather in the regions in which investors trade can affect their moods (e.g., Howarth & Hoffman, 1984), which, in turn, influences economic decision-making (e.g., Lucey & Dowling, 2005). Prices and returns may increase or decrease

Publication date: 30 August 2017

To cite this article: Khanthavit, A. (2017). Instrumental-variable estimation of Bangkok-weather effects in the Stock Exchange of Thailand. *Asian Academy of Management Journal of Accounting and Finance, 13*(1), 83–111. https://doi.org/10.21315/aamjaf2017.13.1.4

To link to this article: https://doi.org/10.21315/aamjaf2017.13.1.4

according to the weather conditions due to changing risk preferences, which leads marginal investors to increase or decrease the discount rates (Mehra & Sah, 2002), or attitude misattribution, which causes marginal investors to incorrectly associate good or bad weather and attitudes regarding good or bad prospects for the assets (e.g., Hirshleifer & Shumway, 2003). Recently, Brahmana, Hooy and Ahmad (2012) explained that the changing prices and returns could result from herd behaviour of investors. These incidents constitute weather effects. However, because these weather conditions do not affect the fundamentals of firms, their values remain unchanged. In an efficient market, rational investors trade against and profit from these weather-sensitive investors. Weather effects should not exist or should disappear within a short time.

It is important to test for weather effects because significant effects imply market inefficiency. Furthermore, they imply that economic and behavioural factors determine asset prices and returns. Tests for weather effects have been conducted extensively using national and international market data. Reviews of early studies are presented, for example, by Cao and Wei (2005), as well as in recent studies by Furhwirth and Sogner (2015). The test results were mixed depending on the sample periods, countries, markets, assets, weather variables, and econometric models.

Despite the various choices for econometric models for weather effects, the ordinary least squares (OLS) regression model — in which returns are related linearly to interesting weather variables — is the most popular model and can be found in recent studies (e.g., Goetzman, Kim, Kumar, & Wang, 2015). I argue that the OLS regression model suffers from at least four estimation problems.

First, the model assumes that weather effects are fixed over the sample period. This assumption is inconsistent with the empirical findings in previous studies. For example, Yoon and Kang (2009) found significant temperature effects in the Korean stock market for the full sample period of 15 January 1990, to 13 December 2006. However, when the researchers divided the sample into two sub-samples — from 15 January 1990, to 30 September 1997, and from 1 October 1997, to 13 December 2006 — they found significant effects in the first but not the second sub-period.

Second, weather variables may be missing due to faulty equipment or missed observations. When variables are missing, researchers may choose an imputation approach and impute proxies for the missing data. Alternatively, they may choose a listwise-deletion approach in which they remove the missing observations and consider only complete observations in the analyses. Worthington (2009) chose the former approach; Khanthavit (2016a) chose the latter. If researchers choose the imputation approach, the OLS estimates are necessarily biased and inconsistent because the proxies have errors and induce an errors-in-variables (EIV) problem in regressions (Durbin, 1954). However, if they choose the listwise-deletion approach, the analyses omit useful information that would have been drawn from the discarded observations (Little, 1992).

Third, even when weather variables are complete, the variables can be observed erroneously. The samples are observed at a weather station near the market; however, the relevant weather variables that induce moods and potentially affect prices are in areas where investors trade. Although the literature argued that most investors were in the same city as the market, the weather station may not be located near the market or investors. For example, in Saunders (1993), the LaGuardia weather station is approximately 13 kilometers from the New York Stock Exchange and Wall Street; it is well known that New York City is large, covering an area of 789 square kilometers. For this reason, the observed weather variables are mere proxies; the OLS estimates are biased and inconsistent (Durbin, 1954).

Fourth, investors can be sensitive to various weather conditions such as temperature, cloud cover, and rainfall (Watson, 2000). If the model omits one or more influential weather variables, the OLS results are necessarily biased and inconsistent (Ramsey, 1969). Studies such as those by Saunders (1993) and Cao and Wei (2005), which considered single-weather variables, were vulnerable to this omitted-variable problem. Other studies, such as that by Worthington (2009), who considered large sets of weather variables, risked introducing biases and inconsistencies. Despite their large sizes, the sets may still be incomplete.

In this study, I propose an approach to resolve the four estimation problems and apply it to test for the weather effects in the Stock Exchange of Thailand (SET). The approach is the main contribution of the study. Some of these estimation problems were addressed separately in the literature, but the outcomes were neither satisfactory nor successful. The remaining problems have not yet been addressed. In this study, the four problems are resolved simultaneously.

Choosing the SET as the sample market allows me to demonstrate the features of the proposed approach. The SET is Thailand's only stock market. It is located in Bangkok, where most stock investors live and trade. Stock News Online (2015) reported that there were 1,134,500 open stock accounts in February 2015, and 88% of these accounts were in the Bangkok metropolitan area. Thus, the Bangkok weather affects most investors.

The SET was established on 30 April 1975, whereas the Bangkok weather began being recorded on 1 January 1991. The sample period necessarily begins on 1 January 1991, and covers 25 years. If weather effects exist, it is unlikely that the effects remain fixed over such a long period.

The weather conditions under consideration are drawn from the meteorological station at Bangkok's Don Muang Airport. Bangkok is much larger than New York City; it covers an area of 1,569 km^2. The airport is 25 km from the stock market's former location and is 22 km from its current location. Due to the size of Bangkok and the distance from the weather station to the market's location, the observed weather variables are proxies for the true variables that affect investors' moods. Below, Table 1, panel 1.1 indicates that on average, 2.66% of the weather data are missing. The proposed approach employs the imputation approach to fill in the missing data. Together, the weather proxies and imputed data induce the EIV problem in estimation.

Seven Bangkok-weather variables, i.e., air pressure, cloud cover, ground visibility, rainfall, relative humidity, temperature, and wind speed, are studied. Despite these many variables, some variables that were included in previous studies are omitted. For example, the geomagnetic storms in Dowling and Lucey (2008) are omitted because the storm data are not available. The wind direction in Worthington (2009) is omitted because the direction cannot be averaged to represent the daily direction data and because it is not a significant variable in that study. If the omitted variables are important, the OLS estimates are biased and inconsistent.

Second, from a practical perspective, the SET is an interesting and important market for study. Thailand is among the world's top emerging economies. Bloomberg Markets (2013) ranked Thailand third only after China and South Korea. From the World Federation of Exchanges database, in May 2016, the SET's market capitalisation was 387.86 billion U.S. dollars, accounted for 1.79% of the aggregate capitalisation of 23 stock markets in the Asia-Pacific region, and ranked eleventh in size after the Singapore market. In terms of trading value, the SET ranked first for three consecutive years among ASEAN stock markets (Stock Exchange of Thailand, 2016).

Third, in the past, weather effects were studied for the SET, including in works by Nirojsil (2009) and Sriboonchitta, Chaitip, Sriwichailamphan, and Chaiboonsri (2014). Significant temperature effects were reported. For those studies, the effects were assumed to be fixed; the number of weather variables was small; and the missing-variable, EIV, and omitted-variable problems were never raised. My results can be compared and contrasted with the results of the above-mentioned studies, and new findings for the SET can be discussed.

METHODOLOGY

The Model, Estimation and Hypothesis Tests

In this study, I follow the procedure of previous studies (e.g., Dowling & Lucey, 2005; Worthington, 2009) to relate the stock return linearly to *M* weather variables on day *t* as in Equation (1).

$$r_t = \beta_0 + \rho r_{t-1} + \beta_1 W_t^1 + ... + \beta_M W_t^M + e_t \quad (1)$$

where r_t and r_{t-1} are the stock returns on days *t* and *t*-1, respectively. Day $t = 1, 2, \ldots, T$, where *T* is the number of observations. W_t^m is the weather variable *m* on day *t*. $m = 1, \ldots, M$. β_0 is the intercept. β_m is the slope coefficient for W_t^m. I add the lagged return r_{t-1} to the model to capture the possible return's autocorrelation (e.g., Saunders, 1993; Yoon & Kang, 2009). ρ is the autocorrelation coefficient. Finally, e_t is the regression error. The model in Equation (1) can be estimated by the OLS technique. If all OLS assumptions are satisfied, OLS coefficients are the most efficient, unbiased, and consistent.

Previous studies, e.g., Yoon and Kang (2009), considered various weather variables but estimated the effect for each variable one at a time. I do not follow this approach because weather variables tend to be correlated (Worthington, 2009). A significant effect may be observed not directly from the regressing variable but rather indirectly from its correlated companions; the model in Equation (1) allows me to identify the unique and direct effect of each variable on returns (Stock & Watson, 2003).

If the weather variable m is significant, the coefficient β_m must be different from zero. Under the null hypothesis, if no weather effects are present, i.e., $\beta_1 = \cdots = \beta_M = 0$, the Wald statistic is distributed as a chi-square variable of *M* degrees of freedom. All hypothesis tests are based on Newey and West's (1987) heteroscedasticity- and autocorrelation-consistent covariance matrix. The Newey-West lag is chosen by the integer part of $\sqrt[4]{T}$ (Baum, 2006).

Estimation Problems and Corrections

Fixed-effect assumptions

In previous studies, the fixed-effect assumption was addressed by dividing a long full sample into several short sub-samples (e.g., Saunders, 1993; Yoon & Kang, 2009). However, these studies still had to use a fixed-effect assumption for the sub-samples. The sub-samples were able to cover a long period of time; thus, the fixed-effect assumption was inappropriate or incorrect. For example, in Yoon and Kang (2009), the sub-samples covered eight years. Akhtari (2011) offered an alternative model to address the fixed-effect assumption, in which the effect was allowed to change linearly with time. This specification was very restrictive. If the relationship of the effect with time was not monotonic, such as that in Saunders (1993), the model failed.

I follow Doyle and Chen (2009) to address the fixed-effect assumption by separating the full sample into one-year sub-samples, estimating the model for each sub-sample, and examining the way in which the effects change annually over the course of the full sample. The one-year sub-samples should be short enough to accommodate possible changes for the effects. The model in Equation (1) in year τ is:

$$r_{\tau t} = \beta_{\tau 0} + \rho_{\tau} r_{\tau,t-1} + \beta_{\tau,1} W_{\tau,t}^{1} + ... + \beta_{\tau M} W_{\tau,t}^{M} + e_{\tau,t} \quad (2)$$

where subscript τ indicates that the variables and coefficients are used for the year τ sub-sample.

In their study, Doyle and Chen (2009) also proposed a comprehensive model in which the full-sample data were considered and in which individual coefficients were assigned to measure the effects of the one-year sub-samples. The comprehensive model allowed the researchers to test for significant weather effects jointly using Wald tests or *F*-tests; however, I do not adopt the comprehensive model. In this study, the full sample period is 25 years, and there are seven weather variables present. Moreover, seven projection errors are added to the artificial Hausman regression to correct possible EIV and omitted-variable problems. The comprehensive model will be too large to be managed adequately. However, a joint test is possible by using the summed chi-square Wald statistics of individual sub-samples.

Missing-variable problems

Some weather records are missing. To fix this problem, I impute the unconditional means of the variables into the missing cases (Afifi & Ekashoff, 1967). The unconditional means are chosen over the means that are conditioned on stock returns (Dagenais, 1973) and over the observed variables from a nearby weather station (Worthington, 2009) because the unconditional means are convenient and readily available. Moreover, the records from the nearby City Hall station — which is the other weather station in Bangkok — are also missing; under the null hypothesis under which the stock returns and weather variables are uncorrelated, the conditional and unconditional means are the same.

Errors-in-variables and omitted-variable problems

When the estimation is free of EIV and omitted-variable problems, the OLS estimates are optimal. Otherwise, the estimates are biased and inconsistent. I discussed why OLS estimation of weather effects generally had problems. For the same reasons, it is likely that the problems are present in this study. Instrumental-variable (IV) regressions help resolve these problems. IV estimates are consistent, regardless of whether the two problems are present.

In this study, I use the artificial Hausman (AH) regression (Dagenais & Dagenais, 1997) to estimate the models in Equations (1) and (2). The AH regression is a form of IV regression and is preferred to alternative IV regressions, e.g., the two-stage least squares regression, because the test for the EIV problem can be performed before the analyses begin (Racicot & Theoret, 2008; 2010). In my study, if the EIV problem is significant, I use the AH estimates for the analyses. However, if the problem is not significant, I use the OLS estimates.

Artificial Hausman Regression

The modified model

I modify the model in Equation (1) for the AH regression as follows.

$$r_t = \beta_0 + \rho r_{t-1} + \beta_1 W_t^1 + \ldots + \beta_M W_t^M + \theta_1 \hat{u}_t^1 + \ldots + \theta_M \hat{u}_t^M + e_t \tag{3}$$

where $\hat{u}_t^m$ is defined by the projection regression, $W_t^m = \gamma_0 + \gamma_1 Z_t^1 + \ldots + \gamma_K Z_t^K + \hat{u}_t^m$, of W_t^m onto a set $(Z_t^1, \ldots, Z_t^k)$ of K IVs. The AH estimates $(\beta_0, \rho, \beta_1, \ldots \beta_M)$ from Equation (3) are identical to the two-stage least squares estimates (Racicot & Theoret, 2008). The model in Equation (2) can be modified for the AH regression in the same way. Once the models are modified, they can be estimated by the OLS. If the problems are not present, $\theta_1 = ... = \theta_M = 0$. The Wald statistic is a chi-square variable of *M* degrees of freedom. Racicot and Theoret (2008, 2010) used the conventional OLS covariance matrix for hypothesis tests, while Coen and Hubner (2009) used White's (1980) heteroscedasticity-consistent matrix. In this study, however, I use Newey and West's (1987) heteroscedasticity- and autocorrelation-consistent matrix because e_t can be heteroscedastic as well as autocorrelated.

Choices for instrumental variables

IVs must be informative, in that they must explain the movement of W_t^m well, and must be valid, in that they are not correlated with e_t in Equations (1) and (2). It is difficult to choose IVs satisfactorily for a weather variable. The first choice is its lag or other weather variables. These variables are informative. As seen in Table 1, Panel 1, the weather variables have significant AR(1) coefficients, whereas Panel 2 and Worthington (2009) reported strong correlations among weather variables. In this study, the current variables cannot be IVs because they will all appear as regressors in the model. Their lags may not be possible because some observations are missing.

The second choice is cumulant IVs, as proposed by Dagenais and Dagenais (1997). The cumulant IVs are convenient because they can be computed from the stock returns and weather variables. For the models in Equations (1) and (2), the IVs are a unit vector ι_T of size *T*,

$$
\begin{aligned}
z_1^m &= w^{m*}w^m, \\
z_2^m &= w^{m*}r, \\
z_3^m &= r^*r, \\
z_4^m &= w^{m*}w^{m*}w^m - 3w^m\left[E\left(\frac{w^{m'}w^m}{T}\right)*I_T\right], \\
z_5^m &= w^{m*}w^{m*}r - 2^m\left[E\left(\frac{w^{m'}r}{T}\right)*I_T\right] - r\left\{\iota_T'\left[E\left(\frac{w^{m'}w^m}{T}\right)*I_T\right]\right\}, \\
z_6^m &= w^{m*}r^*r - w^m\left[E\left(\frac{r'r}{T}\right)\right] - 2r\left[E\left(\frac{r'w^m}{T}\right)\right], \\
z_7^m &= r^*r^*r - 3r\left[E\left(\frac{r'r}{T}\right)\right],
\end{aligned}
$$

where w^m and r are the vectors of deviation of weather variable W^m and stock return r from their means. I_T is the identity matrix of size *T*, and * denotes the Hadamard element-by-element matrix multiplication operator. Note that z_1^m is Durbin's

(1954) IV and z_4^m is Pal's (1980) IV. Dagenais and Dagenais (1997) acknowledged that the results improved when they only considered $\{\iota_T, z_1^m, z_4^m\}$.

The third choice is two-step IVs in Racicot and Theoret (2010). These IVs are extremely informative and strongly valid. In the first step, a set of IVs is chosen and regressed on the weather variable W^m. In the second step, the regression errors are treated as IVs for computing the projection errors $\hat{u}_t^m$. Racicot and Theoret (2010) showed empirically that the adjusted R^2 of erroneous dependent variables for the two-step IVs, based on the $\{\iota_T, z_1^m, z_4^m\}$. set, could reach 80%, whereas the correlation of OLS errors with the IVs was almost zero.

Due to their informativeness and validity, in this study, I use Racicot and Theoret's (2010) two-step IVs in the estimation. Four sets of IVs are considered in the first step Durbin's (1954) $\{\iota_T, z_1^m\}$, Pal's (1980) $\{\iota_T, z_4^m\}$, Racicot and Theoret's (2010) $\{\iota_T, z_1^m, z_4^m\}$, and Dagenais and Dagenais's (1997) $\{\iota_T, z_1^m, ..., z_7\}$. Their informativeness performances are compared, and the set with the highest average R^2 will be chosen for the analyses.

The data

The data are daily. The stock returns are computed from log index differences. The stock indexes to be studied are the closing SET, SET 50, and MAI indexes. The SET index is a broad-based, value-weighted index of all stocks on the Stock Exchange of Thailand; the SET 50 index is the value-weighted index of the 50 largest and most actively trading stocks; and the MAI index is the value-weighted index of all stocks on the Market for Alternative Investment (MAI). The SET index, SET 50 index, and MAI index began on 28 December 1990, 16 August 1995, and 2 September 2002, respectively. All indexes ended on 30 December 2015. The indexes were retrieved from the Stock Exchange of Thailand's database.

Approximately 58% and 96% of the trading volumes of SET and MAI stocks are from small, individual investors, and the remainder is from local institutes, proprietary traders, and foreign investors (Khanthavit & Chaowalerd, 2016). It is likely that the percentage share from small, individual investors for the SET 50 stocks is not above 58%. While the SET index is intended to represent the overall market, the SET 50 and MAI indexes can represent the parts of the market that are dominated by large investors and individuals, respectively.

The weather variables are air pressure (hectopascal), cloud cover (decile), ground visibility (km), rainfall (mm), relative humidity (%), temperature (°C) , and wind speed (knots per hour). These variables are a collection of weather variables that have also been considered in previous studies (e.g., Dowling & Lucey, 2008); they are the most comprehensive set of variables among all weather studies for Thailand (e.g., Hirshleifer & Shumway, 2003; Dowling & Lucey, 2005; Nirojsil, 2009).

The weather variables affect stock returns via investors' moods. Goldstein (1972) and Keller et al. (2005) reported a link between high air pressure and positive mood. Low cloud cover was related to good moods, while high cloud cover was related to bad moods and depression (Eagles, 1994). As for ground visibility, Lu and Chou (2012) explained that people were more prone to melancholy feelings and a decline in their general spirit due to insufficient light levels. In Schwarz and Clore (1983), people rated their life satisfactions much higher on sunny days than on cloudy or rainy days; in Sanders and Brizzolara (1982), low levels of humidity were associated with good moods. The relationship of temperature with moods was mixed. While Cunningham (1979) and Howarth and Hoffman (1984) reported a positive relationship, Griffitt and Veitch (1971) and Goldstein (1972) reported a negative one. Finally, Troros, Deniz, Saylan, Sen and Baloglu (2005) and Denissen, Butalid, Penke, and van Aken (2008) found that wind deteriorated moods.

Recently, Brahmana, Hooy and Ahmad (2015) pointed out that weather conditions in tropical countries varied much less relatively to those in colder countries, e.g. the U.S., for which most weather studies were conducted. The researchers challenged whether or not weather conditions could influence return behaviours in tropical countries in ways similar to those in colder countries. I argue that the ways weather conditions affect moods are contingent on how good or bad the weather conditions were prior to the time the relationship between moods and current weather is measured (Keller et al., 2005). For this reason, weather effects can exist in Thailand too, although it is a country in the tropical zone. Moreover, significant weather effects were found for tropical countries. For example, in national studies, Brahmana, Hooy and Ahmad (2015) found cloud-cover effects for Indonesia, and Nirojsil (2009) found temperature effects for Thailand. In international studies, Hirshleifer and Shumway (2003) and Dowling and Lucey (2008) found the effects for Brazil, Indonesia, Malaysia, Mexico and Singapore.

Table 1
Descriptive statistics

Panel 1: Index Returns and Untreated Weather Variables

Statistics	Index Returns[1]			Untreated Weather Variables[2]						
	SET	SET 50	MAI	Air Pressure (hectopascal)	Cloud Cover (decile)	Gr. Visibility (km)	Rainfall (mm)	Re. Humidity (%)	Temperature (°C)	Wind Speed (knots/hour)
Mean	1.21E-04	–4.14E-05	5.07E-04	96.8359	5.4684	8.8597	0.3415	65.9481	29.9739	5.6941
S.D.	0.0160	0.0184	0.0159	29.7429	1.4240	1.4502	1.5404	10.5586	2.1562	2.3735
Skewness	0.0284	0.2149	–0.1347	0.3750	–0.5623	–1.1244	7.9375	–0.4709	–0.8150	1.0708
Excess Kurtosis	6.8443	7.1564	110.2023	0.0041	–0.2794	1.2496	84.6261	2.9606	2.8484	1.8259
Minimum	–0.1606	–0.1723	–0.3234	0.0000	0.0909	2.5091	0.0000	4.0909	8.1000	0.2727
Maximum	0.1135	0.1259	0.3269	250.5455	8.0000	14.2727	27.5500	97.3636	36.3455	18.8182
JB Stat.	11,954***	10,687***	1,649,645***	209***	494***	2,443***	2,746,116***	3,588***	4,004***	2,927***
AR(1)	0.0919***	0.0856***	–0.0761***	0.9095***	0.7099***	0.6667***	0.1031***	0.8066***	0.7993***	0.7335***
Trading Days	6,124	4,990	3,260	6,124	6,124	6,124	6,124	6,124	6,124	6,124
Miss. T-Days	0	0	0	141	200	185	163	140	140	176
Miss. T-Intervals	0	0	0	11	27	14	7	10	10	23
Calendar Days	N.A.	N.A.	N.A.	9,131	9,131	9,131	9,131	9,131	9,131	9,131
Miss. C-Days	N.A.	N.A.	N.A.	211	296	272	241	209	209	262
Miss. C-Intervals	N.A.	N.A.	N.A.	13	34	15	7	11	11	31

Note: *** = significance at the 99% confidence level. N.A. = not applicable, [1] and [2] = statistics are computed from the observed data on trading days and calendar days, respectively, Gr. Visibility = Ground Visibility; Re. Humidity = Relative Humidity

Panel 2: Correlations[1] and Variance-Inflation Factors[2] of Imputed, De-seasonalised Weather Variables

Weather Variables	Air Pressure	Cloud Cover	Ground Visibility	Rainfall	Relative Humidity	Temperature	Wind Speed
Air Pressure	1.0000						
Cloud Cover	–0.1044***	1.0000					
Ground Visibility	–0.0047	–0.1206***	1.0000				
Rainfall	0.0034	0.1821***	–0.1620***	1.0000			
Relative Humidity	–0.1073***	0.5014***	–0.2253***	0.2681***	1.0000		
Temperature	–0.3420***	–0.3286***	0.1414***	–0.2628***	–0.2899***	1.0000	
Wind Speed	–0.1029***	–0.0443***	0.1875***	–0.0813***	–0.1319***	0.0872***	1.0000
VIF	1.2434	1.4438	1.1023	1.1376	1.4861	1.4351	1.0602

Note: VIF = Variance Inflation Factors; *** = significance at the 99% confidence level. [1] and [2] = statistics are computed from the de-seasonalised observed data on calendar days (8,742 observations) and imputed, de-seasonalised observed data on trading days (6,124 observations), respectively.

The weather data are for Bangkok weather and are measured by the Thai Meteorological Department's weather station at Don Muang Airport. The data coverage began on 1 January 1991, and ended on 31 December 2015. I retrieved the data from the Thai Meteorological Department's database.

During the sample period, the SET had four regimes of trading hours:

1. From 9.00 to 12.00 for the 1 January 1991–30 June 1992 period
2. From 10.00 to 12.30 and from 14.30 to 16.00 for the 1 July 1992–3 November 1994 period
3. From 10.00 to 12.30 and from 14.30 to 16.30 for the 4 November 1995–5 September 1999 period
4. From a random morning beginning time (between 9.55 and 10.00 to 12.30) and from a random afternoon beginning time (between 14.25 and 14.30) to a random closing time (between 16.35 and 16.40) for the 6 September 1999–31 December 2015 period

Following Hirshleifer and Shumway (2003), I calculate the daily weather variables by their average levels from 6.00 to 16.00. I am aware that in regime (1), the weather conditions in the afternoon are not able to affect morning prices and returns. However, the averages can serve as samples for the days because the weather variables were autocorrelated, they served as proxies, and the induced EIV problem was readily addressed by the proposed approach.

Significant weather effects may be spurious due to weather and return seasonality (Hirshleifer & Shumway, 2003). To avoid possible spuriousness, I de-seasonalised the weather variables, as in Hirshleifer and Shumway (2003), with their averages for each week of the year over the 1991–2015 sample period. Zero is imputed in the missing cases because it is the unconditional means of de-seasonalized variables.

Table 1, Panel 1 reports the descriptive statistics of the index returns and untreated weather variables. The daily mean returns are small, relative to their standard deviations. The return skewnesses are almost zero, whereas the excess kurtoses are very large. The return autocorrelations are significant, thus supporting the use of Newey and West's (1987) covariance matrix for hypothesis tests. Although the Jarque-Bera (JB) tests reject the normality hypothesis for the three indexes, the OLS regressions are valid even for the one-year sub-periods. The number of observations for each sub-period is large, ranging from 242 to 245 trading days.

Temperature, cloud cover, humidity, and ground visibility are negatively skewed; rainfall, wind speed, and air pressure are positively skewed. All variables, except for cloud cover, have fat-tailed distributions. The normality hypothesis is rejected for the seven weather variables. The AR(1) coefficients are significant, which suggests that weather's lagged values are informative and can be candidates for IVs. It is important to note, nevertheless, that the number of weather observations is not equal for either calendar or trading days. The significant AR(1) coefficients are indicative, and the lagged values may not be very useful.

Table 1, Panel 2 reports the correlations among the de-seasonalised variables. The weather samples are those for non-missing calendar days. All correlations, except those for air pressure-ground visibility and air pressure-rainfall pairs, are highly significant. The significant correlations support the models in Equations (1) and (2), which show a direct and unique effect for each variable. In placing correlated variables together in a regression risk multicollinearity, I check for multicollinearity using the variance inflation factors (VIFs) in the last row of the panel. The statistics are computed from the imputation series for trading days because these series will be used in the estimation. The largest VIF is 1.4861 and is much smaller than the 10-level threshold. The VIFs do not suggest multicollinearity.

Table 2 reports the informativeness and validity performance of the two-step IV sets. Informativeness is measured by a high R^2 of the regression of weather variables on IVs; validity is measured by a low R^2 of the regression of the error term in Equation (1) on IVs. For all seven weather variables and three index returns, the two-step IVs based on Pal's (1980) set perform the best. The average informativeness R^2s are highest at more than 0.85, and the validity R^2s are practically zero. With respect to their performance, the Pal (1980)-based, two-step IVs are used in the estimation.

Table 2
Informativeness and validity of two-step instrumental variables

IV Choice	Index Return	Informativeness R^2								Validity R^2
		Air Pressure	Cloud Cover	Ground Visibility	Rainfall	Relative Humidity	Temperature	Wind Speed	Average	
Durbin (1954)	SET	0.9595	0.9353	0.7929	0.2693	0.8960	0.8000	0.8200	0.7819	2.78E-06
	SET 50	0.9647	0.9377	0.6943	0.2703	0.9532	0.7958	0.8653	0.7831	3.43E-05
	MAI	0.9464	0.9457	0.7270	0.2455	0.9202	0.7684	0.9668	0.7886	8.13E-07
Pal (1980)	SET^C	0.9613	0.9724	0.8801	0.5121	0.8734	0.9228	0.9103	0.8618	3.04E-06
	SET 50^C	0.9573	0.9711	0.8563	0.5240	0.9814	0.8875	0.9176	0.8707	5.21E-05
	MAI^C	0.9306	0.9666	0.8403	0.4727	0.9755	0.8966	0.9564	0.8627	2.89E-05
Racicot-Theoret (2010)	SET	0.9352	0.8988	0.7740	0.0990	0.8206	0.7477	0.8096	0.7264	4.00E-06
	SET 50	0.9343	0.9107	0.6775	0.0978	0.9152	0.7390	0.8502	0.7321	6.26E-05
	MAI	0.9164	0.9204	0.7145	0.0861	0.8793	0.7398	0.9280	0.7406	2.65E-05
Dagenais-Dagenais (1997)	SET	0.9300	0.8926	0.7681	0.0986	0.8145	0.7383	0.8037	0.7208	1.81E-07
	SET 50	0.9259	0.9039	0.6719	0.0973	0.9038	0.7298	0.8430	0.7251	1.67E-05
	MAI	0.8964	0.8714	0.6986	0.0853	0.8453	0.7132	0.8802	0.7129	3.31E-06

Note: ^{C} = instrumental variables chosen for the analysis.

EMPIRICAL RESULTS

Tests for Errors-in-Variable (EIV) Problems and Weather Effects

I test for the EIV problems first. If the problems are significant, the tests for significant individual-weather coefficients and weather effects are based on AH regressions. However, if they are not, the tests are based on OLS regressions. Table 3, Panel 1 reports the results for the SET index return. For the full period from 1991 to 2015, the test cannot detect the EIV problem. The OLS coefficient for ground visibility is significant but weak at the 90% confidence level. The Wald test cannot identify the weather effects. The inability to detect the weather effects may result from the incorrect assumption of fixed weather effects over the full period. When I repeat the procedure for the one-year sub-periods, the results are quite different.

The joint test, based on the summed $\chi^2(7)$ statistics for EIV problems over the 25-year period, rejects the no-EIV hypothesis at a 99% confidence level. For individual sub-periods, the EIV problems are significant in 1991, 1996, 1998, 2002, 2004, 2005, 2006, 2007, 2008, 2013, 2014, and 2015. As opposed to the full-period regression test, the summed -$\chi^2(7)$ joint test is able to identify significant weather effects. The confidence is very high at the 99% level. The effects for individual sub-periods are found in 1991, 1992, 1995, 1999, 2002, 2003, 2008, 2011, and 2013. To further identify the weather variables that contribute to the significant effects, I add the 25 $\chi^2(1)$ statistics for individual weather variables over the 25 one-year sub-samples. The summed statistics are significant for air pressure and rainfall. This finding leads me to conclude that the significant weather effects for the SET index return are air pressure and rainfall effects.

Table 3, Panel 2 reports the results for the SET 50 index return. The full period is 21 years from 1995 to 2015. The results are similar to those for the SET index return. The full-sample regression tests cannot detect either EIV problems or weather effects. However, when the full period is broken into 21 one-year sub-periods, the summed chi square statistics suggest significant EIV problems and weather effects. Air pressure and rainfall are the contributing variables to the significant weather effects.

The results for the MAI index return are reported in Table 3, Panel 3. The 14-year full-period regression detects the EIV problem at the 90% confidence level; the joint tests from individual sub-sample regressions also find significant EIV problems. The weather effects are not significant in the full-period regression test. Although the sub-sample tests for 2008 and 2014 find significant weather effects, based on the joint test, the effects are not significant for the full period. Because the effects are weak or nonexistent in the full period and sub-periods, I conclude that weather does not influence the MAI index returns.

Table 3
Test results for errors-in-variables problems and weather effects

Panel 1: SET Index Returns

Period	Joint EIV Problems $\chi^2(7)$	Individual Regression Coefficients $\chi^2(1)$								Joint Weather Effects $\chi^2(7)$
		Lagged Return	Weather Variables							
			Air Pressure	Cloud Cover	Ground Visibility	Rainfall	Relative Humidity	Temperature	Wind Speed	
1991-2015	11.1611	16.0137***	2.0422	0.9597	2.9155*	0.5333	0.1066	2.3966	0.1510	7.7263
1991	21.4992***	0.0039	0.1173	1.9959	0.1089	2.1054	0.0020	2.5329	4.1593**	18.8048***
1992	1.8380	0.1112	0.9880	0.6086	0.0483	4.2269**	0.7330	0.7805	0.1895	12.9761*
1993	5.4128	5.8212**	2.1591	0.2481	0.3722	1.3637	0.1801	0.9295	0.4641	8.8417
1994	10.8720	0.1818	0.4676	1.2496	1.5643	0.0797	1.9500	2.8453*	0.0005	7.8758
1995	5.8836	4.4570	2.7801*	0.9116	7.2904***	0.0526	0.0171	0.2860	1.2665	12.8647*
1996	20.2902***	2.6881	0.0656	0.1530	3.5558*	0.8058	1.0248	0.0160	1.8659	9.3154
1997	11.2448	7.7710***	1.2002	4.1569**	0.0320	0.0216	0.0104	2.8247*	0.0341	8.9169
1998	18.5791***	2.6889	1.0644	4.6411**	0.0006	4.7449**	1.5486	0.0616	0.2874	11.4691
1999	2.9577	3.8762**	2.0390	2.7050	0.1251	2.7983*	0.1062	2.8749*	0.0743	13.6880*
2000	1.0434	0.2531	1.0536	0.4368	0.1073	1.9379	0.8410	0.8910	0.1671	5.0422
2001	8.9603	0.4252	1.5488	0.0458	0.0002	0.0402	0.3289	2.8030*	0.0039	4.7817
2002	26.0256***	2.5744	1.8324	2.3428	0.0315	17.4375***	0.4962	0.1485	1.3056	26.7597***
2003	9.4662	4.1825**	5.6235**	0.6125	0.2318	4.3067**	0.4709	0.3561	0.3032	19.8781*
2004	29.5476***	0.0042	0.5720	0.0969	0.5728	0.0079	0.0335	0.0145	0.2798	2.1754
2005	25.6466***	3.6331*	3.1481*	0.0216	0.4454	1.6001	0.2623	2.5071	2.5399	8.5241
2006	14.2256**	2.8726*	0.1932	2.60E-5	0.0971	2.0475	0.0564	0.0412	1.7086	7.9538
2007	64.1189***	2.6707	0.0143	1.5086	0.0140	1.1890	1.2174	0.8963	0.0970	5.3124
2008	28.3844***	0.4515	5.3053**	1.1748	4.1674**	3.7328*	1.2236	0.5370	1.5055	20.0672***
2009	7.6383	0.9005	1.2310	0.0069	2.3948	0.9463	0.2950	0.0200	0.1548	8.5274
2010	8.0449	0.1116	0.0330	0.2858	1.2015	0.3847	1.8525	0.2502	1.3324	10.6605
2011	6.9352	0.6594	2.0334	0.0167	0.2004	0.0703	3.4824*	1.9141	3.6174*	12.7987*
2012	7.2667	0.0946	0.0650	6.5844**	3.1954*	0.3921	2.7496*	0.0943	0.3189	11.4803
2013	15.8180**	0.0452	3.4837*	0.7602	0.4645	0.6769	1.3596	2.4337	1.0498	14.0294*
2014	13.5893*	1.8738	2.4654	0.4271	1.0810	0.0411	0.0822	0.0019	0.8894	9.4056
2015	30.3922***	0.0550	0.1565	1.2496	0.3318	0.0239	0.6914	1.0190	0.0219	6.9359
Joint Ho. χ^2 (d.f.)	395.6806*** (175)	48.4068*** (25)	39.6405** (25)	32.2400 (25)	27.6346 (25)	51.0337*** (25)	21.0151 (25)	27.0793 (25)	23.6367 (25)	279.0849*** (175)

(*continued on next page*)

Table 3: (*continued*)

Panel 2: SET 50 Index Return

Period	Joint EIV Problems $\chi^2(7)$	Individual Regression Coefficients $\chi^2(1)$								Joint Weather Effects $\chi^2(7)$
		Lagged Return	Weather Variables							
			Air Pressure	Cloud Cover	Ground Visibility	Rainfall	Relative Humidity	Temperature	Wind Speed	
1995-2015	8.8996	10.9749^{***}	3.6016^{**}	0.5397	0.4184	0.3361	0.1076	2.3172	0.0197	7.1809
1995	5.0252	0.4235	0.1022	0.0516	1.5035	0.0667	0.2168	0.0846	2.1656	7.2301
1996	25.4553^{***}	2.2913	0.0025	0.1595	4.1782^{*}	1.2454	1.2091	0.0389	2.5739	10.7780
1997	8.3435	8.1335^{***}	1.1698	4.0766	8.59E-04	0.0137	0.0043	2.4156	0.0139	8.0863
1998	15.8826^{**}	2.5608	0.8202	5.3947^{**}	0.0024	4.3627^{**}	1.8623	0.1097	0.1671	11.7195
1999	3.3853	3.8759^{**}	2.4791	2.7985^{*}	0.1606	2.2137	0.3002	3.2144^{*}	0.2775	15.0331^{**}
2000	1.1338	0.4717	1.2260	0.3840	0.0415	1.0880	0.9985	0.8752	0.1788	4.0575
2001	8.3910	0.2971	1.9173	2.73E-06	0.0346	0.0810	0.7380	3.3307^{*}	0.0106	6.7658
2002	22.7391^{***}	3.1530^{*}	1.3467	2.0092	0.0191	18.3017^{***}	0.5939	0.0691	2.0486	25.9243^{***}
2003	10.7521	6.9559^{***}	5.7508^{**}	1.3437	0.0495	2.4070	0.0397	0.0270	0.0502	15.5127^{**}
2004	28.3276^{***}	0.1108	0.5178	0.6498	0.4980	0.1184	0.5545	0.0498	0.4446	2.9174
2005	24.8223^{***}	2.4485	3.0333^{*}	0.0590	0.3247	1.0859	0.3772	2.1441	2.5472	7.6225
2006	16.1366^{**}	2.6831	0.0797	0.0014	0.0435	2.3281	0.0863	0.0408	1.4246	8.7377
2007	61.6746^{***}	2.1180	0.0220	1.5082	0.0603	1.4910	1.6071	0.8669	0.1745	6.7304
2008	28.7694^{***}	0.1492	4.2015^{**}	1.2973	1.4552	3.5658^{**}	0.3265	0.3092	1.2095	15.3666^{**}
2009	7.8143	1.3668	1.4589	0.0113	2.1868	0.9707	0.2191	0.0209	0.2092	8.8685
2010	9.1244	0.0963	0.0700	0.3260	1.0861	0.3393	1.9387	0.4746	0.8543	9.5850
2011	8.6512	0.3020	2.2533	0.0183	0.3325	0.0578	3.3846^{*}	1.9359	3.1277^{*}	12.2582^{*}
2012	9.6098	0.2904	0.0316	7.3967^{***}	3.0912^{*}	0.5393	3.6614^{*}	0.2754	0.3687	12.8014^{*}
2013	19.8580^{*}	0.2410	3.6838^{*}	0.5156	0.5173	0.3606	0.9803	1.9837	1.3901	12.0008
2014	15.4010^{**}	1.4388	2.7586^{*}	0.2921	1.2854	0.0539	0.0415	0.0129	0.7488	10.3139
2015	21.4061^{***}	0.0213	0.1130	1.0024	0.6926	0.0017	0.0711	0.2503	0.0055	4.3716
Joint Ho. χ^2(d.f.)	352.7030^{***} (147)	39.4289^{***} (21)	33.0381^{**} (21)	29.2960 (21)	17.5639 (21)	40.6924^{***} (21)	19.2112 (21)	18.5297 (21)	19.9909 (21)	216.6815^{***} (147)

(*continued on next page*)

Table 3: (*continued*)

Panel 3: MAI Index Return

Period	Joint EIV Problems $\chi^2(7)$	Individual Regression Coefficients $\chi^2(1)$								Joint Weather Effects $\chi^2(7)$
		Lagged Return	Weather Variables							
			Air Pressure	Cloud Cover	Ground Visibility	Rainfall	Relative Humidity	Temperature	Wind Speed	
2002-2015	12.5102*	0.4393	0.2720	0.0005	0.8597	2.3125	0.9802	0.2672	0.5772	6.0490
2002	20.1022***	2.4105	6.6000**	2.4687	2.1253	0.7406	1.0045	3.4212*	0.3263	7.3761
2003	6.1235	0.8187	0.6177	2.5634	0.7532	5.5392**	1.6312	0.1000	0.2302	10.7521
2004	40.9875***	0.7816	0.3237	0.0090	3.10E-4	0.1344	0.0062	0.1555	0.2341	1.9196
2005	7.5942	3.0708*	0.0313	0.4965	0.2514	0.0082	0.9539	0.4743	1.9278	3.1415
2006	3.8403	2.7419*	0.7770	0.0850	2.9195	0.0082	1.3029	1.3664	2.1308	6.1711
2007	7.8029	9.1828***	0.6014	2.8127*	3.48E-04	1.1915	0.2581	0.3009	2.3456	9.9397
2008	7.1613	5.1891**	4.5967**	0.3500	0.2366	7.9097***	0.1163	0.4080	0.0149	14.3343**
2009	10.9464	0.1752	0.0075	0.0060	1.1825	0.5334	0.0196	0.3439	0.0011	3.1193
2010	2.7323	3.3785*	0.0319	1.5119	4.3584**	0.7183	1.5751	0.0075	2.1857	11.0308
2011	7.1032	4.2680**	0.6430	0.0147	0.0971	0.0056	2.4390	0.0429	3.8920**	11.4595
2012	6.3406	3.2385	0.4733	0.4268	1.3134	0.0403	0.0537	0.5213	0.1023	2.8607
2013	15.2938	0.1005	1.5618	1.8983	0.2229	0.4142	0.1741	3.2673*	0.9861	10.3045
2014	10.2514	1.6044	1.1948	2.1545	0.8226	0.7767	0.0844	0.0186	0.1267	15.0025**
2015	23.8521***	7.0503***	0.3745	0.7465	0.2293	0.1452	1.5991	0.1732	2.3015	5.4304
Joint Ho. χ^2(d.f.)	170.1316*** (98)	44.0110*** (14)	17.8346 (14)	15.5440 (14)	14.5130 (14)	18.1655 (14)	11.2180 (14)	10.6011 (14)	16.8053 (14)	112.8422 (98)

Note: *, **, and *** = significance at the 90%, 95%, and 99% confidence levels, respectively. d.f. = degrees of freedom; Joint Ho. = Joint Hypothesis.

DISCUSSION

Usefulness of Artificial Hausman Regressions

Although the EIV problems are present, OLS and AH regressions may yield similar results. If the results for the two regressions are generally similar, the AH regression is not useful; this regression should be avoided because it is more complicated and more difficult to estimate.

To demonstrate that AH regression warrants the effort, I check for the sub-periods in which EIV problems are significant and then compare the weather-test results for the AH regression against the OLS regression. The fact that the two regressions give the same weather-test results implies a zero probability of conflict. I test the no-conflict hypothesis using Pearson's chi square test. The test fails if the probability is zero. Thus, I assume small probabilities of 1% and 5% under the null hypothesis. The results are shown in Table 4.

From the table, the hypothesis is rejected for the three index returns when the probability is 1%. At a 5% probability of conflict, the hypothesis is rejected for the SET and SET 50 index returns. Based on this finding, the AH regression is useful. The analyses begin with the OLS results. However, when the EIV and missing-variable problems are present, the OLS coefficients are both biased and inconsistent. The AH coefficients remain consistent. The quality improves if the analyses switch from using OLS results to AH results.

Table 4
Tests for the Usefulness of artificial hausman regressions

Statistics		SET Index Return	SET 50 Index Return	MAI Index Return
Number of Significant EIV Cases		12	11	5
Number of Conflicting Weather Results		2	3	1
$\chi^2(1)$	Pb = 1%	29.4533^{***}	75.9282^{***}	18.0500^{***}
	Pb = 5%	3.2667^{*}	10.9136^{***}	2.2500

Note: * and *** = significance at 90% and 99% confidence levels, respectively. *Pb* = Probability of conflicting results for the OLS regression with the artificial Hausman regression, given that the EIV problem is significant.

IV Regressions in Furhwirth and Sogner (2015)

Furhwirth and Sogner (2015) noted that the weather effects on asset prices were indirect and resulted from changes in investor's mood. In the indirect-effects specification, weather and control variables can be correlated with regression errors. Hence, an IV two-stage least squares estimation was used to provide consistent estimates. The researchers reported that the IV results differed from the OLS results, implying that the IV regressions were important and useful. My approach is able to manage the misspecification from the weather's indirect effects as well. The AH regressions produce exactly the same estimates as the two-stage least squares regressions (Racicot & Theoret, 2008).

Time-Varying Weather Effects and Market Efficiency

If the market is efficient, weather effects cannot exist or must disappear quickly. The fact that the effects exist is evidence against market efficiency. Although the market is not fully efficient, efficiency should improve over time due to factors such as adaptive investors, strong competition, communication networks and financial innovation (Lo, 2004). For Thailand, Khanthavit (2016b) found improving efficiency for the SET and SET 50 index returns but not for the MAI index return.

Researchers, e.g., Yoon and Kang (2009), argued that existing weather effects in early sub-samples and disappearing effects in later sub-samples supported the improving-efficiency hypothesis. In essence, the researchers linked improving efficiency to a negative relationship between weather effects and time.

In this study, the results in Table 3 allow me to examine this important improving-efficiency hypothesis. I follow the procedure in Doyle and Chen (2009) by using the sizes of chi-square statistics in the last columns of Panels 1 to 3 to measure the significance of the weather effects and relate them to time. Before I continue with the test, I note in Table 3 that the weather effects appeared in early sub-periods, disappeared, re-appeared, and then disappeared again. This is known as wandering behaviour. Although market efficiency improves over time, it may also wander. The results in Table 3 allow me to relate the weather effects to the efficiency levels. In equation (2), the size and significance of the return's autocorrelation coefficient ρ_τ indicate the efficiency levels (Lo, 2004). The chi square statistics for the significance of ρ_τ are readily available in Column 3 of Panels 1 to 3. Table 5 shows the regression coefficients of the chi square statistics for weather effects with those of ρ_τ's significance and time. This test is new and is the first to explicitly relate the weather effects with the efficiency levels. If the weather effects disappear over time, the time coefficient must be negative and significant. If the effects wander with the efficiency level, the market-efficiency coefficient must be positive and significant. However, in Table 5, none of the time coefficients are significant; therefore, I conclude that the weather effects in the SET exist and wander over time. It is interesting and important to find for the SET 50 index that the market-efficiency coefficient is positive and significant at the

95% confidence level. The results support the covariation of weather effects with market-efficiency levels.

Table 5
Relationships of Bangkok-weather effects with time and market efficiency

Index Return	Time	Market-Efficiency
SET^{OLS}	–0.0583	0.1050
$SET\ 50^{AH(Pal)}$	0.1615	1.4656^{**}
MAI^{OLS}	0.2259	0.2170

Note: ** = significance at the 95%, confidence level, ^{OLS} = results from the OLS regression, and $^{AH(Pal)}$ = results from the artificial Hausman regression using the two-step, Pal (1980)-based IVs.

Who are Weather-Sensitive Investors?

Forgas (1995) proposed that investors with limited knowledge tended to allow mood to interfere with decision-making. In Thailand, these investors are small, local, individual investors (Dowling & Lucey, 2008). Comparing the results of the SET 50 index returns, in which large investors are dominant, against the MAI index returns, in which small individuals are dominant, sheds light on Forgas' (1995) proposal.

In Table 3, Column 3 of Panels 2 and 3, the no return autocorrelation-based market-efficiency hypothesis was rejected for both the SET 50 and MAI index returns. Thus, if the weather effects were present, the dominant investors should have been the contributors. The fact that weather effects existed for the SET 50 index return but not for the MAI index return negates the Forgas (1995) hypothesis. It is likely that large investors were weather-sensitive and caused weather effects in the Stock Exchange of Thailand. This finding is counter-intuitive. So, how can it be explained?

Consider the Kyle (1985) model. If it is modified to incorporate weather effects, the value known to informed investor can be the sum of the true stock value and weather part, while the random trade quantity of noise trader is due to noise plus the weather part. Moreover, if the volatility of the noise is large, the weather part in the random trade quantity is effectively zero. In equilibrium, the price reflects the true value, the weather part, and the noise-trader's volume.

Small, individual investors were considered noise traders in the literature (e.g., De Bondt, 1998). For MAI stocks, they were the majority, whose trading constituted 96% of the aggregate volume (Khanthavit & Chaowalerd, 2016). The noise-trader's volume was large and dominant vis-à-vis the weather part, so that weather effects were not significant.

Comparison with Previous Studies on the Stock Exchange of Thailand

Weather effects were studied for the Stock Exchange of Thailand, for example, by Nirojsil (2009) and Sriboonchitta et al. (2014). Although their methodologies and sample periods differed, their results corresponded to one another. The temperature effects were significant. In Table 3, I could not find significant temperature effects in the summed chi square tests or full sample tests. By examining the results in Table 3, Panel 1 for the same sample periods as theirs, i.e., from 1992 to 2008 for Nirojsil (2009) and from 1996 to 2010 for Sriboonchitta et al. (2014), I find significant but weak temperature effects at the 90% confidence level in 1994, 1997, 1999, and 2001. An important and interesting question is why our results differ. Three possible explanations are as follows.

First, their models were mis-specified due to measurement errors in the temperature variable. To check this theory, I re-estimate Equation (1) for their sample periods and with the lagged return and only using the temperature variable. I check for the EIV problem and test for the temperature effect using the OLS estimates when the EIV problem is not present. If it is present, I use the AH estimates. The results are in Columns 2 and 3 of Table 6. Using the approach I proposed, the temperature effects are found. Thus, the EIV problem cannot be the explanation.

Second, from Table 1, Panel 2, the temperature was significantly correlated with air pressure and rainfall. Thus, the significant temperature effects could, in fact, have been the air pressure and rainfall effects. I check for this explanation by estimating Equation (1) in their sample periods. The results are in Table 6, Columns 4 to 6. In Column 5, the temperature effects are still significant, but they are at a 90% confidence level and are much weaker than the effects shown in Column 3. The significant temperature effect is partly explained by the significant air pressure and rainfall effects.

Third, the fixed-effect hypothesis implicitly made by Nirojsil (2009) and Sriboonchitta et al. (2014) was incorrect. If the incorrect hypothesis is the explanation, the temperature effect should disappear in the regression of Equation (2) for the one-year sub-periods in their full samples. I use the chi square statistics in Table 3, Panel 1 to check for this explanation. The results are in Table 6, Columns 7 to 9. The summed chi square statistics in column 8 for significant temperature coefficients are small and not significant for the two studies. However, the joint tests in Table 6, Column 9 find significant weather effects. To link the main contributors of the significant effects with air pressure and rainfall, I compute the summed chi square statistics for significant air pressure and rainfall effects for Nirojsil (2009) and Sriboonchitta et al.'s (2014) sample periods. I find that the air pressure statistics for Nirojsil (2009) and Sriboonchitta et al. (2014) are significant at the 95% and 90% confidence levels, respectively. The rainfall statistics for both studies are significant at the 99% confidence level. These findings, together with that for the second explanation, lead me to conclude that the significant temperature results in the previous studies were incorrect. They were driven by the incorrect fixed-effect assumption. In fact, the significant weather effects were the air pressure and rainfall effects I found in this study.

Further Investigation of Air Pressure and Rainfall Effects on Stock Returns

Boker, Leibenluft, Deboeck, Virk, and Postolache (2008) explained that air pressure affected moods due to its effect on neurotransmitters implicated in mood regulation. With respect to Wurtman and Wurtman (1989), sunlight associated with rainy days caused falling serotonin levels to fall, which led to bad moods. Studies, e.g., Goldstein (1972), have reported that good moods were associated with high air pressure levels, but others, e.g., Schwarz and Clore (1983), reported that bad moods were associated with rainfall. Based on these findings, the air pressure and rainfall effects on stock returns should be unidirectional. In this study, however, I find that the significant air pressure and rainfall coefficients can change signs from one sub-period to another (Khanthavit, 2016c). For example, for the SET index return, the air pressure coefficients were significant and positive in 1995, 2003, 2011, and 2013 but were significant and negative in 2005 and 2008. The rainfall coefficients were significant and positive in 1998 and 2002; they were significant and negative in 1992, 1998, 2003, and 2008. Sign changes are also possible. Denissen et al. (2008) and Keller et al. (2005) noted that mood reactions to day-to-day weather fluctuations might not be generalised to reactions to seasonal fluctuations. Although seasonality was removed from among the sample weather variables (Hirshleifer & Shumway, 2003), the issue of whether the good or bad weather was temporary or prolonged was important to both investors and their moods (Watson, 2000).

Table 6
Comparison with previous studies

Sample Periods	Full-Period Regressions					Sub-Period Regressions on Seven Weather Variables		
	Temperature Only		Seven Weather Variables					
	EIV Problems[1]	Temperature Effects[1]	EIV Problems[2]	Temperature Effects[1]	Joint Weather Effects[2]	EIV Problems[3]	Temperature Effects[4]	Joint Weather Effects[3]
Nirojsil (2009)	4.4999**	5.6582**	9.7270	3.7792*	0.1820	284.4968***	18.8132	276.1736***
Sriboonchitta et al. (2014)	2.2414	4.1466**	10.0305	2.8939*	0.2451	186.4423***	14.2421	163.0719***

Note: *, **, and *** = significance at the 90%, 95%, and 99% confidence levels, respectively. [1] and [2] = $\chi^2(1)$ and $\chi^2(7)$ statistics. [3] = $\chi^2(119)$ statistics for Nirojsil (2009) and $\chi^2(105)$ statistics for Sriboonchitta et al. (2014). [4] = $\chi^2(17)$ statistic for Nirojsil (2009) and $\chi^2(15)$ statistic for Sriboonchitta et al. (2014).

CONCLUSION

Tests for weather effects generally have at least four estimation problems: incorrect fixed-effect assumptions, missing-data problems, errors-in-variables (EIV) problems, and omitted-variable problems. The incorrect assumptions, missing-data problems, and omitted-variable problems were addressed in previous studies. However, the results were not satisfactory or the approaches were not successful. Moreover, the EIV problem had never been raised. In this study, I proposed an approach to resolve the four estimation problems simultaneously. The incorrect fixed-effect assumption was fixed by breaking a long full-sample period into short one-year sub-periods. The missing-data problem was resolved by imputing unconditional means of weather variables into the missing cases. I mitigated the omitted-variable problem by considering a comprehensive set of weather variables. Finally, I corrected the EIV and omitted-variable problems by using OLS regressions together with artificial Hausman (AH) regressions and choosing consistent AH results when the problem was present. Otherwise, the efficient, unbiased, and consistent OLS results were chosen for the analyses.

I revisited the Bangkok weather effects to demonstrate the advantages of the proposed approach. Bangkok was chosen because it featured conditions that led to the four estimation problems, and the Stock Exchange of Thailand is an important emerging market. The study found conflicting results in OLS and AH regressions in some sub-periods when the EIV problem was present. In the conflict cases, the study chose consistent AH results over biased and inconsistent OLS results. As opposed to previous studies, this study did not find significant temperature effects but instead identified significant air pressure and rainfall effects. The study showed that the temperature effects were due to the incorrect fixed-effect assumption. The temperature effects were, in fact, the air pressure and rainfall effects.

It is important to note that the approach did not completely resolve the incorrect fixed-effect assumption; the assumption was still made for the one-year sub-periods. It is more realistic to allow the effects to vary daily over the sample period. The study can be extended into time-varying weather effects, but I leave this extension for future research.

ACKNOWLEDGEMENTS

The author thanks the Faculty of Commerce and Accountancy, Thammasat University for the research grant. The author also thanks Sumridh Sudhibrabha, Somchai Sanplang, and the Thai Meteorological Department for the weather-variable data.

REFERENCES

Afifi, A. A., & Ekashoff, R. M. (1967). Missing observations in multivariate statistics II. Point estimation in simple linear regression. *Journal of the American Statistical Association*, *61*(317), 10–29. https://doi.org/10.1080/01621459.1967.10482884

Akhtari, M. (2011). Reassessment of the weather effect: Stock prices and Wall Street weather. *Michigan Journal of Business*, *4*(1), 51–70.

Barnston, A. G. (1988). The effect of weather on mood, productivity, and frequency of emotional crisis in a temperate continental climate. *International Journal of Biometeorology*, *32*(2), 134–143. https://doi.org/10.1007/BF01044907

Baum, C. F. (2006). *An introduction to modern econometrics using Stata*. Texas: StataCorp.

Bloomberg Markets. (2013). The top 20 emerging markets, 31 January. Retrieved from http://www.bloomberg.com/slideshow/2013-01-30/the-top-20-emerging-markets.html#slide19

Boker, S. M., Leibenluft, E., Deboeck, P. D., Virk, G., & Postolache, T. T. (2008). Mood oscillations and coupling between mood and weather in patients with rapid cycling bipolar disorder. *International Journal of Child Health and Human Development*, *1*(2), 181–203.

Brahmana, R. K., Hooy, C. W., & Ahmad, Z. (2012). The role of herd behaviour in determining the investor's Monday irrationality. *Asian Academy of Management Journal of Accounting and Finance*, *8*(2), 1–20.

Brahmana, R. K., Hooy, C. W., & Ahmad, Z. (2015). Does tropical weather condition affect investor behavior? Case of Indonesian stock market. *Global Business and Economics Review*, *17*(2), 188–202. https://doi.org/10.1504/GBER.2015.068566

Cao, M., & Wei, J. (2005). Stock market returns: A note on temperature anomaly. *Journal of Banking and Finance*, *29*(6), 1559–1573. https://doi.org/10.1016/j.jbankfin.2004.06.028

Coen, A., & Hubner, G. (2009). Risk and performance estimation in hedge funds revisited: Evidence from errors in variables. *Journal of Empirical Finance*, *16*(1), 112–125.

Cunningham, M. (1979). Weather, mood and helping behavior: Quasi-experiments with the sunshine Samaritan. *Journal of Personality and Social Psychology*, *37*(11), 1947–1956. https://doi.org/10.1037/0022-3514.37.11.1947

Dagenais, M. G. (1973). The use of incomplete observations in multiple regression analysis: A generalized least squares approach. *Journal of Econometrics*, *1*(4), 317–328. https://doi.org/10.1016/0304-4076(73)90018-3

Dagenais, M. G., & Dagenais, D. L. (1997). Higher moment estimators for linear regression models with errors in variables. *Journal of Econometrics*, *76*(1–2), 193–221. https://doi.org/10.1016/0304-4076(95)01789-5

De Bondt, W. F. M. (1998). A portrait of the individual investor. *European Economic Review*, *42*(3), 831–844. https://doi.org/10.1016/S0014-2921(98)00009-9

Denissen, J. J. A., Butalid, L., Penke, L., & van Aken, M. A. G. (2008). The effects of weather on daily mood: A multilevel approach. *Emotion*, *8*(5), 662–667. https://doi.org/10.1037/a0013497

Dowling, M. & Lucey, B. M. (2005). Weather, biorhythms, beliefs and stock returns—Some preliminary Irish evidence. *International Review of Financial Analysis*, *14*(3), 337–355. https://doi.org/10.1016/j.irfa.2004.10.003

Dowling, M., & Lucey, B. M. (2008). Robust global mood influences in equity pricing. *Journal of Multinational Finance*, *18*(2), 146–164. https://doi.org/10.1016/j.mulfin.2007.06.002

Doyle, J. R., & Chen, C. H. (2009). The wandering weekday effect in major stock markets. *Journal of Banking and Finance*, *33*(1), 1388–1399. https://doi.org/10.1016/j.jbankfin.2009.02.002

Durbin, J. (1954). Errors in variables. *Review of the International Statistical Institute*, *22*(1/3), 23-32. https://doi.org/10.2307/1401917

Eagles, J. (1994). The relationship between mood and daily hours of sunlight in rapid cycling bipolar illness. *Biological Psychiatry*, *36*(6), 422–424. https://doi.org/10.1016/0006-3223(94)91216-5

Forgas, J. P. (1995). Mood and judgment: The affect infusion model (AIM). *Psychological Bulletin*, *177*(1), 39–66. https://doi.org/10.1037/0033-2909.117.1.39

Furhwirth, M., & Sogner, L. (2015). Weather and SAD related effects on the financial market. *Quarterly Review of Economics and Finance*, *57*, 11–31. https://doi.org/10.1016/j.qref.2015.02.003

Goetzman, W. N., Kim, D., Kumar, A., & Wang, Q. (2015). Weather-induced mood, institutional investors, and stock returns. *Review of Financial Studies*, *28*(1), 73–111. https://doi.org/10.1093/rfs/hhu063

Goldstein, K. M. (1972). Weather, mood, and internal-external control. *Perceptual and Motor Skills*, *35*(3), 786.

Griffitt, W., & Veitch, R. (1971). Hot and crowded: Influences of population density and temperature on interpersonal affective behavior. *Journal of Personality and Social Psychology*, *17*(1), 92–98. https://doi.org/10.1037/h0030458

Hirshleifer, D., & Shumway, T. (2003). Good day sunshine: Stock returns and the weather. *Journal of Finance, 58*(3), 1009–1032.

Howarth, E., & Hoffman M. S. (1984). A multidimensional approach to the relationship between mood and weather. *British Journal of Psychology, 75*(1), 15–23. https://doi.org/10.1111/j.2044-8295.1984.tb02785.x

Keller, M. C., Fredrickson, B. L., Ybarra, O., Cote, S., Johnson, K., Mikels, J., Conway, A., & Wager, T. (2005). A warm heart and a clear head: The contingent effects of weather on mood and cognition. *Psychological Science*, *15*(9), 724–731. https://doi.org/10.1111/j.1467-9280.2005.01602.x

Khanthavit, A. (2016a). Bangkok weather, weather-sensitive investors, and Thai government-bond returns (Working Paper). Bangkok: Faculty of Commerce and Accountancy, Thammasat University. https://doi.org/10.13140/RG.2.1.3950.4880

Khanthavit, A. (2016b). The fast and slow speed of convergence to market efficiency: A note for large and small stocks on the Stock Exchange of Thailand. *Social Science Asia*, *2*(2), 1–6.

Khanthavit, A. (2016c). Instrumental-variable estimation of Bangkok-weather effects in the Stock Exchange of Thailand: Appendix (Supplement). Bangkok: Faculty of Commerce and Accountancy, Thammasat University. https://doi.org/10.13140/RG.2.1.2598.8087

Khanthavit, A. & Chaowalerd, O. (2016). Revisiting the day-of-the-week effect in the Stock Exchange of Thailand. *Journal of Business Administration*, *39*(151), 73–89.

Kyle, A. S. (1985). Continuous auction and insider trading. *Econometrica*, *53*(6), 1315–1335. https://doi.org/10.2307/1913210

Little, R. J. A. (1992). Regression with missing X's: A review. *Journal of the American Statistical Association*, *87*(420), 1227–1237.

Lo, A. (2004). The adaptive markets hypothesis: Market efficiency from and evolutionary perspective. *Journal of Portfolio Management, 30*(5), 15–29. https://doi.org/10.3905/jpm.2004.442611

Lu, J., & Chou, R. K. (2012). Does the weather have impacts on returns and trading activities in order-driven stock markets? Evidence from China. *Journal of Empirical Finance*, *19*(1), 79–93. https://doi.org/10.1016/j.jempfin.2011.10.001

Lucey, B., & Dowling, M. (2005). The role of feelings in investor decision-making. *Journal of Economic Surveys*, *19*(2), 211–237. https://doi.org/10.1111/j.0950-0804.2005.00245.x

Mehra, R., & Sah, R. (2002). Mood fluctuations, projection bias, and volatility of equity prices. *Journal of Economic Dynamics and Control*, *26*(5), 869–887. https://doi.org/10.1016/S0165-1889(01)00035-5

Newey, W. K., & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica, 55*(3), 703–708. https://doi.org/10.2307/1913610

Nirojsil, N. (2009). Are stock market returns related to the weather effects? Empirical evidence from Thailand (unpublished master's independent study). Bangkok: Faculty of Commerce and Accountancy, Thammasat University. Retrieved from http://mif2.tbs.tu.ac.th/getFileDownload.php?path=02/file_doc/6620131119040712.pdf

Pal, M. (1980). Consistent moment estimators of regression coefficients in the presence of errors in variables. *Journal of Econometrics*, *14*(3), 349–364. https://doi.org/10.1016/0304-4076(80)90032-9

Racicot, F. E., & Theoret, R. (2008). On comparing hedge fund strategies using new Hausman-based estimators. *Journal of Derivatives and Hedge Funds*, *14*(1), 9–30. https://doi.org/10.1057/jdhf.2008.3

Racicot, F. E., & Theoret, R. (2010). Optimal instrumental variables generators based on improved Hausman regression, with an application to hedge fund returns. *Journal of Wealth Management*, *13*(1), 103–123. https://doi.org/10.3905/JWM.2010.13.1.103

Ramsey, J. B. (1969). Tests for specification errors in classical linear least-squares regression analysis. *Journal of the Royal Statistical Society. Series B (Methodological)*, *31*(2), 350–371.

Sanders, J. L., & Brizzolara, M. S. (1982). Relationships between weather and mood. *Journal of General Psychology*, *107*(1), 155–156. https://doi.org/10.1080/00221309.1982.9709917

Saunders, E. M., Jr. (1993). Stock prices and the Wall Street weather. *American Economic Review*, *83*(5), 1337–1345.

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology*, *45*(3), 513–523. https://doi.org/10.1037/0022-3514.45.3.513

Sriboonchitta, S., Chaitip, P., Sriwichailamphan, T., & Chaiboonsri, C. (2014). Stock market returns and the temperature effects: Thailand. *Global Journal of Marketing and Management*, *1*(1), 11–15.

Stock, J., & Watson, M. W. (2003). *Introduction to econometrics*. New York: Prentice Hall.

Stock Exchange of Thailand. (2016). *Annual report 2015: Towards the 5th decade of sustainable growth*. Retrieved from http://www.set.or.th/en/about/annual/files/annual_report_2015_en.pdf

Stock News Online. (2015). SET, together with Brokers, the Thai Chamber of Commerce and Board of Trade of Thailand, and the Federation of Thai Industries initiated New Frontier Roadshow. Forty thousand, new investors were targeted (ตลท. จับมือโบรกฯ-หอการค้า-ส.อ.ท. เดินหน้าจัดโรดโชว์ ตั้งเป้าปีนี้มีผู้ลงทุนเพิ่ม 4 หมื่นราย), 1 April. Retrieved from http://www.kaohoon.com/online/content/view/6001

Troros, H., Deniz, A., Saylan, L., Sen, O., & Baloglu, M. (2005). Spatial variability of chilling temperature in Turkey and its effect on human comfort. *Meteorology and Atmospheric Physics*, *88*(1–2), 107–118. https://doi.org/10.1007/s00703-003-0072-5

Yoon, S., & Kang, S. H. (2009). Weather effects on returns: Evidence from the Korean stock market. *Physica A*, *388*(5), 682–690. https://doi.org/10.1016/j.physa.2008.11.017

Watson, D. (2000). *Mood and temperament* (1st ed.). New York: Guilford Press.

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*, *48*(4), 817–838. https://doi.org/10.2307/1912934

Worthington, A. (2009). An empirical note on weather effects in the Australian stock market, *Economic Papers*, *28*(2), 148–154. https://doi.org/10.1111/j.1759-3441.2009.00014.x

Wurtman, R. J., & Wurtman, J. J. (1989). Carbohydrates and depression. *Scientific American*, *260*(1), 68–75. https://doi.org/10.1038/scientificamerican0189-68

ASIAN ACADEMY *of* MANAGEMENT JOURNAL *of* ACCOUNTING *and* FINANCE

AAMJAF Vol. 13, No. 1, 113–142, 2017

NORMAL, ABNORMAL BOOK-TAX DIFFERENCES AND ACCOUNTING CONSERVATISM

Rakia Riguen Koubaa[1*] and Anis Jarboui[2]

[1] *Faculty of Economics and Management, University of Sfax, R Aeoport Km4 P14, Sfax, Tunisia*
[2] *Higher Institute of Business Administration, University of Sfax, R Aeoport Km4 P14, Sfax, Tunisia*

*Corresponding author: rakiariguen@yahoo.com

ABSTRACT

The present paper investigates the effect of book-tax differences on the accounting conservatism (as a proxy for financial reporting quality). The major objective of this study was to examine the extent to which regulatory and opportunistic information in book-tax differences influence accounting conservatism. We also aim to examine if book-tax differences are a signal of "bad news" for investors. Using publicly available financial statements from 2005 to 2012 for 28 Tunisian listed firms on the Tunis Stock Exchange and operating in the industrial and commercial sectors, we use a current measure for accounting conservatism and documents that observation with large book-tax differences are associated with low levels of accounting conservatism. Also, we find that firms with abnormal book-tax differences and normal book-tax differences exhibit less accounting conservatism. Overall, the results suggest that the total and differing components of book-tax differences have differential implications on accounting conservatism. Our research is valuable for researchers, shareholders as well as regulators. For researchers, it appears to an innovative area for future research. For shareholders, it shows the role of the information transmitted by book-tax differences into the analysis of earnings quality published by firms. This study also helps regulators to improve accounting rules and tax rule.

Keywords: book-tax differences, abnormal book-tax differences, normal book-tax differences, accounting conservatism

Publication date: 30 August 2017

To cite this article: Riguen, K. R., & Jarboui, A. (2017). Normal, abnormal book-tax differences and accounting conservatism. *Asian Academy of Management Journal of Accounting and Finance, 13*(1), 113–142. https://doi.org/10.21315/aamjaf2017.13.1.5

To link to this article: https://doi.org/10.21315/aamjaf2017.13.1.5

INTRODUCTION

Famous accounting frauds, such as those witnessed to take place at Enron, Worldcom, Tyco and Xerox, have incited several researchers to investigate whether the book-tax differences (BTDs) could well serve as an indication of a potential “red flag” highlighting low earnings quality (Hanlon, 2005). Indeed, BTDs help in providing information concerning earnings quality level, while an increase in book-tax conformity helps improve information quality. Actually, this theme has constituted a subject of major concern for several scholars and drawn the interest of academic researchers, regulators and policymakers for almost a whole decade.

It is a well known fact that accounting information might affect taxable income, particularly in the presence of earnings management. Net income (profit / loss) is one of the most important products of accounting, but this result is sensitive to discretionary adjustments that have little or nothing to do with the reality of the firm. In fact, Revsine, Collins, Johnson and Mittelstaedt (2005) teach that “useful information for assessing the degree of conservatism in a firm’s portfolio of accounting choices can be extracted from the income tax footnote by comparing the ratio of pre-tax book income to taxable income”. In this regard, Mills and Newberry (2001) have discovered a positive relationship to persist between BTDs and financial reports, such as income smoothing, financial difficulties, and premium thresholds. In his conducted study concerning the U.S. context, Jackson (2015) has examined the association between BTDs and future earnings changes. He has discovered that earnings management appears to contribute greatly to the association between BTDs and future earnings changes.

One contemporary paper by Heltzer (2009) focuses on the relationship between BTDs and conservatism. She examines what information, if any, BTDs reveal about financial statement conservatism. She finds that firm-years with a large positive BTDs exhibit similar conditional and unconditional financial statement conservatism, relative to other sample firm-years, and greater conditional and unconditional taxable income conservatism, relative to other sample firm-years. Additionally, firm-years with large negative BTDs exhibit greater unconditional conservatism in book income, relative to other sample firm-years, and less conditional and unconditional conservatism in taxable income, relative to other sample firm-years. However, she does not test whether firms that engage in a high level of tax avoidance and earnings management exhibit less accounting conservatism.

In this study, we extend Heltzer (2009) by investigating whether firms with large book-tax differences driven by earnings management, tax avoidance and their interaction are associated with low accounting conservatism. We examine whether regulatory and opportunistic sources of total BTDs differentially influence accounting conservatism in the Tunisian context. We focus our study on Tunisia because of its unique financial reporting setting. Tunisia is considered among the countries with the differences between the purposes of their accounting and tax rules and the purposes of their accounting and tax law, since each responds to a different standard-setting process. This context which is characterised, by an accounting system which offers several discretionary ways in the choice of accounting methods and a tax system that gives large latitude in tax management, gives rise tax and accounting manipulations and following the differences in accounting and tax results.

This study differs from Heltzer (2009) in several ways. First, we decompose BTDs into normal and abnormal components. According to Tang and Firth (2012), normal BTDs (NBTDs) refer to the differences likely to be derived from the different reporting rules for book and tax purposes. Abnormal BTDs (ABTDs) reflect the differences that are more likely to stem from earnings management and tax evasion practices as well as their interaction.

Second, we include just a conditional conservatism in our accounting conservatism measure. Our primary measure of conservatism is Khan and Watts' (2009) *C-score*, which is based on Basu's (1997) timeliness measure of conservatism. The *C-score* captures both the time series and the cross-sectional variations in measuring individual firms' conditional conservatism (Khan & Watts, 2009). Finally, we examine whether regulatory sources of total BTDs are also associated with low accounting conservatism, and how BTDs represent bad signal information for investors and stakeholders. The present paper will focus on investigating the role of book-tax differences in indicating the earnings quality and especially accounting conservatism.

The major objective of this study was to examine the extent to which regulatory and opportunistic information, as impounded in book-tax differences, proves to influence accounting conservatism. We also aim to analyse that the book-tax differences are a signal of "bad news" for investors.

Using publicly available financial statements from 2005 to 2012 for 28 Tunisian listed firms on the Tunis Stock Exchange and operating in the industrial and commercial sectors, we use a new measure of accounting conservatism and documents that firm-years with large book-tax differences are associated with low levels of accounting conservatism. Also, we find that firms with ABTDs and NBTDs exhibit less accounting conservatism.

Therefore, this study makes a major contribution to research on BTDs by demonstrating their informational value to investors. Our research is valuable for researchers, shareholders as well as regulators. For researchers, it appears to an innovative area for future research. For shareholders, it shows the role of the information transmitted by book-tax differences into the analysis of earnings quality published by firms. This study also helps regulators to improve accounting rules and tax rules.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Prior literature has documented that BTDs are an important area in examining earnings quality. On the one hand, and for report elaboration purposes, financial statements usually communicate information useful for investors, creditors and other users to help them in making the best and most effective decisions. On the other hand, and for the sake of a more efficient earnings quality assessment, several researchers have tended to apply the financial statements' contained tax information, mainly that reflected in BTDs (Hanlon, 2005; Lev & Nissim, 2004; Blaylock, Shevlin, & Wilson, 2011; Wahab & Holland, 2015). In fact, previous studies revealed that companies exhibiting large differences between the book income and the taxable one usually tend to show highly decreased persistent earnings, low earnings growth and remarkably high earnings management practices, as compared to companies with average BTDs levels. More specifically, Lev and Nissim (2004) exposed a significant relationship between total BTDs and earnings shifts. Hanlon (2005) found that firms with large temporary differences appear to have less persistent earnings and accruals. She showed that BTDs reflect a lower earnings quality of broadcast information. In addition, Blaylock et al. (2011) confirm well the Hanlon (2005) research finding, stating that firms with large positive temporary differences tend to have less persistent earnings. Similarly, Ayers, Laplante and McGuire (2010) have examined whether credit analysts use the BTDs' transmitted information to analyse company credit risk. Indeed, since the book income noticeably differs from the taxable income, credit analysts may well be led to interpret such divergence as being an information quality deterioration signal.

Financial texts most often state well that BTDs can stand as means of information telling investors about the earnings quality. Weber (2009) has proved that investors and financial analysts use the BTDs' information when predicting future earnings and firm value. In turn, Phillips, Pincus and Rego (2003) have undertaken to evaluate the usefulness of the deferred tax expense in determining earnings management. Asgari and Behpouri (2014) assume that the discretionary authority is more remarkable in accounting rules rather than into tax rules. Thus, managers usually tend to exploit this discretion to manage book income in an upward trend, leading to large BTDs and, subsequently, to increasing deferred tax expenses. Furthermore, Heltzer (2009) has noted that managerial discretion proves to be more involved in determining accounting earnings in respect of taxable income. She has also revealed the fact that whenever BTDs increase, book income would prove to deviate upwardly as compared to taxable income, allowing for a reduced accounting conservatism.

Several studies have proposed to measure the differences between the book income and the taxable one through deferred tax, dubbing their temporary differences. Yet, total differences include the entirety of components (temporary, permanent, normal and abnormal), involving vast information content regarding information quality. In this respect, Heltzer (2009) has examined, the usefulness of the BTDs' contained information to show the extent of conservatism prevailing in financial statements. In fact, she has shown that the relationship between BTDs and accounting conservatism depends highly on several factors. Indeed, she suggests that this relationship varies depending on the persistence of either large positive BTDs and/or negative ones. Firms with large positive BTDs tend to exhibit the same conditional and unconditional conservatism of financial statements and a higher level of conservatism in regard of taxable income as compared to other firms in the sample. In contrast, firms with large negative BTDs tend to display a higher conditional and unconditional conservatism on the book income and a lower conservatism level on taxable income in respect of other firms in the sample.

Based on the entirety of these cited findings, one may well predict that the BTDs' information content appears to help largely indicate the earnings quality (Jackson, 2015; Huang & Wang, 2013). These differences allow us to reveal their importance if they change investors' as well as financial analysts' expectations concerning the firms' future performance and its created value. Correspondingly, we predict that earnings are less conservative for firms with high total BTDs. Our first hypothesis is:

H1: Firms with high total BTDs exhibit low accounting conservatism.

To note, NBTDs indicate large differences persisting between accounting rules and tax ones. Tang and Firth (2011) noted that these differences have no connection with the firm managers' opportunistic intervention. In this regard, Bouaziz Daoud and Ali Omri (2011a) add that normal BTDs is constituted by temporary and permanent differences. These are caused by the differences between the fiscal rules' objectives and those of the accounting rules. Jackson (2009) found that large permanent differences help reduce future net income as they relate to higher future tax expenses. The author adds that temporary BTDs are negatively associated with earnings quality. Hanlon (2005) demonstrates a negative association between earnings persistence and the large positive (negative) temporary differences. She considers that BTDs stand as "red flags" affecting the firm's potential performance forecasts. This finding was confirmed by Tang and Firth (2012) who found a negative relationship to predominate between the NBTDs and future earnings on the one hand, and even a negative relationship between these differences and stock prices, on the other.

Watts (2003) argues that as the link between financial and tax reporting increase, conservatism will also increase as departures from conservatism will have unfavorable tax consequences. Thus, Plesko (2004) found that, if the conservatism hypothesis is correct, the increase in book-tax differences suggests that the link between tax and financial reporting may have declined, leading to less financial conservatism and a relative increase in the net asset value of firms. In Romania context, Istrate (2011) investigated that intangible assets may be treated differently from the accounting and fiscal viewpoints, which also points out the differences between the fiscal and accounting prudence.

With respect to the Tunisian context, the subject of study, one may well assume that NBTDs can also inform users about poor information quality in a bid to help investors predict future performance and determine the accounting conservatism level.

Consistent with this insight, we predict that firms with high NBTDs are less conservative.

H2: Firms with high NBTDs exhibit low accounting conservatism.

According to Tang and Firth (2012), the discretionary component of the BTDs is due to discretionary practices of managers at the choice of accounting and tax practices. These practices are earnings management and tax management. Previous research has indicated that ABTDs have a negative effect on the earnings quality. Blaylock et al. (2011) found a negative relationship between ABTDs and earnings persistence. In addition, Ayers et al. (2010) question about the relative information in taxable income versus book income. The authors extend Hanlon, Laplante and Shevlin (2005) and document that taxable income has more incremental information relative to book when tax planning is less likely and earnings management is more likely. Contrary to Ayers et al. (2010), Chen, Dhaliwal and Trombley (2012) discovered that the taxable income has less incremental information when earnings management is more likely. For this reason, Tang and Firth (2012) have considered that the information content of ABTDs is relevant. The authors have shown a significantly negative association between ABTDs and earnings persistence and earnings-returns. Heltzer (2009) examines that the variations in book-tax differences reveal information about variations in financial statement conservatism. In their additional test, Heltzer (2009) uses discretionary book-tax differences to provide insights into the causes of book-tax differences. Their findings suggest that large positive book-tax differences are not, on average, caused by aggressive book reporting, but may be caused by aggressive tax reporting. Their results also suggest that large negative book-tax differences may be the result of the smoothing of both book income and taxable income. Their additional tests involving discretionary book-tax differences support these notions.

The achieved results indicate that firms with large positive discretionary differences usually tend to exhibit a greater conditional and unconditional conservatism in taxable income as well as a similar conditional and unconditional conservatism in regard to book income. Heltzer (2009) means that the relation between tax and conservatism is stronger when firms' reported income is more conform to its taxable income.

Overall, there seems to be some evidence to indicate that ABTDs affect negatively accounting conservatism.

As discussed previously, ABTDs reflect a high level of opportunistic book and tax reporting. We predict that ABTDs deteriorate accounting conservatism. Our third hypothesis is as follows:

H3: Firms with high ABTDs exhibit low accounting conservatism.

METHODOLOGY

Sample Selection and Data

The initial obtained sample contains 77 Tunisian firms listed on the Tunisian's Stock Exchange (TSE) during eight years ranging from 2005 to 2012. This choice is justified by the need to provide a favourable framework to study the relation between BTDs and accounting conservatism and by the choice of study variables (including accounting conservatism). From the initial sample, we have eliminated firstly the financial firms. This exclusion is justified by the fact that they are governed by a special legislation in the preparation of their financial statements and by specific sector accounting standards. Secondly, we have chosen to remove firms with missing necessary data to work on a balanced panel. Hence, 28 firms and 224 observations remain in our sample (Table 1).

The listed companies' relevant data are collected from published financial statements on the Tunisian stock exchange and Financial Market Council.

Table 1
Sample selection

Sample	Number of firms
Initial sample	77
Financial firms	(47)
Firms with insufficient data	(2)
Final sample	28
Duration of study	8
Total observations	224

Sector	Firms (2005–2012)
Industrial sector	
Agro-food industry	32
Construction material	48
Chemicals	40
Various industry	16
Total industrial firms	136
Commercial sector	
Total commercial firms	32
Service sector	
Total service firms	56
Total firms-years	224

Variables Measurement

Accounting conservatism

In the present study, the dependent variable is accounting conservatism. There is no single accepted measure of accounting conservatism in the accounting literature. In order to measure the conservatism in each firm-year, we adopt the model of

Khan and Watts (2009), based on Basu (1997). Based on the model developed by Basu (1997), Khan and Watts (2009) have added that conservatism constitutes a linear function of the market-to-book ratio, size and leverage of the annual cross-sectional Basu (1997) regression, the *C-score* is able to take into account both firm and year variation in conservatism. The model of Basu (1997) can be written as:

$$\frac{X_{i,t}}{P_{i,t-1}} = \beta_0 + \beta_1[D_{it}] + \beta_2[R_{it}] + \beta_3[R_{it}D_{it}] + \varepsilon_{i,t} \quad (1)$$

where $X_{i,t}$ is the earnings per share for firm i in fiscal year t, $P_{i,t\text{-}1}$ is the price per share at the beginning of the fiscal year, R_{it} is the return on the firm i over the period nine months before fiscal year-end t to three months after fiscal year-end t, D_{it} is a dummy variable equal to 1 when $R_{it} < 0$ and equal to 0 otherwise and $\varepsilon_{i,t}$ is the residual. The good news timeliness measure is β_2. The measure of incremental timeliness for bad news over good news, or conservatism, is β_3 and the total bad news timeliness is $\beta_2 + \beta_3$.

Watts (2003) suggests that conservatism varies with four factors: contracts (including debt and compensation contracts), litigation, taxation and regulation. Previous research (eg, Watts, 2003; Guay, 2008; Zhang, 2008; Gao, 2013) has documented the role of debt covenants and conservative financial accounting in addressing agency conflicts between lenders and borrowers.

Khan and Watts (2009) introduced in the Basu model the following variables: the market-to-book ratio; firm size; and firm leverage in order to generate "*C-Score*", which estimates the level of conservatism. Khan and Watts (2009) find that conservatism is a linear function of the Market-to-Book Ratio, size and leverage. The specifications of *C-Score* are:

$$C\text{-}SCORE_{it} = \beta_3 = \lambda_0 + \lambda_1\,(SIZE)_{it} + \lambda_2\,(M/B)_{it} + \lambda_3\,(LEV)_{it} \quad (2)$$

where SIZE: stands for the natural log of equity market value; M/B: represents the market-to-book ratio and LEV: is leverage, defined as long-term and short term-debt, deflated by equity market value.

Replacing β_3 in Equation (1) by Equation (2) yields the following empirical regression model:

$$\begin{aligned}\frac{X_{i,t}}{P_{i,t-1}} &= \beta_0 + \beta_0 D_{it} + R_{i,t}(\mu_1 + \mu_2 SIZE_{it} + \mu_3 MTB_{it} + \mu_4 LEV_{it}) \\ &+ D_{it}R_{it}(\lambda_0 + \lambda_1 SIZE_{i,t} + \lambda_2 MTB_{i,t} + \lambda_3 LEV_{i,t}) + (\delta 1 SIZE_{it} + \\ &\delta 2 MTB_{it} + \delta 3 LEV_{it} + \delta 4 D_{it} SIZE_{it} + \delta 5 D_{it} MTB_{it} + \delta 6 D_{it} LEV_{it}) + \varepsilon_{i,t}\end{aligned} \quad (3)$$

To estimate the level of conservatism concerning each company, we adopt the following approach Gao (2013), Francis, Hasan and Wu (2013), and André, Filip and Marmousez (2014): We begin by estimating λ_i, $i = 0$ to 3 in Equation (3), then we introduce the estimated parameters in the Equation (2) of *C-Score*. We interpret a higher value of $C\text{-}Score_{it}$ as accounting information with a higher level of conservatism.

Total book-tax differences

Following most of the conducted researches (e.g., Manzon & Plesko, 2002; Ayers et al., 2010; Frank, Lynch & Rego, 2009; Wilson, 2009; Dhaliwal, Huber, Lee, & Pincus, 2008; Desai & Dharmapala, 2006; Hanlon et al., 2005; Moore, 2012; Hanlon, Krishnan, & Mills, 2012; Tang, 2015), BTD is the spread between pre-tax book income and taxable income. Taxable income is estimated by the rapport between the current tax expense and the tax rate.

Estimating NBTDs and ABTDs

Manzon and Plesko (2002) conducted an investigation of the major differences noticeable between book income and the taxable one. Actually, they identify four activity types likely to affect book-tax income spread namely: 1) demand controls for tax favored investment and financing action, 2) direct investment sources' related timing differences, 3) permanent differences and 4) noise factors. Graham, Raedy and Shackelford (2012) found that the determinants of BTDs include tax planning, earnings management, general business conditions, changes in financial accounting rules, changes in firm-level sales and the level of property, plant and equipment in a given firm. In this study, we adopt the approach developed by Tang and Firth (2011) and isolate the BTD information related to regulatory differences and the BTD information related to opportunistic differences. They regress total BTDs on non discretionary items that are known to cause NBTDs but are less likely to reflect earnings or tax manipulations. These items are changes in sales, gross property, plant and equipment, non-goodwill intangible assets, net operating loss and tax rate differences.

In this study, we use factors related to differences in Tunisian tax and accounting rules to explain non discretionary differences. We regress total book-tax differences on factors of changes in sales, gross property plant and equipment, profitability and lagged BTDs.

The estimation equation is:

$$BTDs_{it} = \beta_0 + \beta_1 \Delta REV_{it} + \beta_2 PROF_{it} + \beta_3 \Delta INV_{it} + \beta_4 LagBTD_{it} + \varepsilon_{it} \quad (4)$$

where

BTD_{it}	=	total book-tax differences for the firm *i* in year *t* obtained from the difference between pretax book income and taxable income;
ΔREV_{it}	=	the change in revenue from year *t*-1 to year *t*;
ΔINV_{it}	=	the change in investment in gross property, plant and equipment from year *t*-1 to year *t*;
$PROF_{it}$	=	a binary variable equal to one if the firm reports positive pre-tax income and zero otherwise;
LagBTDs	=	reported book-tax differences in year *t*-1.

Δ*REV* is used to capture the effect of economic growth on NBTDs. In Tunisian context, sales growth may well lead to enormous credit losses. In financial reporting, these receivables are immediately recognised to stand as losses. Consequently, they lead to reducing the annual income and, subsequently, reducing the income tax expenses. Inversely, however, during tax reporting, these receivables are deductible from the taxable amount, providing certain conditions are met. Such treatment differences may likely will create remarkable non discretionary differences between the book-income and the taxable one.

Δ*INV* is used to capture of the growth in investment on NBTDs. According to the Tunisian accounting standard, the observation of tangible fixed assets' depreciation is mandatory. At tax level, however, no deduction is allowed, which involves negative differences between the accounting income and the taxable one. In this regard, Manzon and Plesko (2002) found a positive relationship to prevail between investment growth and BTDs. Tang and Firth (2011) apply this variable to capture the investment scale growth effect on BTDs relating to mechanical depreciation and amortisation. They claim that investment growth is likely to help increase the provision for fixed and intangible assets' impairment provisions in the income statement appear as required under existing accounting standards.

PROF: Manzon and Plesko (2002) found that profitable companies can effectively apply the tax deductions and tax credits to benefit from tax exemptions. Indeed, in beneficiary firms, managers usually appeal to these tax benefits in a bid to reduce the amount of taxable incomes; thus, increasing the differences between book income and tax income (Sodan, 2012).

LagBTDs: This variable stands as a noise factor with a positive effect on the level of differences between the book income and the taxable income Manzon and Plesko (2002).

To control for firm size, all variables are scaled by average total assets at year *t* except for *PROF*. NBTDs are the fitted values from Equation (4) and the residuals are ABTDs.

Control variables

We add other variables in regression to control for performance, size, sales growth, and growth opportunities. Previous researches suggest a negative association between performance and accounting conservatism. Ahmed, Billings, Morton and Stanford-Harris (2002) argue that the mechanical, negative association between accounting conservatism and ROA dominates the positive association between accounting conservatism and profitability. We expect a negative relationship between ROA and accounting conservatism. Khan and Watts (2009) suggest that small firms exhibit high accounting conservatism level than large firms. Watts and Zimmerman (1986) propose that large firms have high political costs, resulting in high accounting conservatism. We include also leverage to control for the effect of bondholder-shareholder conflicts over dividend policy on accounting conservatism (Ahmed et al., 2002).

Table 2
Statutory variables definitions and measurements

Variables	Symbols	Measures	Authors
Dependent variable			
Accounting conservatism	C-Score	The level of conservatism of firm *i* in year *t* measured by the model of Khan and Watts (2009).	Khan and Watts (2009), Gao (2013), Francis et al. (2013), Jarboui (2013), André et al. (2014).
Independent variables			
Book-tax differences	BTDs	The difference between pretax book income and taxable income.	Manzon and Plesko (2002) , Ayers et al. (2010), Dhaliwal et al. (2008), Desai and Dharmapala, (2006) Hanlon et al. (2005) Moore, (2012), Hanlon et al. (2012)
Normal book-tax differences	NBTDs	Represent the estimated values, in cross sections, of the BTDs' corresponding equation (4)	Tang and Firth (2012)

(*continued on next page*)

Table 2: (*continued*)

Variables	Symbols	Measures	Authors
Abnormal book-tax differences	ABTDs	The residual estimated from equation (4) (The difference between BTDs and ABTDs).	Tang and Firth (2012)
Control variables			
Returns on asset	ROA	The ratio of earnings per share to total assets	Khan and Watts (2009)
Size	SIZE	Ln (total assets)	Khan and Watts (2009) Watts and Zimmerman (1986)
Leverage	LEV	Total debts/total assets	Ahmed et al. (2002), Dichev and Skinner (2002), DeFond and Jiambalvo (1994), Zmijewski and Hagerman (1981)
Growth opportunities	ΔREV	Calculated in terms of current year net sales, as reported on the income statement, minus the previous year net sales.	Ahmed et al. (2002)

EMPIRICAL RESULTS

We examine how different sources of BTDs affect the level of accounting conservatism. We estimate the following models:

$$C\text{-}score_{it} = \alpha_0 + \alpha_1 BTDs_{it} + \alpha_2 ROA_{it} + \alpha_3 SIZE_{\text{it}} + \alpha_4 LEV_{\text{it}} + \alpha_5 \Delta REV_{\text{it}} + \varepsilon_{it} \quad (5)$$

$$C\text{-}score_{it} = \alpha_0 + \alpha_1 NBTDs_{it} + \alpha_2 ROA_{it} + \alpha_3 SIZE_{\text{it}} + \alpha_4 LEV_{\text{it}} + \alpha_5 \Delta REV_{\text{it}} + \varepsilon_{it} \quad (6)$$

$$C\text{-}score_{it} = \alpha_0 + \alpha_1 ABTDs_{it} + \alpha_2 ROA_{it} + \alpha_3 SIZE_{\text{it}} + \alpha_4 LEV_{\text{it}} + \alpha_5 \Delta REV_{\text{it}} + \varepsilon_{it} \quad (7)$$

where $C\text{-}score_{it}$ designates the conservatism level of the firm *i* in year *t*; *BTD* reported book-tax differences in year *t*; *NBTDs* represent the estimated values, in cross sections, of the BTDs' corresponding equation; *ABTDs* are calculated by determining the difference between total *BTD*s and *NBTD*s; *ROA* is the ratio of earnings per share to total assets; *SIZE* is calculated as a logarithm of total assets; *LEV* is calculated as the ratio of total debt to total assets; *ΔREV* changes in revenues from year *t*-1 to year *t*, which is a proxy for growth opportunities.

Results of Estimated BTDs

We estimate ABTDs and NBTDs by using panel data. As shown in Table 3 (Panel A), all coefficients are significantly different from zero except for ΔINV. The adjusted R^2 is 0.54, consistent with the notion that a large proportion of the BTDs is caused by mechanical or economic differences. These results differ from some published studies (Tang & Firth, 2011). In the Chinese context, they find that adjusted R^2 is 0.79. This can be explained by the difference between accounting and tax system of the two contexts.

Table 3
Panel A: Estimated coefficient from BTDs

$$BTDs_{it} = \beta_0 + \beta_1 \Delta REV_{it} + \beta_2 PROF_{it} + \beta_3 \Delta INV_{it} + \beta_4 LagBTD_{it} + \varepsilon_{it} \quad (4)$$

	Coefficients	*P*-value
ΔREV	0.030	0.080*
PROF	0.098	0.000***
ΔINV	0.004	0.892
LagBTDs	0.364	0.000***
Adjusted R^2	0.54	
Sample	224	

Note: In Panel A, ***, **,* denotes the significance of one-tailed test at the level of 0.01, 0.05 and 0.10.
Variable definitions:
BTD = reported book-tax differences in year *t*;
ΔINV = changes in investment in the sum of gross property, plant and equipment in year *t*, which is a proxy for investment growth;
ΔREV = changes in revenues from year *t*-1 to year *t*, which is a proxy for economic growth;
PROF = is a binary variable equal to one if the firm reports positive pre-tax income and zero otherwise;
LagBTDs = reported book-tax differences in year *t*-1;
All variables are scaled by average total assets except for PROF.

Analysis of Conservatism, BTDs and ABTDs Evolution Over the Period of 2005–2012

Figure 1 reports the evolution of accounting conservatism in Tunisia financial statements over the period 2005–2012. Figure 1 reveals that there has been a decrease in the accounting conservatism in Tunisia since 2006 and 2010. Bad news is reflected rapidly in earnings. This variation is due to financial instability in the period of 2010/2011 Tunisian revolution.

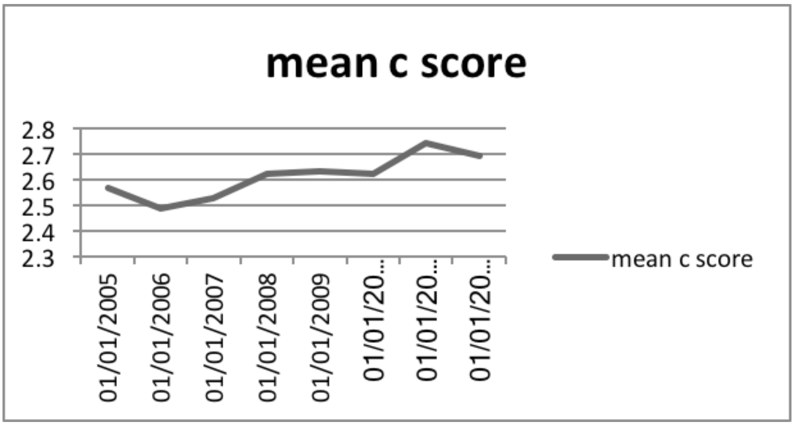

Figure 1. Evolution of accounting conservatism 2005–2012

Figure 2 reports the evolution of BTDs in Tunisia financial statements over the period 2005–2012. We show a volatile variation, the overall trend is on the increase and declining. Figure 2 reveals that there has been an increase in the BTDs since 2006 then by a decrease since 2008. Indeed, in 2009 average BTDs is equal to 0.025 and 0.014 in 2012. This variation in BTDs could be explained by the mechanical differences between the accounting system and the tax system, or from earnings management activities.

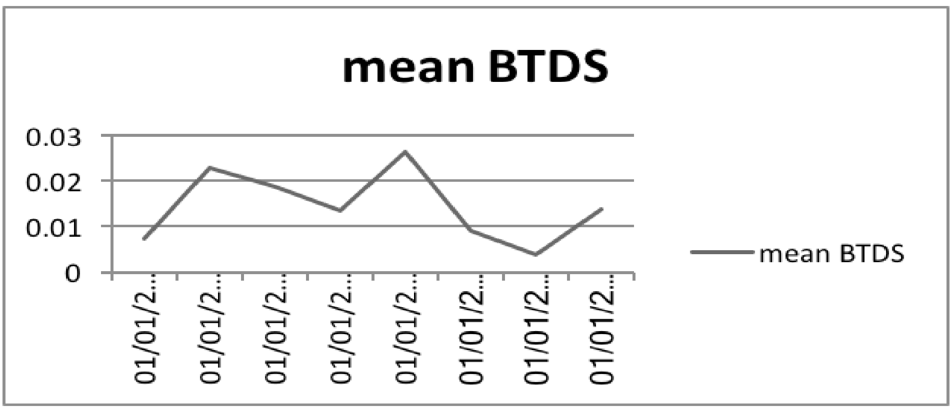

Figure 2. Evolution of total book-tax differences 2005–2012

Figure 3 reports the evolution of ABTDs in Tunisia financial statements over the period 2005–2012. The general trend in this figure is an increase in the ABTDs from the early 2008 and 2011 followed by a sharp decrease in 2012. This variation is explained by the extent of opportunistic practices made in order to lessen the maximum income tax expense.

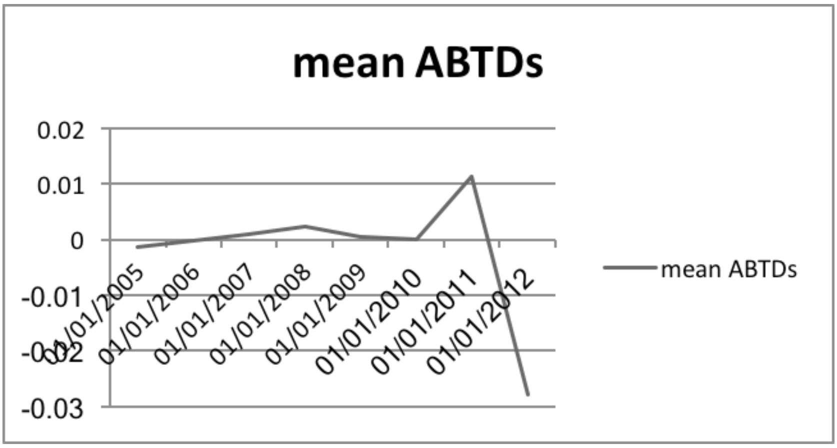

Figure 3. Evolution of abnormal book-tax differences 2005–2012

Descriptive Statistics And Univariate Analysis

Table 4 provides summary statistics for accounting conservatism, BTDs, NBTDs and ABTDs. With regard to our main conservatism measure, *C-score*, we find that the mean value is 2.610 and the median value is 2.481. Our results are higher than those of Khan and Watts (2009) (mean = 0.105 and median = 0.097). Two reasons are possible. The first is relative to difference between contexts. Second, our *C-score* is only for 2005–2012 but Khan and Watts measure *C-score* from 1963 to 2005. Francis et al. (2013) found also that results of the *C-score* are higher than those of Khan and Watts (2009) and the value is much closer to that of Khan and Watts (2009).

The average book-tax difference level is 1.4% with minimum BTDs of –30.7% and a maximum of 16.30%. The discrepancy between the minimum and maximum values is considerably high, denoting large heterogeneity in the firms' reporting gap.

The analysis of control variables shows that leverage (LEV) owns on average 50.2% in the capital of Tunisian firms. It reveals that most Tunisian listed companies have a high level of debt. Sales growths (ΔREV) attain an average rate of 8.14%, while performance (ROA) is of an order of 5.6% of total assets.

Table 4
Descriptive statistics

Variables	Mean	Min	Max	SD	Median
C-score	2.610	2.134	5.283	0.483	2.481
BTDs	0.014	–0.307	0.163	0.061	0.019
ABTDs	.0004	–0.130	0.116	0.041	–0.002
NBTDs	0.013	–0.177	0.098	0.045	0.030
SIZE	18.112	15.489	21.197	1.008	17.959
LEV	0.502	0.081	0.977	0.200	0.524
ROA	0.056	–0.316	0.179	0.067	0.055
ΔREV	0.081	–0.420	1.464	0.175	0.065

Note: $C\text{-}score_{it}$ (dependent variable) designates the conservatism level of firm i in year t; *BTD* is computed by determining the difference recorded between the pre-tax book income and the taxable income; *NBTDs* represent the estimated values, in cross sections, of the BTDs' corresponding Equation (4); *ABTDs* abnormal BTDs residual estimated from Equation (4); *ROA* is the ratio of earnings per share to total assets; *SIZE* is calculated as a natural logarithm of total assets; *LEV* is calculated as the ratio of total debt to total assets; *ΔREV* is calculated in terms of current year net sales, as reported on the income statement, minus the previous year net sales.

Correlation Analysis

Table 5 shows Spearman correlations between main variables used in our analysis. As expected, we find that BTDs and NBTDs are negatively, but insignificantly correlated with the *C-score*. Only ABTDs are significantly negatively correlated with the *C-score.*

We test for multicollinearity in the regressions by calculating variance inflation factors and condition indices. All of the VIFs are under 2, suggesting that multicollinearity does not appear to be a potential problem.

Panel Data Tests

Fixed effects test

To test the presence of individual effects in three models, check whether the specification of the generating process data is homogeneous or heterogeneous. The result of this test is a statistical Fisher presented in Table 6.

According to this table, the Fisher test proves to be significant at the 1% threshold with respect to both regressions, thus confirming the individual fixed effects.

Table 5
Correlation matrix

Panel B (Equation 5)

	C-score	BTDs	SIZE	LEV	ROA	ΔREV	VIF
C-score	1						
BTDs	–0.094 (0.160)	1					2.50
ROA	–0.028 (0.673)	0.771 (0.000***)	1				2.69
ΔREV	0.042 (0.525)	0.195 (0.003***)	0.205 (0.002***)	1			1.14
LEV	0.520 (0.000***)	–0.337 (0.000***)	–0.407 (0.000***)	0.214 (0.001***)	1		1.67
SIZE	0.734 (0.000***)	–0.070 (0.296)	–0.046 (0.493)	0.084 (0.208)	0.442 (0.000***)	1	1.28

Notes: ***C-Score**$_{it}$* designates the conservatism level of the firm i in year t; **BTD** is computed by determining the difference recorded between the pre-tax book income and the taxable income; **ROA** is the ratio of earnings per share to total assets; **SIZE** is calculated as a natural logarithm of total assets; **LEV** is calculated as the ratio of total debt to total assets; **ΔREV** is calculated in terms of current year net sales, as reported on the income statement, minus the previous year net sales. *, **, *** denote significant differences from zero at 0.10, 0.05 and 0.01 levels, respectively.

Panel C (Equation 6)

	C-score	NBTDs	SIZE	LEV	ROA	ΔREV	VIF
C-score	1						
NBTDs	–0.104 (0.119)	1					1.84
ROA	–0.028 (0.673)	0.516 (0.000***)	1				2.04
ΔREV	0.042 (0.525)	0.322 (0.000***)	0.205 (0.002***)	1			1.15
LEV	0.520 (0.000***)	–0.170 (0.010***)	–0.407 (0.000***)	0.214 (0.001***)	1		1.67
SIZE	0.743 (0.000***)	–0.087 (0.194)	–0.046 (0.493)	0.084 (0.208)	0.442 (0.000***)	1	1.27

Notes: ***C-Score**$_{it}$* designates the conservatism level of the firm i in year t; **NBTDs** represent the estimated values, in cross sections, of the BTDs' corresponding equation (4); **ROA** is the ratio of earnings per share to total assets; **SIZE** is calculated as a natural logarithm of total assets; **LEV** is calculated as the ratio of total debt to total assets; **ΔREV** is calculated in terms of current year net sales, as reported on the income statement, minus the previous year net sales. *, **, *** denote significant differences from zero at 0.10, 0.05 and 0.01 levels, respectively.

Hausman specification test

The results of the Hausman test are shown in Table 6.

The probability of the chi-squared test is less than 10% for both models (5) and (6) which allows us to reject the null hypothesis and to promote our regression fixed effect models. Against by, for the model (7), there is a probability of chi square, which is greater than 10%. This allows us to accept a random effects model.

Heteroscedastic test

To check if the error variance is not constant in our data, we use the Breusch-Pagan test. The result of this test is a statistical Fisher. Thus, the null hypotheses of this test indicate the absence of heteroscedasticity problem.

Table 6 reveals that the Breush Pagan test appears to be noticeably significant at the 1%, which means the heteroscedasticity of these models.

Autocorrelation test

For three models, the auto correlation error test is conducted through the Wooldridge test. We can conclude that the residual is auto-correlated. We correct this problem through the Generalised Least Squares method.

Table 6
Results of tests on panel data

Tests	Fixed Effects test	Specification test	Heteroscedastic test	Autocorrelation test
	Fisher test	Hausman test	Breush Pagan test	Wooldridge test
Equation 5	9.42	24.20	308.92	13.115
	(0.000)***	(0.000)***	(0.000)***	(0.001)***
Equation 6	12.10	14.45	274.94	16.523
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Equation 7	11.21	8.57	332.40	10.170
	(0.000)***	(0.127)	(0.000)***	(0.003)***

Notes: *** denotes significant differences from zero at 0.01 level.

$C\text{-}score_{it} = \alpha_0 + \alpha_1 BTDs_{it} + \alpha_2 ROA_{it} + \alpha_3 SIZE_{it} + \alpha_4 LEV_{it} + \alpha_5 \Delta REV_{it} + \varepsilon_{it}$ (5)
$C\text{-}score_{it} = \alpha_0 + \alpha_1 NBTDs_{it} + \alpha_2 ROA_{it} + \alpha_3 SIZE_{it} + \alpha_4 LEV_{it} + \alpha_5 \Delta REV_{it} + \varepsilon_{it}$ (6)
$C\text{-}score_{it} = \alpha_0 + \alpha_1 ABTDs_{it} + \alpha_2 ROA_{it} + \alpha_3 SIZE_{it} + \alpha_4 LEV_{it} + \alpha_5 \Delta REV_{it} + \varepsilon_{it}$ (7)

***C-Score**$_{it}$* (dependent variable) designates the conservatism level of firm *i* in year *t*; **BTD** is computed by determining the difference recorded between the pre-tax book income and the taxable income; **NBTDs** represent the estimated values, in cross sections, of the BTDs' corresponding equation (4); **ABTDs** abnormal BTDs residual estimated from equation (4); **ROA** is the ratio of earnings per share to total assets; **SIZE** is calculated as a natural logarithm of total assets; **LEV** is calculated as the ratio of total debt to total assets; **ΔREV** is calculated in terms of current year net sales, as reported on the income statement, minus the previous year net sales. *, **, *** denote significant differences from zero at 0.10, 0.05 and 0.01 levels, respectively.

Regression Analysis

We first test how BTDs affects accounting conservatism as measured by *C-score*. The results of our regressions are shown in Table 7.

Table 7
Linear regression results

Variables	Panel B (Equation 5)		Panel C (Equation 6)		Panel D (Equation 7)	
	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
BTDs	–1.37	0.001***	–	–	–	–
NBTDs	–	–	–0.071	0.116	–	–
ABTDs	–	–	–	–	–0.835	0.014**
ROA	0.875	0.010***	0.088	0.741	0.203	0.404
SIZE	0.159	0.000***	0.170	0.000***	0.161	0.000***
LEV	0.386	0.000***	0.316	0.000***	0.371	0.000***
ΔREV	–0.036	0.503	–0.029	0.503	–0.076	0.262
Wald Prob > chi2	285.58 (0.000)***		368.76 (0.000)***		205.73 (0.000) ***	

Notes*:* ***C-Score***$_{it}$ (dependent variable) designates the conservatism level of firm *i* in year *t*; **BTD** is computed by determining the difference recorded between the pre-tax book income and the taxable income; **NBTDs** represent the estimated values, in cross sections, of the BTDs' corresponding equation (4); **ABTDs** abnormal BTDs residual estimated from equation (4); **ROA** is the ratio of earnings per share to total assets; **SIZE** is calculated as a natural logarithm of total assets; **LEV** is calculated as the ratio of total debt to total assets; **ΔREV** is calculated in terms of current year net sales, as reported on the income statement, minus the previous year net sales. *, **, *** denote significant differences from zero at 0.10, 0.05 and 0.01 levels, respectively.

The results, as shown in Table 7, indicate that a negative and significant association between BTDs and accounting conservatism. This result is significant at the $p = 0.001$ levels. This finding is in agreement with (Tang & Firth, 2011; Hanlon, 2005; Lev & Nissim, 2002; Blaylock et al., 2011) findings which showed a negative association between BTDs and earnings quality. Furthermore, Revsine et al. (2005) state that BTDs represent a potential danger signal that should be investigated, because it might be an indication of deteriorating earnings quality. These results prove the critical usefulness of accounting information and tax information for shareholders and stakeholders. In addition, accounting conservatism has been manifested at various levels of verification, for the purpose of recognising and deciphering the 'good' news from the 'bad' ones in financial statements (Basu, 1997). Indeed, one could well testify and document a negative impact of BTDs on this proxy of earnings quality. Watts (2003) argues that as the links between financial and tax reporting increase, conservatism will also increase as departures from conservatism will have unfavorable tax consequences.

Concerning panels B and C, and on using the Tunisian context related data, we consider it useful to separate BTDs into normal BTDs (NBTDs) and abnormal BTDs (ABTDs) components. Thus, based on Table 7 (panel B), the regression results prove to reveal that the normal differences (NBTDs) do appear to negatively affect accounting conservatism ($\alpha = -0.071$, $p = 0.116$). However, the findings of the current study do not support the previous research by Tang and Firth (2012). They found that these mechanical differences could as well include low earnings persistence. Besides, this negative connection between the NBTDs and the accounting conservatism might as well lead investors to be confronted with book income that could appear to be less conservative and little informative on the firm's potential profitability prospects. In a Tunisian context, Bouaziz Daoud and Ali Omri (2011b) shown that NBTDs have a negative impact on earnings persistence.

With respect to panel C, Table 7 shows that ABTDs affect negatively and significantly ($\alpha = -0.835$, $p = 0.014$) accounting conservatism. This result indicates that firms with large ABTDs are associated with lower accounting conservatism.

This finding supports previous research into this brain area which links ABTDs and earnings quality (Huang & Wang, 2013; Tang & Firth, 2012; Blaylock et al., 2011; Hanlon, 2005). Huang and Wang (2013) found that firms with large temporary differences are associated with lower earnings persistence. In fact, whenever ABTDs increase, accounting conservatism tends to decrease and, subsequently, information asymmetry and earnings management would seem to increase. The findings of the current study are consistent with those of Tang and Firth (2012) who found that firms with large positive and negative ABTDs exhibit less earnings persistence compared to firms with small ABTDs.

This result may be explained by the fact that firms that engage in more earnings management and tax management exhibit less accounting conservatism level. There are, however, other possible explanations. Our context is characterised by an accounting system which offers maneuver for managers in the choice of accounting policies and a tax system that gives wide latitude in tax management. So, this negative correlation is explained by the existence of accounting manipulations which result lower accounting conservatism.

As for the control variables, Table 7 shows that (SIZE) has a positive and significant effect on accounting conservatism. In fact, the large firms are assumed to be more conservative than small firms. The findings of the current study are consistent with those of (Lafond & Watts, 2008; Khan & Watts, 2009) who, affirming that according to the political costs hypothesis; large firms usually tend to implement accounting conservatism to a higher level than small firms. Table 7 indicates that (LEV) has a positive and significant effect on accounting conservatism. This result corroborates with Khan and Watts (2009) who established the existence of a positive association between leverage and accounting conservatism.

The results, as shown in Table 7, indicate that (ROA) has a positive effect on accounting conservatism. This result is significant at the $p = 0.01$ levels. There was a negative correlation between growth (ΔREV) and accounting conservatism. The results of this study indicate that growth firms are more susceptible having less informative accounting information. Similarly, Ahmed et al. (2002) found that growth opportunities affects negatively accounting conservatism because sales growth may positively affect either accruals or the market's expectation of future growth reflected in accounting conservatism (Sun & Liu, 2011).

Additional Test

The effect of Tunisian revolution on the relationship between book-tax differences and accounting conservatism

The Tunisian revolution period was characterised by some economic troubles which may affect financial institutions' behaviours with respect to the cost of debt. This period was also characterised by the weakness of the economic and financial systems and more critically the problem of trust between the different economic agents: managers, investors, and banks (Achek & Gallali, 2015). In this sub-section, we provide supplemental tests on how BTDs affects accounting conservatism before Tunisian revolution.

To ensure that the results are not affected by this event, we first construct dummy variable "*Revolution*" which equals 1 if the study period is after 2010 and 0 otherwise. We then interact Revolution with *BTDs.* The results are summarised in Table 8.

We find that the coefficient of *BTDs*, which captures the effect of book-tax differences on accounting conservatism for firms, is –3.507 and is significant at the 1% level. The interaction term between Revolution and *BTDs*, which captures the incremental effect of BTDs on accounting conservatism for firms post revolution, is –3.890 and is significant at the 1% level. Hence, the impact of BTDs on accounting conservatism is much more pronounced for firms after the revolution.

Table 8
The effect of revolution on the relationship between book-tax differences and accounting conservatism

$C\text{-}score_{it} = \alpha_0 + \alpha_1 BTDs_{it} + \alpha_2 Revolution_{it} + \alpha_3 BTDs_{it} * Revolution_{it} + \alpha_4 ROA_{it} + \alpha_5 SIZE_{it} + \alpha_6 LEV_{it} + \alpha_7 \Delta REV_{it} + \varepsilon_{it}$ (8)
$C\text{-}score_{it} = \alpha_0 + \alpha_1 NBTDs_{it} + \alpha_2 Revolution_{it} + \alpha_3 NBTDs_{it} * Revolution_{it} + \alpha_4 ROA_{it} + \alpha_5 SIZE_{it} + \alpha_6 LEV_{it} + \alpha_7 \Delta REV_{it} + \varepsilon_{it}$ (9)
$C\text{-}score_{it} = \alpha_0 + \alpha_1 ABTDs_{it} + \alpha_2 Revolution_{it} + \alpha_3 ABTDs_{it} * Revolution_{it} + \alpha_4 ROA_{it} + \alpha_5 SIZE_{it} + \alpha_6 LEV_{it} + \alpha_7 \Delta REV_{it} + \varepsilon_{it}$ (10)

Variables	Equation (8)		Equation (9)		Equation (10)	
	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
BTDs	–3.507	0.000***				
NBTDs			–1.775	0.038**		
ABTDs					–1.931	0.010**
Revolution	0.114	0.039**	0.056	0.365	0.065	0.261
BTDs*Revolution	–3.890	0.000***				
NBTDs*Revolution			–0.861	0.503		
ABTDs*Revolution					–4.462	0.002***
ROA	1.546	0.005***	–0.646	0.234	0.753	0.094*
SIZE	0.163	0.000***	0.183	0.000***	0.180	0.000***
LEV	0.418	0.005***	0.435	0.009***	0.462	0.004***
ΔREV	–0.027	0.849	–0.039	0.804	–0.126	0.406
Wald Prob>Chi^2	211.11 (0.000)***		123.25 (0.000)***		156.54 (0.000)***	

Notes: C-Score$_{it}$ (dependent variable) designates the conservatism level of the firm *i* in year *t*; **BTD** is computed by determining the difference recorded between the pre-tax book income and the taxable income; **NBTDs** represent the estimated values, in cross sections, of the BTDs' corresponding equation (4); **ABTDs** abnormal BTDs residual estimated from equation (4); **Revolution** equals 1 if the study period is after 2010 and 0 otherwise; **ROA** is the ratio of earnings per share to total assets; **SIZE** is calculated as a natural logarithm of total assets; **LEV** is calculated as the ratio of total debt to total assets; **ΔREV** is calculated in terms of current year net sales, as reported on the income statement, minus the previous year net sales. *, **, *** denote significant differences from zero at 0.10, 0.05 and 0.01 levels, respectively.

We also interact Revolution with NBTDs and ABTDs. The result, as shown in table 8, indicate that the coefficient of NBTDs, which captures the effect of normal BTDs on accounting conservatism for firms after the revolution, is –1.775 and is significant at the 5% level. The interaction term between Revolution and NBTDs, which captures the incremental effect of normal BTDs on accounting conservatism, is negative –0.861 but insignificant.

Consistent with our expectation, we find in Table 8 that the interaction term between ABTDs and Revolution is negative –4.462 and significant at the 1% level. This result may be explained by the fact that firms continued in engaging in more earnings management and exhibit less conservative earnings after the revolution. Achek and Gallali (2015) found that economic and political troubles in Tunisia have reduced creditors' confidence in audit quality and in earnings quality.

Our results could provide a possible explanation for why some firms after the revolution are less conservative in their financial reporting.

Overall, it seems that legal and political changes in Tunisia have slightly influenced the negative association between BTDs and accounting conservatism.

Other measures of accounting conservatism

In this section, we use another alternative measure of accounting conservatism to show the robustness of the documented relationship between BTDs and accounting conservatism.

We use the accruals-based model in Ball and Shivakumar (2005) builds on the decomposition of earnings into cash flows and accruals. The Ball/Shivakumar (2005) model[1] is considered to be useful for robustness tests and when return data is not available.

Results are reported in Table 9. As shown the table, the coefficient of BTDs*CF*D is negative and significant (–2.214 with p-value of 0.025). This result is consistent with that found for other accounting conservatism measure, especially Khan and Watts (2009). There was also no increase of accounting conservatism associated with NBTDs and ABTDs. The coefficient of NBTDs*CF*D is –5.478 and is significant at the 1% level. This coefficient becomes significant for this measurement than for a measure of Khan and Watts (2009). This result can be explained by the large differences between accounting rules and tax rules.

We find also that the coefficient of *ABTDs*CF*D* is –7.173 and is significant at the 1% level, indicating our result is robust to an alternative measure of accounting conservatism.

Overall, the results in this table are consistent with the findings of prior studies that firms with a high BTDs level set will be less conservative.

Table 9
Other measures of accounting conservatism

$$ACC_{it} = \beta_0 + \beta_1 CF_{it} + \beta_2 D_{it} + \beta_3 D_{it} CF_{it} + \beta_4 BTDs_{it} + \beta_5 D_{it} BTDs_{it} + \beta_6 CF_{it} BTDs_{it} + \beta_7 D_{it} CF_{it} BTDs_{it} + \varepsilon_{it}$$

Variables	Equation (11)		Equation (12)		Equation (13)	
	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
D	0.001	0.865	0.004	0.710	–0.013	0.337
CF	–0.930	0.000***	–0.939	0.000***	–0.839	0.000***
D*CF	–0.005	0.935	0.045	0.627	–0.149	0.176
BTDs	1.066	0.000***				
D*BTDs	–0.346	0.014**				
CF*BTDs	0.542	0.405				
D*CF*BTDs	–2.214	0.025**				
NBTDs			0.722	0.000***		
D*NBTDs			0.397	0.095*		
CF*NBTDs			4.441	0.004***		
D*CF*NBTDs			–5.478	0.006***		
ABTDs					0.415	0.050**
D*ABTDs					0.186	0.586
CF*ABTDs					2.657	0.053*
D*CF*ABTDs					–7.173	0.005***
Wald Prob>Chi^2	1896.04 (0.000)***		1117.63 (0.000)***		696.36 (0.000)***	

Notes: **ACC_{it}** is the total accruals scaled by average total assets (net income minus operating cash flows); **CF_{it}**: Cash flows from operations in *t* scaled by average total assets; **D_{it}**: indicator variable equals one if CF_{it} is negative and zero otherwise; **BTD** is computed by determining the difference recorded between the pre-tax book income and the taxable income; **NBTDs** represent the estimated values, in cross sections, of the BTDs' corresponding Equation (4); **ABTDs** abnormal BTDs residual estimated from Equation (4); *, **, *** denote significant differences from zero at 0.10, 0.05 and 0.01 levels, respectively.

CONCLUSION

The purpose of the current study was to determine the nature of the relationship associating BTDs and accounting conservatism. Previous studies revealed that BTDs are associated with poor earnings quality (Tang & Firth, 2012; Blaylock et al., 2011; Heltzer, 2009; Hanlon, 2005; Lev & Nissim, 2004; Joos, Pratt, & Young, 2002). We provide an alternative method for partitioning total book-tax differences, into NBTDs and ABTDs using a residual model, to provide additional meaningful information about accounting conservatism.

This study has shown that firm-years with large BTDs have lower accounting conservatism. Our evidence also indicates that in the case where accounting conservatism is measured by Khan and Watts' (2009) model; only opportunistic sources of BTDs are responsible for low accounting conservatism. But, in an additional test, when we use Ball and Shivakumar's (2005) measure of conservatism both regulatory and opportunistic sources of BTDs are responsible for low accounting conservatism. This finding provides an important caveat to researchers and investors when they interpret large BTDs as a surrogate for low earnings quality that is due only to management opportunism Tang and Firth (2012). This confirms the assertion of Plesko (2004) who indicates that the increase in BTDs suggests that the link between tax and financial reporting may have declined, leading to less financial conservatism.

The evidence from this study suggests that both of the regulatory and opportunistic BTDs sources are revealed to help market participants better understand and assess the earnings quality from different dimensions.

This work contributes to existing knowledge BTDs by providing importance and quality of information transmitted by those differences. BTDs are a signal of "bad news" for investors because they show a poor earnings quality.

This study helps also the regulators to improve accounting rules and tax rules. The empirical results of this study provide an answer to the question that has always been asked about maintaining connectivity or the option for the disconnection between accounting and taxation. The regulators may know the bad consequence of the disconnection between accounting and taxation. For this they tend to improve the accounting rules and tax rules to achieve the connection between accounting and taxation.

Several limitations to this pilot study need to be acknowledged. The sample size is small for generalising the results. We can use other measures of accounting conservatism (e.g. Basu, 1997; Givoly & Hayn, 2000) then compare with measurements of Khan and Watts (2009) used in this study.

Further research might explore the relationship between BTDs and earnings quality taking into account the quality of the external auditor.

NOTES

1. The model is expressed by the following piecewise-linear regression equation:

$$ACC_{it} + \beta_0 + \beta_1 CF_{it} + \beta_2 D_{it} + \beta_3 D_{it} CF_{it} + \varepsilon_{it}$$

where ACC_{it} is the total accruals scaled by average total assets (net income minus operating cash flows); CF_{it}: Cash flows from operations in *t* scaled by average total assets; D_{it}: indicator variable equals one if CF_{it} is negative and zero otherwise.

REFERENCES

Achek, I., & Gallali, M. (2015). Audit quality, timely disclosure, and the cost of debt: Tunisian evidence. *Journal of Modern Accounting and Auditing*, *11*(4), 194–209.

Ahmed, A. S., Billings, B. K., Morton, R. M., & Stanford-Harris, M. (2002). The role of accounting conservatism in mitigating bondholder-shareholder conflicts over dividend policy and in reducing debt costs. *The Accounting Review*, *77*(4), 867–890. https://doi.org/10.2308/accr.2002.77.4.867

André, P., Filip, A., & Marmousez, S. (2014). L'impact des normes IFRS sur la relation entre le conservatisme et l'efficacité des politiques d'investissement. *Comptabilité-Contrôle-Audit*, *20*(3), 101–124. https://doi.org/10.3917/cca.203.0101

Asgari, M., & Behpouri, M. (2014). Investigating the effect of tax costs on accounting conservatism: Evidence from Tehran Stock Exchange. *Management Science Letters*, *4*(1), 5–10. https://doi.org/10.5267/j.msl.2013.12.007

Ayers, B. C., Laplante, S. K., & McGuire, S. T. (2010). Credit ratings and taxes: The effect of book–tax differences on ratings changes. *Contemporary Accounting Research*, *27*(2), 359–402. https://doi.org/10.1111/j.1911-3846.2010.01011.x

Ball, R., & Shivakumar, L. (2005). Earnings quality in UK private firms: Comparative loss recognition timeliness. *Journal of Accounting and Economics*, *39*(1), 83–128. https://doi.org/10.1016/j.jacceco.2004.04.001

Basu, S. (1997). The conservatism principle and the asymmetric timeliness of earnings 1. *Journal of Accounting and Economics*, *24*(1), 3–37. https://doi.org/10.1016/S0165-4101(97)00014-1

Blaylock, B., Shevlin, T., & Wilson, R. J. (2011). Tax avoidance, large positive temporary book-tax differences, and earnings persistence. *The Accounting Review*, *87*(1), 91–120. https://doi.org/10.2308/accr-10158

Bouaziz Daoud, I., & Ali Omri, M. (2011a). *Divergences comptabilité-fiscalité, gestion fiscale et gestion des résultats en Tunisie: les nouveaux défis*. Comptabilites, economie et societe, May 2011, Montpellier, France. pp.cd-rom. HAL id 00646800.

Bouaziz Daoud, I., & Ali Omri, M. (2011b). Market perception of the information content in book-tax differences: Empirical evidence in Tunisia. *Journal of Business Studies Quarterly*, *3*(1), 112–135.

Chen, L. H., Dhaliwal, D. S., & Trombley, M. A. (2012). Consistency of book-tax differences and the information content of earnings. *Journal of the American Taxation Association*, *34*(2), 93–116. https://doi.org/10.2308/atax-50174

DeFond, M. L., & Jiambalvo, J. (1994). Debt covenant violation and manipulation of accruals. *Journal of Accounting and Economics*, *17*(1), 145–176. https://doi.org/10.1016/0165-4101(94)90008-6

Desai, M. A., & Dharmapala, D. (2006). Corporate tax avoidance and high-powered incentives. *Journal of Financial Economics*, *79*(1), 145–179. https://doi.org/10.1016/j.jfineco.2005.02.002

Dhaliwal, D. S., Huber, R. E., Lee, H. S., & Pincus, M. (2008). Book-tax differences, uncertainty about fundamentals and information quality, and cost of capital. *Uncertainty about Fundamentals and Information Quality, and Cost of Capital* (November 11, 2008*)*. https://doi.org/10.2139/ssrn.1127956

Dichev, I. D., & Skinner, D. J. (2002). Large–sample evidence on the debt covenant hypothesis. *Journal of Accounting Research*, *40*(4), 1091–1123. https://doi.org/10.1111/1475-679X.00083

Francis, B., Hasan, I., & Wu, Q. (2013). The benefits of conservative accounting to shareholders: Evidence from the financial crisis. *Accounting Horizons*, *27*(2), 319–346. https://doi.org/10.2308/acch-50431

Frank, M. M., Lynch, L. J., & Rego, S. O. (2009). Tax reporting aggressiveness and its relation to aggressive financial reporting. *The Accounting Review*, *84*(2), 467–496. https://doi.org/10.2308/accr.2009.84.2.467

Gao, P. (2013). A measurement approach to conservatism and earnings management. *Journal of Accounting and Economics*, *55*(2), 251–268. https://doi.org/10.1016/j.jacceco.2012.10.001

Givoly, D., & Hayn, C. (2000). The changing time-series properties of earnings, cash flows and accruals: Has financial reporting become more conservative? *Journal of accounting and economics*, *29*(3), 287–320. https://doi.org/10.1016/S0165-4101(00)00024-0

Graham, J. R., Raedy, J. S., & Shackelford, D. A. (2012). Research in accounting for income taxes. *Journal of Accounting and Economics*, *53*(1), 412–434. https://doi.org/10.1016/j.jacceco.2011.11.006

Guay, W. R. (2008). Conservative financial reporting, debt covenants, and the agency costs of debt. *Journal of Accounting and Economics*, *45*(2), 175–180. https://doi.org/10.1016/j.jacceco.2008.05.001

Hanlon, M. (2005). The persistence and pricing of earnings, accruals, and cash flows when firms have large book-tax differences. *The Accounting Review*, *80*(1), 137–166. https://doi.org/10.2308/accr.2005.80.1.137

Hanlon, M., Krishnan, G. V., & Mills, L. F. (2012). Audit fees and book-tax differences. *Journal of the American Taxation Association*, *34*(1), 55–86. https://doi.org/10.2308/atax-10184

Hanlon, M., Laplante, S. K., & Shevlin, T. J. (2005). Evidence on the possible information loss of conforming book income and taxable income. Available at SSRN 686402. https://doi.org/10.2139/ssrn.686402

Heltzer, W. (2009). Conservatism and book-tax differences. *Journal of Accounting, Auditing & Finance*, *24*(3), 469–504.

Huang, D. F., & Wang, C. L. (2013). Book-tax differences and earnings quality for the banking industry: evidence from Taiwan. *Pacific Accounting Review*, *25*(2), 145–164. https://doi.org/10.1108/PAR-12-2011-0052

Istrate, C. (2011). Accounting principles and book-tax (dis)connection in Romania (Working paper), International Conference on Accounting and Management Information Systems (AMIS). Retrieved from http://portal.feaa.uaic.ro/Docs/costel.istrate/Articles/Istrate%20AccPrinciplesBookTaxAfterReviewNotBlind.pdf

Jackson, M. (2009). Book-tax differences and earnings growth. *Working paper*, University of Oregon.

Jackson, M. (2015). Book-tax differences and future earnings changes. *The Journal of the American Taxation Association*, *37*(2), 49–73. https://doi.org/10.2308/atax-51164

Jarboui, A. (2013). Does corporate governance affect accounting conservatism? Empirical evidence in the French context. *International Journal of Accounting and Economics Studies*, *1*(3), 100–110. https://doi.org/10.14419/ijaes.v1i3.1218

Joos, P., Pratt, J., & Young, S. D. (2002). *Using deferred taxes to infer the quality of accruals*. (Working Paper), Massachusetts Institute of Technology (MIT).

Khan, M., & Watts, R. L. (2009). Estimation and empirical properties of a firm-year measure of accounting conservatism. *Journal of Accounting and Economics*, *48*(2), 132–150. https://doi.org/10.1016/j.jacceco.2009.08.002

LaFond, R., & Watts, R. L. (2008). The information role of conservatism. *The Accounting Review*, *83*(2), 447–478. https://doi.org/10.2308/accr.2008.83.2.447

Lev, B., & Nissim, D. (2002). *Taxable income as an indicator of earnings quality*. Working paper, New York University Press, New York.

Lev, B., & Nissim, D. (2004). Taxable income, future earnings, and equity values. *The Accounting Review*, *79*(4), 1039–1074. https://doi.org/10.2308/accr.2004.79.4.1039

Manzon, G., & Plesko, G. (2002). The relation between financial and tax reporting measures of income. *Tax Law Review,* 55(winter), 175–214.

Mills, L. F., & Newberry, K. J. (2001). The influence of tax and nontax costs on book-tax reporting differences: Public and private firms. *Journal of the American Taxation Association*, *23*(1), 1–19. https://doi.org/10.2308/jata.2001.23.1.1

Moore, J. A. (2012). Empirical evidence on the impact of external monitoring on book–tax differences. *Advances in Accounting*, *28*(2), 254–269. https://doi.org/10.1016/j.adiac.2012.06.002

Phillips, J., Pincus, M., & Rego, S. O. (2003). Earnings management: New evidence based on deferred tax expense. *The Accounting Review*, *78*(2), 491–521. https://doi.org/10.2308/accr.2003.78.2.491

Plesko, G. A. (2004). Corporate tax avoidance and the properties of corporate earnings. *National Tax Journal*, 729–737. https://doi.org/10.17310/ntj.2004.3.12

Revsine, L., Collins, D. W., Johnson, W. B., & Mittelstaedt, H. F. (2005). *Financial Reporting & Analysis*. New York, NY: Pearson/Prentice Hall.

Šodan, S. (2012). Book-tax differences and companies' financial characteristics: The case of Croatia. *The Business Review Cambridge*, *19*(2), 265–271.

Sun, J., & Liu, G. (2011). The effect of analyst coverage on accounting conservatism. *Managerial Finance*, *37*(1), 5–20. https://doi.org/10.1108/03074351111092111

Tang, T. Y. (2015). Does book-tax conformity deter opportunistic book and tax reporting? An international analysis. *European Accounting Review*, *24*(3), 441–469. https://doi.org/10.1080/09638180.2014.932297

Tang, T. Y., & Firth, M. (2012). Earnings persistence and stock market reactions to the different information in book-tax differences: Evidence from China. *The International Journal of Accounting*, *47*(3), 369–397. https://doi.org/10.1016/j.intacc.2012.07.004

Tang, T., & Firth, M. (2011). Can book–tax differences capture earnings management and tax management? Empirical evidence from China. *The International Journal of Accounting*, *46*(2), 175–204. https://doi.org/10.1016/j.intacc.2011.04.005

Wahab, N. S. A., & Holland, K. (2015). The persistence of book-tax differences. *The British Accounting Review*, *47*(4), 339–350. https://doi.org/10.1016/j.bar.2014.06.002

Watts, R. L. (2003). Conservatism in accounting part II: Evidence and research opportunities. *Accounting Horizons*, *17*(4), 287–301. https://doi.org/10.2308/acch.2003.17.4.287

Watts, R. L., & Zimmerman, J. L. (1986). *Positive accounting theory*. Englewood Cliffs, NJ: Prentice-Hall.

Weber, D. P. (2009). Do analysts and investors fully appreciate the implications of book-tax differences for future earnings? *Contemporary Accounting Research*, *26*(4), 1175–1206. https://doi.org/10.1506/car.26.4.7

Wilson, R. J. (2009). An examination of corporate tax shelter participants. *The Accounting Review*, *84*(3), 969-999. https://doi.org/10.2308/accr.2009.84.3.969

Zhang, J. (2008). The contracting benefits of accounting conservatism to lenders and borrowers. *Journal of Accounting and Economics*, *45*(1), 27–54. https://doi.org/10.1016/j.jacceco.2007.06.002

Zmijewski, M. E., & Hagerman, R. L. (1981). An income strategy approach to the positive theory of accounting standard setting/choice. *Journal of Accounting and Economics*, *3*(2), 129–149. https://doi.org/10.1016/0165-4101(81)90010-0

ASIAN ACADEMY *of*
MANAGEMENT JOURNAL
of ACCOUNTING
and FINANCE

AAMJAF Vol. 13, No. 1, 143–158, 2017

THE LOW-RISK ANOMALY: EVIDENCE FROM THE THAI STOCK MARKET

Kanis Saengchote

Department of Banking and Finance, Mahitaladhibesra Building,
Chulalongkorn Business School, Chulalongkorn University
Phayathai Road, Pathumwan, Bangkok
10330, Thailand

E-mail: kanis@cbs.chula.ac.th

ABSTRACT

In many developed countries, low-risk stocks tend to earn superior risk-adjusted returns compared to high-risk stock. Using data on the Stock Exchange of Thailand between 2004 and 2015, this paper shows that the abnormal returns associated with investing in low-beta stocks are significant and robust. The zero-cost portfolio that longs low-beta stocks and shorts high-beta stocks delivers monthly four-factor alpha of 1.26%. This paper provides suggestive evidence that, in addition to leverage constraints, the low-risk anomaly can be caused by institutional designs that favour stocks that are index constituents.

Keywords: beta, Capital Asset Pricing Model (CAPM), leverage constraints, benchmarking, index inclusion

INTRODUCTION

Asset pricing theory suggests that investors should not be able to earn abnormal returns in excess of the "fair" compensation they receive for the risks they take on. Such systematic abnormal excess returns have come to be known as returns "anomalies", and are often linked to firm characteristics such as size, growth opportunities, past returns, investments, profitability (e.g., Fama & French (1993); Jegadeesh & Titman (1993); Novy-Marx (2013); Titman, Wei, & Xie (2013)) or

Publication date: 30 August 2017

To cite this article: Saengchote, K. (2017). The low-risk anomaly: Evidence from the Thai stock market. *Asian Academy of Management Journal of Accounting and Finance, 13*(1), 143–158. https://doi.org/10.21315/aamjaf2017.13.1.6

To link to this article: https://doi.org/10.21315/aamjaf2017.13.1.6

market conditions (e.g., Pástor & Stambaugh (2003); Ang, Hodrick, Xing Zhang (2006)). The relationship between such anomalies and identifiable characteristics allow us to gain better understanding of risk determinants, as well as form profitable trading strategies.[1] However, one class of anomaly that is of particular interest is the "low-risk" anomaly, where assets with low risk (e.g. beta or idiosyncratic volatility) seem to outperform assets with high risk. Consider Figure 1, where average Sharpe-Lintner betas of stocks listed in the Stock Exchange of Thailand between January 2004 and December 2015 are plotted against their excess returns. In the Capital Asset Pricing Model that is often taught in finance classes, the relationship between systematic risk and returns is positive, but the figure reveals an opposite picture. In other words, high-risk assets are overpriced, and low-risk assets are underpriced.[2]

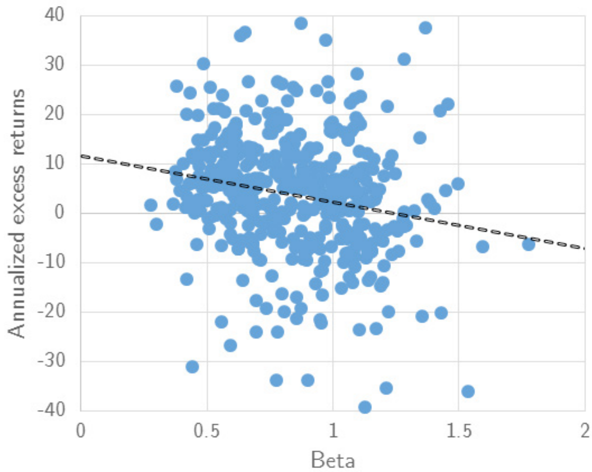

Figure 1. Relationship between stock beta and annualised excess returns. This scatter diagram plots the average excess returns for each stock in the Stock Exchange of Thailand against the calculated Sharpe-Lintner beta over the period of January 2004 to December 2015. Excess returns are calculated as the monthly return minus the one-month Thai Treasury bill rate, annualised and presented as percentage points. To be included in the sample, stocks must have at least 60 months of returns, leaving 453 unique stocks in total. An ordinary least squares regression is fitted to the data points and the resulting best-fit line is plotted as the dotted line in the diagram.

The fact that stocks with low risk seem to earn better returns is appealing for asset managers; after all, this is opposite of the "high-risk, high-return" mantra that is the fundamental principle of finance. There are several candidate theories that seek to explain this anomaly: some rely on behavioral biases and sentiments that affect retail investors (e.g. Barberis & Huang (2008), Kumar (2009), and Antoniou, Doukas & Subrahmanyam (2015)), some on limits to arbitrage through leverage constraints that are binding even for some institutional investors (e.g. Black (1972) and Frazzini & Pedersen (2014)), or a combination of both (e.g. Hong & Sraer (2016)).

The objective of this paper is to document the low-risk anomaly in Thailand and understand the forces that drive the abnormal returns so as to provide insights into if and how market participants can benefit from this anomaly. Consistent with evidence found in developed markets, Thai stocks with low beta also exhibit positive abnormal returns while high-beta stocks exhibit negative abnormal returns over the 12-year period of 2004 to 2015. The zero-cost portfolio that longs low-beta stocks and shorts high-beta stocks delivers monthly four-factor alpha of 1.26%, a very significant amount even after taking into account trading costs. The evidence on the nature and timing of low-beta returns do not fully support the leading explanations that are proposed for developed markets. Using stock trade data from the Stock of Exchange of Thailand between 2004 and 2008 that classifies investors by type, this paper shows that investors tend to be more active in high-beta stocks, particularly non-retail investors. High-beta stocks in Thailand tend to have larger market capitalisation and are more likely to be index constituents. As mutual funds tend to be evaluated based on index-based returns benchmark, this finding is consistent with Baker, Bradley and Wurgler (2011) who argue that the low-beta anomaly is driven by such benchmarking. Moreover, stocks that are included in indices tend to be in higher demand (e.g. Jain (1987), Kaul, Mehrotra & Morck (2000) and Chen, Noronha, & Singal (2004)).[3]

LITERATURE REVIEW

The idea that high-risk assets may be overpriced is not new: Black (1972) shows that, with borrowing restrictions (e.g. margin requirements), low-beta stocks can perform better than predicted by the Sharpe-Lintner Capital Asset Pricing Model (CAPM), while high-beta stocks can perform worse. Empirically, several studies (e.g. Black, Jensen, & Scholes (1972) and Fama & French (1992)) have documented that the relationship between beta and returns of the CAPM is flatter than the model implies. The empirical shortcomings of the CAPM has led to numerous papers that either attempt to extend the model by including other risk factors (e.g. Fama & French (1993), Jegadeesh & Titman (1993); Novy-Marx (2013)) or critique the assumptions behind the model (e.g. Shleifer & Vishny (1997); Gromb & Vayanos (2002); Acharya & Pedersen (2005)), but the main focus of academic studies had not been on the anomaly itself.

The low-risk anomaly received greater attention when Ang et al. (2006) and Ang, Hodrick, Xing and Zhang (2009) find that high-risk stocks (in their papers, risk is defined as idiosyncratic volatility rather than beta) tend to earn very low average returns. The low-risk anomaly has been discussed under both systematic (beta) and idiosyncratic risk measures, but portfolios that have low systematic risk also tends to have low idiosyncratic risk. However, as systematic risk exposure tends to be similar across similar businesses, one may argue that the low-risk returns are attributable to stocks that are in relatively more stable industries. Baker, Bradley and Taliaferro (2014) find that the superior performance comes from both picking low-beta stocks (micro effect) in low-beta industry/country (macro effect). This finding is further corroborated by Asness, Frazzini and Pedersen (2014) who document that low-risk investing strategy delivers positive returns even as industry-neutral bets. In addition, the positive returns have also been found in many developed countries and across several asset classes (e.g. Baker et al. (2014) and Frazzini & Pedersen (2014)).

While there are several potential explanations for this anomaly, the most often-cited theory stems from leverage constraints. Shleifer and Vishny (1997) provides a simple framework that helps us understand how limited arbitrage capital that is constrained by borrowing capacity can allow prices to diverge far from their fundamental values. The intuition has been developed further in Gromb and Vayanos (2002), Acharya and Pedersen (2005), Brunnermeier and Pedersen (2009), Garleanu and Pedersen (2011) and Rytchkov (2014). Frazzini and Pedersen (2014) extend the model of Black (1972) and derive a zero-cost, market-neutral pricing factor called BAB (betting against beta) – that is, a portfolio that longs low-beta stocks and shorts high-beta stocks.[4] In their model, agents that cannot borrow must overweight high-beta stocks in order to achieve higher returns, making the security market line flatter (similar to Black (1972)), but the slope depends on the tightness of the funding constraints. Other forms of institutional frictions can also impose limits to arbitrage. For example, Baker et al. (2011) argue that distortions created by returns benchmarking can induce the anomaly.

Other leading explanations posit that investors/agents are prone to behavioral biases or market sentiments. For example, Kumar (2009) finds that some individuals exhibit preference for stocks with lottery-like payoffs, while Bali, Cakici and Whitelaw (2011) also find that portfolios with lottery-like payoffs tend to exhibit poor returns. Antoniou et al. (2015) find evidence that sentiment affects the security market line; noise traders appear to be more bullish about high-beta stocks when market sentiments are good. Combining both market sentiments and limits to arbitrage, Hong and Sraer (2016) propose a model where the direction of the risk-return relationship depends on disagreement about the market's prospect;

when disagreement is high, high-beta assets tend to be more prone to speculative overpricing when there are short-sale constraints.

DATA AND METHODOLOGY

Data

The data used in the analysis comes from several sources. Equity market data is retrieved from Thompson Reuters Datastream and contains total return, market capitalisation and the book-to-market ratio of all common stocks in the Stock Exchange of Thailand (SET) at monthly frequency between January 2001 and December 2015, and the monthly return of the SET50 index which is used as the proxy for market returns. The index is a market capitalisation-weighted price index of 50 listed companies on SET, selected based on large market capitalisation, high liquidity and availability of free-float stocks for general. Stocks that are classified as under rehabilitation plan as well as stocks that do not trade consecutively for three months are excluded from the sample. Because historical returns are used to estimate the stock beta (methodology to be described subsequently), the final sample runs from January 2004 to December 2015 and contains 453 stocks in total. Risk-free rate used for calculations of excess returns and market risk premium is the one-month Thai government Treasury bill retrieved from Bloomberg. The market capitalisation and book-to-market ratio are used for construction of Fama and French (1993) size small-minus-big (SMB) and value high-minus-low (HML) factor-mimicking portfolios respectively. Past returns are used to construct the Carhart (1997) momentum up-minus-down (UMD) factor.[5]

METHODOLOGY

To rank the stocks based on their ex-ante beta, the beta is estimated based on historical volatility and stock return's correlation with market return. Following Frazzini and Pedersen (2014) procedure for monthly data, each stock's beta is calculated using the following formula:

$$\hat{\beta}_i^{ts} = \hat{\rho}_i (\hat{\sigma}_i / \hat{\sigma}_m)$$

where $\hat{\sigma}_i$ and $\hat{\sigma}_m$ are estimated volatilities for stock and the market using one-year (12 months) rolling window. $\hat{\rho}_i$ is the estimated correlation between stock *i* and the market, calculated over a three-year (36 months) horizon. With the ex-ante betas, stocks can be ranked in each month into 5 groups based on their previous months' beta, construct equally-weighted portfolios, and examine the properties of returns using various specifications of the linear factor pricing model of the following general form:

$$r^{e}_{j,t} = \alpha_j + \beta'_j f_t + \varepsilon_{j,t,} \qquad j = 1,...,5$$

where $r^{e}_{j,t}$ is the equally-weighted excess returns of stocks in portfolio j, f_t is the vector of factors of the pricing model, β_j is the vector of the factor loadings on portfolio j,, and α_j the systematic abnormal excess returns associated with strategy of portfolio j (our outcome of interest). All returns are computed as monthly percentage point. Stocks are sorted based on their ex-ante estimated beta in ascending order, so portfolio 1 corresponds to stocks with lowest beta and portfolio 5 highest beta. The linear factor pricing model specifications to be used are Sharpe-Lintner CAPM single-factor model, Fama and French (1993) three-factor model and Carhart (1997) four-factor model. All standard errors in the linear pricing regressions are adjusted for heteroskedascity and autocorrelation using Newey-West standard error with lag of 12 months.

RESULTS

First, this study examines whether raw returns of beta-sorted portfolio exhibit the low-risk anomaly. Table 1 presents the excess returns of stocks in each portfolio along with the corresponding average beta, market capitalisation and book-to-market ratio. The raw returns are indeed decreasing in the stock beta, as evident in the scatter diagram earlier (Figure 1). Figure 2 plots the excess returns by portfolio for convenient visual inspection. On average, low-beta stocks tend to be smaller, while the average book-to-market ratio is similar across portfolios. Of course, the returns differences can be attributed to different risk characteristics, so in the next step the differences are further investigated under several specifications of the linear factor-pricing model.

Table 1
Summary statistics of beta-sorted portfolios

This table provides descriptive statistics of the beta-sorted portfolio over the period of January 2004 to December 2015 (144 months). At the beginning of each calendar month, stocks in the Stock Exchange of Thailand are ranked based in ascending order based on their estimated beta at the end of the previous month. All stocks are given equal weights within each portfolio, and portfolio are rebalanced every month. Portfolio 1 contains stocks with the lowest beta, and portfolio 5 the highest. Beta is estimated using covariance and standard deviation calculated over rolling windows of 36 months and 12 months respectively. Market capitalisation is measured in millions of baht, and book-to-market ratio is obtained at the monthly frequency.

Portfolio	Excess returns (monthly, %)	Estimated beta	Market capitalisation (THB million)	Book-to-market ratio
1	0.59	0.38	6,254.77	1.03
2	0.50	0.60	11,957.56	1.09
3	0.50	0.78	17,098.99	1.04
4	0.37	0.99	27,347.93	1.03
5	–0.49	1.42	25,112.22	0.95

Figure 2. Monthly excess returns of beta-sorted portfolios. This scatter diagram plots the average monthly excess returns for beta-sorted portfolio over the period of January 2004 to December 2015. Excess returns are calculated as the monthly return minus the one-month Thai Treasury bill rate, presented as percentage points. At the beginning of each calendar month, stocks in the Stock Exchange of Thailand are ranked based in ascending order based on their estimated beta at the end of the previous month. All stocks are given equal weights within each portfolio, and portfolio are rebalanced every month. Portfolio 1 contains stocks

with the lowest beta, and portfolio 5 the highest.

Table 2
Returns of beta-sorted portfolios

The following table reports the returns of the beta-sorted portfolio over the period of January 2004 to December 2015. At the beginning of each calendar month, stocks in the Stock Exchange of Thailand are ranked based in ascending order based on their estimated beta at the end of the previous month. All stocks are given equal weights within each portfolio, and portfolio are rebalanced every month. Portfolio 1 contains stocks with the lowest beta, and portfolio 5 the highest. The sixth column is a self-financing, long-short portfolio that longs portfolio 1 and shorts portfolio 5. In the top half of the table, monthly excess returns of the portfolios are reported along with annualised volatility and Sharpe ratio. The benchmark risk-free rate used is the one-month Thai Treasury bill. The bottom half of the panel reports the alphas corresponding to different specifications of the linear factor pricing model. The CAPM alpha is the single-factor Capital Asset Pricing Model which uses the return on the SET50 index as proxy for market returns. The three-factor model adds the Fama and French (1993) SMB and HML factor-mimicking portfolios, while the four-factor model adds the Carhart (1997) UMD factor. Excess returns and alphas are in monthly percent, and *t*-statistics are reported in square parentheses. All standard errors in the linear pricing regressions are adjusted for heteroskedascity and autocorrelation using Newey-West standard error with lag of 12 months. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Portfolio	(1)	(2)	(3)	(4)	(5)	(1)–(5)
Excess returns	0.593**	0.497	0.503	0.373	–0.495	1.088**
	[2.135]	[1.555]	[1.097]	[0.645]	[–0.681]	[2.003]
Volatility (annualised)	11.55	13.30	19.06	24.02	30.22	22.57
Sharpe ratio (annualised)	0.62	0.45	0.32	0.19	–0.20	0.58
Alphas						
Sharpe-Lintner CAPM	0.546**	0.436*	0.406	0.247	–0.656*	1.203***
	[2.076]	[1.717]	[1.278]	[0.811]	[–1.928]	[3.597]
Three-Factor	0.455**	0.245**	0.178	–0.00197	–0.924***	1.378***
(Fama & French, 1993)	[2.304]	[2.126]	[1.275]	[–0.0128]	[–4.545]	[4.223]
Four-Factor	0.492**	0.308**	0.263*	0.148	–0.767***	1.259***
(Carhart, 1997)	[2.327]	[2.519]	[1.858]	[0.979]	[–4.645]	[4.179]

Before proceeding further with the analysis, the returns characteristics of the beta-sorted portfolios as presented in Table 2. Portfolio 1, which has the lowest beta, also has the lowest volatility (here, annualised), while portfolio 5 which has the highest beta has the highest volatility. The relationship between risk and return is decreasing under both measures of risk, consistent with Baker et al. (2011) and Frazzini and Pedersen (2014). In addition, the Sharpe ratio is also decreasing in beta. A zero-cost investment strategy which longs low-beta stocks (portfolio 1) and shorts high-beta stocks (portfolio 5) returns 1.09% per month with annualised Sharpe ratio of 0.58.

Table 2 also presents the alphas of the portfolios under different specifications of the linear factor pricing model. The Sharpe-Lintner CAPM alpha suggests that the abnormal returns associated at either extremes of the beta spectrum are statistically significant. Stocks with lowest beta earn 0.55% more per month than predicted by the model, while stocks with highest beta earn 0.66% less.[6] The zero-cost, long-short portfolio earns an astonishing 1.2% abnormal returns per month, far in excess of any trading costs that could be involved in executing the strategy.

One concern that may arise from results in Table 1 is that average market capitalisation of stocks in the portfolios is different, which could consequently affect returns. The three-factor model incorporates these characteristics. With the inclusion of the size premium, the alphas the portfolios decrease slightly but the alphas remain statistically significant. Finally, the inclusion of the momentum factor still leaves the results intact. The long-short portfolio delivers monthly four-factor alpha of 1.26%, statistically significant at 1% level. Overall, the superior returns of the low-risk strategy are statistically significant and robust to several specifications of the linear factor-pricing model.

UNDERSTANDING THE LOW-RISK ANOMALY

What could be the economic forces behind the low-risk anomaly in Thailand? In this section, the issue is further explored. Two leading explanations for the anomaly are behavioural biases and leverage constraints, as discussed in Literature Review.

Many classes of investors in Thailand face leverage constraints where securities borrowing and selling is expensive for retail investors, and many institutional investors face explicit borrowing constraints.[7] Consequently, they may be forced to invest in riskier assets in order to generate returns for their investors.[8]

To investigate the leverage constraints, the BAB factor proposed by Frazzini and Pedersen (2014) is employed. The steps in the construction the BAB factor involve partitioning the universe of stocks into two groups: low-beta and high-beta. The stocks in each group are then weighted based on beta-sorted ranks which are scaled by average portfolio beta so that average beta in each group is exactly one. The factor-mimicking portfolio longs low-beta stocks and shorts high-beta stocks. When the two groups are netted off against each other, the resulting portfolio is both zero-cost and zero-beta (i.e. market-neutral). The BAB factor is negatively correlated with stock market returns, as shown in Figure 3. No proxy for funding liquidity (like the TED spread in the U.S.) is available in Thailand, but suppose one argues that funding liquidity tightens during periods when stock market performs poorly, then the correlation between the BAB factor and funding liquidity has the opposite sign to what is expected and demonstrated in Frazzini and Pedersen (2014), where BAB factor performs worse when funding liquidity tightens.

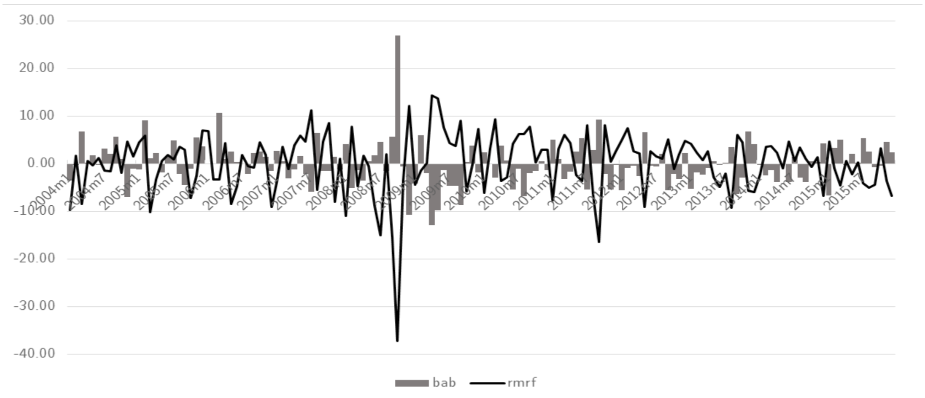

Figure 3. BAB factor versus equity market risk premium. This graph plots the monthly values of the BAB factor and equity market risk premium measured as percentage points. BAB factor is displayed as bars and equity market risk premium as line. The Pearson correlation coefficient between the two factors is –0.7256 and statistically significant at 1% level.

Table 3 shows the results of the linear factor-pricing model with the addition of the BAB factor. As expected, the loading on the BAB factor declines as portfolio beta increases. However, the alphas associated with the portfolios, while lower than the baseline model, are still non-zero and statistically significant, suggesting that the BAB factor cannot fully explain the anomaly. Taken together with Figure 3, the results in Table 3 suggest that leverage constraints can at best partially explain the low-risk anomaly in Thailand.

The next leading explanation is investor behavioural biases. There are several mechanisms through which behavioral biases can affect stock prices, but one mechanism that could be tested here is investor sentiment. Antoniou et al. (2015) find that during periods where market sentiments are pessimistic, average returns on high-beta portfolios are higher than low-beta portfolios, while the low-risk anomaly is found during optimistic periods, where unsophisticated investors are more bullish about prices of high-beta stocks and bid up their prices. However, Figure 3 reveals an opposite pattern: when stock market returns perform well (arguably optimistic market sentiments), the low-risk portfolio performs worse. Investor sentiment does not seem to the driving force in Thailand either.

Table 3
Explaining abnormal returns using BAB factor

The following table reports the factor loadings of the linear pricing model for the beta-sorted portfolio over the period of January 2004 to December 2015. At the beginning of each calendar month, stocks in the Stock Exchange of Thailand are ranked based in ascending order based on their estimated beta at the end of the previous month. All stocks are given equal weights within each portfolio, and portfolio are rebalanced every month. Portfolio 1 contains stocks with the lowest beta, and portfolio 5 the highest. The sixth column is a self-financing, long-short portfolio that longs portfolio 1 and shorts portfolio 5. The linear factor pricing model augments the Carhart (1997) four-factor model with BAB factor as proposed by Frazzini and Pedersen (2014). BAB factor is constructed as self-financing, zero-beta portfolio that longs low-beta stocks and shorts high-beta stocks. The factor-mimicking portfolio is rebalanced every month. Alphas are in monthly percent, and t-statistics are reported in square parentheses. All standard errors in the linear pricing regressions are adjusted for heteroskedascity and autocorrelation using Newey-West standard error with lag of 12 months. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Portfolio	(1)	(2)	(3)	(4)	(5)	(1)–(5)
RMRF	0.774***	0.617***	0.887***	1.066***	1.321***	–0.547***
	[21.27]	[14.26]	[26.90]	[18.76]	[12.57]	[–5.585]
SMB	0.707***	0.616***	0.847***	1.018***	1.191***	–0.485***
	[8.807]	[6.551]	[9.143]	[14.51]	[11.97]	[–5.120]
HML	0.567***	0.592***	0.664***	0.684***	0.695***	–0.128
	[14.41]	[9.185]	[8.070]	[8.470]	[5.843]	[–1.208]
UMD	–0.139***	–0.0857***	–0.0923***	–0.149***	–0.133**	–0.00593
	[–5.285]	[–3.272]	[–2.655]	[–4.140]	[–2.442]	[–0.125]
BAB	0.524***	0.0391	–0.0812*	–0.214***	–0.347***	0.872***
	[10.12]	[1.128]	[–1.739]	[–3.729]	[–2.771]	[8.164]
Alpha	0.395***	0.301**	0.278*	0.187	–0.703***	1.098***
	[3.104]	[2.469]	[1.911]	[1.217]	[–4.468]	[5.576]

Notes. RMRF = market factor (market return minus risk-free rate); SMB = size factor (small [market cap] minus big); HML = value factor (high [book-to-market ratio] minus low); UMD = momentum factor (up [trend] minus down); BAB = betting against beta factor

The results here are rather perplexing: the low-risk anomaly is present and robust in Thailand, yet leading explanations do not seem to explain the anomaly very well in this setting. So in the next step, the analysis turns to identity of the groups of investors that participate in each risk stratum in the market. Using stock trade data in SET that allows classification of traders by investor group (here, retail investors, mutual funds, and other groups which comprise proprietary trading and foreign investors) available from 2004 to 2008, this paper examines the average monthly trade value of stocks in each portfolio. The results are displayed in Table 4. Investors in all groups tend to invest in high-beta stocks more. However, non-retail investors tend to invest in high-beta stocks disproportionately more than retail investors. To the extent that behavioural bias explanations are typically associated with activities of retail investors, the anomaly here seems to be more related to non-retail investors.

Table 4
Trades by investor group of beta-sorted portfolios

This table provides characteristics of the beta-sorted portfolio over the period of January 2004 to December 2008 (60 months). At the beginning of each calendar month, stocks in the Stock Exchange of Thailand are ranked based in ascending order based on their estimated beta at the end of the previous month. All stocks are given equal weights within each portfolio, and portfolio are rebalanced every month. Portfolio 1 contains stocks with the lowest beta, and portfolio 5 the highest. Beta is estimated using covariance and standard deviation calculated over rolling windows of 36 months and 12 months respectively. Market capitalization and trade value (both buy and sell transactions) are measured in millions of baht. Stocks that are SET100 index constituents are identified. Other groups of investors include proprietary trading by securities companies and foreign investors.

Portfolio	Monthly trade value (THB million)			Estimated Beta	Market Capitalisation (THB million)	Index Constituents (%)
	Retail	Mutual	Others			
1	111.60	2.64	12.45	–0.09	2,564.88	1.7
2	50.61	6.79	21.84	0.19	4,077.62	5.4
3	143.67	21.80	80.05	0.42	7,590.62	14.8
4	399.94	87.55	352.89	0.73	21,262.81	26.7
5	1,048.81	137.47	570.60	1.36	27,360.12	35.3

In fact, these high-beta stocks tend to have larger market capitalisation, which make them more likely to be member of stock indices (Table 4). If the investment performance of non-retail investors are evaluated relative to index-based benchmarks, then the fact that such investors tend to be disproportionately more active in large-cap stocks (which happen to have high beta) could be a friction induced by institutional design. In that case, this finding is consistent with Baker et al. (2011), who argue that investment managers happily invest in overpriced, high-beta stocks because it minimises their tracking error, a dimension which they are evaluated on. In addition, some classes of institutional investors – both domestic and foreign – may have explicit investment restrictions that permit to them to invest in only a subset of stocks, typically large-cap stocks which belong to some index. For this reason, such stocks tend to have higher demand relative to other stocks (e.g. Jain (1987), Kaul et al. (2000) and Chen et al. (2004)), so index inclusion could be another force that drives the low-beta anomaly.[9] Given the fact that Thai households are increasingly investing their wealth through mutual funds (up from 7.5% of GDP in 2000 to 30% in 2015), index-based benchmarking of fund returns could be good news for investors of non-index, low-beta stocks.[10]

CONCLUSION

This paper documents the existence of the low-beta anomaly in the Thai stock market. The abnormal returns are significant – both economically and statistically – and robust to several specifications of the linear factor pricing model. Further analyses suggest that leverage constraints may play a part in the existence of this anomaly, but frictions from benchmarking and index inclusion are more plausible explanations in this case. However, the results of the analyses on the cause of the anomaly should only be interpreted as suggestive evidence: to draw a definite conclusion, better data on funding liquidity and investor portfolio holdings are required.

For most other market anomalies, evidence suggests that profits associated with publicly available strategies tend to diminish as “arbitrage capital” grows (e.g. Chordia, Subrahmanyam & Tong (2014) and Hanson & Sunderam (2014)). However, in this case, given that most institutional investors that participate in the Thai stock market are not in the position to exploit this strategy, this provides an opportunity for the unrestricted investors. The low-beta strategy offers superior risk-adjusted returns and the best of both worlds–higher returns and lower volatility.

NOTES

1. Often, this is referred to as “style investing”, where portfolio formation strategies are designed based on stock characteristics that earn anomalous returns not predicted by baseline pricing model.
2. The positive relationship between beta and return has been questioned long in the past (e.g. Black et al. (1972) and Fama & French (1992)) and received renewed attention recently (e.g. Ang et al. (2006), Ang et al. (2009), Baker et al. (2011), Baker et al. (2014) and Frazzini & Pedersen (2014)).
3. To illustrate why stocks with abnormally high demand can be bad for investors, consider a high-beta stock. High demand for such stock causes investors to bid

up its price. Note that investor demand – high or low – does not affect expected future cash flow that such stock would generate. With future payoffs the same, all else equal, higher purchase price translates into lower return than the asset-pricing model predicts in equilibrium. Conversely, if a low-beta stock has abnormally low demand, its price will be lower than it should be; all else equal, its return will be higher than predicted.

4. The BAB portfolio is not like a typical long-short portfolio in a sense that the weights of each stock and risk-free asset in the long and short groups are determined such that both groups have beta of one. When they are netted off against each other, the portfolio is market-neutral, i.e. has beta of zero.
5. All stocks in SET are used in the construction of the factors. SMB and HML factors are created from 2 x 3 sort and rebalanced annually using the market capitalisation and book-to-market ratio at the end of December in each year. UMD is calculated based on past cumulative returns from 2 to 12 months and sorted into 3 equal-size portfolios which are rebalanced monthly.
6. The beta loadings of the portfolios are unreported, but are similar in magnitude to the average ex-ante beta of the portfolios.
7. In particular, Securities and Exchange Act B.E. 2535 Section 126 prohibits mutual funds in Thailand from borrowing.
8. Explicit investment restrictions have been shown to artificially affect demand for risky assets and compel institutional investors to "reach for yield", as shown by Becker and Ivashina (2015).
9. Large-cap stocks in Thailand tend to receive more media coverage, and consequently investors may be disproportionately more inclined to invest in such stocks, bidding up their prices. However, the inclusion of the SMB factor in the linear factor pricing model partially mitigates the size-coverage effect. The author thanks the referee for suggesting the discussion of this issue.
10. As investment in mutual funds gains popularity, the proportion of retail investors trading value in the Thai stock market has declined steadily from 76% in 2003 to 50% in 2016.

REFERENCES

Acharya, V. V., & Pedersen, L. H. (2005). Asset pricing with liquidity risk. *Journal of Financial Economics, 77*(2), 375–410. https://doi.org/10.1016/j.jfineco.2004.06.007

Ang, A., Hodrick, R. J., Xing, Y., & Zhang, X. (2006). The cross-section of volatility and expected returns. *The Journal of Finance, 61*(1), 259–299. https://doi.org/10.1111/j.1540-6261.2006.00836.x

Ang, A., Hodrick, R. J., Xing, Y., & Zhang, X. (2009). High idiosyncratic volatility and low returns: International and further US evidence. *Journal of Financial Economics, 91*(1), 1–23. https://doi.org/10.1016/j.jfineco.2007.12.005

Antoniou, C., Doukas, J. A., & Subrahmanyam, A. (2015). Investor sentiment, beta, and the cost of equity capital. *Management Science, 62*(2), 347–367. https://doi.org/10.1287/mnsc.2014.2101

Asness, C. S., Frazzini, A., & Pedersen L. H. (2014). Low-risk investing without industry bets. *Financial Analysts Journal, 70*(4), 24–41. https://doi.org/10.2469/faj.v70.n4.1

Baker, M., Bradley, B., & Taliaferro, R. (2014). The low-risk anomaly: A decomposition into micro and macro effects. *Financial Analysts Journal*, *70*(2), 43–58. https://doi.org/10.2469/faj.v70.n2.2

Baker, M., Bradley, B., & Wurgler, J. (2011). Benchmarks as limits to arbitrage: Understanding the low-volatility anomaly. *Financial Analysts Journal, 67*(1), 40–54. https://doi.org/10.2469/faj.v67.n1.4

Bali, T. G., Cakici, N., & Whitelaw, R. F. (2011). Maxing out: Stocks as lotteries and the cross-section of expected returns. *Journal of Financial Economics, 99*(2), 427–446. https://doi.org/10.1016/j.jfineco.2010.08.014

Barberis, N., & Huang, M. (2008). Stocks as lotteries: The implications of probability weighting for security prices. *The American Economic Review 98*(5), 2066–2100. https://doi.org/10.1257/aer.98.5.2066

Becker, B., & Ivashina, V. (2015). Reaching for yield in the bond market. *The Journal of Finance, 70*(5), 1863–1902. https://doi.org/10.1111/jofi.12199

Black, F. (1972). Capital market equilibrium with restricted borrowing. *The Journal of Business, 45*(3), 444–455. https://doi.org/10.1086/295472

Black, F., Jensen, M. C., & Scholes, M. (1972). The capital asset pricing model: Some empirical tests. In M. C. Jensen (Ed.), *Studies in the Theory of Capital Markets*. (pp.1–54) New York: Praeger.

Brunnermeier, M. K., & Pedersen, L. H. (2009). Market liquidity and funding liquidity. *Review of Financial Studies, 22*(6), 2201–2238. https://doi.org/10.1093/rfs/hhn098

Carhart, M. M. (1997). On persistence in mutual fund performance. *The Journal of Finance, 52*(1), 57–82. https://doi.org/10.1111/j.1540-6261.1997.tb03808.x

Chen, H., Noronha, G., & Singal, V. (2004). The price response to s&p 500 index additions and deletions: Evidence of asymmetry and a new explanation. *The Journal of Finance, 59*(4), 1901–1930. https://doi.org/10.1111/j.1540-6261.2004.00683.x

Chordia, T., Subrahmanyam, A., & Tong, Q. (2014). Have capital market anomalies attenuated in the recent era of high liquidity and trading activity? *Journal of Accounting and Economics, 58*(1), 41–58. https://doi.org/10.1016/j.jacceco.2014.06.001

Fama, E. F., & French, K. R. (1992). The cross-section of expected stock returns. *The Journal of Finance 47*(2), 427–465. https://doi.org/10.1111/j.1540-6261.1992.tb04398.x

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics, 33*(1), 3–56. https://doi.org/10.1016/0304-405X(93)90023-5

Frazzini, A., & Pedersen, L. H. (2014). Betting against beta. *Journal of Financial Economics, 111*(1), 1–25. https://doi.org/10.1016/j.jfineco.2013.10.005

Garleanu, N., & Pedersen, L. H. (2011). Margin-based asset pricing and deviations from the law of one price. *Review of Financial Studies, 24*(6), 1980–2022. https://doi.org/10.1093/rfs/hhr027

Gromb, D., & Vayanos, D. (2002). Equilibrium and welfare in markets with financially constrained arbitrageurs. *Journal of Financial Economics, 66*(2), 361–407. https://doi.org/10.1016/S0304-405X(02)00228-3

Hanson, S. G., & Sunderam, A. (2014). The growth and limits of arbitrage: Evidence from short interest. *Review of Financial Studies, 27*(4), 1238–1286. https://doi.org/10.1093/rfs/hht066

Hong, H., & Sraer, D. A. (2016). Speculative betas. *The Journal of Finance*. https://doi.org/10.1111/jofi.12431

Jain, P. C. (1987). The effect on stock price of inclusion in or exclusion from the S&P 500. *Financial Analysts Journal, 43*(1), 58–65. https://doi.org/10.2469/faj.v43.n1.58

Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of Finance, 48*(1), 65–91. https://doi.org/10.1111/j.1540-6261.1993.tb04702.x

Kaul, A., V. Mehrotra, V., & Morck, R. (2000). Demand curves for stocks do slope down: New evidence from an index weights adjustment. *The Journal of Finance, 55*(2), 893–912. https://doi.org/10.1111/0022-1082.00230

Kumar, A. (2009). Who gambles in the stock market? *The Journal of Finance, 64*(4), 1889–1933. https://doi.org/10.1111/j.1540-6261.2009.01483.x

Novy-Marx, R. (2013). The other side of value: The gross profitability premium. *Journal of Financial Economics, 108*(1), 1–28. https://doi.org/10.1016/j.jfineco.2013.01.003

Pástor, L., & Stambaugh, R. F. (2003). Liquidity risk and expected stock returns. *Journal of Political Economy, 111*(3), 642–685. https://doi.org/10.1086/374184

Rytchkov, O. (2014). Asset pricing with dynamic margin constraints. *The Journal of Finance, 69*(1), 405–452. https://doi.org/10.1111/jofi.12100

Shleifer, A., & Vishny, R. W. (1997). The limits of arbitrage. *The Journal of Finance, 52*(1), 35–55. https://doi.org/10.1111/j.1540-6261.1997.tb03807.x

Titman, S., Wei, K. J., & Xie, F. (2013). Market development and the asset growth effect: International evidence. *Journal of Financial and Quantitative Analysis, 48*(5), 1405–1432. https://doi.org/10.1017/S0022109013000495

ASIAN ACADEMY *of* MANAGEMENT JOURNAL *of* ACCOUNTING *and* FINANCE

AAMJAF Vol. 13, No. 1, 159–178, 2017

THE EFFECT OF INVESTOR SENTIMENT ON STOCK RETURNS: INSIGHT FROM EMERGING ASIAN MARKETS

Shangkari V. Anusakumar[1], Ruhani Ali[2]* and Hooy Chee Wooi[3]

[1, 3] School of Management, Universiti Sains Malaysia,
11800 USM, Pulau Pinang, Malaysia
[2]Graduate School of Business, Universiti Sains Malaysia
11800 USM, Pulau Pinang, Malaysia

*Corresponding author: ruhani@usm.my

ABSTRACT

This paper investigates the link between investor sentiment and stock returns in emerging Asian markets. Two dimensions of sentiment are examined: stock specific sentiment and market wide sentiment. Using panel regression with firm fixed effects, we show that stock specific sentiment strongly and positively affects stock returns after controlling for firm characteristics. Overall, there is a positive relationship between market wide sentiment and returns but the relationship does not hold at the country level. For individual countries, we detect substantial country-to-country variations in the influence of market wide sentiment on returns. The evidence also suggests that stock specific sentiment may have a greater influence on returns than market specific sentiment. Furthermore, the effect of investor sentiment on stock returns in emerging Asian markets generally persists after accounting for macroeconomic factors.

Keywords: Investor sentiment, optimism and pessimism, stock returns, market sentiment, emerging markets

Publication date: 30 August 2017

To cite this article: Anusakumar, S. V., Ali, R., & Hooy, C. W. (2017). The effect of investor sentiment on stock returns: Insight from emerging Asian markets. *Asian Academy of Management Journal of Accounting and Finance, 13*(1), 159–178. https://doi.org/10.21315/aamjaf2017.13.1.7

To link to this article: https://doi.org/10.21315/aamjaf2017.13.1.7

INTRODUCTION

Recent years have borne witness to a surge in sentiment[1] related studies. A large number of these studies, however, take an indirect approach. The likely effect of sentiment on returns is deduced from the investigation of other variables (Kurov, 2010; Kaplanski & Levy, 2012; Kaustia & Knupfer, 2012) or specific events such as natural disasters (Kaplanski & Levy, 2010; Shan & Gong, 2012), man-made disasters (Drakos, 2010), sporting events (Chang, Chen, Chou & Lin, 2012; Curatola, Donadelli, Kizys & Riedel, 2016), and religious festivities (Białkowski, Etebari & Wisniewski, 2012). The sentiment, inferred using the aforementioned methods, may not represent investor sentiment in its entirely or may misrepresent sentiment. Thus, much work is needed in the direct examination of the association between sentiment and stock returns. It is this aspect of sentiment studies that we venture into by directly examining the effect of sentiment on stock returns.

In a recent study, Aissia (2016) examine the effect of home and foreign investor sentiment in the French stock market and found that both sentiments affect stock returns. In addition, Liston (2016) document that both individual and institutional investor sentiments influence sin stocks returns. Venturing further, Tsai (2017) examine the sentiment of three different types of institutional investors (foreign investors, trust investors, and dealers) in the Taiwan stock market. In a similar manner, we extend earlier studies of sentiment by incorporating additional dimensions of sentiment: market and stock level sentiment.

Past research has largely concentrated on either the sentiment of the stock market (e.g. Miwa, 2016) or individual stocks (e.g. Sayim & Rahman, 2015). This paper differs in that both sentiments, at the stock level and market level, are examined in relation to stock returns. Researchers thus far have relied mostly on aggregate market returns or portfolio returns (sorted based on specific characteristics such as growth) for their analysis. We use the returns of individual stocks as the dependent variable. Moreover, we use panel data for the analysis which allows us to take advantage of the data to the fullest extent. Unlike past studies, we take a long term perspective with the use of yearly instead of monthly or weekly returns. Past papers have largely concentrated on western and developed markets, especially the US stock market (e.g. Baker & Wurgler, 2006; Lemmon & Portniaguina, 2006; Abdelhédi-Zouch, Abbes, & Boujelbène, 2015; Smales, 2017). Literature on emerging markets and also Asian markets are not as extensive as developed markets; we hope to simultaneously fill these gaps in literature by examining emerging Asian markets.

In this study, we examine the link between stock returns and sentiment in 8 emerging Asian countries: Malaysia, India, Indonesia, Philippines, Taiwan, Thailand, South Korea and China. In particular we cover two different dimensions of sentiments: stock specific and market wide sentiment. As the name implies, stock specific sentiment is the sentiment for each individual stock (i.e. at the stock level.) whilst market wide sentiment refers broadly to the sentiment prevailing in the stock market (i.e. at the market level). We find that stock specific sentiment is positively related to returns even after controlling for macroeconomic factors. On the other hand, the effect of market wide sentiment on returns is country specific. However, market wide sentiment is, overall, positively related to stock returns. The evidence also suggests that stock specific sentiment may have a greater influence on returns than market specific sentiment.

RELATED LITERATURE

Sentiment is purported to affect returns as investor's optimistic or pessimism may induce mispricings to occur in the stock market. Optimism (pessimism) may drive stock prices well above (below) that warranted by the underlying fundamental value as investors overvalue (undervalue) asset prices due to optimism (pessimism). Congruent with this notion, Brown and Cliff (2004) document a strong association between sentiment and contemporaneous stock returns. Brown and Cliff (2005) find that sentiment affects mispricing in the US stock market. Chen (2011) document a negative relationship between returns and lack of confidence in the US market which indicates that low sentiment (i.e. pessimism) is associated with low returns. Focusing on a sample of hospitality firms in the US, Singal (2012) also argues that sentiment affects stock returns; the changes in sentiment were found to be correlated with the returns of hospitality firms.

However, the aforementioned mispricings do not persist for long. As succinctly noted by Chung, Hung and Yeh (2012), mispricings driven by investor sentiment is corrected in the following periods as sentiment declines and the true value of the stocks is realized. This, then, implies that investor sentiment will be negatively related to future stock returns. Research seems to support this argument. Brown and Cliff (2005) find an inverse relationship between sentiment and future returns of 25 portfolios formed based on Fama and French (1993). Fisher and Statman (2003) and Baker and Wurgler (2006) among others also document a similar association. Recently, Chung et al. (2012) find evidence that sentiment predicts returns of portfolios, formed based on specific characteristics such as size and age, in the US market. However, this predictive power is largely limited to expansion state. International evidence is provided by Schmeling (2009) using a sample of 18 industrialised countries. The evidence indicates that sentiment predicts future aggregate stock returns. However, the results are not universal as sentiment does not display any predictive ability in certain countries. Bathia and Bredin (2012) demonstrate that sentiment is negatively related to future aggregate stock returns in G7 countries.

Sentiment studies in Asian markets are sparse. Moreover, Kim and Nofsinger (2008) note that Asians may experience behavioural biases to a greater extent than people of other cultures. Thus investigating investor sentiment in Asian markets is critical as it educates global investors on the effect of sentiment on stocks and also reveals any peculiarities that may be present in Asia owing to the psychological uniqueness of Asians (i.e. higher propensity to experience cognitive biases). Chen, Chen and Lee (2013) investigate the effect of sentiment in Asian markets. It should be noted that there are several key distinctions with our study in terms of study aim and design. Chen et al.'s (2013) sample consists of Asian markets but developed Asian markets such as Japan and Singapore are also included in the sample. Critically, the stock specific sentiment is not considered in the study. Moreover, the focus is solely on industry returns rather than individual stock returns.

Firm characteristics are suggested to be a critical factor in determining the extent to which sentiment affects returns. For instance, Lee, Shleifer and Thaler (1991) assert that small firms are most affected by sentiment. Baker and Wurgler (2006) suggest that stocks that are harder to value are more susceptible to the influences of sentiment. Concentrating on size and market wide sentiment, Lemmon and Portniaguina (2006) construct a portfolio with short position on small stocks and long position on large stocks in the US market. When sentiment is high (low), the returns for small stocks are found to be lower (higher) than large stocks in the following period. However, Brown and Cliff (2004) do not find any such increased tendency for sentiment to affect returns of small stocks. In addition, Berger and Turtle (2012) document that sentiment has greater effect on stocks with specific firm characteristics especially firms that are transparent whereas Zhu and Niu (2016) suggest that firms with high information uncertainties are more affected by sentiment. In a recent study, Tuyon, Ahmad and Matahir (2016) note that degree to which sentiment affects stock prices may differ based on firm size. Accordingly, we include firm-level controls to incorporate this aspect in our analysis.

DATA AND METHODOLOGY

Sample and Return Data

We investigate the effect of sentiment on stock returns in emerging Asian markets for the period January 2001 to December 2011. For the purpose of this study, eight countries, Malaysia, India, Indonesia, Philippines, Taiwan, Thailand, South Korea and China, are selected. We define markets as emerging based on Datastream classification to ensure a uniform segregation of the markets. Yearly stock returns are obtained for all listed ordinary stocks in the stock markets. The sample consists of 67,489 firm-year observations from 11,634 firms. As in past studies, data on stock returns, trading volume and control variables are obtained from Datastream (Ali, Ahmad, & Anusakumar, 2011; Chen et al., 2013). All data are denominated in US currency. For each country, we winsorise all variables at the 1st and 99th percentiles to minimise the potential effects of outliers.

Investor Sentiment

We examine stock specific and market wide sentiment. Thus a consistent and reliable measure of sentiment across the sample countries is required. Survey data such as consumer confidence index, whilst a popular sentiment proxy, is not suitable for this study as the data is sparse and possibly constructed in a vastly different manner across emerging markets. Trading volume, in its capacity as a gauge of liquidity, has been suggested to be a measure of investor sentiment (Baker & Stein, 2004). Liao, Huang and Wu (2011), Baker and Wurgler (2006) and Chen et al. (2013) among others use trading volume as a proxy for sentiment. In the interest of maintaining a consistent proxy of sentiment across markets, we adopt trading volume as measure of sentiment throughout this study.

Stock specific sentiment refers to the sentiment of individual stocks. Following Liao et al. (2011), stock specific sentiment is computed for all of the stocks in each market as follows:

$$SentimentS_{i,t} = \text{Log}\left(V_{i,t}\right) - \text{Log}\left(V_{i,t-1}\right) \tag{1}$$

where $SentimentS_{i,t}$ is the sentiment for stock i at year t. $V_{i,t}$ is the trading volume for stock i at year t and $V_{i,t\text{-}1}$ is the trading volume for stock i at year t–1.

Market wide sentiment represents the overall sentiment of the market. We measure market wide sentiment for each of the emerging markets using the trading volume of the local market indices from Datastream:

$$SentimentM_{e,t} = \text{Log}(IV_{e,t}) - \text{Log}(IV_{e,t-1}) \quad (2)$$

where $SentimentM_{e,t}$ is the market wide sentiment for emerging market *e* at year *t*. $IV_{e,t}$ is the trading volume of Datastream local market index for emerging market *e* at year *t* and $IV_{e,t-1}$ is the trading volume of Datastream local market index for emerging market *e* at year *t*-1.

Control Variables

We employ two sets of controls for our analysis. Firstly, firm level controls are designed to capture the potential effects of the discrepancies in firm characteristics. Baker and Wurgler (2006) find that sentiment exerts greater influence on stocks with certain characteristics in the US stock market. In particular, small stocks, volatile stocks, unprofitable stocks, growth stocks and distressed stocks are greatly affected by sentiment. Berger and Turtle (2012) also suggest that sentiment may have a greater impact on firms with certain characteristics, which the authors term as sentiment-prone stocks. Stocks that are harder to value and arbitrage are expected to be sentiment-prone stocks. Berger and Turtle (2012) find that whilst transparent stocks are not affected much by sentiment, the returns of those that are harder to value are indeed swayed by sentiment.

We use several variables to control for such sentiment prone stocks. Similar to Baker and Wurgler (2006), we adopt a set of firm level variables comprising of firm size, book-to-market ratio, sales growth and return on equity. Firm size is the market capitalisation of the firm. Baker and Wurgler (2006) and Berger and Turtle (2012) argue that small stocks are less transparent and harder to value and are accordingly more sentiment prone than large stocks. Sales growth is the change in net sales over the net sales for the previous year. Firms with high (low) book-to-market ratio or sales growth may be associated with distress (high growth opportunities). Distressed firms would be more sentiment-prone. Firm profitability is measured by the return on equity (ROE) which is noted to be inversely related to sentiment sensitivities.

Secondly, we also include macroeconomic variables to account for differing macroeconomic conditions. This allows us, to an extent, to isolate the effect of sentiment from that of economic conditions. It may be necessary to ensure that the results obtained are not merely a reflection of variations in business-cycle. Baker and Wurgler (2006) and Lemmon and Portniaguina (2006) also consider this aspect and attempt to isolate the effect of macroeconomic factors from that of sentiment. Similarly, Schmeling (2009) also employed several macroeconomic variables in their panel regression. However, Chen et al. (2013) chose business cycle as the sole factor to represent macroeconomic conditions. We undertake a similar procedure as in Schmeling (2009). Specifically, our control variables market dividend yield, inflation (based on consumer price index), industrial production, money supply (M1), term spread (difference between long term bond rate and interbank or money market short term rate) and short-term interest rate.

Panel Regression

In order to examine the relationship between sentiment and stock returns, we employ a linear panel regression with firm fixed effects. Firm fixed effects controls for firm heterogeneity. We run the panel regression separately for each country in our sample and for emerging Asian markets as a whole (i.e. all 8 markets). Our basic regression can be represented as:

$$R_{i,t} = \alpha_i + \gamma SentimentS_{i,t} + \beta SentimentM_t + \eta FI + \varepsilon_{i,t} \quad (3)$$

where $R_{i,t}$ is the return for stock *i* in year *t*. *SentimentS* and *SentimentM* represent the stock specific sentiment and market wide sentiment respectively. *FI* is the control variables for firm characteristics which are firm size, book-to-market ratio, sales growth and return on equity.

Baker and Wurgler (2006) argue that sentiment may reflect business cycle variations and correspondingly proceed to extract any component of these business cycle variations from their sentiment measures. On the other hand, Schmeling (2009) incorporate macroeconomic controls into their model in order to mitigate common risk factors. In order to address such concerns, we take an approach similar to Schmeling (2009). We include macroeconomic variables in our regression to determine if the effect of sentiment on returns is solely due to macroeconomic factors. We estimate the following equation separately for each country in our sample and also for the sample as a whole:

$$R_{i,t} = \alpha_i + \gamma SentimentS_{i,t} + \beta SentimentM_t + \eta FI + \phi MA + \varepsilon_{i,t} \quad (4)$$

where $R_{i,t}$ is the return for stock *i* in year *t*. *SentimentS* and *SentimentM* represent the stock specific sentiment and market wide sentiment respectively. *FI* is the controls for firm characteristics which are firm size, book-to-market ratio, sales growth and return on equity. *MA* is the macroeconomic control variables which includes annual CPI inflation and dividend yield.

RESULTS

Descriptive Statistics

The sample consists of 11,634 firms in eight countries. The data is collected over an 11-year period from 2001 to 2011. Table 1 lists the descriptive statistics for all the variables used in this study. Return is the yearly return, *SentimentS* is the stock specific sentiment whereas *SentimentM* is the market wide sentiment. SIZE, GROWTH, BM and ROE are firm level data representing firm size, sales growth, book-to-market ratio, and return on equity respectively. Dividend and inflation are the macroeconomic control variables.

As can be observed, mean values of all variables are positive. Market wide sentiment has a higher mean value than stock specific sentiment, which would suggest that investor's display greater sentiment on an overall market level than for specific stocks. However, it should be noted that variability for stock specific sentiment is greater than market wide sentiment.

Table 1
Descriptive statistics

This table reports the summary of descriptive statistics of the variables for the individual firms of 8eight Asian markets. The total sample of the 8eight markets consists of 64,308 firm-year observations from 11,634 firms over the period 2001–2011.

Variable	Observation	Mean	Standard Deviation
Return	94610	0.0359	0.6656
SentimentS	87833	0.0198	0.5200
SentimentM	127973	0.0440	0.1882
SIZE	84630	0.2328	0.6359
GROWTH	100935	3.8047	2.3978
BM	79708	1.0051	1.4452
ROE	82251	7.8537	23.1095
Dividend	127974	2.7136	1.3762
Inflation	127974	4.8170	3.2521

Correlation

Table 2 reports the correlation matrix. The correlation between the dependent, independent and control variables are provided. As expected, the sentiment measures are positively correlated with stock returns. Compared with market wide sentiment (*SentimentM*), stock specific sentiment (*SentimentS*) shows substantially greater correlation with returns. This implies that stock specific sentiment may have more influence on stock returns than market wide sentiment. As explored and discussed further, this is also reflected in regression results presented in section "*Does investor sentiment affect stock returns?*". With a low value of 0.0443, there is little correlation between *SentimentS* and *SentimentM*. In the context of our study, this information offers an important insight as the low correlation suggests that the two dimensions of sentiment are in fact distinct and warrant the separate investigation accorded in our investigation.

In general, firm level variables display positive correlation with the exception of BM. Book-to-market ratio (BM) is negatively correlated with other variables and this correlation is most prominent in the case stock returns. This is to be expected as book-to-market ratio is a variable that is denominated by market price. As noted by Pontiff and Schall (1998, p. 145), "positive (negative) market return shocks will produce negative (positive) shocks to price-denominated variables". SIZE is positively correlated with SentimentS and SentimentM. The positive correlation is consistent with the findings of Brown and Cliff (2005) that there is positive relationship between sentiment and size. Furthermore, the two sentiment dimensions and the other control variables do not display a strong correlation (absolute value ranging from 0.0031 to 0.1312). As noted by Brown and Cliff (2005), the lack of substantial correlation indicates that sentiment may contain additional information (apart from the marginal overlap between the information of sentiment and controls).

Table 2
Correlation Matrix

This table reports the correlations of the variables for the individual firms of 8 Asian markets. The total sample of the 8 markets consists of 64,308 firm-year observations from 11,634 firms over the period 2001–2011.

	Return	SentimentS	SentimentM	SIZE	GROWTH	BM	ROE	Dividend	Inflation
Return	1								
SentimentS	0.3729	1							
SentimentM	0.0637	0.0443	1						
SIZE	0.1280	0.0661	0.0458	1					
GROWTH	0.2310	0.0832	0.0830	0.0933	1				
BM	–0.2776	–0.1312	–0.1163	–0.0978	–0.4655	1			
ROE	0.1618	0.0088	0.0060	0.1550	0.2616	–0.0763	1		
Dividend	0.0790	0.0228	–0.0031	–0.0008	–0.0213	–0.0528	0.0144	1	
Inflation	–0.0252	–0.0336	0.0722	0.0558	0.0842	–0.0623	0.0743	–0.1647	1

Does Investor Sentiment Affect Stock Returns?

Table 3 presents the results of the panel regression including the coefficient estimates and R^2 values. We regress stock returns on stock specific sentiment and market wide sentiment and include firm fixed effects to account for firm heterogeneity. We also include firm level control variables in the regression: firm size (SIZE), sale growth (Growth), book-to-market ratio (BM), and Return on Equity (ROE). The results for the individual markets are reported sequentially in the first eight columns of the table. The last column, "Asia", represents the results for the regression using all eight emerging Asian markets. The firm clustered robust standard errors are provided in parenthesis.

Most notably, the coefficients for *SentimentS* are positive and statistically significant at the 1% level for all of the individual countries and also for Asia as a whole. This finding is consistent with the notion that stock specific sentiment is positively associated with stock returns. An increase in stock specific sentiment would be accompanied by an increase in stock returns. Similarly, a decrease in sentiment is followed by a decrease in returns. Based on the evidence, Indonesia seems least affected by stock specific sentiment. On the other hand, annual returns in Chinese stock market appear to be highly susceptible to sentiment at the stock level. The findings for South Korea corroborate those of Ryu, Kim and Yang (2016) wherein stock level sentiment was found to be positively related to stock market returns.

In contrast, the evidence for market wide sentiment is not as uniform as stock specific sentiment. As can be observed, India, South Korea and Taiwan have highly significant positive coefficients for *SentimentM* which would imply that an increase (decrease) in sentiment is associated with an increase (decrease) in stock returns. The regression result for Asia is also similar with a positive coefficient that is significant at the 1% level. The findings for these countries are largely consistent with those of Brown and Cliff (2004) and Singal (2012). Market wide sentiment has no effect in Thailand as the coefficient, though positive, is insignificant. However, the coefficients of SentimentM are significantly negative for the remaining four countries: China, Indonesia, Malaysia and Philippines. The negative coefficients indicate that sentiment is inversely related to returns.

Table 3
Estimates of the model

This table reports panel modelling of the effect of market sentiment on stock return employing individual firms of eight Asian markets. The total sample of the eight markets consists of 67,489 firm-year observations from 11,634 firms over the period 2001–2011. The dependent variable is stock return and the subject variables are stock sentiment (SentimentS) and market sentiment (SentimentM), which are measured by logarithm changes of trading volume. The control variables are four firm fundamentals: firm size (SIZE), sale growth (Growth), book-to-market ratio (BM), and Return on Equity (ROE). The panel estimates accounted for firm heterogeneity using fixed effect estimators. Firm clustered robust standard errors are reported in parentheses while *, **, and *** denote statistical significance at the levels of 10%, 5% and 1%, respectively.

	China	India	Korea	Taiwan	Indonesia	Malaysia	Philippines	Thailand	Asia
Constant	–0.9307***	–1.3363***	–0.4183***	–0.2367***	–0.4688***	–0.5405***	–0.4904***	–0.5195***	–1.0805***
	(0.0569)	(0.0887)	(0.0760)	(0.0595)	(0.0864)	(0.0673)	(0.1250)	(0.1253)	(0.0343)
SentimentS	0.9594***	0.4866***	0.3910***	0.5110***	0.1309***	0.3119***	0.1994***	0.1792***	0.4480***
	(0.0133)	(0.0198)	(0.0146)	(0.0143)	(0.0141)	(0.0105)	(0.0251)	(0.0145)	(0.0072)
SentimentM	–0.0457***	0.6809***	0.1551***	0.3240***	–0.2600***	–0.6820***	–0.7134***	0.0459	0.1854***
	(0.0151)	(0.0257)	(0.0251)	(0.0370)	(0.0424)	(0.0406)	(0.0637)	(0.0295)	(0.0107)
SIZE	0.0330***	0.0922***	0.1303***	0.0218	0.0495*	0.0042	0.0376***	0.1551***	0.0652***
	(0.0087)	(0.0143)	(0.0136)	(0.0134)	(0.0256)	(0.0126)	(0.0126)	(0.0291)	(0.0057)
GROWTH	0.2156***	0.4001***	0.1510***	0.1241***	0.1727***	0.1898***	0.1788***	0.1856***	0.2697***
	(0.0083)	(0.0206)	(0.0148)	(0.0113)	(0.0178)	(0.0151)	(0.0274)	(0.0229)	(0.0064)
BM	–0.8116***	–0.1243***	–0.1492***	–0.3805***	–0.1302***	–0.1081***	–0.0677***	–0.1676***	–0.1506***
	(0.0299)	(0.0141)	(0.0121)	(0.0156)	(0.0190)	(0.0110)	(0.0151)	(0.0300)	(0.0078)
ROE	0.0028***	–0.0062***	0.0051***	0.0023***	0.0028***	0.0024***	0.0018**	–0.0023***	0.0007***
	(0.0003)	(0.0005)	(0.0004)	(0.0005)	(0.0005)	(0.0004)	(0.0008)	(0.0005)	(0.0002)
Observation	16,361	11,960	11,379	11,819	2,772	6,883	1,602	4,713	67,489
R^2	0.5404	0.4257	0.2918	0.4416	0.2442	0.3831	0.2895	0.2207	0.3345
Adjusted R^2	0.5403	0.4254	0.2914	0.4413	0.2426	0.3825	0.2868	0.2197	0.3345

In certain countries, the two dimensions of sentiment have an equally significant and yet opposing effect on returns. For instance, stock returns in Indonesia increase following an increase in sentiment at the stock level but decline after an increase in sentiment at the market level. The absolute magnitude of the coefficients is greater for *SentimentS* compared to *SentimentM* for half of the sample countries. For Asia, the magnitude of the coefficient for *SentimentS* is considerably higher than *SentimentM* (0.4480 vs. 0.1854). Overall, our findings suggest that market wide sentiment does not have as much of an effect on stock returns as stock specific sentiment in emerging Asian markets.

For individual markets, the effect of market wide sentiment, if any, is largely dependent on the country. In this respect, our findings for market wide sentiment are congruent with Schmeling (2009). Schmeling (2009) documents that the effect of sentiment varies drastically from country to country for a sample of industrialised countries. As noted by the author, the variation seems to be unrelated to country size and location. Accordingly, we also find no readily apparent cause for the cross-country differences.

In the regression, we control for four firm characteristics which are firm size (SIZE), sale growth (Growth), book-to-market ratio (BM), and Return on Equity (ROE). With the exception of SIZE for Taiwan and Malaysia, all of the four variables enter significantly into the regressions. It appears that firm size has no effect in Taiwan and Malaysia. Moreover, the firm level control variables generally have positive coefficients for all countries and Asia. The only exception is book-to-market ratio. BM coefficients are significantly negative for all of the individual country regressions and also the regression for the whole sample (Asia). This evidence is consistent with the earlier findings of a negative correlation between BM and the other variables.

In general, the results in Table 3 suggest that the effect of sentiment on prices may be stronger than that of firm fundamentals. This finding might support the notion that Asians are more prone to behavioural biases than people of other cultures (Kim & Nofsinger, 2008). However, a direct comparative study between Asian and other countries would be needed to provide a conclusive evidence.

Is It Macroeconomic Factors?

The results in Table 3 show that sentiment has a significant effect on stock returns. Nevertheless, it is may be pertinent to consider whether the results are driven macroeconomic factors or are largely due to the influence of sentiment. In this section, we take into account of the potential effects of macroeconomic variables.

Specifically, we include six macroeconomic variables in the model: market dividend yield, inflation, industrial production, money supply, term spread and interest rate. Table 4 presents results of the regression of stock returns on stock specific sentiment and market wide sentiment after including the macroeconomic variables. As before, we retain the firm level control variables in the regression. The results for the individual markets are reported sequentially in the first eight columns of the table. The last column, 'Asia', represents the results for the regression using all 8 emerging Asian markets. The firm clustered robust standard errors are provided in parenthesis.

The coefficients for *SentimentS* are still positive and statistically significant at the 1% level for all of the countries and for Asia. The values of the coefficients are marginally lower than that of Table 3 but there are no substantial differences after including the macroeconomic variables. The only exception is China where the value declined from 0.9594 to 0.1425. However, the statistical significance remains unaltered (at the 1% level). Overall, we find that stock specific sentiment retains its influence on returns. Therefore, the results obtained for *SentimentS* in Table 3 cannot be attributed to macroeconomic factors.

Unlike *SentimentS*, there are notable changes for *SentimentM*. Interestingly, the nature of the relationship between the variables changes for India and South Korea. As can be seen in Table 3, *SentimentM* is positively related to returns but a negative relationship exists when macroeconomic variables are included in the model (Table 4). A similarly drastic change can be observed for Indonesia where the negative relationship between returns and *SentimentM* turns to positive once we account for macroeconomic factors. For Taiwan and Philippines, the relationship between market wide sentiment and returns dissipates entirely as the coefficient of *SentimentM* is insignificant. This indicates that the relationship observed in Table 3 for these two countries is due the influence of macroeconomic factors. In contrast, the coefficient of *SentimentM* for Thailand changes from insignificant (Table 3) to significantly negative (Table 4).

Table 4
Robustness checking with macroeconomic control variables

This table reports panel modelling of the effect of market sentiment on stock return employing individual firms of 8 Asian markets over the period 2001–2011. The dependent variable is stock return and the subject variables are stock sentiment (SentimentS) and market sentiment (SentimentM), which are measured by logarithm changes of trading volume. The control variables are four firm size (SIZE), sale growth (Growth), book-to-market ratio (BM), and Return on Equity (ROE); and six macroeconomics indicators: market dividend yield, inflation rate based on Consumer Price Index (CPI), industrial production, money supply M1, term spread is the difference between long term bond rate and interbank or money market short term rate, and interest rate refers to short term rate. The panel estimates accounted for firm heterogeneity using fixed effect estimators. Firm clustered robust standard errors are reported in parentheses while *, **, and *** denote statistical significance at the levels of 10%, 5% and 1%, respectively.

	China	India	Korea	Taiwan	Indonesia	Malaysia	Philippines	Thailand	Asia
Constant	–1.9007***	0.1022	1.7971***	0.5957***	0.2353	–1.3780***	–1.3436**	–0.7150***	–1.1530***
	(0.0541)	(0.0876)	(0.1074)	(0.0603)	(0.1552)	(0.1150)	(0.4343)	(0.1433)	(0.0360)
SentimentS	0.1425***	0.1502***	0.2603***	0.3345***	0.0933***	0.2130***	0.1412***	0.1187***	0.3646***
	(0.0140)	(0.0135)	(0.0132)	(0.0124)	(0.0128)	(0.0109)	(0.0229)	(0.0118)	(0.0066)
SentimentM	–0.7262***	–2.1629***	–0.3794***	–0.0726	0.6966***	–0.3407***	–0.0863	–0.4216***	0.0627***
	(0.0374)	(0.0417)	(0.0318)	(0.0436)	(0.0661)	(0.0408)	(0.1017)	(0.0393)	(0.0110)
SIZE	0.1447***	0.3752***	0.0719***	0.0918***	0.1327***	0.1257***	0.2548***	0.3056***	0.2898***
	(0.0089)	(0.0153)	(0.0139)	(0.0102)	(0.0192)	(0.0156)	(0.0324)	(0.0210)	(0.0066)
GROWTH	0.0470***	0.016	0.0729***	0.0984***	0.0319	0.0113	0.0231*	0.1329***	0.0620***
	(0.0058)	(0.0101)	(0.0107)	(0.0128)	(0.0230)	(0.0119)	(0.0109)	(0.0251)	(0.0054)
BM	–0.4133***	–0.0323***	–0.1080***	–0.2884***	–0.1219***	–0.1122***	–0.0489***	–0.0918***	–0.1422***
	(0.0196)	(0.0067)	(0.0108)	(0.0129)	(0.0176)	(0.0112)	(0.0134)	(0.0215)	(0.0075)
ROE	0.0025***	–0.0026***	0.0046***	0.0038***	0.0027***	0.0028***	0.0022**	–0.0023***	0.0007***
	(0.0002)	(0.0003)	(0.0003)	(0.0004)	(0.0005)	(0.0004)	(0.0007)	(0.0005)	(0.0002)
Dividend	–0.1626***	–1.1250***	–0.0222	–0.0424***	–0.1149***	0.2309***	0.2602***	0.0239*	–0.0257***
	(0.0043)	(0.0234)	(0.0165)	(0.0030)	(0.0186)	(0.0140)	(0.0294)	(0.0094)	(0.0020)
Inflation	–0.0518***	0.2319***	–0.2384***	0.0953***	–0.1581***	–0.1204***	–0.1965***	–0.1372***	–0.0345***
	(0.0016)	(0.0074)	(0.0116)	(0.0036)	(0.0106)	(0.0080)	(0.0250)	(0.0118)	(0.0013)
Industrial P	0.0907***	–0.2744***	–0.0283***	–0.0208***	–0.1340***	0.0181***	0.0090**	0.0106***	–0.0149***
	(0.0029)	(0.0046)	(0.0021)	(0.0008)	(0.0116)	(0.0022)	(0.0033)	(0.0009)	(0.0005)
M1	0.0530***	0.3719***	0.0063***	–0.0348***	0.0233***	–0.0078**	0.003	–0.0083	0.0246***
	(0.0012)	(0.0051)	(0.0007)	(0.0013)	(0.0015)	(0.0028)	(0.0028)	(0.0060)	(0.0004)
Term Spread	–0.0005	1.5860***	0.0131	–0.0297**	0.0031	0.2606***	0.0448	–0.1963***	–0.0255***
	(0.0049)	(0.0307)	(0.0110)	(0.0092)	(0.0133)	(0.0300)	(0.0397)	(0.0244)	(0.0020)
Interest Rate	0.0617***	–0.2762***	–0.2145***	–0.1144***	0.1113***	0.2801***	0.1894***	0.0585***	0.0016
	(0.0095)	(0.0084)	(0.0067)	(0.0076)	(0.0076)	(0.0324)	(0.0162)	(0.0111)	(0.0028)
Observation	16,361	11960	11379	11819	2772	6883	1602	4713	66423
R^2	0.7983	0.7696	0.5076	0.5947	0.3911	0.4801	0.4663	0.4608	0.4052
Adjusted R^2	0.7981	0.7694	0.5071	0.5943	0.3884	0.4792	0.4623	0.4594	0.4051

There are no substantial changes for *SentimentM* for China and Malaysia indicating that macroeconomic fundamentals have little bearing on the effect of sentiment on returns in these two countries. However, differences in the magnitude of the coefficients could be observed. For China, there is an increase in the absolute value of the coefficient once macroeconomic variables are included in the regression. In contrast, there is a reduction in the absolute value of the coefficient for Malaysia (from –0.6820 to –0.3407). Nevertheless, the coefficients are statistically significant at the 1% level regardless of whether macroeconomic variables are included in model. Likewise, *SentimentM* coefficients for Asia are similar before and after including macroeconomic variables in the model. Thus, the influence of market wide sentiment on returns in emerging Asian markets is, overall, unaffected by the inclusion of macroeconomic variables.

Congruent with Schmeling (2009), market wide sentiment significantly affects returns in a regression model that incorporates macroeconomic variables. The effect of sentiment also remains a largely country specific matter. It should be noted that for the overall sample (Asia), the value of coefficients and R^2 do not have undergo any substantial changes. In general, the effect of sentiment on stock returns in emerging Asian markets in unaffected by macroeconomic fundamentals. Nevertheless, there are differences, for a majority of the individual countries, in the results for market wide sentiment with and without the macroeconomic control variables. Moreover, the adjusted R^2 also experience an increase (Table 3 vs. Table 4) which indicates that the macroeconomic variables do hold some explanatory power. Inflation, interest rate and industrial production exert the most influence as the coefficients are statistically significant for all the countries. Taken together, the evidence highlights the importance of incorporating of macroeconomic variables in the regression model for individual countries.

CONCLUSION

In this study, we examine the link between returns and investor sentiment in emerging Asian markets. Overall, sentiment appears to be positively related to stock returns. Specifically, there is significant and positive relationship between stock specific sentiment and returns for all eight countries and for overall sample. On the other hand, we find that the effect of market wide sentiment varies vastly from country to country. Market wide sentiment is negatively related to returns for half of the sample countries. Nevertheless, a positive association can be observed for the overall sample and three of the individual countries. The evidence suggests that stock specific and market wide sentiment are distinct and in some cases, stock specific sentiment may exert a greater influence on returns than market wide sentiment.

This study has filled the gap in sentiment literature by examining the effect of investor sentiment on stock returns in emerging Asian markets. The results demonstrate that sentiment also affects stock returns in emerging Asian markets and reassert the importance of investor sentiment. Furthermore, we extend the literature by shedding light on the effect of two dimensions of sentiment, market wide sentiment and stock specific sentiment, on stock returns. From a practical standpoint, the findings of this paper may be relevant to investors as the results suggest that sentiment has an effect on stock prices. Additionally, we have shown that prices are influenced by two distinct sentiments: market wide and stock specific sentiment. Investors may use these findings to guide their investment decisions. Although robustness test was conducted, the study could benefit from additional tests that make use of alternative time periods, samples and sentiment proxies. In short, the paper contributes to the limited literature on investor sentiment and paves the way for future studies to conduct additional investigation on investor sentiment in Asia.

Though this study provides substantial evidence on the association between sentiment and stock returns, there are numerous aspects that could be explored. Future studies could examine the cause of the drastic cross-country variations in the effect of market wide sentiment. The relationship between stock specific sentiment and market wide sentiment also deserves further attention. In particular, the contrasting nature of the two dimensions of sentiment in certain countries is undoubtedly of interest.

ACKNOWLEDGEMENTS

The authors gratefully acknowledges the support of Universiti Sains Malaysia Research University Grant No. 1001.PPAMC.816192.

NOTES

1. There are various definitions of investor sentiment. Kurov (2010) defined investor sentiment as “the propensity to speculate” (p. 140) whereas Baker and Wurgler (2007) stated that sentiment is the “belief about future cash flows and investment risks that are not justified by the facts” (p. 120).

REFERENCES

Abdelhédi-Zouch, M., Abbes, M. B., & Boujelbène, Y. (2015). Volatility spillover and investor sentiment: Subprime crisis. *Asian Academy of Management Journal of Accounting and Finance*, *11*(2), 83–101.

Aissia, D. B. (2016). Home and foreign investor sentiment and the stock returns. *The Quarterly Review of Economics and Finance*, *59*, 71–77. https://doi.org/10.1016/j.qref.2015.06.009

Ali, R., Ahmad, Z., & Anusakumar, S. V. (2011). Stock market overreaction and trading volume: Evidence from Malaysia. *Asian Academy of Management Journal of Accounting & Finance*, *7*(2), 103–119.

Baker, M., & Stein, J. C. (2004). Market liquidity as a sentiment indicator. *Journal of Financial Markets, 7*(3), 271–299. https://doi.org/10.1016/j.finmar.2003.11.005

Baker, M., & Wurgler, J. (2006). Investor sentiment and the cross-section of stock returns. *Journal of Finance, 61*(4), 1645–1680. https://doi.org/10.1111/j.1540-6261.2006.00885.x

Baker, M., & Wurgler, J. (2007). Investor sentiment in the stock market. *The Journal of Economic Perspectives, 21*(2), 129–151. https://doi.org/10.1257/jep.21.2.129

Bathia, D., & Bredin, D. (2012). An examination of investor sentiment effect on G7 stock market returns. *The European Journal of Finance, 9*, 1–29.

Berger, D., & Turtle, H. J. (2012). Cross-sectional performance and investor sentiment in a multiple risk factor model. *Journal of Banking & Finance, 36*(4), 1107–1121. https://doi.org/10.1016/j.jbankfin.2011.11.001

Białkowski, J., Etebari, A., & Wisniewski, T. P. (2012). Fast profits: Investor sentiment and stock returns during Ramadan. *Journal of Banking & Finance, 36*(3), 835–845. https://doi.org/10.1016/j.jbankfin.2011.09.014

Brown, G. W., & Cliff, M. T. (2004). Investor sentiment and the near-term stock market. *Journal of Empirical Finance, 11*(1), 1–27. https://doi.org/10.1016/j.jempfin.2002.12.001

Brown, G. W., & Cliff, M. T. (2005). Investor sentiment and asset valuation. *Journal of Business, 78*(2), 405–440. https://doi.org/10.1086/427633

Chang, S.-C., Chen, S.-S., Chou, R. K., & Lin, Y.-H. (2012). Local sports sentiment and returns of locally headquartered stocks: A firm-level analysis. *Journal of Empirical Finance, 19*(3), 309–318. https://doi.org/10.1016/j.jempfin.2011.12.005

Chen, M.-P., Chen, P.-F., & Lee, C.-C. (2013). Asymmetric effects of investor sentiment on industry stock returns: Panel data evidence. *Emerging Markets Review, 14*(0), 35–54. https://doi.org/10.1016/j.ememar.2012.11.001

Chen, S.-S. (2011). Lack of consumer confidence and stock returns. *Journal of Empirical Finance, 18*(2), 225–236. https://doi.org/10.1016/j.jempfin.2010.12.004

Chung, S.-L., Hung, C.-H., & Yeh, C.-Y. (2012). When does investor sentiment predict stock returns? *Journal of Empirical Finance, 19*(2), 217–240. https://doi.org/10.1016/j.jempfin.2012.01.002

Curatola, G., Donadelli, M., Kizys, R., & Riedel, M. (2016). Investor sentiment and sectoral stock returns: Evidence from World Cup games. *Finance Research Letters, 17*, 267–274. https://doi.org/10.1016/j.frl.2016.03.023

Drakos, K. (2010). Terrorism activity, investor sentiment, and stock returns. R*eview of Financial Economics, 19*(3), 128–135. https://doi.org/10.1016/j.rfe.2010.01.001

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics, 33*(1), 3–56. https://doi.org/10.1016/0304-405X(93)90023-5

Fisher, K. L., & Statman, M. (2003). Consumer confidence and stock returns. *Journal of Portfolio Management, 30*(1), 115–127. https://doi.org/10.3905/jpm.2003.319925

Kaplanski, G., & Levy, H. (2010). Sentiment and stock prices: The case of aviation disasters. *Journal of Financial Economics, 95*(2), 174–201. https://doi.org/10.1016/j.jfineco.2009.10.002

Kaplanski, G., & Levy, H. (2012). Real estate prices: An international study of seasonality's sentiment effect. *Journal of Empirical Finance, 19*(1), 123–146. https://doi.org/10.1016/j.jempfin.2011.11.004

Kaustia, M., & Knupfer, S. (2012). Peer performance and stock market entry. *Journal of Financial Economics, 104*(2), 321–338. https://doi.org/10.1016/j.jfineco.2011.01.010

Kim, K. A., & Nofsinger, J. R. (2008). Behavioral finance in Asia. *Pacific-Basin Finance Journal, 16*(1), 1–7. https://doi.org/10.1016/j.pacfin.2007.04.001

Kurov, A. (2010). Investor sentiment and the stock market's reaction to monetary policy. *Journal of Banking & Finance, 34*(1), 139–149. https://doi.org/10.1016/j.jbankfin.2009.07.010

Lee, C. M. C., Shleifer, A., & Thaler, R. H. (1991). Investor sentiment and the closed-end fund puzzle. *Journal of Finance, 46*(1), 75–109. https://doi.org/10.1111/j.1540-6261.1991.tb03746.x

Lemmon, M., & Portniaguina, E. (2006). Consumer confidence and asset prices: Some empirical evidence. *Review of Financial Studies, 19*(4), 1499–1529. https://doi.org/10.1093/rfs/hhj038

Liao, T.-L., Huang, C.-J., & Wu, C.-Y. (2011). Do fund managers herd to counter investor sentiment? *Journal of Business Research, 64*(2), 207–212. https://doi.org/10.1016/j.jbusres.2010.01.007

Liston, D. P. (2016). Sin stock returns and investor sentiment. *The Quarterly Review of Economics and Finance*, 59, 63–70. https://doi.org/10.1016/j.qref.2015.08.004

Miwa, K. (2016). Investor sentiment, stock mispricing, and long-term growth expectations. *Research in International Business and Finance*, *36*, 414–423. https://doi.org/10.1016/j.ribaf.2015.10.003

Pontiff, J., & Schall, L. D. (1998). Book-to-market ratios as predictors of market returns. *Journal of Financial Economics, 49*(2), 141–160. https://doi.org/10.1016/S0304-405X(98)00020-8

Ryu, D., Kim, H., & Yang, H. (2016). Investor sentiment, trading behavior and stock returns. *Applied Economics Letters, 24*(12), 826–830. https://doi.org/10.1080/13504851.2016.1231890

Sayim, M. & Rahman, H. (2015). The relationship between individual investor sentiment, stock return and volatility. *International Journal of Emerging Markets, 10*(3), 504–520. https://doi.org/10.1108/IJoEM-07-2012-0060

Schmeling, M. (2009). Investor sentiment and stock returns: Some international evidence. *Journal of Empirical Finance, 16*(3), 394–408. https://doi.org/10.1016/j.jempfin.2009.01.002

Shan, L., & Gong, S. X. (2012). Investor sentiment and stock returns: Wenchuan Earthquake. *Finance Research Letters, 9*(1), 36–47. https://doi.org/10.1016/j.frl.2011.07.002

Singal, M. (2012). Effect of consumer sentiment on hospitality expenditures and stock returns. *International Journal of Hospitality Management, 31*(2), 511–521. https://doi.org/10.1016/j.ijhm.2011.07.009

Smales, L. A. (2017). The importance of fear: investor sentiment and stock market returns. *Applied Economics, 49*(34), 3395–3421. https://doi.org/10.1080/00036846.2016.1259754

Tsai, I. C. (2017). Diffusion of optimistic and pessimistic investor sentiment: An empirical study of an emerging market. *International Review of Economics & Finance*, *47*, 22–34. https://doi.org/10.1016/j.iref.2016.10.008

Tuyon, J., Ahmad, Z., & Matahir, H. (2016). The role of investor sentiment in malaysian stock market. *Asian Academy of Management Journal of Accounting and Finance, 12*(Suppl. 1), 43–75. https://doi.org/10.21315/aamjaf2016.12.S1.3

Zhu, B., & Niu, F. (2016). Investor sentiment, accounting information and stock price: Evidence from China. *Pacific-Basin Finance Journal*, *38*, 125–134. https://doi.org/10.1016/j.pacfin.2016.03.010