Essays on investment decisions

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Introduction

An investment decision involves a commitment today, with a return from this commitment at some later date. This return is often uncertain at the time the investment decision is made. When evaluating such investment opportunities, a decision maker therefore needs to make a prediction about the relative likelihood of the different future possible outcomes.

Muth (1961) revolutionized how economists view the expectations that inform investment decisions. Individual investors might disagree in their forecasts of future events, but the aggregation of these subjective probability distributions would be a good approximation to the objective probability distribution of outcomes. Applying this insight to capital markets, Lintner (1969) shows that

> *"The market's composite assessment of the end-of-period aggregate value of [a] stock is thus the weighted sum of each investor's judgement". Consequently, "... the market price of any security will in principle change as a result of any change in any one of these assessments".*

Thus, investors make decisions based on all available information, and update their forecast when new information arrives. The current stock price for a firm therefore offers an aggregation of the forecasts by all investors, and the price is updated as new information becomes available.

In the first paper of my thesis, I elicit investor expectations to a major news release, and then test to see if these expectations match the actual outcome. I use the stock market reaction to the introduction of the Norwegian gender quota on company boards to estimate the expected impact of this new law on firm value. I find that investors anticipate that the new directors will be more effective in firms with less information asymmetry between insiders of the firm and outsiders. As female directors predominantly classify as external directors, this result is in line with economic theory: Outsiders are at an informational disadvantage in firms with high information asymmetry. To test if these expectation are corroborated by the actual outcome, I then investigate changes in the affected firms' performance subsequent to the introduction of the new law. The results are consistent with the stock market reaction, whereby the impact of the quota on firm performance depends on firms specific information asymmetry.

Thus, the first paper seems to support the concept of rational expectations, whereby the stock market's aggregation of investor forecasts was consistent with the actual subsequent outcome. But investors may not only differ with respect to the forecast they make but how they value different outcomes; the utility that they attach to each possible outcome. In fact, Borch (1962) claims that

> *"...[w]hether two rational persons on the basis of the same information can arrive at different evaluations of the probability of a specific event, is a question of semantics. That they may act differently on the same information is well known, but this can usually be explained assuming that the two persons attach different utilities to the event."*

Consider a simple gamble with an equal probability of winning either nothing or NOK 2,000. The expected value, or the probability weighted average outcome, is NOK 1,000. But why would very few people be willing to pay that amount to participate in this gamble? The answer is that instead of investors valuing gambles based on the expected outcome, they use a measure of the expected utility that the gamble offers them. This idea dates back to Bernoulli (1738), who observed that

> *"...the price on the item is dependent only on the thing itself and is equal for everyone; the utility, however, is dependent on the particular circumstances of the person making the estimate. Thus there is no doubt that a gain of one thousand ducats is more significant to a pauper than to a rich man though both gain the same amount".*[1]

Thus, the same incremental increase in wealth has a bigger impact on individual utility when current total wealth is low, compared to when wealth is high. Such an individual would prefer a certain payment to a gamble with the same expected value. This concept was later formulated more precisely by von Neumann and Morgenstern (1944), and now constitutes the standard economic model: Investors make investment decisions to maximize

[1]The ducat was a gold coin used as currency throughout Europe from the 12^{th} century up to the beginning of the 20^{th} century. A pauper is a very poor person.

expected utility, where they take into consideration an individual degree of aversion towards risk.

However, later empirical tests of this expected utility model found that it did not adequately describe how real people evaluate investment decisions. Kahneman and Tversky (1979) propose different monetary gambles to real people, and find that they assign value to gains and losses, rather than to the final total wealth that each different outcome would generate. Moreover, they find that whereas people are generally risk averse over gains, they are attracted to risk when experiencing losses. In addition, around break-even they are extremely averse to risk. This alternative model is called "prospect theory". A recent theoretical paper finds a clear prediction for the owner of an asset who is motivated by prospect theory: he will tend to sell the asset more readily at a gain than at a loss, and also have a tendency to liquidate at break-even (Kyle, Ou-Yang and Xiong, 2006). Thus, being attracted to risk when experiencing a loss tends to induce delayed liquidation of the stock, whereas the extreme risk aversion close to break-even induces liquidation near this point.

The investigation of how individual investors actually make decisions is naturally constrained by access to high quality data. It is difficult to find, and gain access to, detailed data of individual investment decisions over time. In my second paper, I use a novel investor accounts dataset from Norway. The data enable me to specifically analyze how each individual household investor trades in stocks; the data specifies who owns each of the stocks on the Oslo Stock Exchange on any day from 2002 to 2007. I find that household investors are more likely to sell at a gain than at a loss, and they are particularly likely to sell close to break-even. This trading pattern is therefore consistent with investors motivated by prospect theory.

In the first two papers of my thesis, I investigate investment decisions in a stock market. We discovered that although the aggregate of investor expectations is in line with the relevant economic theory, individual investors seem to deviate from the standard expected utility model. Thus far we have implicitly assumed that people care only about their own interest. This assumption has a long standing tradition in economics, and its usefulness in explaining behavior was well captured as far back as Smith (1776):

> *"It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest. We address ourselves, not to their humanity, but to their self-love, and never talk to them of our own necessities, but of their advantages. Nobody but a beggar chooses to depend chiefly upon the benevolence of his fellow-citizens."*

However, many investment decisions involve direct interaction, even co-operation, with other people. When entering into an economic relation with another person, it is often not possible to write a contract that takes into account all possible future outcomes. Such incomplete contracts enable opportunistic behavior in unforeseen circumstances, whereby one party takes advantage of the other. The possibility of opportunistic behavior from the person you are contracting with will therefore likely lead to underinvestment in the joint project (Tirole, 1986). This underinvestment in turn leads an inefficient outcome. One way to mitigate this problem is to trust that the other party will deviate from narrow self-interest in unforeseen circumstances. We might therefore form expectations about the trustworthiness of the person we are dealing with. Important when forming these expectations is an evaluation of what motivates the other person. Is it only narrow self-interest, or do other preferences come in to play? This question is the subject of the third and final paper. To answer the question, we conduct an economic experiment where real people interact anonymously through personal computers. We find that, in their interactions, people do deviate from narrow-self interest in systematic ways. In particular, they are motivated by concerns for efficiency, i.e. they care about total production and not only the fraction of the total that falls to themselves. Such social preferences would then form part of how people value different possible future outcomes, in addition to narrow self-interest.

Finally, then, we can conclude that evaluating investment decisions based on the standard economic model with rational expectations seems to offer a useful approximation at the aggregate level. However, we have uncovered evidence of important deviations from this standard economic model at the individual level, which add to our understanding of how real people make investment decisions.

The following sub-sections briefly characterize the specific contribution of each the three papers in the thesis.

"Forced board changes: Evidence from Norway"

The recently introduced gender quota on Norwegian corporate boards dramatically increased the share of female directors. This reform offers a natural experiment to investigate changes in corporate governance from forced increases in gender diversity, and whether these changes in turn impact firm performance. I find that investors anticipate the new directors to be more effective in firms with less information asymmetry between insiders of the firm and outsiders. Firms with low information asymmetry experience positive and significant cumulative abnormal returns (CAR) at the introduction of the quota, whereas firms with high information asymmetry show negative but insignificant CAR.

"The disposition effect and momentum: Evidence from Norwegian household investors"

Using a novel investor accounts dataset from Norway, I find that household investors are particularly likely to sell stocks when they experience a capital gain between 0% and 5%. The likelihood of a sale falls quickly both below and above this range; big losses and big gains are equally unlikely to trigger a sale. Thus, the disposition effect is driven by sales close to break-even, rather than a monotonically increasing relation between current capital gain and the likelihood of a sale. I also find that this household investor trading pattern contributes to momentum in small cap stocks.

"Efficiency, equality and reciprocity in social preferences: A comparison of students and a representative population"

The debate between Engelmann and Strobel (2004, 2006) and Fehr, Naef and Schmidt (2006) highlights the important question of the extent to which lab experiments on student populations can serve to identify the motivational forces present in society at large. We address this question by comparing the lab behavior of a student group and a non-student

group, where the non-student group on all observable factors is almost identical to the representative adult population in Norway. All participants take part in exactly the same lab experiment. Our study shows that students may not be informative of the role of social preferences in the broader population. We find that the representative participants differ fundamentally from students both in their level of selfishness and in the relative importance assigned to different moral motives. It is also interesting to note that while we do not find any substantial gender differences among the students, males and females in the representative group differ fundamentally in their moral motivation.

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Forced board changes: Evidence from Norway

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Abstract

The recently introduced gender quota on Norwegian corporate boards dramatically increased the share of female directors. This reform offers a natural experiment to investigate changes in corporate governance from forced increases in gender diversity, and whether these changes in turn impact firm performance. I find that investors anticipate the new directors to be more effective in firms with less information asymmetry between insiders of the firm and outsiders. Firms with low information asymmetry experience positive and significant cumulative abnormal returns (CAR) at the introduction of the quota, whereas firms with high information asymmetry show negative but insignificant CAR.

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With the threat of forced liquidation for non-compliance, the Norwegian government mandated a quota of 40% female directors for public limited liability companies (PLC) in 2005. The average PLC board had 15.5% female directors at the time; and 40.7% three years later. Several other countries are implementing or considering similar measures to increase the number of female directors on company boards, e.g Belgium, Canada, Finland, France, Iceland, Italy, the Netherlands, Spain, and Sweden. What can regulators expect to achieve by imposing a quota on a particular director characteristic, such as gender?

The board of directors has the critical functions of monitoring and advising top management (Hermalin and Weisbach, 2003; Adams, Hermalin and Weisbach, 2010). There is evidence that firms compose their boards in close relation to firm characteristics, which determine the costs and benefits of the board's monitory and advisory roles (Coles, Daniel and Naveen, 2008; Linck, Netter and Yang, 2008). These findings suggest that a regulatory framework imposing uniform requirements on board composition, like the Norwegian gender quota, could be ill-conceived. Indeed, if firms compose their boards optimally (to maximize firm value conditional on firm characteristics), any regulatory imposed constraints on board composition can only reduce firm value.

However, if the CEO dislikes being monitored he will derive private benefits from a board dominated by directors more aligned with him than with shareholders, irrespective of firm characteristics. For instance, Hermalin and Weisbach (1998) show how a CEO through increased bargaining power can influence the board selection process, and thereby reduce the monitoring prowess of the board. This would generate friction in the selection of directors, and possibly lead to a gap between the optimal and the actual monitoring capabilities of the board.

In this paper I use the stock market reaction to the introduction of the Norwegian gender quota to elicit the expected impact of an increase in female directors on firm value, conditional on firm specific information asymmetry. This setup is motivated by recent research showing that female directors predominantly classify as outside directors[1], and that firm specific information asymmetry determines the effectiveness of an outside director

[1]Staubo (2010) classifies 83% of female directorships in Norway, compared to 50% of male directorships, as outside directors. Outside directors are defined as not current or former employees, not employees of closely related firms, not relatives of officers, and not persons with a business relation to the firm. Using a comparable definition, Adams and Ferreira (2009) classify 84% of US female directorships as outsiders.

(Raheja, 2005; Adams and Ferreira, 2007; Harris and Raviv, 2008; Duchin, Matsusaka and Ozbas, 2010). Thus, although outside or female directors are less aligned with the CEO, and should therefore be better monitors of the same CEO on behalf of shareholders, they are less likely to be effective in firms with high information asymmetry due to the information disadvantage they face in such firms. High information asymmetry firms with few female directors are therefore likely to be hurt by being forced to increase the share of female directors in order to comply with the gender quota. In contrast, an outside or female director is likely to be effective in a firm with low information asymmetry. If the firm nevertheless has few female directors, this could indicate that the board is constituted to minimize oversight. Low information asymmetry firms with few female directors before the introduction of the gender quota might therefore benefit from the forced increase in female directors, due to potentially sub-optimal monitoring pre-reform.

I measure the daily stock returns of firms listed on the Oslo Stock Exchange, relative to the return on the Morgan Stanley Capital International (MSCI) World Index, around 9^{th} December 2005 when the quota was mandated. In OLS regressions controlling for firm size, board size, and industry sector, I find that firms with low information asymmetry and few female directors experience positive and significant cumulative abnormal returns (CAR). In contrast, firms with high information asymmetry and few female directors show negative but insignificant CAR. Thus, the expected impact of the reform on firm value depends on firm specific information asymmetry, which is consistent with some firms having sub-optimal boards prior to the reform. Analysis of change in return on assets in listed firms from 2004 to 2008 offers evidence consistent with these results, and I do not find evidence of a selection bias whereby firms de-list in order to avoid the quota.

Ahern and Dittmar (2010) report that the same Norwegian gender quota generated younger and less experienced boards, which reduced firm value (Tobin Q). I find that these results may be driven by their particular sampling procedure that over-emphasizes new firms, with both younger directors and bigger fall in Tobin Q compared to older firms, rather than by the introduction of the gender quota. Moreover, they do not condition their analysis on firm specific information asymmetry, which I find to be important in explaining the impact of the reform.

The paper is organized as follows: Section 1 offers a background to the Norwegian gender quota, argues that this reform is a natural experiment to investigate forced increases in gender diversity on corporate boards, looks at the board selection process in Norway, and reviews the literature on outside directors and information asymmetry; section 2 presents the data sources used; section 3 analyses the stock market reaction to the introduction of the quota; section 4 looks at whether firms changed organizational form in order to avoid the quota and at how the quota impacted return on assets in affected firms; section 5 relates my findings to those in Ahern and Dittmar (2010); section 6 concludes.

1 Background and context

1.1 The quota

Under the new law, each gender must make up at least 40% of directors representing owners, with a less stringent quota for directors representing employees.[2] In this paper I therefore focus on the directors representing owners. The quota was mandated 9^{th} December 2005 and applies to all public limited liability companies (PLC); but not to limited liability companies (LTD). PLC ("Allmennaksjeselskap", ASA) is a separate organizational form designed for large companies with many shareholders and liquid stock, whereas the LTD organizational form is for small companies with few shareholder and less liquid stock (Woxholth, 2007). For instance, PLCs can do public offering of stock and list on the Oslo Stock Exchange, whereas a LTD can only do private placement. There are both listed and non-listed PLCs, and the quota applies equally to both groups. PLCs registered after 1^{st} January 2006 had to comply with the new regulation immediately, whereas existing PLCs had to comply by 1^{st} January 2008. The sanction for not meeting the quota is forced liquidation. In April 2008 the Norwegian Business Register ("Bronnoysund registrene")

[2]With 2 or 3 directors representing owners, each gender must be represented. For 4 or 5 directors, at least two directors for each gender. From 6 to 8 directors, at least 3 from each gender. For 9 directors, at least 4 from each gender. For 10 or more directors, at least 40% from each gender. In Norway, employees in companies above a certain size are entitled to their own directors on the company board, elected by and from the workforce. Up to one third of directors may be such employee representatives, and a separate gender quota applies to these directors: For 2 or more directors representing employees, each gender must be represented, but not if the workforce is dominated (more than 80%) by one gender. Many directors representing the employees are union representatives (Hagen, 2008).

announced that all PLCs were in compliance, and no firm was forced to liquidate for failing to meet the quota.

Overall compliance from 2008 onwards is confirmed in Table 1, which reports director characteristics in all PLCs from 1999 to 2009. In 2008 and 2009 around 2% of PLCs did not strictly comply with the quota, which is likely due to temporary fluctuations in board composition. Overall compliance was accomplished without overloading the typical female director, as the average number of PLC directorships per female director remains stable over the period at around 1.2. Nor was the increased demand for female directors met by disproportionate recruitment of directors from outside Norway. From 2003 through to 2009, foreigners as a share of female directors is largely unchanged at around 12%, and always below the share of foreigners among male directors, which was 15% in 2009. Female directors are on average somewhat younger than male directors, and the introduction of the quota does not seem to have widened the age gap by much. In 2005, the average female director was 45 years old, compared to 51 for the average male director. By 2008, the average female director was one year older; the average male director was only two years older than in 2005.

1.2 A natural experiment

The new law investigated in this paper deals only and specifically with gender representation on corporate boards. The government claimed that the low share of women on corporate boards was due to traditional ideologies and cultural aspects, which resulted in women not being considered for these posts. It therefore found it necessary to intervene in order to arrange for a societal development that acknowledged and made use of both genders' competences (Ministry of Children, Family and Equality, 2003). Thus, the introduction of the quota was exogenous to firm performance measures.

A gender quota on corporate boards was first suggested in 1999, and a conditional law amendment on the quota passed the Norwegian Parliament in 2003. However, the government continued to encourage voluntary compliance before surprisingly mandating the quota in December 2005 with the sanction of forced liquidation. See the appendix for a full account of the legislative process. Following a favorable vote in the Norwegian Parliament, a

law proposal needs a sanction and a mandate to become binding law. Both these additional steps are taken by the government, and usually immediately following the vote in the Parliament. However, neither of these steps were taken in the case of the gender quota in 2003. This was because the law contained a "self-destruct" clause: If firms voluntarily complied with the quota by mid-2005, the law would not be mandated. Therefore, there was uncertainty about whether the law would ever be binding. Moreover, there was no specific sanction associated with the law until the day it was mandated. The government surprisingly opted for forced liquidation as the sanction for non-compliance. Just a few days before the law was mandated, the Prime Minister had said in a public statement that if the quota was to become binding law the sanction for non-compliance would most likely be a fine ("Verdens Gang", Norway's largest daily newspaper, 1^{st} December 2005). Finally, the law proposal specified that if the law was mandated, firms would have two years to recruit the required female directors.

Thus, a firm that, for whatever reason, resisted female directors is unlikely to have changed their director selection procedures before December 2005, when they were forced to do so by law. Table 1 shows that a full 79.9% of firms were not in compliance with the law at the end of 2005, and the reform had a massive impact on board composition thereafter. The average PLC board had 15.5% female directors in 2005, compared to 40.7% in 2008. The share of female directors on Norwegian PLC boards prior to the introduction of the gender quota is similar to other comparable countries. Adams and Ferreira (2009) report 14.8% female directors in Fortune 500 firms in the US, 8.7% in Australia, 10.6% in Canada and 8.0% in Europe (based on various data sources from 2004 to 2007).

1.3 The selection of directors in Norway

In this section I argue that there is room for the CEO to express personal preferences in the selection of directors in Norwegian PLCs, at least prior to the reform, and that these preferences could have substantial influence over the selection process. This potential friction is important because it may have generated sub-optimal board structures, to the extent that the CEO derives personal benefits from being monitored less. In fact, Norwegian firms ranked next to last out of 14 European countries in a corporate governance ranking

from 2001 ("Okonomisk rapport" 21/2001), just above Portugal. The review highlights that Norwegian boards use independent sub-committees to a very limited extent, and they do not communicate enough information to shareholders.

Norwegian corporate law does not regulate how candidates are nominated for election to the board. It is nevertheless common for firms to have a nomination committee elected at the shareholders' annual meeting. Following communication with management, the current board and large shareholders, the nominating committee proposes the list of candidates, which is then voted on at the shareholders' annual meeting. In an exhaustive study of Norwegian ownership structure on the Oslo Stock Exchange, Bohren and Odegaard (2006) conclude that Norwegian firms have remarkably low concentration of ownership relative to comparable countries. The lack of large shareholders could increase the CEO's relative influence on the director nomination process. Moreover, an analysis of all firms listed on the Oslo Stock Exchange in 2005 found that 60% of firms offered no or very limited information about the nomination committee (Nymark and Thaysen, 2006). This seeming lack of transparency could arguably augment the influence of the CEO in the nominating process. Finally, most large Norwegian firms have a corporate assembly ("Bedriftsforsamling"), in which case the vote on directors is done there rather than at the shareholders' annual meeting. Such a setup would further distance the election of directors from direct shareholder scrutiny.

The personal preferences of the CEO likely have less to do with direct discrimination of women, and more to do with CEOs selecting people in their informal networks (Becker, 1971). If informal networks are important for director recruitment, and women are generally outside such networks, then the result would be fewer female directors. Indeed, in a survey of Norwegian male business leaders prior to the reform, 66% of the respondents say that women do not participate in the "forums" where recruitment to boards take place (NHO, 2003). A survey of PLC directors done prior to the reform reports that male directors were five times more likely than female directors to cite informal networks as the primary vehicle for their recruitment to the board (ECON, 2003).

Thus, there seems to be room for the CEO's personal preferences to influence the selection of directors in Norwegian PLCs, at least prior to the reform. To the extent

that the CEO derives personal benefits from being monitored less, this would constitute a potential friction that could generate sub-optimal board structures.

1.4 Outside directors and information asymmetry

Outside directors, largely independent from the CEO, should be in a better position to monitor the same CEO on behalf of shareholders (Fama and Jensen, 1983). Rosenstein and Wyatt (1990) and Nguyen and Nielsen (2010) show that shareholders value the very independence of an outside director, over and above the individual skills and competence of that director. Nevertheless, shareholders may not always prefer a board dominated by outside directors. The board of directors has two primary roles: monitoring and advising (Hermalin and Weisbach, 2003; Adams et al., 2010). A new strand of research argues that the effectiveness of outside directors in performing both these roles is constrained by their access to information (Raheja, 2005; Adams and Ferreira, 2007; Harris and Raviv, 2008; Duchin et al., 2010). Although outside directors are privy to non-public information about the company, outside directors are at an informational disadvantage relative to insiders of the firm.

Such information asymmetries have long been acknowledged in economics. For instance, Myers and Majluf (1984) point out that the informational advantage of firm insiders goes beyond proprietary information. Insiders know better what the proprietary information means for the firm. They have an insider's view of the organization and what it can and cannot do. This organizational knowledge it is part of the insiders' human capital; acquired by conscious effort and through trial and error. Educating outsiders takes time and money. Thus, there is an inherent informational asymmetry between insiders of the firm and outsiders, specific to each firm, which makes it costly or time consuming for an outside director to access and evaluate information about the firm. Indeed, Ravina and Sapienza (2010) find that both outside and inside directors earn abnormal profits when trading in their companies' stocks, but inside directors earn better returns than outside directors.

Thus, the effectiveness of an outside director depends on the degree of information asymmetry between insiders of the firm and outsiders. With less information asymmetry,

it is easier for an outside director to transform her general expertise to a specific firm and become an effective director. Based on this information asymmetry, therefore, some firms would optimally choose to have an insider dominated board, and others an outsider dominated board.

If firms compose their boards optimally according to the information asymmetry between insiders of the firm and outsiders, then any regulatory imposed increase in the share of outside directors can only reduce firm value. However, if the CEO dislikes being monitored he will derive private benefits from a board dominated by directors more aligned with him than with shareholders, irrespective of the firm specific information asymmetry. This would generate friction in the selection of directors, and possibly lead to a gap between the optimal and the actual share of outside directors. This friction would be particularly detrimental to a low information asymmetry firm; less so for a high information asymmetry firm, which optimally has more inside directors. If a firm with low information asymmetry has very few outside directors due to this friction, a reform that increases the share of outside directors, for instance by increasing the share of female directors, will increase firm value. On the other hand, a firm with high information asymmetry could decrease in value from the same reform.

Duchin et al. (2010) show that the impact on firm performance of the exogenous increase in outside directors generated by the US Sarbannes-Oxley Act (SOX) of 2002 depends on firm specific information asymmetry.[3] They find that outside directors improve firm performance when information asymmetry is low, and hurt performance when information asymmetry is high. This evidence is consistent with high information asymmetry firms already having constituted their board optimally with many inside directors, and that the legislated increase in outside directors was harmful to these firms. On the other hand, low information asymmetry firms had constituted their boards with few outsiders to minimize

[3]SOX defines an outside director as a person who does not accept any fee from the appointing firm (other than as director) and is not an affiliated person of the firm or any subsidiary. It requires that all members of corporate audit commitees are outside directors. SOX generated changes in the regulations of the NYSE and Nasdaq stock exchanges in 2003, beyond that required by SOX. The NYSE defines an outside director as a person who has no material relationship with the company; a majority of directors, and all members of the compensation and nominating committees must be outsiders. The Nasdaq defines an outsider as a person who does not have a relationship with the company that would interfere with independent judgment; a majority on the board, and the compensation and nominating committees, must be outsiders.

oversight, and the increase in outside directors was therefore helpful in these firms.

Recent research from Norway, Sweden and the US suggests that female directors differ from male directors; they are more likely to align with shareholders (Staubo, 2010; Adams and Funk, 2010; Adams and Ferreira, 2009). The reasons pointed to are institutional arrangements, e.g. women are less likely to be members of the "old boys club", and that women tend to be more universally concerned than men. As such, an increase in the share of female directors is equivalent to an increase in the share of outside directors. The impact on firm performance of the exogenous increase in female directors generated by the Norwegian gender quota should therefore depend on firm specific information asymmetry. This relation is what I set out to test in this paper.

2 Data sources

Data on board composition for all Norwegian PLCs is compiled by the Norwegian Business Register ("Bronnoysundregistrene"). The dataset covers all board members in all PLCs (listed and non-listed) registered each year from 1999 to 2009, and includes the background information that firms are required by law to report: name, age, gender, and nationality. This data was presented in Table 1. Also from the Norwegian Business Register, I have aggregate board composition data for each PLC at the monthly frequency up to March 2008. Daily Oslo Stock Exchange (OSE) stock prices, including split/reverse split and dividend adjustments, and index data are from the Stock Exchange database at the Norwegian School of Economics and Business Administration (NHH). I collect daily series of the MSCI World Index from Thomson Reuters Datastream, and NOK/USD exchange rate data from the Norwegian Central Bank. Accounting data and business sector information up to 2008 are from the NHH database constructed by Mjos and Oksnes (2010).

My measure of information asymmetry is based on a survey of all Norwegian listed firms done by the auditing firm PricewaterhouseCoopers (PWC) in 2005 on behalf of the OSE. In preparation for a corporate governance initiative, the OSE wanted to gauge how much information each firm revealed about its governance structure through public information. Thus, the PWC survey measures the quality and availability of public information on the governance structure in each firm, and not a firm's relative compliance with a code of

practice. PWC evaluated each firm listed on the OSE, placing a score from 0 to 3 on each of 14 dimensions[4] for a maximum total information score of 42 points for each firm. A score of zero indicates that there was no information on a particular dimension. A score of one indicates very limited information; two points average information; and three points adequate information. The lesser quality and availability of information about a firm, the higher is the information asymmetry between insiders of the firm and outsiders. I normalize the information score of each firm by the maximum score to get an information index from zero to one. Thus, for each firm i

$$\text{Information index}_i = \frac{\text{Total information score}_i}{42} \tag{1}$$

Figure 1 provides a histogram of the information index for all firms. We observe a rather even distribution, with a mean (and median) value of 0.4. Some firms have an information index of zero. This means that efforts to locate relevant public information on these firms were unsuccessful along all the 14 dimensions.

3 The impact of the reform on firm value

The announcement on 9^{th} December 2005 that the quota would be mandated, with the threat of forced liquidation, came as a surprise. To the extent that the ensuing influx of female directors was relevant for the valuation of the firms, investors would right away incorporate into the stock price the expected net present value of the costs and benefits of the quota for each particular firm. Work on the new law started before it was mandated. If the effects of the quota were already anticipated and therefore partly included in prices, the events on 9^{th} December 2005 removed all uncertainty about whether the quota would be made binding law, and to the surprise of the market added the sanction of forced liquidation for non-compliance. Any residual price effects generated by the introduction of the quota would therefore be captured on this date. To examine if there were any valuation effects of

[4]Implementation and reporting on corporate governance; Business, objectives and strategies; Equity, dividend policy and capital increase; Equal treatment of shareholders and transactions with close associates; Freely negotiable shares; General meetings; Nomination committee; Corporate assembly and board of directors: composition and independence; The work of the board of directors; Renumeration of the board of directors; Renumeration of the executive personnel; Information and communications; Take-overs; Auditor.

the quota, I estimate the abnormal announcement stock returns for the firms on the Oslo Stock Exchange (OSE) around 9^{th} December 2005.

I estimate the abnormal return for firm i on day t as $AR_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{mt})$, where R_{it} is the return on the stock of firm i on day t; R_{mt} is the return on the MSCI World Index; and $\hat{\alpha}_i$ and $\hat{\beta}_i$ are the coefficients estimated from the single-factor market model $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$ over the days -255 to -6.[5] To account for the possibility of information overflow before the announcement, and underreaction on the announcement day, I calculate the cumulative abnormal return for five different return windows: $(-1, +1)$, $(-2, +2)$, $(-3, +3)$, $(-4, +4)$, and $(-5, +5)$, all centered on 9^{th} December 2005. The cumulative abnormal return (CAR) for a window that starts at day $-k$ and ends at day $+k$ is $CAR_i(-k, +k) = \sum_{t=-k}^{k} AR_{it}$.

I first calculate the simple average CAR for all firms, in addition to four subgroups based on firm specific information asymmetry and the pre-announcement share of female directors. Table 2 shows the results. From Panel A we see that the average OSE firm experienced positive abnormal returns on the introduction of the gender quota. For all the five return windows, ACAR is significantly positive. Panel B shows the results for the firms with low information asymmetry and few female directors. Across all the five investigated windows, ACAR is significantly positive for this group. Firms with low information asymmetry and many female directors would not be much affected by the new law, and Panel C reveals that the measured ACAR for these firms is not significant. Panels D and E relate the results for firms with high information asymmetry. For some of the return windows investigated, ACAR is significantly positive. Overall, the results support the conjecture that the forced increase in gender diversity added value to firms with low information asymmetry.

[5]Results are similar when I use the OSE All Share Index (OSEAX) or the OSE Benchmark Index (OSEBX) instead of the MSCI World Index. OSEAX includes all shares listed on OSE; OSEBX the most traded shares. Both indices are value weighted and adjusted for dividend payments. The MSCI index includes a large collection of stocks from all the developed markets in the world. I use the price index in US Dollars, which is adjusted for dividends. I then convert the MSCI index to NOK using the NOK/USD daily exchange rate.

3.1 CAR controlling for sector and size

To specifically test the relation between an increase in the share of female directors and firm value conditional on information asymmetry, I want to control for possible sector-wide shocks and firms size. I therefore perform OLS regressions of CAR, separately for low and high information asymmetry firms, on an indicator variable that equals 1 if the firm has less than the median share of female directors in November 2005. This dummy captures the valuation impact on the firms most affected by the quota.[6] I also include controls for the logarithm of the market value of equity, the total number of directors, and industry sector indicator variables. Table 3 gives the results. In the low information asymmetry group (panel A), firms with relatively few female directors experience strong and positive abnormal returns over each of the return windows. This means that investors expected the impact of the reform in these firms to be positive. In panel B, where I look at high information asymmetry firms, the coefficient estimate on the dummy variable for few female directors is negative, but not significant in either of the return windows. Thus, the impact on firms affected by the Norwegian gender quota seems to depend on the information asymmetry between insiders of the firm and outsiders, as expected. This result suggests that an increase in female directors is tantamount to an increase in outside directors, which is valuable only for certain firms.

4 Robustness

4.1 Conversion from PLC to LTD

After the gender quota was mandated, there was a subsequent drop in the number of PLCs. It is possible that firms hurt by the forced change of board members chose to instead take the LTD corporate form, and thus avoid being subject to the reform. The last row in Table 1 shows that the number of PLCs dropped each year from 2006 to 2009: from 505 firms down to 360; a drop of 28.7%. In this section, I investigate the potential selection issue

[6]Results are similar when this dummy instead equals one if the firm needs more than the median percentage or absolute number of women to meet the quota, else zero. F-tests show that, in each of the five windows, the explanatory variables have different impacts on the two sub-samples low and high information asymmetry firms.

associated with this decline in the number of PLCs.

A non-listed PLC could easily convert to LTD, while a listed PLC would first have to delist from the OSE, and then convert to LTD in order to avoid the quota. Moverover, a non-listed PLC is likely to exhibit higher information asymmetry between insiders of the firm and outsiders compared to a listed firm, as there is less public information available than for listed firms. As highlighted in Section 1.4, a firm with high information asymmetry is likely to optimally resist outside directors. Therefore, to the extent that firms converted from PLC to LTD in order to avoid the gender quota, I expect this issue to be particularly relevant for non-listed PLCs.

Figure 2 shows the rate of conversion from PLC to LTD separately for listed and non-listed PLCs from 1999 to 2008. The conversion rate is always higher for non-listed PLCs, and there is a peak in 2006, the year after the quota was mandated. Table 4 reports on the firm characteristics over the same years, separately for listed and non-listed PLCs. On average, listed PLCs are less likely to convert; have a higher share of female directors; have bigger boards; are older; are more likely to have directors representing employees; and have higher book asset values. The mean values are significantly different between the two groups for all these variables ($p < 0.01$). Non-listed PLCs have slightly higher equity ratio compared to listed PLCs, and the return on assets is not significantly different between the two groups. See Table 4 for variable definitions.

To test whether the conversion rate is associated with the quota, I investigate whether converting firms systematically had few female directors. To do this I perform OLS regressions each year from 1999 to 2008 of the conversion decision on the share of female directors the same year, controlling for firm characteristics. This constitutes a test of the conditional correlation between the conversion decision and the share of female directors at the time of the conversion decision.

Table 5 and Table 6 show the results for listed and non-listed PLCs, respectively. We observe that there is no correlation between the conversion decision and the share of female directors for listed firms. This indicates that the stock price reaction I report in this paper does not suffer from a selection bias caused by firms delisting subsequent to the introduction of the quota in order to avoid the quota. For non-listed PLCs, however, there is a strong

negative correlation between the conversion decision and the share female directors in both 2006 and 2007. This corresponds well with the legislative process of the quota outlined in Section 1, whereby the quota only had an impact after it was mandated in December 2005.

4.2 Return on assets

The stock market reaction suggests that investors expected the quota to impact firm performance differently depending on firm specific information asymmetry. In this subsection I investigate whether this result is corroborated by changes in return on assets in the affected firms. In investigating the effect of the quota on firm performance, I am interested specifically in firm performance from 2004 to 2008. The quota was mandated towards the end of 2005, and 1st January 2008 was the final deadline to have the new women physically on the board. Thus, 2008 was the first year that all affected firms were in compliance, and I start the analysis one year before the law was introduced.

Reminiscent of the setup in Duchin et al. (2010), my empirical model assumes that firm performance is determined by the following relation:

$$ROA_{it} = \beta_1 F_{it} + \beta_2 F_{it} I_i + \beta_3 I_i + \cdots + \gamma X_i + \lambda S_t + \epsilon_{it}, \tag{2}$$

where i indexes a firm, t indexes a year, ROA is return on assets, F is the share of female directors, I is the information index score, X holds other firm specific effects, and S is time specific effects (captured by year dummies). This relation assumes that performance and the share of female directors vary over time, and that the information index does not vary over time. The setup allows for the marginal effect of female directors on performance to depend on information asymmetry, which is a firm specific effect: $\partial ROA/\partial F = \beta_1 + \beta_2 I$. Instead of estimating equation (2), I estimate the first difference relation:

$$\triangle ROA_i = \beta_1 \triangle F_i + \beta_2 (\triangle F_i \times I_i) + \cdots + \lambda \triangle S + \triangle \epsilon_i, \tag{3}$$

where $\triangle Z \equiv Z_{2008} - Z_{2004}$. This removes the firm-specific effects, the time-specific effects are reduced to a constant, and the information index remains only in the interaction term. In the regressions I also add the following control variables: board size, equity ratio, firm

age, indicator variable for employee representative on the board, total assets, market value of equity, and Tobin Q. All these control variables are from 2004, and thus account for the initial conditions. Norway transitioned from domestic GAAP (Generally Accepted Accounting Principles) to IFRS (International Financial Reporting Standards) in 2005. Beisland and Knivsflaa (2010) find that IFRS represents a less conservative accounting framework than the Norwegian GAAP, which could lead to an increase in listed firms' book value of assets from 2005 with an associated reduction in ROA even with unchanged earnings. This transition would impact all firms, but there might also be sector specific variation in how firm respond to these rule changes. I therefore include industry-sector indicator variables in all the regressions.

Following Duchin et al. (2010), I perform an "instrumented approach". In this setup I first regress the change in the share of female directors on a dummy variable that is equal to one if the firm did not comply with the quota in 2004, in addition to the control variables. Then I take the predicted changes in the share of female directors from this regression, in place of the actual change, to estimate equation (3).

The results are reported in Table 7: Column 1 shows the results from the first stage of the instrumented approach, and Column 2 and Column 3 the results from the second stage regression without and with the information index interaction term. From Column 1, we see that whether the firm was compliant with the quota in 2004 is a strong predictor of changes in the share of female directors, making compliance in 2004 a useful instrument for future changes in the share of female directors. Column 2 shows that the coefficient estimate on predicted change in the share of female directors is close to zero and insignificant (p-value = 0.780). In Column 3, where I include the information index interaction term, the coefficient estimate on change in share of female directors is now negative and becomes bigger in absolute terms, but is not significantly different from zero at standard significance levels (p-value = 0.366). The coefficient estimate on the information index interaction term is positive and significant at the 10% level (p-value = 0.087). This means that among firms that had to increase the share of female directors to comply with the quota, the firms with low information asymmetry (i.e. high information index score) benefited more from the change than high information asymmetry firms did. Although the coefficient on the change

in share of female directors is not significant at standard significance levels, the size of the coefficient is large enough that it would partly off-set the positive effect from the interaction term, and even generate a negative impact on high information asymmetry firms.[7] These results are consistent with the stock market reaction presented in this paper, whereby the impact of the quota on firm performance depends on firm specific information asymmetry.

5 Comparison with Ahern and Dittmar (2010)

Ahern and Dittmar (2010) investigate the same Norwegian gender quota and report somewhat different results from those presented here. In this section I relate their findings to mine. I find that their particular sampling procedure seems to account for their results. Moreover, they do not condition their analysis on firm specific information asymmetry, which I find to be important in explaining the impact of the reform.

Ahern and Dittmar (2010) undertake the huge taks of hand collecting background information on directors in Norwegian firms listed in 2007. They collect this information on these firms from 2001 to 2008, which of course introduces a sampling bias in years other than 2007. If more than half a firm's board has missing data they drop the firm-year observation. They thereby construct one of the most comprehensive databases used for academic research on directors in a single country. My dataset on board members, presented in Table 1, is constructed by the Norwegian Business Register and contains all board members in all PLCs (listed and non-listed) registered each year from 1999 to 2009, but includes only the background information that firms are required to report by law: name, age, gender, and nationality.

Ahern and Dittmar (2010) first investigate the stock market reaction to the quota on 22^{nd} February 2002, and find a reduction in the market value of the OSE firms in their sample. On that day, the Minister of Trade and Industry supported the idea of a quota in a newspaper interview. However, all work on the law, both prior and subsequent to this date,

[7] To see this, consider a firm that increases the share of female directors by 25%, which is around the average increase for non-compliant firms. The change in ROA would depend on the information index: $\triangle ROA_i = -0.242 * 0.25 + 0.595 * 0.25 * I_i$. Thus, $\triangle ROA_i = 0$ for $I_i \approx 0.41$, which is close to the average value of the information index. For higher values of I_i (i.e. low information asymmetry firms) $\triangle ROA_i$ is positive; for lower values of I_i (i.e. high information asymmetry firms) $\triangle ROA_i$ is negative.

is done by the Ministry of Children, Family and Equality; not Trade and Industry. This date is therefore not highlighted in the appendix on the legislative process of the new law. In addition, their sampling procedure forces them to investigate the stock market reaction in 2002 only on firms that were also listed in 2007. Their regressions include 47 firms, less than one third the number of firms included in my analysis. Moreover, they do not control for firm specific variation in exposure to market risk or industry sector effects, which I do in the tests presented here. It is therefore not clear that the negative stock market reaction reported by Ahern and Dittmar (2010) was generated by the gender quota.

Next, Ahern and Dittmar (2010) find that young directors with less experience is associated with reduced market value (Tobin's Q). They argue that this is a result of the gender quota. However, their sampling bias in years other than 2007 generates an emphasis on new firms in their analysis, which could account for this result. The law was effective from 1^{st} January 2006, and firms established after this date would have to comply immediately whereas already established firms had two years to comply. Not only would new firms have to comply to the gender quota right away, they also likely attract younger directors. In unreported work, I identify 87 new PLCs registered in 2006 (of which 15 were listed), and 94 new PLCs in 2007 (of which 24 were listed). These 39 new listed firms would constitute more than half the firms that enter the analysis of Tobin Q and board member characteristics in Ahern and Dittmar (2010). Both male and female directors in these new firms are significantly younger than the directors in already existing firms. Moreover, these new firms experience a significantly bigger reduction in Tobin Q up to 2008 than did the firms established before 2006. Thus, the relation between young directors with less experience and lower Tobin's Q reported by Ahern and Dittmar (2010) could be an artifact of their sampling procedure that over-emphasizes new firms, rather than a result from the introduction of the gender quota.

6 Conclusion

The gender quota on Norwegian corporate boards dramatically increased the share of female directors. I find that the impact of the reform on firm value depends on the firm specific information asymmetry between insiders of the firm and outsiders. This result

points to several conclusions. First, an increase in female directors is tantamount to an increase in outside directors. With less information asymmetry, it is easier for an outside or female director to transform her general expertise to a specific firm and become an effective director. Second, some firms had sub-optimal governance structure before the introduction of the quota, and the increased monitoring with more female directors on the board was beneficial for these firms. I also find suggestive evidence that high information asymmetry firms were hurt by the same reform, as they would have had to alter an already optimal governance structure to comply with the quota. Though the evidence of a negative impact from the Norwegian gender quota is mostly insignificant at standard levels of statistical significance, it does offer caution to regulators who think there are only benefits to forced gender diversity on corporate boards.

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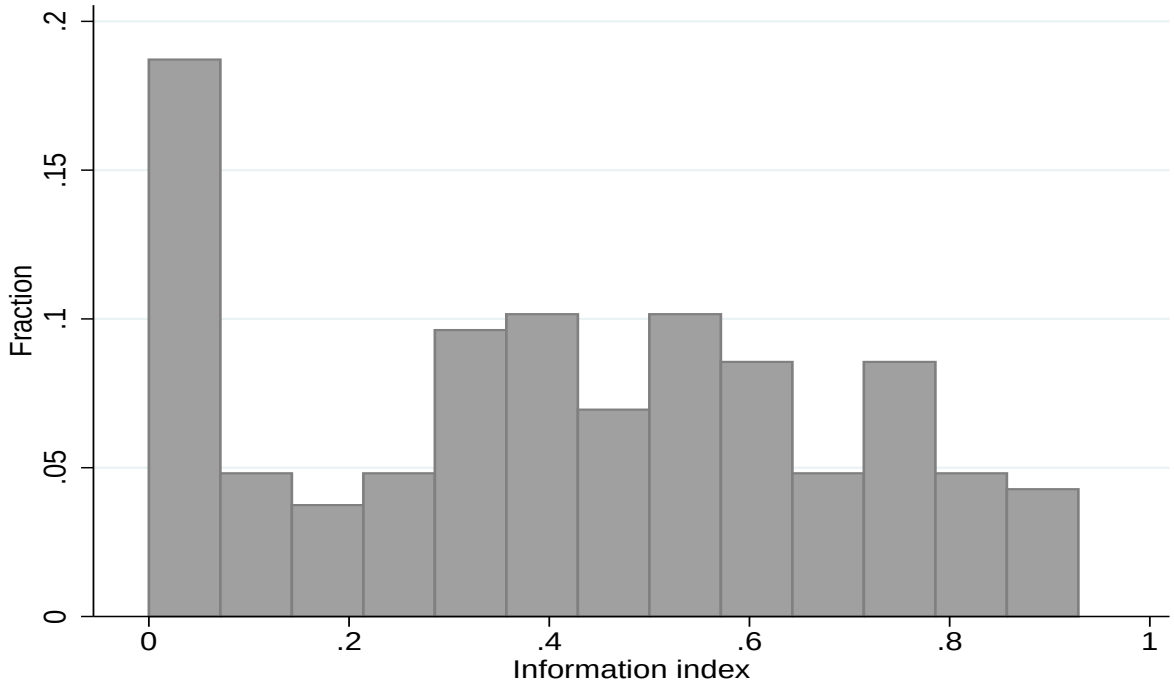
Appendix: The legislative process

- **October 1999**: The first public hearing on gender representation in private company boards. The government sent out a proposal to overhaul of the entire gender equality act from 1978. Among other things gender representation on boards. The 1978 law specified a minimum of 40% of both genders on committees appointed by a public body. This hearing suggested four possible extensions of the quota: (1) wholly government owned enterprises, (2) partly government owned enterprises, (3) businesses listed on the Oslo Stock Exchange, (4) boards generally (including LTD and foundations). The proposal intended for this to be covered by gender equality law, not corporate law. Several different alternatives as to how to implement the new law were discussed. The hearing includes the following suggestion for new law: "On the boards of all listed firms both genders must be represented. For boards with 4 or more members, each gender shall be represented by at least 25%."
- **July 2001**: Second public hearing. The government takes out gender representation on boards as a separate issue from the overhaul of the gender equality law. The proposal suggests that the quota is incorporated into corporate law instead of the gender equality law; now with a higher 40% target. The proposal presented three models: (1) quota for government owned firms only, (2) also PLCs, i.e. listed firms and non-listed PLCs, (3) no quota but instead a demand for gender representation in the nomination process for board election.
- 8^{th} **March 2002**: The government announce that they will continue the work towards a law proposal. They explicitly state that they invite cooperation with the private sector for a voluntary increase in female representation, rather than making a quota mandatory through law.
- **April 2003**: In relation with the public hearings on the issue, both the business community and the government initiated several programmes to increase the share of women on boards, and also to specifically increase skills for prospective board members. An online database was also established ("Kvinnebasen"), where women interested in board membership could register. As of April 2003 this database held 3,500 women (Ministry of Children, Family and Equality, 2003).
- 13^{th} **June 2003**: The law proposal is presented. It covers goverment owned companies and all PLCs, with a quota of 40%. Importantly, it includes a voluntary compliance deadline, which is set to 1^{th} July 2005. If firms meet the required ratio by that date, the law will not be mandated, i.e. it will be stricken from existence.
- 27^{th} **November 2003**: The law passes Parliament's lower chamber ("Odelstinget") with broad majority.
- 9^{th} **December 2003**: The law passes Parliament's upper chamber ("Lagtinget") without comments.
- 19^{th} **December 2003**: The law is formally included into Norwegian corporate law, though still under the condition that voluntary compliance by 1^{st} July 2005 would completely void the law. The law does not have a sanction or a mandate, i.e. it is not binding.

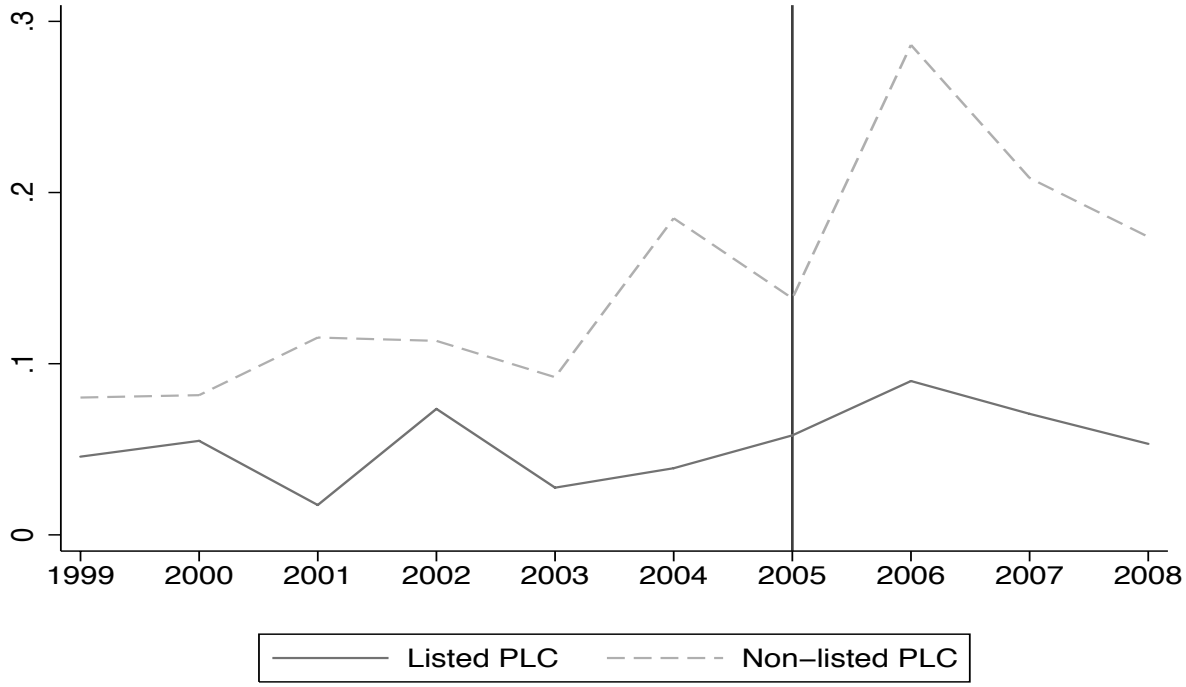
- 1^{st} **July 2005**: The passing of the voluntary deadline for compliance generated massive media attention on gender diversity, and public debate on the law in Norway. A business daily ("Finansavisen") establishes a free online database that lists the gender composition in each PLC board. The public debate centered on whether a quota should be made mandatory by law at all, and, if so, what sanctions should be put in place.
- 9^{th} **December 2005**: The government decides to put the new law into effect. Prior to this date, the law had no mandate nor any specified associated sanction. The government opted for forced liquidation as the sanction for non-compliance. This is surprising. Just a few days earlier the Prime Minister made a public statement where he specifically stated that the government would most likely associate fines with the law, if mandated ("Verdens Gang", 1^{st} December 2005).
- 1^{st} **January 2006**: All PLCs registered after this date had to comply with the quota immediately. Existing firms are given two years to comply.
- 1^{st} **January 2008**: Final deadline. 77 PLC are in not in compliance with the law. These receive a letter from the Norwegian Business Register informing them to comply by February 2008. 12 of these firms had still not made the necessary arrangements by that deadline, and were given a final warning to comply or be dissolved.
- **April 2008**: All PLCs are in compliance, and no firm was forced to liquidate for failing to meet the quota.

FIGURE 1: HISTOGRAM OF THE INFORMATION INDEX



Notes: The figure reports the distribution of the information index, defined in equation (1).

Figure 2: Conversion from PLC to LTD



Notes: The figure plots the conversion rate for listed and non-listed PLCs, separately. A converting firm is one that is registered as a PLC in the current year, but is no longer registered as a PLC the subsequent year. This conversion decision is then cleaned for firms that in the current or subsequent year are no longer registered as active, are bankrupt, or do not report sales revenue (accounting data available up to 2008). Converting firms therefore include firms that convert due to mergers and acqusition activity. Such activity is not likely to be systematically related to the share of female directors.

Table 1: Director characteristics, all Norwegian PLCs, 1999-2009

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Firms that did or did not comply with the gender quota, percentage											
Comply	2.1	2.2	3.8	5.3	7.2	10.6	20.1	40.4	80.3	97.8	98.3
Not comply	97.9	97.8	96.2	94.7	92.8	89.4	79.9	59.6	19.7	2.2	1.7
Directors (owner representative), percentage by gender											
Men	96.8	96.5	96.0	94.9	93.2	90.7	84.5	76.8	64.3	59.3	59.2
Women	3.2	3.5	4.0	5.1	6.8	9.3	15.5	23.2	35.7	40.7	40.8
Average number of PLC directorships per person (owner representative), separately by gender											
Men	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2
Women	1.2	1.2	1.1	1.2	1.3	1.2	1.2	1.3	1.3	1.3	1.3
Foreign directors (owner representative), percentage separately by gender											
Men	13.1	14.9	14.0	13.5	13.3	14.3	15.0	16.2	14.9	15.7	15.1
Women	4.7	7.3	6.9	8.8	11.7	12.4	9.9	12.7	11.1	12.8	13.0
Average age of directors (owner representative), separately by gender											
Men	48.8	48.4	48.5	49.3	49.9	50.4	50.6	50.8	51.7	52.8	53.4
Women	45.2	44.5	45.7	46.0	47.0	46.4	45.3	44.9	45.6	46.2	47.1
Directors (employee representative), percentage by gender											
Men	81.5	83.1	80.3	79.1	77.5	74.7	73.2	73.2	69.1	67.3	74.0
Women	18.5	16.9	19.7	20.9	22.5	25.3	26.8	26.8	30.9	32.7	26.0
Chair of the board, percentage by gender											
Men	97.9	99.0	98.7	98.5	97.3	97.5	97.6	97.0	95.0	93.2	93.0
Women	2.1	1.0	1.3	1.5	2.7	2.5	2.4	3.0	5.0	6.8	7.0
Dir. (Owner)	2,484	2,833	2,945	2,797	2,575	2,413	2,333	2,401	2,250	1,945	1,677
Dir. (All)	2,762	3,099	3,199	3,064	2,834	2,673	2,585	2,637	2,492	2,187	1,907
Firms	524	602	630	600	553	521	493	505	483	414	360

Notes: The table reports director characteristics based on all PLCs registered in Norway 31^{th} December each year from 1999 to 2009. Dir. (Owner) counts the number of directorships representing owners, Dir. (All) counts all directorships, and the difference between the two gives the number directorships representing employees.

Table 2: Average cumulative abnormal return

	Return windows				
	(-1,+1)	(-2,+2)	(-3,+3)	(-4,+4)	(-5,+5)
Panel A: All firms					
ACAR	0.008	0.012	0.016	0.020	0.016
Ordinary test stat.	(3.311)	(4.998)	(7.029)	(8.528)	(6.954)
Ordinary cross sectional test stat.	(2.029)	(2.243)	(2.912)	(3.096)	(2.193)
Ratio positive CAR	0.477	0.490	0.569	0.582	0.536
Sign test stat.	(0.566)	(0.243)	(1.698)	(2.021)	(0.889)
Firms/Observations	153	153	153	153	153
Panel B: Firms with low information asymmetry and few female directors					
ACAR	0.033	0.049	0.057	0.077	0.072
Ordinary test stat.	(5.100)	(7.634)	(8.917)	(11.916)	(11.182)
Ordinary cross sectional test stat.	(1.936)	(2.921)	(2.537)	(3.515)	(3.248)
Ratio positive CAR	0.619	0.714	0.619	0.762	0.667
Sign test stat.	(1.091)	(1.964)	(1.091)	(2.400)	(1.528)
Firms/Observations	21	21	21	21	21
Panel C: Firms with low information asymmetry and many female directors					
ACAR	0.003	0.008	0.007	0.005	-0.002
Ordinary test stat.	(0.850)	(1.943)	(1.706)	(1.188)	(-0.527)
Ordinary cross sectional test stat.	(0.703)	(1.181)	(0.904)	(0.567)	(-0.156)
Ratio positive CAR	0.455	0.491	0.582	0.527	0.436
Sign test stat.	(0.674)	(0.135)	(1.214)	(0.405)	(0.944)
Firms/Observations	55	55	55	55	55
Panel D: Firms with high information asymmetry and few female directors					
ACAR	0.008	0.012	0.018	0.026	0.021
Ordinary test stat.	(1.327)	(2.054)	(3.032)	(4.318)	(3.477)
Ordinary cross sectional test stat.	(0.826)	(0.863)	(1.305)	(1.745)	(1.435)
Ratio positive CAR	0.448	0.448	0.552	0.552	0.586
Sign test stat.	(0.557)	(0.557)	(0.557)	(0.557)	(0.928)
Firms/Observations	29	29	29	29	29
Panel E: Firms with high information asymmetry and many female directors					
ACAR	0.010	0.017	0.021	0.014	0.012
Ordinary test stat.	(2.391)	(4.069)	(5.159)	(3.441)	(3.007)
Ordinary cross sectional test stat.	(1.945)	(2.000)	(2.449)	(0.923)	(0.813)
Ratio positive CAR	0.543	0.486	0.600	0.629	0.571
Sign test stat.	(0.507)	(0.169)	(1.183)	(1.521)	(0.845)
Firms/Observations	35	35	35	35	35

Notes: The table reports the average CAR for all listed PLCs. See Table 3 for details on the CAR estimation, and information asymmetry and female director classifications. All ACARs are tested if significantly different from zero using tests outlined in Boehmer, Masumeci and Poulsen (1991). Results are similar for ordinary and standardized test statistics; I report only the ordinary test statistics. All test statistics assume that the null distribution is standard normal.

Table 3: Regressions with cumulative abnormal return

	Return windows				
	(-1,+1)	(-2,+2)	(-3,+3)	(-4,+4)	(-5,+5)
Panel A: Firms with low information asymmetry					
Few female directors	0.027*	0.042**	0.052**	0.072***	0.070***
	(0.016)	(0.019)	(0.025)	(0.023)	(0.024)
Market value, logarithm	-0.002	0.007	0.009	0.010	0.003
	(0.005)	(0.006)	(0.007)	(0.007)	(0.012)
Board size	-0.001	-0.010**	-0.010	-0.010	-0.005
	(0.004)	(0.005)	(0.007)	(0.007)	(0.009)
Constant	0.038	-0.096	-0.151	-0.171	-0.035
	(0.107)	(0.119)	(0.153)	(0.148)	(0.240)
R^2	0.174	0.190	0.197	0.286	0.163
Firms/Observations	75	75	75	75	75
Panel B: Firms with high information asymmetry					
Few female directors	-0.007	-0.016	-0.013	-0.002	-0.003
	(0.012)	(0.014)	(0.014)	(0.018)	(0.019)
Market value, logarithm	-0.003	0.000	0.002	0.005	0.005
	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)
Board size	-0.003	-0.007*	-0.008	-0.011*	-0.008
	(0.003)	(0.004)	(0.005)	(0.006)	(0.006)
Constant	0.094	0.035	-0.023	-0.035	-0.018
	(0.066)	(0.093)	(0.102)	(0.112)	(0.122)
R^2	0.164	0.503	0.464	0.416	0.356
Firms/Observations	64	64	64	64	64

Notes: The table reports results from cross sectional OLS regressions of CAR, separately for low and high information asymmetry firms. A high information asymmetry firm has an information index score below the median value; the remaining firms are classified as low information asymmetry firms. The event windows are centered on 9^{th} December 2005, the date when the gender quota was mandated. CAR is calculated over each of the (-1,+1), (-2,+2), (-3,+3), (-4,+4), (-5,+5) day return windows. CAR is each firm's actual stock return over the event window, net of normal return. Normal return is estimated for each firm based on the firm's daily stock return in the 250 days window (-255,-6) prior to the event window, and the MSCI World Index converted to NOK. Returns are calculated as the logarithm of the ratio of price on day t and price day $t-1$; prices are adjusted for splits/reverse splits and dividends. A stock needs 100 observations over the estimation window to enter the CAR calculation. In the case of dual listings, I use the average abnormal return over the listings for that firm. Few female directors is an indicator variable that equals to 1 if the firm has below the median share of female directors in November 2005, else zero. Board size is the total number of directors, including directors representing employees. The market value equals the close price of the firm's stock on the Oslo Stock Exchange on the last day in the estimation window multiplied by the number of shares issued. In the case of dual listings I use the aggregate market value over the listings of that firm. All regressions include indicator variables for industry sectors. Robust standard errors (Huber/White/sandwich estimator) reported in parenthesis; stars indicate significance levels: *** 1%, ** 5%, *10%.

Table 4: Summary statistics, PLCs 1999-2008

	Mean	Std. Dev.	Observations
Panel A: Listed PLC			
Conversion decision	0.054	0.226	1727
Female directors	0.185	0.185	1751
Board size	6.256	1.819	1751
Equity ratio	0.441	0.238	1704
Firm age	23	27	1712
Return on assets	-0.002	0.178	1684
Employee rep.	0.404	0.491	1751
Total assets (mill NOK)	12613	71058	1707
Market equity (mill NOK)	5734	26736	1631
Tobin Q	1.773	1.584	1597
Panel B: Non-listed PLC			
Conversion decision	0.140	0.347	3278
Female directors	0.111	0.169	3376
Board size	4.691	1.705	3376
Equity ratio	0.475	0.396	3187
Firm age	11	19	3368
Return on assets	-0.006	0.269	3082
Employee rep.	0.140	0.347	3376
Total assets (mill NOK)	4894	52020	3287

Notes: The table reports summary statistics for all PLCs over the period 1999 to 2008, separately for listed and non-listed PLCs. The conversion variable is defined in Figure 2. Female directors is the ratio of female directors representing owners relative to the total number of directors representing owners. Board size is the total number of directors, including directors representing employees. Equity ratio is equity divided by assets, both book values. Firm age is the current year minus the year of incorporation. Return on assets is calculated as earnings before interest and taxes divided by total book value of assets. The employee board representative indicator variable equals to one if the firm has at least one director representing employees, else zero. Total assets is the book value of assets. The market value of equity is the end of year close price of the firm's stock on the Oslo Stock Exchange multiplied by the number of shares issued. Tobin Q = (Book value of total assets - book value of equity + market value of equity) / Book value of total assets. The following values are excluded as outliers: Absolute value of return on assets above 100%; Tobin Q value above 20; book value equal to or below zero; equity ratio below minus 100%.

Table 5: Conversion from PLC to LTD, listed PLCs

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Female directors	-0.070	-0.036	0.100	-0.140	0.005	-0.132	-0.030	0.029	0.001	0.150
	(0.182)	(0.137)	(0.126)	(0.195)	(0.034)	(0.102)	(0.070)	(0.160)	(0.195)	(0.342)
Board size	-0.004	0.005	-0.022*	-0.041**	-0.003	-0.023	-0.016	0.015	-0.017	-0.006
	(0.011)	(0.010)	(0.013)	(0.017)	(0.003)	(0.016)	(0.011)	(0.017)	(0.015)	(0.020)
Equity ratio	0.054	0.038	-0.055	-0.270**	0.124*	0.087	-0.075	0.152	0.134	-0.126
	(0.081)	(0.051)	(0.064)	(0.134)	(0.066)	(0.122)	(0.075)	(0.136)	(0.096)	(0.092)
Firm age	0.001	-0.001	-0.001	-0.001	0.000	0.001	0.000	-0.001	-0.000	-0.001
	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
Return on assets	-0.000	-0.095***	0.001	0.036	-0.182*	-0.114*	0.010	0.099	0.153	0.009
	(0.055)	(0.025)	(0.025)	(0.023)	(0.094)	(0.068)	(0.087)	(0.125)	(0.139)	(0.068)
Employee rep.	0.015	-0.050	0.069*	0.103*	0.005	0.003	0.041	-0.059	0.008	0.072
	(0.042)	(0.048)	(0.040)	(0.057)	(0.010)	(0.037)	(0.045)	(0.049)	(0.070)	(0.053)
Total assets, logarithm	-0.013	0.024	-0.015	-0.089**	0.027*	0.046	-0.012	0.100*	0.037	-0.027
	(0.020)	(0.030)	(0.023)	(0.037)	(0.016)	(0.033)	(0.024)	(0.056)	(0.031)	(0.030)
Market value, logarithm	-0.006	-0.015	0.026	0.098**	-0.028*	-0.029	0.022	-0.122*	-0.035	0.008
	(0.021)	(0.026)	(0.026)	(0.038)	(0.016)	(0.030)	(0.022)	(0.068)	(0.039)	(0.019)
Tobin Q	-0.001	0.001	-0.012	-0.094**	-0.005	0.000	-0.001	0.012	0.011	-0.074*
	(0.002)	(0.006)	(0.009)	(0.042)	(0.008)	(0.000)	(0.006)	(0.009)	(0.022)	(0.040)
Constant	0.210	-0.088	-0.003	0.352*	-0.034	-0.001	-0.046	0.115	0.056	0.353
	(0.160)	(0.121)	(0.064)	(0.211)	(0.043)	(0.111)	(0.148)	(0.196)	(0.198)	(0.293)
R^2	0.063	0.136	0.093	0.175	0.576	0.113	0.081	0.116	0.099	0.101
Firms/Observations	165	158	153	141	137	146	166	158	174	143

Notes: The table reports the results from cross sectional OLS regression of the conversion decision of PLC firms on the share of female directors in the current year. Only listed PLCs included. Variable definitions in Table 4. Outlier values (as defined in Table 4) are not excluded. Results are similar when excluding outliers. All regressions include indicator variables for industry sectors. Robust standard errors (Huber/White/sandwich estimator) reported in parenthesis; stars indicate significance levels: *** 1%, ** 5%, *10%

Table 6: Conversion from PLC to LTD, non-listed PLCs

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Female directors	-0.044	0.109	0.255	0.420	-0.072	0.224	-0.170	-0.849***	-0.537***	-0.315
	(0.134)	(0.205)	(0.218)	(0.281)	(0.119)	(0.177)	(0.133)	(0.164)	(0.179)	(0.396)
Board size	0.026*	-0.023**	-0.009	-0.017	0.021	-0.015	-0.019	-0.000	0.019	0.015
	(0.013)	(0.011)	(0.013)	(0.015)	(0.013)	(0.016)	(0.015)	(0.019)	(0.019)	(0.025)
Equity ratio	0.000	0.000	0.001***	0.000*	0.000	0.001	-0.000*	-0.036	-0.037	-0.091
	(0.001)	(0.003)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.057)	(0.053)	(0.088)
Firm age	-0.001*	0.000	-0.000	0.001	0.001	-0.000	-0.001	0.000	0.002*	-0.000
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Return on assets	0.003	-0.006	-0.021	-0.012***	-0.000	-0.025	0.009**	0.016	0.040	-0.017
	(0.006)	(0.012)	(0.016)	(0.001)	(0.001)	(0.018)	(0.004)	(0.022)	(0.030)	(0.038)
Employee rep.	0.087	0.030	-0.058	-0.038	-0.077	0.015	0.017	0.037	-0.121	0.046
	(0.064)	(0.052)	(0.062)	(0.065)	(0.060)	(0.078)	(0.069)	(0.090)	(0.082)	(0.107)
Total assets, logarithm	-0.014*	-0.005	-0.014	-0.003	-0.022**	0.005	0.009	-0.012	-0.039***	-0.028**
	(0.008)	(0.011)	(0.012)	(0.014)	(0.010)	(0.011)	(0.010)	(0.011)	(0.012)	(0.014)
Constant	0.034	0.156	0.181	0.011	0.160	-0.002	-0.054	0.817***	0.605***	0.349**
	(0.078)	(0.135)	(0.135)	(0.121)	(0.103)	(0.117)	(0.092)	(0.261)	(0.143)	(0.172)
R^2	0.052	0.033	0.152	0.083	0.082	0.095	0.086	0.174	0.152	0.110
Firms/Observations	317	268	274	250	344	331	275	289	259	178

Notes: The table repeats the regressions of Table 5 for non-listed PLCs only, which excludes the variables market value and Tobin Q. Robust standard errors (Huber/White/sandwich estimator) reported in parenthesis; stars indicate significance levels: *** 1%, ** 5%, *10%

Table 7: Change in return on assets, 2004 - 2008

	First stage	△ ROA	
	(1)	(2)	(3)
Dummy = 1 if firm did not comply with quota in 2004	0.264***		
	(0.028)		
△ Female directors (predicted values)		0.054	-0.242
		(0.191)	(0.266)
△ Female directors (predicted values) × Information index			0.595*
			(0.343)
Board size	-0.006	-0.012	-0.010
	(0.008)	(0.011)	(0.013)
Equity ratio	-0.220***	0.057	0.058
	(0.077)	(0.122)	(0.133)
Firm age	-0.000	-0.000	-0.000
	(0.000)	(0.001)	(0.001)
Employee rep.	0.029	-0.033	-0.053
	(0.034)	(0.042)	(0.042)
Total assets, logarithm	-0.038	0.042	0.050
	(0.028)	(0.036)	(0.037)
Market value, logarithm	0.034	-0.035	-0.052
	(0.029)	(0.038)	(0.040)
Tobin Q	-0.002	0.010	0.017
	(0.009)	(0.016)	(0.017)
Constant	0.300***	-0.123	0.315**
	(0.099)	(0.206)	(0.150)
R^2	0.587	0.082	0.148
Firms/Observations	101	97	88

Notes: The table reports estimates from regressing the change in return on assets ($\triangle ROA$) from 2004 to 2008 on the change in the share of female directors over the same period. Only firms listed in both 2004 and 2008 are therefore included. Each column represents estimates from a single regression. Variable definitions in Table 4. Column 1 reports the results from the first stage, where I regress changes in the share of female directors on a dummy variable that equals to 1 if the firm did not comply with the quota in 2004, and other variables. The second stage (Column 2 and 3) uses the fitted changes in the share of female directors from the first stage as an explanatory variable. The information index is defined in equation (1). All regressions include indicator variables for industry sectors. Outlier values (as defined in Table 4) are excluded. Robust standard errors (Huber/White/sandwich estimator) reported in parenthesis; stars indicate significance levels: *** 1%, ** 5%, *10%.

The disposition effect and momentum: Evidence from Norwegian household investors

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Abstract

Using a novel investor accounts dataset from Norway, I find that household investors are particularly likely to sell stocks when they experience a capital gain between 0% and 5%. The likelihood of a sale falls quickly both below and above this range; big losses and big gains are equally unlikely to trigger a sale. Thus, the disposition effect is driven by sales close to break-even, rather than a monotonically increasing relation between current capital gain and the likelihood of a sale. I also find that this household investor trading pattern contributes to momentum in small cap stocks.

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Why do investors trade? The standard economic model is concerned with asset prices, with little or no regard to trading activity. Nevertheless, aggregate turnover on European stock markets was 189% in 2007; a total volume of more than EUR 22 trillion.[1] Investors voluntarily pay financial intermediaries billions of Euro to facilitate trading volume of this magnitude.

When investigating investor trading decisions there are good reasons to focus on household investors. First, household investors operate in a different regulatory environment than other investors, and are less constrained to follow particular investment mandates. Therefore, their trading decisions are likely to more directly reflect their personal preferences. Second, when tracking household investors over time we track the same individual. When tracking the investment decisions of institutional investors, for instance a mutual fund, the decision maker in the institution might change over time or there might be several decision makers. The multitude of decision makers further complicates the link between trading decisions and personal preferences, which is more clear for household investors.

In this paper I investigate how the capital gain that a household investor experiences on a stock relates to sell decisions. This focus is motivated by research that documents a so-called "disposition effect": a tendency among household investors to realize gains more readily than losses (Shefrin and Statman, 1985; Odean, 1998; Grinblatt and Keloharju, 2001). It is therefore often assumed that household investors exhibit a monotonically increasing likelihood of selling a stock as their capital gain on the same stock increases; the selling of stocks with big gains could be a rational response to avoid excessive concentration in a portfolio (Odean, 1998; Grinblatt and Han, 2005; Frazzini, 2006; Campbell, 2006). Using a novel investor accounts dataset from Norway, I therefore investigate whether this assumed pattern in the relationship between sell decision and capital gain is borne out by the data. The null hypothesis is that there is no pattern.

I find that household investors are particularly likely to sell stocks when they experience a capital gain between 0% and 5%. The likelihood of a sale falls quickly both below and above this range; big losses and big gains are equally unlikely to trigger a sale. Thus,

[1]Based on data from the Federation of European Securities Exchanges. The total value of equity trading (volume) in 2007 on the 21 member exchanges was EUR 22,171,930 million, from a total market capitalization of EUR 11,752,014 million.

the disposition effect is driven by sales close to break-even, rather than a monotonically increasing relation between the likelihood of a sale and current capital gain.

I then investigate the price impact of this capital gain induced pattern in the trading of household investors. As household investors are particularly likely to liquidate stock close to break-even, if the median household investor has a capital gain close to break-even that would likely generate selling pressure from household investors as a group. If the median household investor experiences a capital loss, then the majority of household investors also experience a capital loss, and household investors as a group would be more likely to hold on to the stocks that they own. This trading pattern, which is caused by capital gains, could result in price continuation for the stocks where household investors represent a relatively large share of ownership. For instance, as good news for a particular stock arrives and other investors who trade on this news buy the stock, the price of the stock increases. As the price then moves into the zone where household investors are induced to realize gains, the resulting selling pressure might dampen the positive price reaction to the good news. Thus, the household investor trading pattern established in this paper could help explain the momentum effect in stock returns, which shows that past intermediate horizon return is positively correlated with future intermediate horizon return (Jegadeesh and Titman, 1993). Stocks with high returns over the past intermediate horizon are likely to have triggered capital gain induced selling pressure from household investors. In that case, as also argued by Grinblatt and Han (2005), the momentum strategy works because past return proxy for the current capital gain experienced by investors who exhibit a disposition effect. Therefore, past intermediate horizon return should not be related to future return when properly controlling for the capital gain currently experienced by these investor.

I want to test the relative impact of momentum versus capital gain induced household investor trading on future returns. I perform Fama and MacBeth (1973) regressions of one week future return on past intermediate horizon return and measures of the current capital gain experienced by the median household investor. I find that with the inclusion of the household investor capital gain measures, past intermediate horizon returns no longer predict future returns for small cap stocks. I do not find a similar relation in large cap stocks, where household investors represent a relatively small share of stock ownership.

Thus, cross sectional differences in the median household investor's capital gain dominates momentum in predicting cross sectional differences in future returns for small cap stocks.

The paper is organized as follows: Section 1 reviews the related literature; section 2 describes the data and offers summary statistics; section 3 reports on household investor trading in relation to capital gain; section 4 relates household investor trading to momentum; and section 5 concludes.

1 Related literature

1.1 Household investor trading

The literature is brimming with stylized facts on how household investors trade in stocks. Incidentally, the majority of these findings point out choices that are hard to reconcile with any standard model. For instance, household investors have poor diversification and own relatively few individual stocks (Blume and Friend, 1975; Kelly, 1995; Polkovnichenko, 2005); have a preference for local or domestic securities (French and Poterba, 1991; Grinblatt and Keloharju, 2001; Seasholes and Zhu, 2010); have large holdings in the stock of their employer and firms in sectors close to their employer (Benartzi, 2001; Doskeland and Hvide, forthcoming); trade so intensively that it hurts their performance (Odean, 1999; Barber and Odean, 2000); and buy attention-grabbing stocks (Barber and Odean, 2008). These results apply to the average household investor and echo the pioneering study of Schlarbaum, Lewellen and Lease (1978), who document that the majority of household investor stock round trips (the gain from purchase to sale) do not beat investments in Treasury bills with the same duration.[2]

Campbell (2006) offers two alternative interpretations of the investment mistakes made by the average household investor. The first alternative is to concede that investors have non-standard preferences, and express these preferences optimally. With this interpreta-

[2]In contrast, some specialized and sophisticated sub-groups of household investors exhibit relatively better results in the stock market. For instance, some top performing active household investors consistently get a better return than would be available from a passive investment in a marked index fund (Che, Norli and Priestley, 2009); high income and well educated household investors have relatively better diversified portfolios (Calvet, Campbell and Sodini, 2007, 2009a,b); and high IQ investors exhibit superior stock picking skills (Grinblatt, Keloharju and Linnainmaa, 2010).

tion, it is therefore useful to document which non-standard model of preferences has support in the data. The second alternative is to consider instead the possibility that household investors may not be able to express their preferences optimally, and that they can be educated to make the choices that maximize household welfare, as prescribed by standard economic theory. The latter interpretation therefore also demands an understanding of the particular behavioral biases that generate these investment mistakes in order to more effectively address these issues when educating investors. Either interpretation, then, demands an investigation of the behavioral biases that account for these investment mistakes.

In this paper I focus on a particularly robust finding among household investors, the so-called "disposition effect". The disposition effect is the tendency among household investors to realize gains more readily than losses (Shefrin and Statman, 1985; Odean, 1998; Grinblatt and Keloharju, 2001). This means that when a household investor sells a stock, that stock is likely to have increased in price since purchase (a gain), whereas he is likely to keep holding on to other stocks in his portfolio that have declined in price since purchase (a loss). Selling gains can be a rational response to avoid excessive concentration in a portfolio, but holding losses is hard to rationalize mainly because realizing these losses would reduce the overall tax bill (Odean, 1998; Campbell, 2006).

What can explain this tendency to trade in relation to current capital gain? One possible explanation is prospect theory (Kahneman and Tversky, 1979). According to prospect theory, investors translate an asset's state-dependent payoffs into gains and losses. The outcomes are then valued with a value function that is concave for gains, convex for losses, and steeper for losses than for gains. Investors that accord with this theory are therefore risk seeking over losses, risk avers over gains, in addition to being loss averse (more sensitive to losses than to gains). Barberis and Xiong (2009) show that a prospect theory investor with rational beliefs exhibits a disposition effect if he cares differently about realized gains and losses than paper gains and losses. For prospect theory to account for a disposition effect in a multi-asset stock market, investors also need to regard each stock they buy as a separate gamble. Thaler (1980, 1999) documents that participants in economic experiments follow such "mental accounting" rules. Thus, investors motivated by prospect theory and mental accounting would exhibit a disposition effect.[3]

[3] An alternative explanation for why household investors exhibit a disposition effect is that these investors

Kyle, Ou-Yang and Xiong (2006) model the liquidation decision of a prospect theory investor in more detail and show that such an investor will not only exhibit a disposition effect, but also have a tendency to liquidate at break-even. The convexity in the investor's value function over losses tends to induce delayed liquidation when experiencing a loss, whereas the loss aversion makes the investor more risk averse close to beak-even thereby inducing liquidation near this point. This theoretical prediction of a tendency to liquidate close to break-even seems to run counter to the standard interpretation of the disposition effect, where researchers assume a monotonically increasing relation between the likelihood of a sale and current capital gain (Odean, 1998; Grinblatt and Han, 2005; Frazzini, 2006; Campbell, 2006).[4] One reason why this interpretation has taken hold is because the standard way to measure the disposition effect only looks at days when a sell decision is made. Moreover, the size of the gain or loss is not taken into account; all that matters in the computation is whether the capital gain is positive or negative.

The exact relation between the sell decision of household investors and capital gain is therefore an unanswered empirical question that demands high quality investor accounts data. In this paper, I therefore investigate the relation between sell decisions and capital gains using a novel dataset from the entire population of household investors at a national exchange.

1.2 The price impact of household investor trading

To the extent that there are traces of particular behavioral biases in the trading of household investors, a critical question is whether these biases are merely peculiar idiosyncrasies that cancel each other out on average, or whether the biases have any impact on prices. We know from Kyle (1985) that if a group of investors trade based on random demand shocks,

hold an irrational belief in mean reversion. Weber and Camerer (1998) find that participants in an economic experiment with a hypothetical stock market at first exhibit a disposition effect. But when automatic selling is introduced after each trade period, the participants did not systematically re-purchase losing stocks, which they would have done with a strong belief in mean reversion. The disposition effect is thereby greatly reduced. Therefore, a belief in mean reversion does not seem to account for the disposition effect.

[4]This assumption seems confirmed by Seru, Shumway and Stoffman (2010) who document a positive relation between capital gains and the likelihood of a sale among Finnish household investors. However, Seru et al. (2010) only investigate highly active and sophisticated investors, 3.7% of the household investors in their sample. Such investors are likely to differ markedly from the average household investor.

then they will have no impact on prices. However, Barber, Odean and Zhu (2009) show that the trades of household investors are highly correlated, and argue that behavioral biases common to these investors act as coordination mechanisms. If household investors are coordinated through exhibiting preferences consistent with prospect theory, what would be the impact on the market?

Grinblatt and Han (2005) build an model where a rational investor with limits to arbitrage and a biased investor with demand distortions from his current capital gain interact in the market for a stock. They find that the influence of the biased investor shows up as predictable stock-price continuation over the intermediate horizon. They then test to see if this relation can help explain the momentum effect, which shows that past intermediate horizon return is positively correlated with future intermediate horizon return (Jegadeesh and Titman, 1993). They perform Fama and MacBeth (1973) regressions of one week future return on past intermediate horizon return and a proxy for the average unrealized capital gain (past market prices weighted by past turnover). They find that with the inclusion of the capital gain proxy, the momentum effect largely disappears.

In this paper, I revisit the setup of Grinblatt and Han (2005) to test the relative impact of momentum and capital gain induced household investor trading on future returns, but with a direct measure of median household investor capital gains rather than a proxy.

2 Data and summary statistics

In this paper, I investigate household investor trading on the Oslo Stock Exchange (OSE) from 2002 to 2007. OSE has been in operation for almost 200 years (established in 1819). At the end of December 2007, OSE ranked 8^{th} out of 21 European stock markets based on market capitalization, 12^{th} based on the number of listed firms, and 5^{th} in terms of turnover. Thus, OSE is a mature and liquid market, and therefore a useful laboratory to study investor behavior. The appendix offers summary statistics from OSE for the years 2001 to 2008. Data from the OSE used in the analysis (prices, including split/reverse split and dividend adjustments, volume, and indexes) are from the Stock Exchange database at the Norwegian School of Economics and Business Administration (NHH).

Investor accounts data are from Norwegian Central Securities Depository ("Verdipapir-

sentralen", VPS). I use the daily transactions on investor accounts in VPS from 2002 to 2007. For my purpose, it is important to note that VPS was introduced through legislation in 1985 and is the only company with a license to run a securities depository for Norwegian securities. Therefore, the aggregate holdings of OSE registered stocks in VPS investor accounts is equivalent to the universe of stocks registered at the OSE. VPS thereby accounts for who owns each of these stocks on any day. In addition, I have data on holdings as of the last trading day in 2001. Finally, the data allows me to distinguish between different groups of investors. Investors can be aggregated into the following categories: households, non-profit institutions, general government, finance and insurance institutions, non-financial corporations, and foreign investors. Thus, my dataset from Norway is comparable to that from Finland introduced by Grinblatt and Keloharju (2000). Though the data covers all investors on OSE, I focus on household investors in this paper. In the appendix I give an overview of the Norwegian tax system for stock ownership. I show that realizing losses will reduce the overall tax bill for Norwegian household investors throughout my sample period, as it does for the US investors investigated by Odean (1998).

2.1 Summary statistics

Table 1 shows the ownership share of OSE market value by investor category. This is based on the data file on holdings, which reports the number of stocks held in each investor account in each stock at the end of 2001. Ownership shares are reported for all stocks, and separately for large cap and small cap stocks. Small cap stocks are defined as firms with a market value below the median valued firm on the exchange at the end of 2001; the remaining stocks are classified as large cap stocks. Though small cap stocks thereby make up half the number of stocks, they only represent 2.6% of OSE total market value. We see that household investors exhibit a relatively small share of ownership in large cap stocks, but a relatively large share of the ownership in small cap stocks. An artifact of the Norwegian securities market is the large government ownership, at 37.8% of total OSE market value. This is a result of relatively large holdings in a few large firms, rather than a general governmental involvement, which is evident from government ownership representing only 1% of the market value in small cap stocks.

The dataset is obviously large with millions of observations, and I include two filters. First, since I do not know the purchase prices for shares purchased before 2002, investor-stock pairs in the holding file as of year-end 2001 are excluded from the analysis. Second, I exclude stocks that experienced split/reverse split over the sample period.[5] Although the sample is reduced through these filters, it is difficult to find a reason why it should bias the results in any particular direction. Also, pure day-traders are excluded from the analysis by netting positions each day. If an investor first buys and then sells 100 shares in the same firm during the same trading day, then his position change on that day is zero, and neither of these transactions is therefore included. Each observation includes the date, volume (positive if buy, and negative if sell), transaction price (from 2002 brokers were required to include the transaction price when reporting to VPS), age and gender.

Table 2 offers summary statistics of the household investors in my dataset. Panel A includes all investors in the holding file at the end of 2001. We see that the average portfolio is worth NOK 128,157 (then equivalent to USD 14,000), and consists of 1.9 different stocks. The average household investor is 51.7 years old; 33% are women. There are 380,833 unique household investors in the holding file. In the analysis I use the transactions data from 2002 to 2007. In these data there are 477,588 unique household investors. Through the data exclusion filters, the transactions data used in the analysis covers 170,225 unique household investors, or 35.6%. Panel B reports summary statistics on these investors based on all non-zero positions at the end of 2007. Compared to the investors in the holding file in 2001 the investors that enter the analysis have similar diversification (number of stocks) and age. There are fewer women, 23% compared to 33%, and the average portfolio has a higher nominal value (NOK 260,147, then equivalent to USD 48,000). Thus, the household investors covered by the analysis are largely representative of the household investors that operate on OSE. Their characteristics are also in line with those reported for the average household investor in comparable studies (Che et al., 2009; Seru et al., 2010; Doskeland

[5]Grinblatt and Keloharju (2001) take account of pre-transaction data holdings by including transactions in these investor-stock pairs only after such holdings are sold. However, this requires the use of two different inventory principles: first-in-first-out (FIFO) until the pre-transaction data holdings are sold, and then volume weighted basis thereafter. I choose instead to exclude these investor-stock pairs to consistently use the volume weighted basis inventory principle. Stock split/reverse split are accounted for in the VPS data with a delay. To avoid the dramatic capital gain effects that any inconsistencies that split/reverse split would have on the results, stocks that experience split/reverse split over the sample period are excluded.

and Hvide, forthcoming).

3 Household investor sales and capital gains

The traditional way to measure the disposition effect only looks at days when a sell decision is made. Moreover, the size of the gain or loss is not taken into account: all that matters is whether the capital gain experienced on the position is positive or negative. In the appendix I confirm that the household investors in my sample exhibit a disposition effect using the traditional method for measuring this effect. Instead of this traditional method, I want to investigate the capital gain experienced every day from the time a household investor buys a stock until the day he sells it. This enables me to determine whether any particular capital gains tend to trigger sales for household investors.

First, I calculate the volume weighted basis on each position for each household investor from the time he first enters a position until each sell decision. I use the actual purchase prices to update the volume weighted basis. For instance, if an investor initially purchased 100 shares at price NOK 100, and then subsequently 200 shares at NOK 400, his total holding is now 300 shares at a basis of NOK 300: $(100 \times 100 + 200 \times 400)/300 = 300$.

I then find the capital gain experienced every day over the full duration of the holding period. I use the daily market close price to calculate the capital gain on days without trade in an existing position. I use the actual sell price to calculate the capital gain at each sell decision. Each observation is then either a sale (partial or complete liquidation of a position), or a hold, and I know the capital gain on each of the observations.

Next, I group observations into capital gain intervals:

$$\ldots, [-2,-1), [-1,0), [0,1), [1,2), [2,3), \ldots \quad .$$

All observations are then aggregated to find the estimated likelihood of a sale relative to continued hold, given the interval of the concurrent capital gain from $a\%$ to $b\%$, i.e.

$$p_{[a,b)} = \frac{\text{Sales}}{\text{Sales + Holds}}\Bigg|[a,b)$$

Figure 1 shows this estimated likelihood of a sale for capital gains between -50% and +50%. We see that there is a jump in the likelihood of a sale from capital gains in the range $[-1, 0)$ to capital gains in the range $[0, 1)$. The likelihood of a sale then increases slightly from $[0, 1)$ to $[1, 2)$; falling thereafter, especially after $[4, 5)$. These findings point to two relations in the trading pattern of household investors. First, household investors are particularly likely to sell stocks when experiencing a capital gain close to break-even, specifically in the capital gain range $[0, 5)$. Second, both big losses and big gains have a small likelihood of triggering a sale.

On the first relation, I test the hypothesis that the likelihood of a sale in a particular capital gain range $[a, b)$, is equal to the likelihood of sale in the capital gain range $[0, 1)$. This means I am testing the following hypothesis

$$\begin{aligned} H_0: &\quad p_{[0,1)} = p_{[a,b)} \\ H_1: &\quad p_{[0,1)} \neq p_{[a,b)}. \end{aligned}$$

I perform this test for each of the capital gain ranges. Figure 2 gives the resulting Z-value for each capital gain range, and details on the calculation of the test statistic.

As the number of observations is very large, small differences in these likelihoods could be statistically significant at standard levels. I therefore set the level of significance for these tests at the stricter level of 0.1%. My setup involves testing multiple comparisons, and I need to adjust the significance level accordingly. There are 100 different groups (the different capital gain ranges), which offers $100 \times (100 - 1)/2 = 4,950$ possible pairwise comparisons. Applying the Bonferroni adjustment on my two-sided test at 0.1% significance, the level of significance that each of these hypothesis tests needs to pass is therefore $0.05\%/4,950 = 1/9,900,000$. This gives a critical Z-value of ± 5.2. From Figure 2, we see that for all capital ranges below zero, the likelihood of a sale is significantly smaller than that in $[0, 1)$. Compared to $[0, 1)$, the likelihood of a sale is significantly higher in both the capital gain ranges $[1, 2)$ and $[2, 3)$. The likelihood of a sale in the capital gain ranges $[3, 4)$ and $[4, 5)$ is not significantly different from that in $[0, 1)$. All capital gains greater than 5% are significantly less likely to trigger a sale compared to capital gains in the range $[0, 1)$. Thus, household investors are particularly likely to sell stocks when experiencing a capital

gain close to break-even, specifically a capital gain between 0% and 5%.

To investigate the second relation, I test the hypothesis that the likelihood of a sale in a capital gain range $[a, b)$ above $[0, 1)$ is equal to the corresponding capital gain range $[c, d)$ below $[0, 1)$. For instance, I compare $p_{[1,2)}$ to $p_{[-1,0)}$, and $p_{[2,3)}$ to $p_{[-2,-1)}$, and so on. Figure 3 gives the results, and details regarding the calculation of the test statistic. We see that household investors are more likely to sell stocks when they experience a capital gain close to break-even then they are to sell at a comparable capital loss. However, as capital gains increase in size, the likelihood of a sale decreases, and approaches the low probability of a sale at correspondingly large capital losses. Thus, household investors are particularly likely to sell stocks when experiencing a capital gain close to break-even, and big losses and big gains are equally unlikely to trigger a sale.

Thus, the disposition effect is driven by sales close to break-even, rather than a monotonically increasing relation between current capital gain and the likelihood of a sale. The household investor trading pattern established in this paper is also consistent with the theoretical prediction of liquidation decisions by an investor motivated by prospect theory as shown by (Kyle et al., 2006).

4 Household investor trading and momentum

In this section I investigate the price impact of the household investor trading pattern established in this paper. As household investors are particularly likely to liquidate stock close to break-even, if the median household investor has a capital gain close to break-even this would likely to induce a selling pressure from household investors as a group. If the median household investor experiences a capital loss, then the majority of household investors experience a capital loss, and household investors as a group would be more likely to hold on to the stocks that they own. This trading pattern, which is caused by capital gain, could result in price continuation in the stocks where household investors represent a relatively large share of ownership. For instance, as good news for a particular stock arrives and other investors who trade on this news buy the stock, the price of the stock increases. As the price moves into the zone where household investors are induces to realize gains, the resulting selling pressure might dampen the positive price reaction to the good

news. Thus, the household trading pattern established in this paper could help explain the momentum effect in stock returns, which shows that past intermediate horizon return is positively correlated with future intermediate horizon return (Jegadeesh and Titman, 1993). In the appendix I verify that the returns to the momentum strategy on OSE over my sample period are consistent with those reported from the US and elsewhere.

I want to test the relative impact of momentum and capital gain induced household investor trading on future returns. I perform Fama and MacBeth (1973) regressions of one week future return on past intermediate horizon return and measures of the current capital gain experienced by the median household investor; controlling for short and long term horizon returns, size and turnover. This setup is reminiscent of Grinblatt and Han (2005) who instead use past prices weighted by past turnover as a proxy for average current capital gain.

Thus, each week t I am interested in the following cross-sectional relationship, where I have suppressed superscripts for stock j

$$r_{t,t+1} = \alpha + \beta_1 r_{t-4:t} + \beta_2 r_{t-52:t-4} + \beta_3 r_{t-156:t-52} + \beta_4 \bar{V}_t + \beta_5 s_t + \beta_6 g_t + \beta_7 |g|_t + \beta_8 \Big[g_t \times |g|_t \Big] + \epsilon_{t,t+1}.$$

The one week future return of stock j, $r^j_{t:t+1}$, is the dependent variable. Similarly, past cumulative returns from week $t - t_2$ to week $t - t_1$ are denoted by $r^j_{t-t_2:t-t_1}$. Momentum is captured by returns over the previous year excluding the past month $r_{t-52:t-4}$, following the documented effect in Jegadeesh and Titman (1993). In addition, I need a measure of the capital gain on current holdings by household investors in each stock. I calculate this measure by first finding the holding weighted median basis among household investors with holdings in the stock as of week t; B^j_t. This median basis is then held against the current market price. Following Grinblatt and Han (2005), I lag the market price P^j_t one week to avoid confounding market microstructure effects, such as bid-ask bounce. The current capital gain at the end of week t is then

$$g^j_t = ln(P^j_{t-1}/B^j_t) \quad . \tag{1}$$

To account for household investors' propensity to liquidate around break-even, I also include

the absolute value of current capital gain, $|g|_t^j$, in addition to an interaction term with capital gain and absolute capital gain, $\left[g_t^j \times |g|_t^j\right]$.

I also add controls for other variables known be to related to cross sectional differences in future returns. I include controls for the short horizon ($r_{t-4:t}$) and long horizon ($r_{t-156:t-52}$) past return patterns found in Jegadeesh (1990) and DeBondt and Thaler (1985), respectively. As control for the return premium effect of firm size (Fama and French, 1993), I include the regressor s_t^j, which is the logarithm of firm j's market capitalization at the end of week t. In addition, I control for possible return effects from differences in volume (Lee and Swaminathan, 2000; Gervais, Kaniel and Mingelgrin, 2001) by including the regressor

$$\bar{V}_t^j = \frac{1}{52}\sum_{i=0}^{51} \frac{\text{number of shares traded}_{t-i}^j}{\text{total number of shares outstanding}_{t-i}^j} \quad , \tag{2}$$

which is stock j's average weekly turnover the 52 weeks prior to, and including, week t.

I have transaction data from 2002 to 2007, and I run regressions starting in 2003 to allow a relevant basis to develop. I also perform separate regressions for weeks in the months February to November. This is motivated by the seasonality in the momentum effect noted in Jegadeesh and Titman (1993), the much stronger disposition effect in months other than January (Odean, 1998), and that household investors engage in tax motivated trading in December and January not seen in the rest of the year (Grinblatt and Keloharju, 2004).

Table 3 gives the results: Panel A covers small cap and Panel B large cap stocks. Small cap stocks are defined as the firms with a market capitalization below the median valued firm on the exchange each week; the remaining stocks are classified as large cap stocks. In Panel A, when the household capital gain measures are excluded, we see evidence of momentum in stock returns (positive β_2). When I include the measures of household capital gain β_2 is no longer significant: The momentum effect largely disappears. The capital gain of the median household investor is positively related to future returns (positive and significant β_6). This means that when the median household investor experiences a capital gain, this is associated with positive future returns, whereas a capital loss is associated with negative future returns. The absolute value of capital gain enters with a negative coefficient (β_7). Thus, although there is a positive relation between current household capital gains and future stock returns, for capital gains this relationship is strongest near break-even.

For capital losses this relation increases with the size of the loss.

The same pattern is not found in Panel B where I investigate large cap stocks. With the inclusion of the household investor capital gains measures, β_2, measuring the momentum effect, is only marginally reduced. In addition, β_6 and β_7, which capture the impact of household investors, are both small and insignificant. That household investors may impact prices in small cap but not in large cap stocks is not surprising given that they represent a relatively small share of ownership in large cap stock (see Table 1). Thus, cross sectional differences in the median household investor's capital gain dominates momentum in predicting cross sectional differences in future returns for small cap stocks, but not for large cap stocks.

5 Conclusion

I wish to suggest a causal relation from capital gain induced household investors trading to momentum in stock return. By holding losing stocks and selling at a pre-determined capital gain target (break-even), household investors contribute to prices reacting more slowly to news; generating price continuation. Limits to arbitrage prevent rational investors from immediately wiping out this pattern (Shleifer and Vishny, 1997; Liu and Longstaff, 2004; Grinblatt and Han, 2005), and the result is momentum in the stock returns of small cap stocks where household investors represent a relatively large share of the ownership. Thus, rather than random noise with no impact on prices (Kyle, 1985), household investors constitute systematic noise contributing to the momentum effect in small cap stocks.

Fama and French (2008) find that momentum is a persistent phenomenon, not only in small cap stocks but also in large cap stocks. If household investors generate momentum in small cap stocks only, how can we explain momentum in large cap stocks? In a complementary study, Lou (2009) finds that net capital flows to mutual funds, and the corresponding scaling up or down of mutual fund holdings, explain momentum in large cap stocks. Mutual funds often have investment mandates that preclude them from investing in stocks other than large cap stocks. Thus, the investment decisions of household investors, either directly through stock ownership or indirectly through mutual fund investments, are intrinsically linked to the momentum effect.

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6 APPENDIX A: Tax system in Norway

In Odean (1998) the disposition effect is held against the fact that realizing losses would reduce the investor's overall tax-bill. How relevant is this normative ideal for Norwegian household investors? There were two major tax reforms over my sample period (2002-2007). A reform in 2004 affected company ownership of stocks, and a reform in 2006 affected individual ownership of stocks. Prior these reforms, all stock owners were taxed under the same tax system. In this section, I first outline the basics of each of the three tax systems, and then discuss the relevance of these tax considerations for my study. Much of the following discussion is based on Brudvik (2005). I find that realizing losses would reduce the overall tax bill for Norwegian household investors throughout my sample period, as it does for the US investors investigated by Odean (1998).

6.1 Remuneration and RISK methods of 1992

In 1992, a new tax system for shareholders introduced the Remuneration and RISK methods ("Godtgjorelsesmetoden" and "Regulering av inngangsverdien med skattelagt kapital"). This system applied to all shareholders.

The Remuneration method meant that shareholders did not pay tax on dividends received. Technically, this was accomplished in two steps. First, dividend was classified as capital income and taxed at the flat rate 28% at the shareholder level. The shareholder then received an identical tax deduction, which exactly off-set the tax on dividend received.

The RISK method was introduced to avoid double taxation on retained earnings (firm profits not paid out as dividend). The rationale was that when a company retained earnings, the added equity would lead to an increase in the share price. As the company had already paid tax on the new capital, the shareholder's capital gain should be adjusted for the associated increase in the share price. Each year the firm calculated earnings net of dividends and taxes to find the total RISK amount for that firm.

As long as the firm retained a share of earnings, the RISK amount that year would be positive. A negative RISK amount would result if taxes and dividend were higher than earnings, for instance if the firm paid out dividend out of retained earnings in previous years. If the firm paid out all earnings as dividends each year the RISK amount would be

zero.

Dividing the total RISK amount by the number of stocks in the company gave the RISK amount per stock for that year. The person that owned a stock on the 31^{st} December each year accumulated these RISK amounts. When the owner sold a stock for which he had accumulated RISK amounts, the sum of these RISK amounts was tax deductible. To illustrate, let an investor buy a stock for 200 and sell at 100. Over the holding period the investor has accumulated the RISK amount 10 for this stock. The investor's capital gain is $100 - 200 = -100$. His capital gain for tax purposes is $100 - (200 + 10) = -110$.

6.2 Exemption method of 2004

In 2004, the Exemption method ("Fritaksmetoden") for taxation of company ownership of stocks was introduced. Companies that own stock are now tax neutral. This means that they receive dividends tax free, are no longer subject to tax on capital gains, and may no longer deduct capital losses from taxable income.

In 2008 this new system for company shareholders was amended such that 3% of the payments received (dividend and capital gains) is defined as taxable income. This new tax was introduced to off-set the fact that companies can deduct from other taxable income the costs associated with the tax-free income from stock ownership (though not the costs directly associated with the actual buying and selling of stocks).

6.3 Shielding method of 2006

Since 2006, individual ownership of stocks has been taxed according to the Shielding method ("Skjermingsmetoden"). Individual investors now pay tax on dividend (they no longer receive an identical tax deduction, as they did under the Remuneration method), and the RISK method was stopped. Accumulated RISK amounts on stocks purchased before 1^{st} January 2006 are still deductible. After that date, an individual investor instead accumulates a "risk free amount", which is shielded from taxation. The risk free amount corresponds to the return on a three month government bond, and is allocated to the person who owns the stock on 31^{st} December each year. This risk free amount is deducted from dividends received, thereby reducing the tax payment. Any surplus risk free amount is then accu-

mulated and can be used against dividend payments in later years, or to reduce the tax bill from a capital gain at realization. The accumulated surplus risk free amount is each year added to the purchase value of holdings in each stock to calculate that year's risk free amount for that stock.

If the person sells at a loss, he loses the accumulated surplus risk free amount. The accumulated surplus risk free amount can only be used to reduce the capital gain to zero. To illustrate, let an investor buy a stock for 200 before 1^{st} January 2006, and sell at 100 after that date. Over the holding period the investor has accumulated RISK amounts of 10, up to 1^{st} January 2006. From that date and up to the day he sold the stock he accumulated a surplus risk free amount of 10. The investor's capital gain is $100 - 200 = -100$. His capital gain for tax purposes is $100 - (200 + 10) = -110$. Since he sells at a loss he is unable to use his accumulated surplus risk free amount.

6.4 Discussion

In my analysis, household investors use the volume weighted basis from the actual purchase prices as their reference point to calculate capital gains and losses. This accords with the regulatory treatment of capital gains, though additional tax credits are available through the RISK method prior to 2006 and the Shielding method from 2006. Realizing losses would reduce the overall tax bill of household investors under both of these tax systems. The Exemption method, introduced for company shareholders in 2004, may have offered an incentive for sophisticated household investors to organize their trading as a limited liability company in order to avoid taxation. However, it is difficult to control for this issue, other than by focusing on household investors, which I have done throughout my analysis.

7 APPENDIX B: Summary statistics from OSE

Table 4 offers key figures on the Oslo Stock Exchange (OSE) for the years 2001 to 2008, one year before the start and one year after the end of my investor accounts data. Following a drop in the benchmark index value in 2001 and 2002, the index increases in value each subsequent year up to 2007. At the end of 2007 the market value of all firms listed on the exchange was NOK 2,157 billion (then equivalent to USD 400 billion). From the end of 2007 to the end of 2008, this market value was more than halved. The number of transactions increased substantially over the period, whereas the number of firms listed at the end of the year was fairly stable with an average of 212 firms.

8 APPENDIX C: The disposition effect

In this section I investigate whether the household investors in my dataset exhibit a dispostion effect similarly to that found in US household investors first reported by Odean (1998); I follow his measurement procedure. This is important because the high probability of selling around break-even goes against the generally held intuition that the disposition effect is driven by a monotonically increasing relation between capital gains and the likelihood of a sale (Odean, 1998; Campbell, 2006; Grinblatt and Han, 2005; Frazzini, 2006). If the household investors in my sample do not also exhibit a disposition effect, the tendency to liquidate around break-even could be an aspect of Norwegian household investors in my sample, rather than a trait common to household investors.

I compare the aggregate proportion of losses realized (PLR) to the aggregate proportion of gains realized (PGR).

$$PLR = \frac{\text{Realized losses}}{\text{Realized losses} + \text{Paper losses}}; \quad PGR = \frac{\text{Realized gains}}{\text{Realized gains} + \text{Paper gains}} \tag{3}$$

First, I determine whether the sale decisions are realized losses or gains. Then, for each of these sale decisions, I classify the other stocks in the portfolio of that household investor on that day as paper losses or paper gains. Table 5 shows that PGR is significantly greater than PLR over the entire year, and in the months January through November, but much less so in December. This is in line with the disposition effect reported in Odean (1998). Thus, the Norwegian household investors in my dataset exhibit a disposition effect similar to that reported for other datasets on household investor trading.

9 APPENDIX D: Momentum strategy on OSE

This section investigates the returns to a momentum strategy on OSE. There is evidence of persistent momentum returns in the US and in other developed countries around the world (Jegadeesh and Titman, 1993; Rouwenhorst, 1998). However, it is important to verify that the momentum strategy holds at the OSE for the sample period investigated in this paper. I follow the "event time" procedure (Jegadeesh and Titman, 1993, p84), and I also adjust the raw momentum returns for market and size risks (Rouwenhorst, 1998, p280). I find that the pattern of momentum returns at the OSE over the sample period are consistent with those reported by Jegadeesh and Titman (1993) and Rouwenhorst (1998).

Each month t from 1999 to 2008, I rank stocks based on their cumulative return for the past 12 months. The 20% of stocks with the lowest cumulative past return is the "loser" group; the top 20% is the "winner" group. I then calculate the equal weighted portfolio return for each of these two groups in each of the subsequent 24 months. The return to the momentum strategy, which buys the winner portfolio and sells the loser portfolio, is then the return of the winner portfolio minus the return of the loser portfolio in each month.

These raw excess returns are then held against two common risk factors: a market factor $(R_{m,t} - R_{f,t})$ and a size factor (SB_t). See Table 6 for variable definitions. Thus, at k months following each of the portfolio formation dates t over the sample period, I estimate the regression

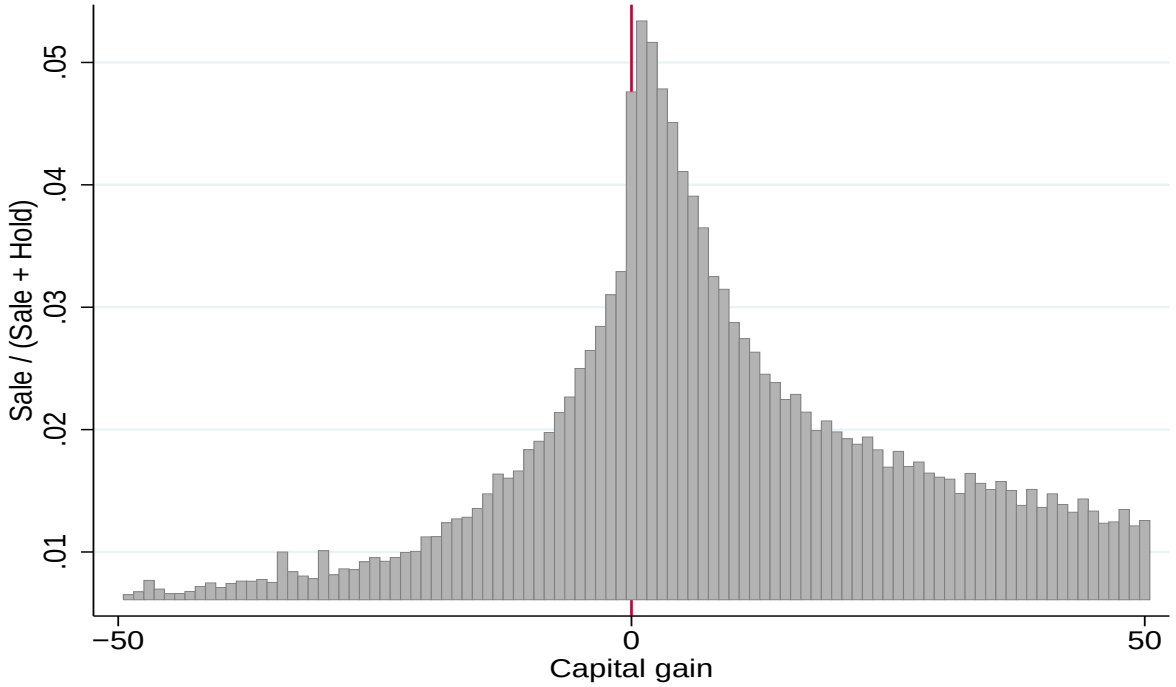
$$W_{k,t} - L_{k,t} = \alpha_k + \beta_k[R_{m,t} - R_{f,t}] + \gamma_k SB_t + \epsilon_{k,t},$$

where W_k is the return to the winner portfolio k months after portfolio formation; L_k is the return to the loser portfolio k months after portfolio formation. The risk adjusted trading profits to the momentum strategy in the k^{th} month after the portfolio formation is then the resulting α_k from this regression.

Table 6 reports the results: Column 2 the mean raw returns to the momentum strategy; Column 4 the risk adjusted returns. We see positive and significant returns to the momentum strategy up to about six months after portfolio formation, followed by a reversal in returns from about 18 months after portfolio formation. The return to the momentum strategy on the OSE over the sample period is thus largely in line with those reported

by Jegadeesh and Titman (1993) for the US, and Rouwenhorst (1998) for several stock markets around the world. Table 7 confirms that momentum returns persist at the OSE when I exclude firms with a market cap below the 20^{th} percentile or a share price below NOK 10 (approx. USD 2).

FIGURE 1: THE LIKELIHOOD OF A SALE RELATIVE TO CONTINUED HOLD, GIVEN CURRENT CAPITAL GAIN



Notes: The figure plots the estimated likelihood of a sale relative to continued hold given the current capital gain, aggregating over all stocks, all days and all household investors. First, I calculate the volume weighted basis on each position for each household investor from the time he first enters a position until each sell decision. I use the actual purchase prices to update the volume weighted basis. I find the capital gain at each sell decision from the actual sell price, and the capital gain on days without trade in an existing position from the daily market close price. Each observation is then either a sale (partial or complete liquidation of a position), or a hold, and I know the capital gain on each observation. All observations are grouped into capital gain intervals:

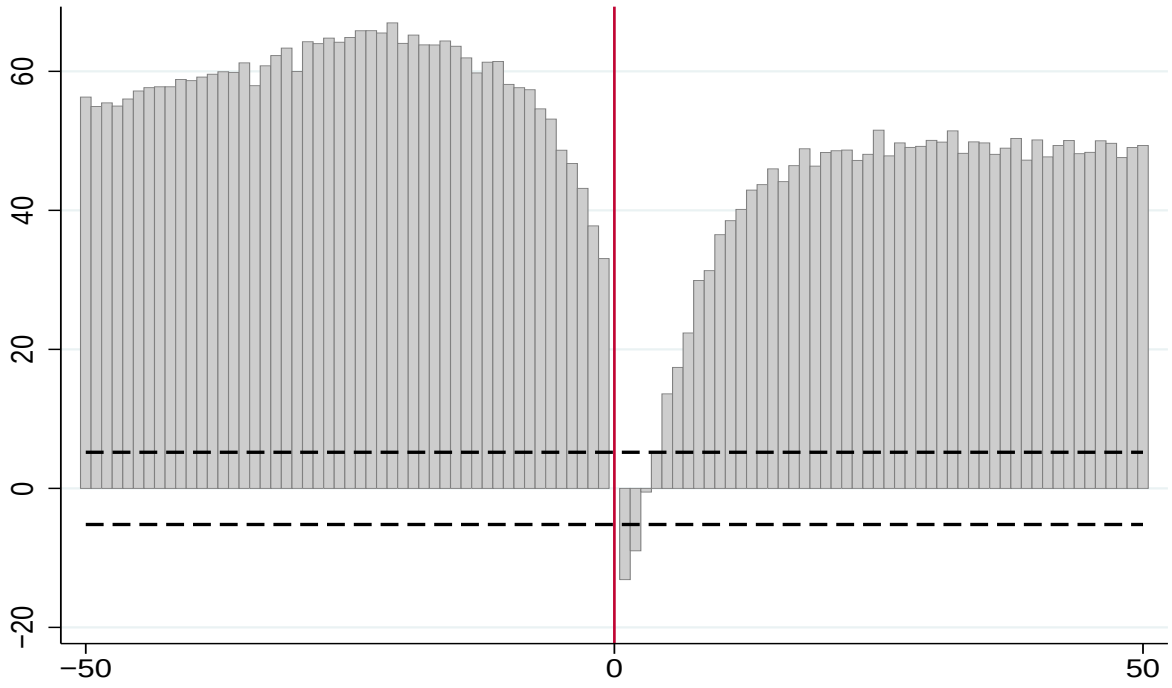
$$\ldots, [-2,-1), [-1,0), [0,1), [1,2), [2,3), \ldots \quad .$$

I then aggregate all observations to find the likelihood of a sale versus continued hold, given the interval of the concurrent capital gain from $a\%$ to $b\%$, i.e.

$$p_{[a,b)} = \frac{\text{Sales}}{\text{Sales + Holds}}\Bigg|[a,b)$$

Pure day-traders are excluded from the analysis by netting positions each day. I exclude investor-stock pairs for which I do not know the purchase price (holdings as of year-end 2001), and stocks that experience split/reverse split over the sample period.

FIGURE 2: Z-VALUES FROM TESTING THE DIFFERENCE IN LIKELIHOOD OF A SALE IN CAPITAL GAIN RANGES [A,B) VERSUS THAT IN [0,1)



Notes: The figure plots the Z-values from testing the difference in the estimated likelihood of a sale in the capital gain range $[a, b)$ versus that in $[0, 1)$. Thus, I perform a standard Z-test comparing the binomial probability of two groups. The test statistics is thereby

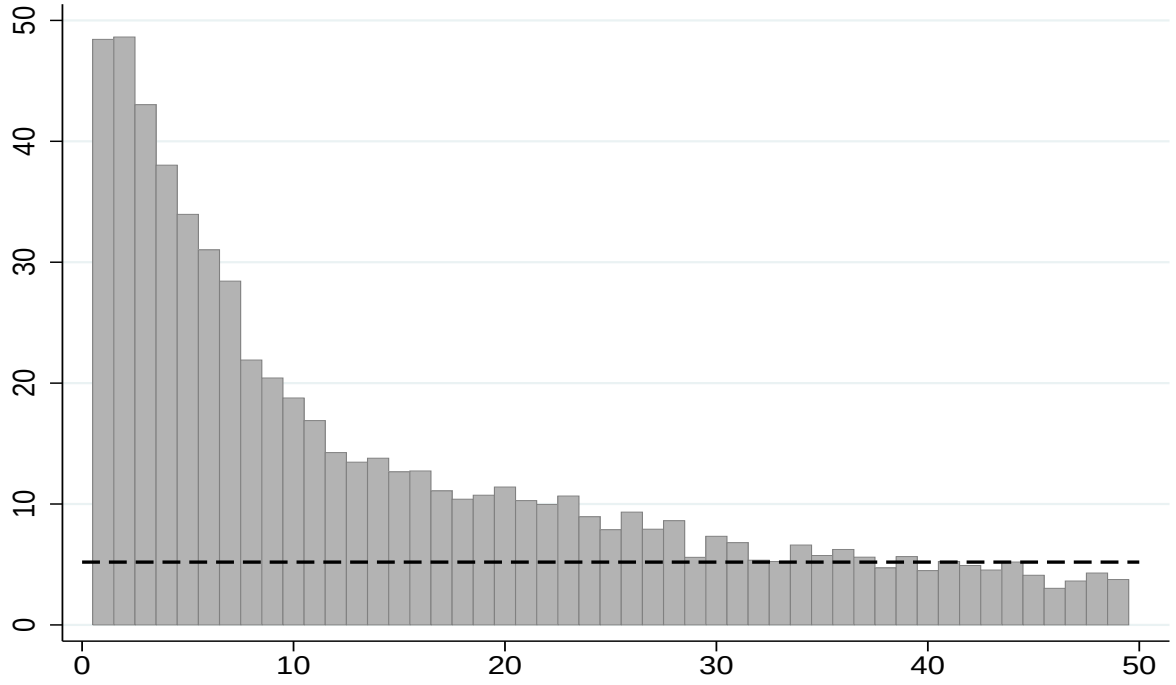
$$Z = (p_{[0,1)} - p_{[a,b)}) \Bigg/ \sqrt{\left(\frac{1}{(Sales + Holds)_{[0,1)}} + \frac{1}{Sales + Holds_{[a,b)}} \right) p(1-p)} \quad ,$$

where

$$p = \frac{Sales_{[0,1)} + Sales_{[a,b)}}{(Sales + Holds)_{[0,1)} + (Sales + Holds)_{[a,b)}}.$$

Under the null hypothesis, Z will be approximately standard normal. See Figure 1 for details on the calculation of the likelihood of a sale in each capital gain range. Dashed horizontal lines give the critical Z-value= ± 5.197 for each test. This value follows from a Bonferroni adjustment of a two-sided test with 0.1% level of significance for pairwise comparisons of 100 different groups. 100 groups offer $100 \times (100 - 1)/2 = 4,950$ pairwise comparisons, and the level of significance that each of these hypothesis tests need to pass is therefore $0.05\%/4,950 = 1/9,900,000$.

FIGURE 3: Z-VALUES FROM TESTING THE DIFFERENCE IN LIKELIHOOD OF A SALE IN CAPITAL GAIN RANGE [A,B) ABOVE [0,1), AND THE CORRESPONDING CAPITAL GAIN RANGE [C,D) BELOW [0,1)



Notes: The figure plots the Z-values from testing the difference in the estimated likelihood of a sale in capital gain range $[a, b)$ above $[0, 1)$ and the corresponding capital gain range $[c, d)$ below $[0, 1)$. Thus, I perform a standard Z-test comparing the binomial probability of two groups. The test statistic is thereby

$$Z = (p_{[a,b)} - p_{[c,d)}) \Bigg/ \sqrt{\left(\frac{1}{(Sales + Holds)_{[a,b)}} + \frac{1}{Sales + Holds_{[c,d)}}\right) p(1-p)} \quad ,$$

where

$$p = \frac{Sales_{[a,b)} + Sales_{[c,d)}}{(Sales + Holds)_{[a,b)} + (Sales + Holds)_{[c,d)}}.$$

For instance, I compare $p_{[1,2)}$ to $p_{[-1,0)}$, and $p_{[2,3)}$ to $p_{[-2,-1)}$, and so on. Under the null hypothesis, Z will be approximately standard normal. See Figure 1 for details on the calculation of the likelihood of a sale in each capital gain range, and the critical Z-value=$\pm$5.197, which is represented by the dashed horizontal line in the figure.

Table 1: Percentage ownership share of Oslo Stock Exchange by investor category, December 2001

Investor category	All stocks	Large cap stocks	Small cap stocks
Household	7.5	6.9	28.6
General government	37.8	38.8	1.1
Financial institution	11.3	11.2	14.2
Non-financial institution	15.2	14.5	43.3
Non-profit institution	0.3	0.3	0.4
Foreign institution	27.8	28.2	12.2
Unknown sector	0.1	0.1	0.3

Notes: The table reports the ownership share of Oslo Stocks Exchange market value by investor category. Ownership shares are reported for all stocks, and separately for large cap and small cap stocks. Small cap stocks are defined as the firms with a market value below the median valued firm on the exchange at the end of 2001; the remaining firms are large cap stocks. The value of each investor category's holding is calculated by pricing the aggregate holding of each investor category in each stock by the last available stock price quote in December 2001. Share of market value for all stocks, large cap and small cap stocks, are then calculated from the aggregate value of each investor category's holdings relative to the total value. Small cap stocks make up 2.6% of the total market value on the Oslo Stocks Exchange, but half the number of stocks.

Table 2: Summary statistics, household investors

	Mean	St.Dev.	Median	5%	95%	N
Panel A: All investors, 2001						
Value of stock portfolio	128,157	9,395,832	13,775	165	305,503	380,833
Diversification (number of stocks)	1.9	2.3	1	1	5	380,833
Age	51.7	17.6	52	24	81	380,222
Gender (female = 1)	0.33					380,222
Panel B: All investors with known basis, 2007						
Value of stock portfolio	260,147	2,511,794	42,500	1,140	843,750	108,719
Diversification (number of stocks)	2.0	2.2	1	1	6	108,719
Age	48.5	16.2	48	24	76	108,352
Gender (female = 1)	0.23					108,352

Notes: The table reports summary statistics of household investors. Panel A reports on all household investors in the holding file at the end of 2001. Female is a dummy variable equal to one if the investor is female, and equal to zero if male. Age is calculated as 2002 minus birth year. Each investor's holding in each stock is valued using the last available stock price quote in December 2001. Panel B reports the same statistics using the investor accounts for which I am able to calculate a basis, and which I use in the analysis. In the calculation of these summary statistics, I include all non-zero holdings at the end of 2007, which is the end of my sample period. Each investor's holding in each stock is valued using the last available stock price quote in December 2007. Age is calculated as 2008 minus birth year.

Table 3: Cross sectional regression estimates

Months	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	J	N
Panel A: Small cap stocks										
All	-0.0299	0.0060	0.0000	0.0881	-0.0004				75	311
	-(4.0889)	(3.8213)	-(0.0319)	(1.7463)	-(0.5285)					
	-0.0468	0.0029	-0.0017	0.0760	-0.0006	0.0213	-0.0118	-0.0139	62	260
	-(6.0847)	(1.3948)	-(1.4744)	(0.8691)	-(0.6099)	(2.6728)	-(1.5069)	-(0.9693)		
Feb-Nov	-0.0268	0.0060	-0.0002	0.0805	-0.0002				75	259
	-(3.2187)	(3.4987)	-(0.2426)	(1.5123)	-(0.2268)					
	-0.0433	0.0019	-0.0015	0.1461	-0.0003	0.0241	-0.0167	-0.0059	63	216
	-(4.9315)	(0.8432)	-(1.2954)	(1.4951)	-(0.3087)	(2.6275)	-(1.8652)	-(0.358)		
Panel B: Large cap stocks										
All	0.0016	0.0062	-0.0013	-0.0097	-0.0002				78	311
	(0.2773)	(3.7796)	-(1.5421)	-(0.7088)	-(0.6763)					
	-0.0115	0.0049	-0.0008	0.0187	-0.0005	0.0007	0.0048	-0.0112	50	260
	-(1.4385)	(2.0538)	-(0.7088)	(0.5932)	-(1.3197)	(0.0769)	(0.4925)	-(1.356)		
Feb-Nov	0.0043	0.0059	-0.0008	-0.0129	-0.0002				78	259
	(0.6554)	(3.2329)	-(0.8283)	-(0.8458)	-(0.6026)					
	-0.0082	0.0044	-0.0007	0.0135	-0.0003	0.0022	0.0048	-0.0162	50	216
	-(0.9161)	(1.6592)	-(0.4978)	(0.3909)	-(0.7752)	(0.2151)	(0.4454)	-(1.7473)		

Notes: The table gives the results from Fama and MacBeth (1973) regressions of one week future returns on past short (one month), intermediate (one year) and long horizon (three years) returns; logarithm of market value; turnover as defined in (2); the current median household investor capital gain as defined in (1); the absolute value of this capital gain; in addition to an interaction term with capital gain and the absolute value of capital gain. Thus, at each week t I am interested in the following cross-sectional relationship, where I have suppressed superscripts for stock j:

$$r_{t,t+1} = \alpha + \beta_1 r_{t-4:t} + \beta_2 r_{t-52:t-4} + \beta_3 r_{t-156:t-52} + \beta_4 \bar{V}_t + \beta_5 s_t + \beta_6 g_t + \beta_7 |g|_t + \beta_8 \Big[g_t \times |g|_t \Big] + \epsilon_{t,t+1}.$$

Small cap stocks are defined as the firms with a market value below the median valued firm on the exchange each week; the remaining stocks are classified as large cap. J denotes the average number of stocks over the regressions performed. N denotes the number of regressions performed over the sample period. t-statistics are in parenthesis. I have transactions data from 2002 to 2007, and I start the analysis in 2003 to allow a relevant basis to develop.

Table 4: Key figures Oslo Stock Exchange, 2001 - 2008

Description	2001	2002	2003	2004	2005	2006	2007	2008
Index	167	115	171	237	333	440	491	225
Index (%)	-14.6	-31.1	48.4	38.4	40.5	32.4	11.5	-54.1
Market cap.	677	503	690	932	1403	1916	2157	999
Trading days	249	249	250	253	253	251	250	252
New Issues	28	6	7	9	28	57	54	13
Dividends	20	20	23	37	49	51	69	75
Transactions	2,529	2,048	2,348	3,406	5,480	8,846	12,138	16,850
Turnover	86.4	74.7	97.7	110.3	128.9	153.7	153.2	156.8
Companies	212	203	178	188	219	229	241	224
Listings	17	6	5	22	46	32	30	6
De-listings	19	15	30	12	15	22	18	23
Foreign comp.	26	24	20	22	28	33	31	41

Notes: Market index is the year-end Oslo Stock Exchange Benchmark index. Market capitalization, new issues, and total dividends are in billion Norwegian Kroner (NOK) at year-end. Dividends includes only dividends paid by companies listed at the end of each year. Number of transactions are in thousands. Turnover is the average of the annualized turnover per month divided by the market value at the end of each month. Listings include de-mergers and de-listings include merger. Source: OSE.

Table 5: The disposition effect

	Entire year	December	Jan - Nov
PLR	.148	.165	.147
PGR	.243	.226	.245
Difference	-.095	-.061	-.098
t-statistic	-27.05	-4.92	-26.76

Notes: The table compares the aggregate proportion of losses realized (PLR) to the aggregate proportion of gains realized (PGR), defined in (3). First, I classify all the sale decisions in the dataset as losses or gains. Then, for each of these sales, I determine if the other stocks in the portfolio of that household investor on that day are paper losses or gains. Sales when there are at least 2 stocks left in the portfolio after the sale are included. The table reports PLR and PGR for the entire year, for December only, and January through November. The t-statistic tests the null hypothesis that the difference in proportions are equal to zero assuming that all the realized losses, paper losses, realized gains, and paper gains result from independent observations. Based on a random sample of 10,000 sale observations over the sample period 2002 to 2007.

Table 6: Momentum strategy, excess returns in event time

k	mean $(W_k - L_k)$	t(mean)	α_k	$t(\alpha_k)$	β_k	$t(\beta_k)$	γ_k	$t(\gamma_k)$	R^2
1	0.0339	4.66	0.0270	4.17	-0.35	-3.75	-0.94	-6.25	0.29
2	0.0373	4.91	0.0299	4.45	-0.37	-3.75	-1.00	-6.36	0.29
3	0.0327	4.67	0.0259	4.18	-0.24	-2.68	-0.94	-6.56	0.29
4	0.0296	4.42	0.0236	3.98	-0.22	-2.59	-0.90	-6.59	0.29
5	0.0243	3.62	0.0170	2.94	-0.27	-3.26	-0.93	-6.98	0.32
6	0.0200	2.83	0.0127	2.11	-0.25	-2.84	-0.97	-6.96	0.32
7	0.0181	2.54	0.0122	1.95	-0.24	-2.75	-0.87	-6.12	0.27
8	0.0162	2.33	0.0121	1.98	-0.27	-3.14	-0.80	-5.76	0.26
9	0.0097	1.52	0.0060	1.06	-0.20	-2.54	-0.73	-5.62	0.24
10	0.0069	1.08	0.0032	0.58	-0.24	-2.97	-0.78	-6.10	0.28
11	0.0063	0.96	0.0022	0.38	-0.26	-3.21	-0.82	-6.40	0.30
12	0.0041	0.65	-0.0003	-0.05	-0.18	-2.29	-0.80	-6.45	0.29
13	0.0019	0.32	-0.0024	-0.46	-0.13	-1.76	-0.67	-5.57	0.24
14	0.0038	0.60	0.0002	0.04	-0.11	-1.32	-0.69	-5.29	0.22
15	0.0042	0.68	0.0002	0.04	-0.11	-1.34	-0.70	-5.48	0.23
16	0.0025	0.39	-0.0005	-0.09	-0.10	-1.19	-0.62	-4.71	0.19
17	0.0030	0.50	0.0023	0.42	-0.05	-0.68	-0.50	-4.11	0.15
18	-0.0028	-0.45	-0.0052	-0.95	-0.06	-0.82	-0.62	-5.05	0.21
19	-0.0004	-0.07	-0.0000	-0.00	-0.07	-0.97	-0.41	-3.32	0.11
20	-0.0015	-0.24	-0.0009	-0.15	0.05	0.64	-0.37	-2.81	0.10
21	-0.0044	-0.72	-0.0024	-0.39	0.08	0.96	-0.19	-1.37	0.04
22	-0.0038	-0.59	-0.0026	-0.40	0.11	1.23	-0.15	-1.03	0.04
23	-0.0041	-0.62	-0.0019	-0.28	0.04	0.48	-0.15	-1.04	0.02
24	-0.0045	-0.74	-0.0025	-0.41	0.09	1.01	-0.09	-0.63	0.02

Notes: The table reports the returns to a momentum strategy on the Oslo Stock Exchange from 1999 to 2008. At each month t I rank stocks based on their cumulative return the past 12 months. Specifically, I use the log return from the ratio of the stock price at the end of month $t-1$ and month $t-12$. Prices are adjusted for split/reverse split and dividends. Stocks that do not have enough data for this calculation are excluded. The 20% of stocks with the lowest cumulative past return is the "loser" group; the top 20% the "winner" group. This gives me the loser and winner group at the end of month t. For each of the 24 months following t, I then calculate the equal weighted portfolio return of each of these two groups. The return in month k is the return on the winner portfolio net of the loser portfolio in the $t+k$ month after portfolio formation. Column 2 reports the mean return for this strategy. Column 4 reports the risk adjusted mean return for this strategy. I adjust the momentum returns for two common risk factors: the market factor $(R_{m,t} - R_{f,t})$, and a size factor (SB_t). R_m is the log-return on the Oslo Stock Exchange All Share Index (OSEAX) monthly close value. R_f is the one month Norwegian Inter Bank Offered Rate (NIBOR); the rate used for the current month is the rate quoted at the last day of the previous month. The size factor (SB_t) is the value weighted return on the portfolio of firms with a market value below the median-valued firm on the market, minus the value weighted return on the portfolio of the remaining firms. Thus, I estimate the regression $W_{k,t} - L_{k,t} = \alpha_k + \beta_k[R_{m,t} - R_{f,t}] + \gamma_k SB_t + \epsilon_{k,t}$, where $W_{k,t}$ is the return to the winner portfolio k months after portfolio formation at the end of month t; $L_{k,t}$ is the return to the loser portfolio.

Table 7: Momentum strategy, excluding micro cap stocks

k	mean $(W_k - L_k)$	t(mean)	α_k	$t(\alpha_k)$	β_k	$t(\beta_k)$	γ_k	$t(\gamma_k)$	R^2
1	0.0242	3.61	0.0204	3.07	-0.21	-2.16	-0.50	-3.20	0.10
2	0.0250	3.83	0.0216	3.40	-0.29	-3.18	-0.51	-3.43	0.14
3	0.0183	2.99	0.0154	2.55	-0.11	-1.21	-0.46	-3.31	0.09
4	0.0180	3.00	0.0155	2.61	-0.15	-1.68	-0.44	-3.22	0.09
5	0.0150	2.32	0.0105	1.66	-0.22	-2.36	-0.56	-3.86	0.14
6	0.0124	1.84	0.0075	1.15	-0.09	-0.99	-0.63	-4.18	0.14
7	0.0120	1.82	0.0078	1.21	-0.07	-0.81	-0.56	-3.81	0.12
8	0.0095	1.40	0.0063	0.95	-0.09	-0.98	-0.51	-3.38	0.10
9	0.0094	1.57	0.0064	1.07	0.00	0.00	-0.47	-3.47	0.11
10	0.0061	1.07	0.0030	0.53	-0.05	-0.63	-0.48	-3.72	0.12
11	0.0025	0.43	-0.0005	-0.09	-0.03	-0.31	-0.45	-3.36	0.10
12	-0.0009	-0.15	-0.0023	-0.39	0.04	0.51	-0.26	-1.94	0.04
13	-0.0002	-0.04	-0.0025	-0.45	-0.01	-0.11	-0.30	-2.48	0.06
14	-0.0018	-0.32	-0.0027	-0.47	-0.01	-0.07	-0.29	-2.18	0.05
15	0.0051	0.88	0.0036	0.61	0.01	0.16	-0.27	-1.98	0.04
16	0.0003	0.05	-0.0016	-0.29	-0.02	-0.25	-0.38	-3.02	0.09
17	0.0007	0.14	0.0002	0.03	-0.03	-0.45	-0.33	-2.72	0.07
18	-0.0049	-0.89	-0.0051	-0.95	0.04	0.59	-0.31	-2.58	0.08
19	-0.0022	-0.41	-0.0004	-0.07	0.09	1.28	-0.19	-1.61	0.06
20	-0.0053	-0.89	-0.0036	-0.62	0.19	2.37	-0.16	-1.29	0.09
21	-0.0123	-2.05	-0.0104	-1.67	0.14	1.68	-0.07	-0.51	0.04
22	-0.0120	-1.89	-0.0093	-1.42	0.18	2.05	0.01	0.09	0.05
23	-0.0088	-1.29	-0.0051	-0.73	0.20	2.09	0.05	0.32	0.05
24	-0.0116	-1.83	-0.0084	-1.30	0.20	2.23	0.14	0.96	0.05

Notes: The table repeats the estimation of Table 6, but now firms with a market cap below the 20^{th} percentile or a share price below 10 NOK (approx. 2 USD) are excluded from the calculation of the momentum returns.

Efficiency, equality and reciprocity in social preferences: A comparison of students and a representative population

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Abstract

The debate between Engelmann and Strobel (2004, 2006) and Fehr, Naef, and Schmidt (2006) highlights the important question of the extent to which lab experiments on student populations can serve to identify the motivational forces present in society at large. We address this question by comparing the lab behavior of a student group and a non-student group, where the non-student group on all observable factors is almost identical to the representative adult population in Norway. All participants take part in exactly the same lab experiment. Our study shows that students may not be informative of the role of social preferences in the broader population. We find that the representative participants differ fundamentally from students both in their level of selfishness and in the relative importance assigned to different moral motives. It is also interesting to note that while we do not find any substantial gender differences among the students, males and females in the representative group differ fundamentally in their moral motivation.

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The relative importance of different motivational forces has been a major issue in recent research on social preferences (Bolton and Ockenfels, 2000; Andreoni and Miller, 2002; Charness and Rabin, 2002; Engelmann and Strobel, 2004; Fisman, Kariv, and Markovits, 2007; Fehr et al., 2006; Cappelen, Drange Hole, Sørensen, and Tungodden, 2007), and it has been argued that there may be important differences across subject pools and economic environments. In particular, Fehr et al. (2006) report results suggesting that the efficiency motive is especially salient among students of economics and business administration, who have been trained in the idea that efficiency is desirable, whereas equality appears to be of major importance for non-economists (ranging, in their study, from students of various other disciplines to low-level employees of banks and financial institutions).[1] On this basis, they argue that the prominence of the efficiency motive in Engelmann and Strobel (2004), where all participants are students in economics and business administration, is due to a subject pool effect.

The debate between Engelmann and Strobel (2004, 2006) and Fehr et al. (2006) highlights the important question of the extent to which lab experiments on student populations can serve to identify the motivational forces present in society at large. We address this question by providing a comparison of the lab behavior of a student group and a non-student group. Our student group consists of second year students in economics and business administration, whereas our non-student group is almost identical to the adult population in Norway on observable factors. Both groups take part in exactly the same lab experiment. To our knowledge, this is the first study on social preferences that attempts to bring a nationally representative adult population into the lab, and we believe that such an endeavor is useful for gaining further understanding of the generality of the findings of lab experiments done on student populations.[2]

As pointed out by Fehr et al. (2006), social preferences may differ fundamentally across economic environments. They argue that equality is even more important in strategic games than in non-strategic games, but underline that better understanding of the functioning of different motivational forces in different environments is needed. The present study contributes to this by comparing the behavior of students and non-students both in a dictator game (a non-strategic environment) and in a generalized trust game (a strategic environment), where we focus on the relative importance of equality, efficiency and reciprocity in motivating the participants' behavior.[3]

Our study shows that the representative group differs fundamentally from the students both in their level of selfishness and in the relative importance assigned to different moral

[1] See also Fisman, Kariv, and Markovits (2009) for a study of how training in economics may affect the concern for efficiency.

[2] A related interesting literature has looked at social preferences in non-student groups by conducting survey-experiments (Fehr, Fischbacher, von Rosenbladt, Schupp, and Wagner, 2003; Bellemare, Kröger, and van Soest, 2008).

[3] Our experiment does not investigate the distinction between a concern for equality and a concern for maximin, see Engelmann and Strobel (2004).

motives. First, the representative group gives away 81.5% more than the student group in the dictator game and returns 70.5% more in the trust game. Second, in the trust game, we find that the efficiency motive is stronger among representative males than among students, whereas representative females do not assign importance to efficiency. Third, only for representative males and students does the concern for equality expressed in the dictator game carry over to the return decision in the trust game. Among representative females, reciprocity concerns crowd out a concern for equality in a strategic environment.

The comparison of the student group and the representative group also illustrates the potential danger of studying gender differences on the basis of a very selected group such as students of economics and business administration. In our student group, males and females appear to have the same moral motives, whereas the behavior of males and females is fundamentally different in the representative group.

It is interesting to compare our findings for the representative group to Almås, Cappelen, Sørensen, and Tungodden (2010), who report results from a social preference lab experiment done on a group of children from 5th grade to 13th grade that is fairly representative for these age groups in Norway.[4] In particular, it is striking to observe that the male-specific focus on efficiency among representative adults in the present study maps closely to the the finding in Almås et al. (2010) that a concern for efficiency mainly develops among males throughout adolescence.[5] This suggests that social preferences established in childhood have long-lasting effects on individual behavior.

The paper is organized as follows: Section 1 describes the sampling procedure; section 2 provides details on the experimental design; section 3 and section 4 report results from the dictator game and the trust game, respectively; section 5 concludes.

1 Samples and participants

Of the 256 participants in our study, 120 were second year students at the Norwegian School of Economics and Business Administration (NHH). The student group consisted of about 60% males and 40% females, which is in line with the gender distribution in the student population at NHH.

The remaining 136 participants were recruited from a representative sample of the Norwegian population. Two criteria determined the selection of the non-student sample. First, we wanted this sample to be representative of the Norwegian population with respect to age, gender, employment and income. Second, as we wanted all participants in our study to participate in a lab experiment at NHH, we considered it important that non-

[4]There is now a growing experimental literature on moral development in children, see among others Krause, Harbaugh, and Berry (2001); Sutter and Kocher (2007); Fehr, Bernhard, and Rockenbach (2008); Martinsson, Nordblom, Rützler, and Sutter (forthcoming).

[5]Martinsson et al. (forthcoming) report a similar finding in a study of social preferences among children in Sweden and Austria.

student participants did not have to travel too far. Based on data from Statistics Norway, we established that the population living in the 27 basic statistical units closest to NHH is representative for the population in Norway with respect to the selected dimensions.[6] This region includes parts of the second largest city in Norway as well as less populated rural farming areas.

Following the approval of the experiment by both the Norwegian Social Science Data Services ("Norsk samfunnsvitenskaplig datatjeneste") and the Norwegian Public Register ("Norsk Folkeregister"), EDB Infobank drew a random subset of 1000 persons from our representative population. We then randomly selected 460 individuals from this subset to be invited to take part in the experiment. Each individual received a personal letter inviting them to participate in a research project involving economic choices, but they were not informed about the details or the purpose of the experiment. The letter also gave the date and time of the session to which they had been assigned.[7] The response rate for the representative group was 30.2% and for the student group 28.6%.[8]

Table 1 reports the characteristics of the non-student group relative to the representative sample and the Norwegian population at large. The data for Norway and the sample population were collected from Statistics Norway. The participants self-reported age, gender, and employment, but not income.[9] We collected the income data for the participants from a publicly available tax return database. Since the participants were anonymous in the experiment, we cannot link income data and experimental data at the individual level.

We observe that the non-student group is fairly representative in terms of employment, gender, income, and age, with females being slightly overrepresented. Hence, even though the non-student group may not be fully representative relative to other characteristics, we retain the label representative in describing these participants.

[6] A basic statistical unit is the smallest geographical unit used by Statistics Norway.

[7] In the invitation they were told that they would receive 300 NOK (45 USD) in participation compensation for an experiment that would last for about one hour, and that they could earn more during the experiment. The student subjects received a similar invitation by email and were told that they would receive 100 NOK in participation compensation. The difference in participation compensation was based on the additional travel time and cost that people in the representative population would incur relative to the students in order to participate. Student sessions where held during the day, and representative sessions in the evening.

[8] 10 of the invitations to the representative subset were returned to the research group because of wrong address. The response rate was thus 136 out of 450. The total number of second year NHH students was 420, of which 120 participated in our study.

[9] Two students did not report gender and thus are excluded from the analysis

2 Design

All interaction between the participants was anonymous and through a web-interface developed for the experiment.[10] In the first part of the experiment, the participants played standard dictator games. Each participant was involved in four dictator games, two as dictator and two as passive recipient, each time randomly paired with another participant in the same session. The endowment e in each game was either 500 NOK or 1000 NOK. The dictator was asked to choose an amount y for the other person and $(e - y)$ for himself. The choice set of the dictator was limited to amounts divisible by 25 NOK. The participants were not informed about the outcome in the situations where they were recipients until the end of the experiment.

In the second part of the experiment, the participants completed ten trust games, five as sender and five as responder, each time randomly paired with another participant in the same session. In each trust game, both the sender and the responder were allocated an endowment $e_i \in \{100, 200, 300\}$, for $i = 1, 2$, where the sum of the endowments for each pair of players was always 400 NOK. In addition, there was a multiplier of m_1 on the sent amount and a multiplier m_2 on the returned amount, where $m_i \in \{1, 2, 4\}$, for $i = 1, 2$, and the product of the two multipliers in each situation was 4.

All participants first completed their decisions as senders. In each situation, before they made a decision, they were informed about the vector (e_1, e_2, m_1, m_2), and the sender then decided whether to send an amount $y_1 \leq e_1$ of the endowment to the responder. The responder would then receive $y_2 = m_1 y_1$. After completing all five sender decisions, each participant was presented with an overview of their choices and given the opportunity to revise each of them. All participants then completed their decisions as responders. In each situation, the responder was informed about the vector $(e_1, e_2, m_1, m_2, y_1, y_2)$, and the responder then decided the amount $y_3 \leq e_2 + y_2$ to return to the sender. The sender received $y_4 = m_2 y_3$. When the responders had completed their decisions in all the five situations, they were presented with an overview of their choices and given the opportunity to revise each of them. The total payoff for the sender (π_1) and the responder (π_2) in a particular game is given by:

$$\pi_1 = e_1 - y_1 + m_2 y_3 = e_1 - y_1 + y_4,$$
$$\pi_2 = e_2 + m_1 y_1 - y_3 = e_2 + y_2 - y_3.$$

The choice set of both players was limited to amounts divisible by 25 NOK.

At the end of the experiment, for each person and with equal probability, one of the games in which the participant had been involved was randomly drawn to determine actual payment. The final payment procedure ensured that neither the participants nor

[10] Instructions were given in Norwegian. See the appendix for an English translation of the instructions.

the research team were in a position to identify how much each participant earned in the experiment.

3 The dictator game

The distributive situation in the dictator game has three important characteristics that limit the possible motives the dictator may have for sharing. First, the other participant is unable to respond to the decision made by the dictator, which implies that sharing cannot be motivated by self-interest. Second, the total income is fixed, which implies that sharing cannot be motivated by efficiency concerns. Third, the dictator does not respond to a decision made by the other participant, which implies that sharing cannot be motivated by reciprocal concerns.

We interpret the amount given as a measure of the extent to which a concern for equality motivates the dictator to act non-selfishly. Figure 1 provides a histogram of the share given for both subject groups by gender, the average share given is reported in Table 2. We observe that there are large differences between students and representatives. Whereas the mode among students is to take everything for themselves, the mode among representatives is to share equally. On average, representative males give away twice as much as student males (40.3 % versus 19.8 %), and representative females give away 55 % more than student females (41.7 % versus 26.9 %).[11] Table 3 shows that the difference between students and representatives is substantial and statistically significant also when controlling for age and employment ($p < 0.001$).[12] In sum, the dictator game provides clear evidence of the strong motivational force of equality in our non-student group, and shows that the great importance of equality may be underestimated if we solely focus on a subject group of students of economics and business administration.

4 The trust game

We now turn to a study of the behavior in the trust game, where the participants potentially may be motivated by efficiency, equality and reciprocity considerations.

Figure 2 and Figure 3 provide histograms for share sent and returned for both subject groups by gender, the average shares are reported in Table 2. We observe that share sent is almost the same for the representative group and the student group (51.7% ver-

[11] There is no statistically significant difference in share given for 500 NOK and 1000 NOK; 23.6% versus 21.9% for students (p=0.143), 41.1% versus 41.3% for representatives (p=0.868).

[12] We observe from Table 2 that the difference in average share given between males and females is not statistically significant for representatives ($p = 0.608$), whereas for students it is ($p = 0.035$). If we consider the share of situations where the dictator takes everything there is a statistically significant difference between males and females among students (36.4% versus 17.7%, p=0.013), but not among representatives (5.0% versus 3.0%, p=0.517).

sus 54.2%), but with some gender differences. Almost half of the student males send everything (43.7%) and, overall, they send more than representative males, whereas representative females send less than student females. In both cases, however, we observe large standard errors and the differences between students and representatives are not statistically significant ($p = 0.16$ for males and $p = 0.14$ for females, correcting for clustering on individuals). In the return decision, students, both males and females, return less than the representatives, with an overall difference of 70.5% (17.6% versus 30.0%). We observe that the share of students returning nothing is more than twice the share of representatives acting in a completely selfish way.

We here focus on the return decision, which provides the most direct test of how the participants trade off selfishness and different moral motivations in a strategic environment. The efficiency motive comes into play through the multiplier on the returned amount, which varies from 1 to 4. When the multiplier is 1, there is no efficiency argument for returning anything, whereas a multiplier of 2 or 4 provides a strong efficiency argument for returning everything. The reciprocity motive comes into play because the responder may want to reward participants who have sent a large share of the endowment. Both these motives, however, may interact with the concern for equality in the return decision; the equality motive may dampen the willingness to act on the efficiency motive, and it may generate reciprocal behavior independent of the reciprocity motive.

To capture the extent to which a concern for equality motivates the return decision, we calculate the amount, y_3^{target}, that each participant has to return to achieve the distribution he or she selected as dictator.[13] We do so by first solving the following equation for y_3^*,

$$\frac{\pi_1}{\pi_1 + \pi_2} = \frac{(e_1 - y_1 + m_2 y_3^*)}{(e_1 - y_1 + m_2 y_3^*) + (e_2 + m_1 y_1 - y_3^*)} = s^{dictator},$$

where $s^{dictator}$ is the share given to the other person in the dictator game.[14] The return amount has to be non-negative, and thus we define,

$$y_3^{target} = \max(0, y_3^*). \tag{1}$$

In the following, we use y_3^{target} to control for the importance of the equality motive in the return decision.

Table 4 reports regressions of share returned by gender on the three other-regarding motives, where we control for age and employment. We observe some striking differences between males and females in the representative group. Representative males assign great importance to efficiency concerns, the point estimate of the multiplier is 9.2% and

[13] A similar approach is used in Ashraf, Bohnet, and Piankov (2006).

[14] In calculating $s^{dictator}$, we take, for each participant, the average share given away in the dictator game.

thus the estimated difference in share returned between situations with a multiplier of 1 and 4 is 27.6%, whereas the share returned among representative females is not at all sensitive to the multiplier. Representative females exhibit a strong reciprocal motivation in the return decision, but not a concern for equality as expressed in the non-strategic environment. In contrast, the reciprocal motive does not seem to have any force among representative males, who also in the strategic environment assign importance to equality considerations.

A very different picture emerges for the student group. First, students assign far less importance to efficiency than representative males, but much more importance to equality than female representatives. Second, the reciprocity motive has some motivational force among the students, but is less prominent than among female representatives. Third, there are no statistically significant gender differences in the student group, which is in stark contrast to what we find in the representative group. In sum, the trust game shows that the social preferences of representatives and students group are very different.

5 Conclusion

Our study demonstrates clearly that, as suggested by Fehr et al. (2006), student subject groups may not be representative of the social preferences in society at large. They differ fundamentally from a representative group of non-students both in their level of selfishness and in the relative importance assigned to different moral motives. Moreover, we show that while there are no significant gender differences in the student group, males and females in the representative group differ fundamentally in their moral motivation.

We find that both equality and efficiency are important motivational forces among representative males, whereas representative females seem to move from a concern for equality in non-strategic environments to a focus on reciprocity in economic environments. The fact that all three motives play a role in explaining lab behavior of a group that is fairly representative for the Norwegian population, suggests that these motives are important also when analyzing economic and social phenomena in society at large.

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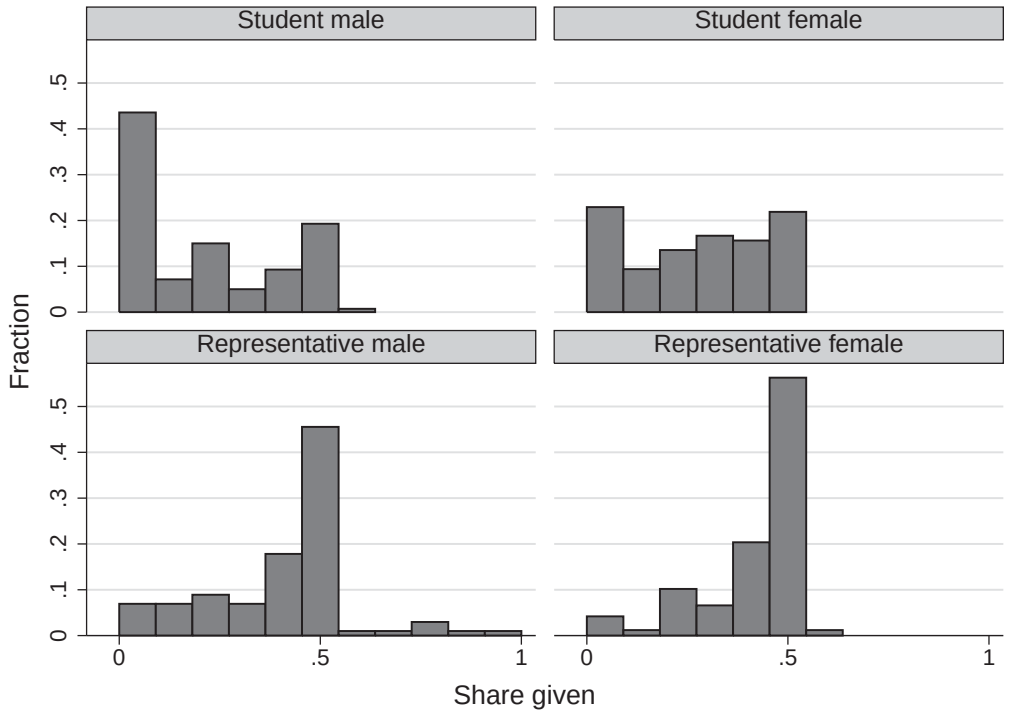
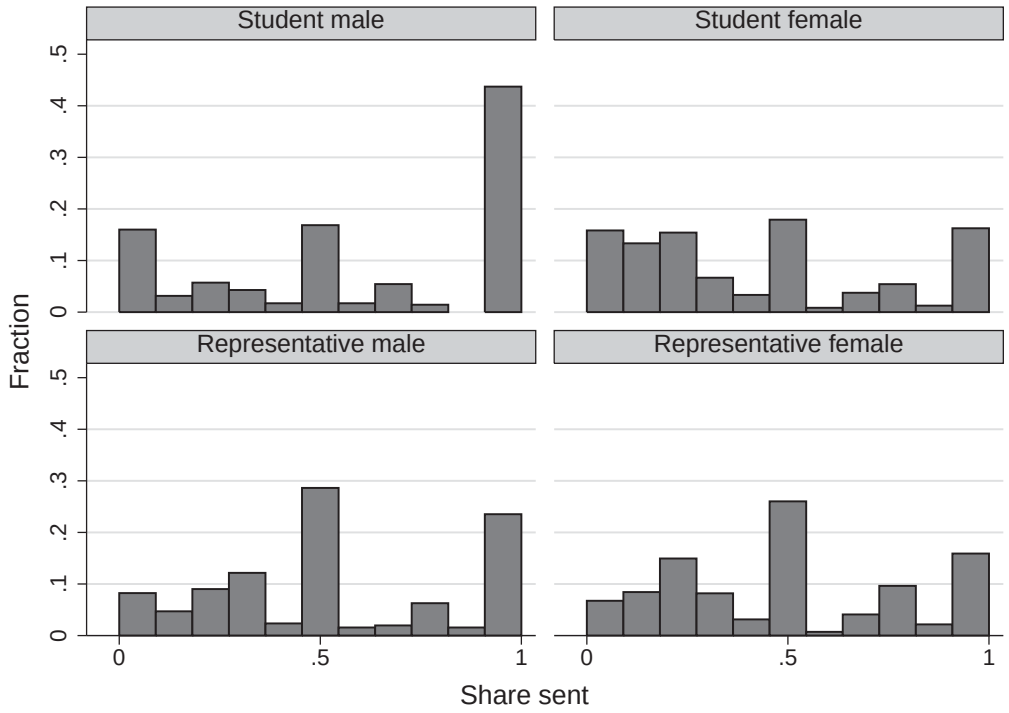
Figure 1: Histogram of share given in the dictator game



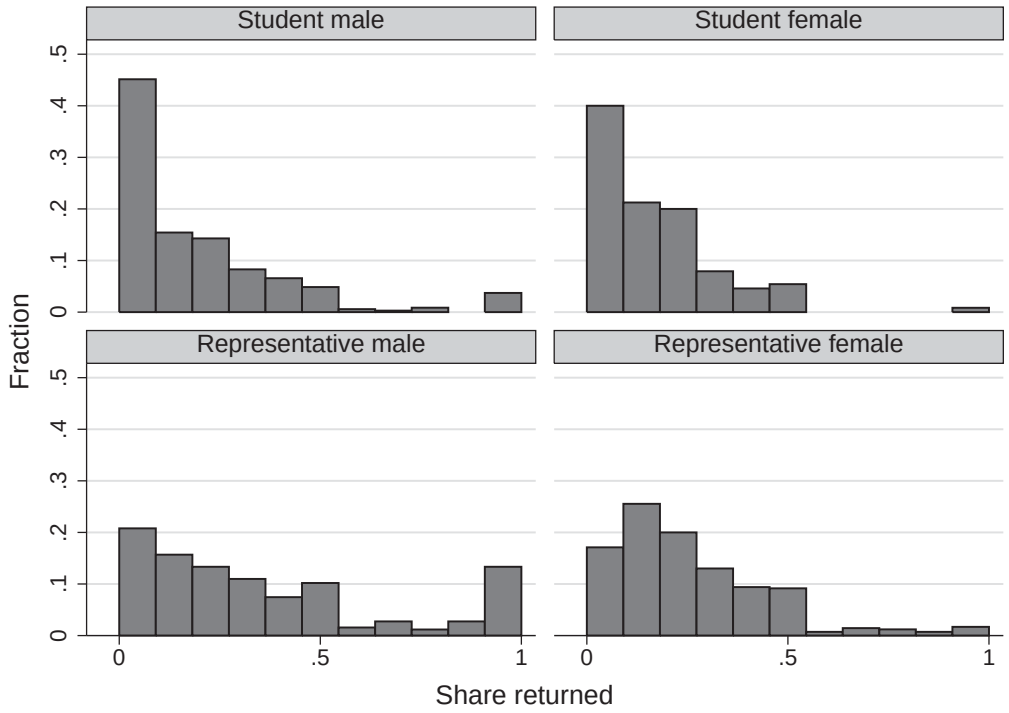
Notes: The figure reports, for each subgroup, the distribution of the share given in the dictator game. Each participant acts as the dictator in two dictator game situations, and each dictator game situation enters here as an independent observation.

Figure 2: Histogram of share sent in the trust game



Notes: The figure reports, for each subgroup, the distribution of the share sent in the trust game. Each participant acts as the sender in five trust game situations, and each trust game situation enters here as an independent observation.

FIGURE 3: HISTOGRAM OF SHARE RETURNED IN THE TRUST GAME



Notes: The figure reports, for each subgroup, the distribution of the share returned in the trust game. Each participant acts as the responder in five trust game situations, and each trust game situation enters here as an independent observation.

Table 1: Age, gender, employment and income distributions for the non-student group, the sample population, and the Norwegian population

	Non-student group	Sample population	Norway
A. Age			
17-30	25.6	26.8	25.5
31-40	14.3	23.7	22.3
41-50	30.1	19.2	20.6
51-60	16.5	16.5	19.1
61-70	13.5	13.8	12.5
B. Gender			
Male	38.6	48.4	49.6
Female	61.4	51.6	50.4
C. Employment			
Private sector	55.6	58.1	63.8
Public sector	44.4	41.9	36.2
D. Income			
0-99,999	20.9	23.5	24.7
100,000-199,999	24.8	25.7	29.8
200,000-299,999	27.1	24.2	24.8
300,000-399,999	15.5	11.6	10.7
400,000-499,999	6.2	5.8	4.1
500,000 and over	5.4	9.3	5.8

Notes: **Non-student group**: Age, gender, and employment are self-reported by the participants in the experiment. Income is taxable income in NOK, including labor income and capital gains over the year, net of all deductables including interest payments; collected from publicly available tax return database (Year: 2005). **Sample population and Norway**: Age and gender are collected from Statistics Norway (Year: 2006). Employment is collected from Statistics Norway (Year: 2001). Income is collected from Statistics Norway (Year: 2004).

Table 2: Share given in the dictator game, share sent and share returned in the trust game

	Student			Representative		
	Male	Female	All	Male	Female	All
A. Share given, dictator game						
Mean	0.198	0.269	0.227	0.403	0.417	0.412
	(0.023)	(0.024)	(0.017)	(0.024)	(0.012)	(0.012)
B. Share sent, trust game						
Mean	0.620	0.429	0.542	0.542	0.502	0.517
	(0.040)	(0.041)	(0.031)	(0.038)	(0.027)	(0.022)
C. Share returned, trust game						
Mean	0.186	0.161	0.176	0.365	0.259	0.300
	(0.021)	(0.016)	(0.014)	(0.037)	(0.016)	(0.018)
n	70	48	118	52	84	136

Notes: The table reports, for each subgroup, the average share given in the dictator game, average share sent in the trust game, and average share returned in the trust game (n is the number of individuals in each subgroup). Each individual acts as dictator in two dictator games, as sender in five trust games, and as responder in five trust games. Standard errors corrected for clustering on individuals in parentheses.

Table 3: Regressions of share given in the dictator game

	Student		Representative		
	Male	Female	Male	Female	All
Above 30 years old			0.049	0.042	0.043
			(0.053)	(0.036)	(0.030)
Working, public sector			0.028	-0.022	-0.008
			(0.086)	(0.037)	(0.036)
Working, private sector			-0.015	-0.007	-0.014
			(0.077)	(0.034)	(0.036)
Female					0.011
					(0.028)
Student					-0.182
					(0.048)
Female x student					0.061
					(0.044)
Constant	0.198	0.269	0.367	0.395	0.380
	(0.023)	(0.024)	(0.077)	(0.036)	(0.042)
Observations	140	96	99	159	494
R^2			0.021	0.020	0.231

Notes: The table reports results from OLS regressions of the share given in the dictator game. All students are coded as not working and as below 30 years old. The dummy variable "above 30 years old" is equal to one if the dictator in the situation is above 30 years old, otherwise zero. There are two dummies for working status, one for the public and one for private sector. The excluded working status category is "not working". Standard errors corrected for clustering on individuals reported in parentheses.

Table 4: Regressions of share returned in the trust game

	Student		Representative		
	Male	Female	Male	Female	All
Share sent	0.095	0.059	-0.088	0.150	0.058
	(0.036)	(0.030)	(0.064)	(0.057)	(0.023)
Share returned target	0.659	0.522	0.713	0.122	0.511
	(0.101)	(0.110)	(0.149)	(0.138)	(0.072)
Multiplier return	0.023	0.011	0.092	0.007	0.034
	(0.010)	(0.011)	(0.020)	(0.014)	(0.007)
Above 30 years old			0.145	0.035	0.073
			(0.095)	(0.033)	(0.039)
Working, public sector			-0.061	-0.008	-0.032
			(0.102)	(0.036)	(0.044)
Working, private sector			-0.139	0.009	-0.051
			(0.100)	(0.038)	(0.047)
Female					-0.117
					(0.038)
Student					-0.109
					(0.059)
Female x student					0.077
					(0.044)
Constant	0.031	0.047	0.038	0.110	0.145
	(0.028)	(0.025)	(0.102)	(0.061)	(0.056)
Observations	350	240	250	395	1235
R^2	0.180	0.229	0.268	0.098	0.230

Notes: The table reports the results from OLS regressions of the share returned in the trust game. Share returned target is defined by (1). The multiplier varies from 1 to 4. For the remaining variable definitions, see Table 3. Standard errors corrected for clustering on individuals reported in parentheses.