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Group Gender Composition and Economic Decision-Making: Evidence from the *Kallystée* Business Game

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Group gender composition and economic decision-making: Evidence from the *Kallystée* business game

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Abstract

This paper analyses data collected in 2012 and 2013 at the ESSEC Business School from *Kallystée*, a proprietary mass-attendance business game. Company boards are simulated by groups of five students selected at random. We manipulate the gender composition of the management teams to allow for all possible gender combinations. We show that all-men and mixed teams with four women perform significantly better than all-women teams. However, when controlling for the average tolerance to risk of the teams, the performance advantage of all-men teams vanishes, while the “residual” economic performance of mixed-gender teams with a majority of women is still positive and strong. Further analysis of “actual” risk-taking behavior shows that in these mixed-gender teams a “risk shift” mechanism is at play, as they take risks beyond what their total tolerance to risk as a group would suggest.

Keywords: Group decision, gender studies, risk-taking, business game, performance, governance.

JEL Classification: D71; C93; M14

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1. Introduction

Following the 2000-2001 “governance crisis”, the question of whether the gender composition of an executive board is linked to the quality of its managerial decisions moved from the academic debate to policymakers’ desks. At that time, it appeared that poorly functioning boards of trustees were not able to monitor rogue executives who manipulated earnings in order to first push up the price of and then sell their pending stock options (Lev, 2003; Stiglitz, 2003; Healy and Palepu, 2003). After the crisis, many observers pointed out that boards were dominated by men and suggested that increased participation of women was one strategy worth testing to avoid such corporate misbehavior in the future. The European Commission (EC) is representative of this strong belief in the benefits of wider gender diversity in executive boards: *“Having more women in top jobs can contribute to a more productive and innovative working environment and improved company performance overall. This is mainly due to a more diverse and collective mind-set which incorporates a wider range of perspectives and therefore reaches more balanced decisions”* (European Commission, 2012). Following the example of Norway, which introduced a 40% corporate board quota target for women as early as 2003, 11 EU member states have introduced legal instruments to promote gender diversity on company boards.¹ As a consequence of these new opinion trends and legal changes in some countries, female representation in corporate boards worldwide continues to increase. As reported by Azmat (2014), the percentage of seats held by women on Fortune 500 boards rose from 9.6% in 1995 to 16.9% in 2013.

Several scholars aimed to determine whether or not there is a positive link between executive board diversity and firms’ economic performance. So far, the evidence is at best mixed if not negative. Several authors have analyzed the Norwegian firm data, before and after increasing the number of women in executive boards. For instance, Ahern and Dittmar (2012) the measure was followed by a decline of the firm stock market valuation, and Matsa and Miller (2013) reveal an increase in labor hoarding and a reduction in short-term profits. Adams and Ferreira (2009) found that board gender diversity in a sample of US firms was adversely related to firm performance, perhaps because mixed-gender boards monitor CEO’s decisions too tightly. Joecks et al. (2013) provide evidence supporting a U-shape relationship, according to which women’s presence in boards becomes beneficial only when a critical mass is reached.

In the wake of the Great Recession (2007-2009), the public debate moved from analyzing the impact of board gender composition on performance, to analyzing its impact on risk-taking. Many

¹ Belgium, France, Italy, the Netherlands, Spain, Portugal, Denmark, Finland, Greece, Austria and Slovenia. In France for instance, a law passed on 27th January 2011 sets a quota of 20% female board members to be achieved by 2014 (40% by 2017). In 2014, the German government passed legislation requiring that women participation to corporate boards rises to 30% by 2016 (Bertrand et al., 2014).

journalists and policymakers argued that a more gender-balanced composition of banks' boards would have contained banks' addiction to risk, as women tend to be more risk-averse than men. Neelie Kroes, the European Union Commissioner for Competition, stated in 2009: "*My clear line is that if Lehman Brothers had been 'Lehman Sisters,' would the crisis have happened like it did? No.*" In this line of reasoning, a higher female participation is desirable not because it would lead to better firm "performance", but because it would attenuate the volatility of this performance.

This belief is backed by many studies in experimental economics which revealed that, in abstract decision problems involving basic lotteries, women display higher aversion to risk than men (Eckel and Grossman, 2008a; Croson and Gneezy, 2009; Charness and Gneezy, 2012, Booth and Nolen 2012).² Taking stock on a lab experiment simulating a financial market, Eckel and Füllbrunn (2015) show that the likelihood of bubbles is lower in markets with female traders than in markets with male traders, as if, in their quest for the higher profit the latter paid less attention to the fundamentals. On the other hand, in framed experiments, the evidence for higher risk aversion among women is mixed (Eckel and Grossman, 2008b). For instance, Schubert et al. (1999) compared men's and women's choices in unframed lotteries and in a contextual financial investment game. They found a significant gender difference in the former, but not in the latter. In a framed experiment, Moore and Eckel (2003) found that women are more risk-averse than men in an investment situation (gain domain) but not in an insurance situation (loss domain).

Several scholars aimed to infer the relationship between risk-taking behavior and board gender composition using real firm data.³ For example, Bansak et al. (2011) analyzed decisions taken by US banks in financial distress to apply for rescue funds provided by the Target Asset Relief Program (TARP). It is very probable that such financial distress was the direct consequence of high-risk managerial decisions. They found that the probability of applying for Program funds was negatively associated with the number of women in the senior management team. Similarly, Muller-Kahle et al. (2011) showed that mortgage issuers with a smaller proportion of women than men in their management boards were more likely to engage in subprime lending. In contrast, using data from a set of 300 large publicly-traded U.S. banks, Adams and Ragunathan (2012) found that listed banks

² However, Filippin and Crossetto (2014) take stock of the whole issue in a meta-analysis, highlighting that all these results on risk differences in lottery choices are nonetheless highly sensitive to the elicitation method, and, when considering a large data set, the difference in tolerance to risk between men and women turns out to be weaker than what is currently assumed.

³ In the Expected Utility Theory, *risk aversion* allows characterizing an individual's (dis)taste for risk; it is related to the curvature of his/her utility function. *Tolerance to risk* can be seen as the opposite of risk aversion. The latter concept is preferred by psychologists who refer to a broader definition of an individual's attitude toward risk, most often contextualized. In real life or in the experimental setting when individuals can choose between several actions involving different levels of risk, we can refer to *risk taking behavior* as the choice of the higher-risk action (for instance if he/she has the choice between not smoking, smoking electronic cigarettes or smoking traditional cigarettes, the latter is referred as risk-taking).

with more female directors did not engage in fewer risk-taking activities during the crisis nor did they have lower risk than other banks.

This paper aims at contributing to the literature on collective decision making by addressing the question whether the gender composition of a management team has an impact on the “economic performance” of the firm and if so, whether this effect is direct, or is mediated through the team’s tolerance to risk.

For so doing, we analyze data generated by a proprietary business game – *Kallystée* – developed in the 1990s by Daniel Tixier and Raymond Gambini for the ESSEC Business School, with the support of *l’Oréal Paris*. The game simulates the managerial decision-making process at a large cosmetics company over several decision rounds (depending on the group, eight or five rounds). The firm has some ability to differentiate its products in a typical imperfect competition market environment. In the game, a typical executive board is represented by a team of five students.

Besides measuring “economic performance” by total equity, the game allows to grasp teams’ risk-taking behavior. Indeed, in this game, the early launch of a new, high-quality product appears to be a good proxy for a “high-risk” decision. This high-end, high-risk positioning strategy is also indirectly captured by firms’ investment in R&D, which is a prerequisite for launching new products. We therefore have two good proxies to assess group risk-taking behavior, which we can relate to the gender composition of the groups involved.

According to a standard principle in financial economics, companies that take higher risks can expect a better average return. This assumption was introduced in the simulation through a relationship between total demand and the number of product varieties in that market. Accordingly, each new product will push up total market demand, and pull the profits of all firms upwards. This relationship is spelled out clearly in the rules of the game. In our sample, 70% (resp. 45%) of firms that launched a high quality product at round 2 (resp. 3) achieved the best or the second-best performance in terms of equity within their markets.

During the game, we collected data on the individual tolerance to risk of the 1100 ESSEC Business School students who played the game in 2012/2013 and 2013/2014. Working with large numbers of subjects in the special context of a business game administered over a short period imposes certain constraints on the methods one can implement to measure individual tolerance to risk. In particular, the lack of time available for activities in the game other than decision-making made impossible the implementation of a cash-incentivized method. We therefore adopted the self-reported survey measure introduced by Dohmen et al. (2011) who asked individuals to report their willingness to take risks in general on a 10-point scale. Additional personal data were collected from official school records, including gender, age, parents’ educational level, and administrative district of residence (called a “department” in France) during high-school.

At the time of the experiment, ESSEC's administration allowed us to manipulate the gender composition of the five-member participant teams. We used a random selection process to make teams of five women (i.e. all-women teams), and teams with four (i.e. four women and one man), three, two, one and, finally, no women (i.e. all-men teams) (respectively referred to as 5W, 4W, 3W, 2W, 1W and 5M teams).

Based on a first regression analysis, 5M teams and 4W appear to perform significantly better than 5W teams. Controlling for group tolerance to risk (defined as the average tolerance to risk of the team members) dampens the estimated coefficient on the 5M dummy, thereby suggesting that group tolerance to risk is one important mechanism through which gender composition impacts economic performance. We then study actual risk taking behavior in the game, by analyzing the decision to launch a new product and the decision on how much to invest in R&D. Men dominated teams and 4W teams behave as typical "first movers", a strategy that, in this game, is quite successful.

Our analysis can be closely related to the paper by Apesteguia et al. (2012) who, to the best of our knowledge, were the first to use data from a business game in order to study the impact of the gender composition of a decision group on its economic performance. They used the data provided by *StratX*, a private company which runs an online mass-attendance business game for *l'Oréal Paris*. In that game, management teams are simulated by groups of three students (instead of five in *Kallystée*) who self-select for participating as a team to the game contest. They must make business decisions of a similar nature to those in *Kallystée*, but the rules of the game are somewhat different. In particular, a corporate social responsibility (CSR) channel is explicitly introduced. The stated goal of each firm is to maximize shareholder value.⁴ Furthermore, in *StratX* each company plays against the computer (they do not compete against each other like in *Kallystée*). Accordingly, a company cannot take advantage of a possible mistake by a rival.

Using data from the first round only (as many as 16,000 teams from 1,500 universities), the authors show that all-women teams (i.e. 3 women) performed the worst as compared with mixed gender and all-men groups.⁵ The best performers were mixed groups of two men and one woman.⁶

Hoogendorn et al. (2013) also provide supporting evidence on the belief that mixed-gender company boards perform better. In that study, the authors collected data on real companies created and managed by students enrolled in the Entrepreneurship program of the Department of

⁴ In the game, the firm share value is driven by past performance.

⁵ This statistically significant result is driven by the extremely poor performance of the first decile of 3W teams along the performance measure.

⁶ Kuhn and Villeval (2015) have shown that selection in teams depends on incentives, with men being attracted to most competitive compensations systems, such as tournament awards. In order to make sure that the main result is not grounded in some self-selection bias (for instance, attracting to this tournament relatively better men than women), the authors use a large list of controls.

International Business Studies of the Amsterdam College of Applied Sciences. In 2008-2009, 550 students created 45 companies, with teams of between 9 and 16 students. Students were randomly allocated to a group; the average proportion of women in each group varied between 0.17 to 0.58. The authors' key finding from analyzing the results was that business teams with an equal gender mix performed better than male-dominated teams in terms of profits and sales. Groups with a majority of women seemed to perform better in terms of profits than groups with a majority of men, but statistical tests were inconclusive. The authors acknowledge that despite running several tests, they could not identify any process which could potentially explain these differences in performance.

Our study differs from that by Apesteguia et al. (2012) in several respects. First, the data set is different, and builds on a business game that incorporates the strategic dimension by allowing teams to compete one against the other. Second, while they use only cross section data, our performance analysis includes firms and rounds, in a standard panel analysis. Third, in our sample students were randomly allocated to teams, like in the study by Hoogendorn et al. (2013), which allows ruling out any potential self-selection bias. Finally, we collected data on individual tolerance to risk, and investigated whether group tolerance to risk had a mediating effect on the relationship between gender composition and firm performance.

The paper is organized as follows: The next section introduces the *Kallystée* business game. Section 3 provides the empirical methodology and results. The last section presents our conclusion.

2. The *Kallystée* Business Game: a primer

Kallystée was developed for a population of first-year university students with a strong general educational background, not yet trained in business administration. At ESSEC business school, the game is played by students admitted in the Master in Management Program (MiM) (19.8 years old on average in our sample), and those enrolled in the school's Bachelor in Business Administration (BBA) Program (18 years old on average).⁷ To date, approximately 10,000 students have participated in the game.

The game lasts for three days, with a dedicated time slot in the first-year students' Integration Week in October (November for BBA). It alternates periods of decision-making, with periods of training and marketing-related conferences. It has several learning goals which include: (1) providing young students who have very limited practical experience with a taste of real-life business decision-

⁷ The two degree programs have different admission tracks and different curricula. BBA students are recruited directly after high school, while the Master in Management program, which is part of the prestigious French "Grandes Ecoles" classification, recruits students who have studied a very intensive and demanding two-year post-high school program of Maths, History and Literature. These students must then pass a National competitive exam for admission to the program. Traditionally ESSEC admits approximately 350 such students each year. ESSEC's MiM program was ranked third by the 2014 *Financial Times's* ranking for Master in Management Programs.

making, (2) introducing fundamental concepts which will be further developed in specialized classes (e.g. return on assets, balance sheets, interest rates, demand elasticity, advertising, etc), (3) increasing student awareness of how important firms' strategic interaction is for decision making, and finally, (4) creating strong team-building skills by sharing a common academic experience (participation in the game by all first- year students is mandatory).

As with other business games, *Kallystée* aims to simulate the essentials of the market dynamics of a large company, with an established brand name, facing competition by a small number of similar rivals. In *Kallystée*, the virtual company is part of the cosmetics sector, the strong involvement of *l'Oréal Paris* bringing a touch of the real business world to the game.

The key observation unit is the "firm", represented by its "executive board" which comprises five students teamed together at random. Each team takes all the decisions over several periods or rounds. Firms are then grouped by five and assigned to a market, called "Universe". The composition of each Universe is kept constant and Universes are independent of each other. Each Universe reflects a market with five suppliers and its own computer- simulated demand (for each product variety). The simulation is run independently for each market. At the end of the game, a reward is provided to the best firm in each Universe. Students also obtain an individual grade for their assiduity and the presence is strictly monitored (which probably explains why the attendance is close to 100% during the whole of the three days).

The practical organization of the game requires substantial logistics. In the first day, the 300 to 400 first year students are allocated to teams, and provided with the rules and general instructions.⁸ For each Universe (5 firms), a "supervisor" (a professor or a last year student) is appointed to ensure that students understand the rules of the game, clarifies the most difficult concepts and monitors the teams in terms of group and individual assiduity. Decisions and interactions are computerized.

Groups then move to the school's gymnasium ("The Dome"), transformed for the purpose of the game in a large meeting room. Each firm has its own decision desk, where students meet, discuss, analyze and record the decisions using their laptops. Each firm's computers are connected to the ESSEC server. Once the decisions are recorded, the simulation is run on that server under the direct control of the administrators. Desks of firms belonging to the same Universe are placed as far as possible from each other. Teams are forbidden to communicate with other teams. A short movie filmed in 2011 shows how the simulation is actually played out (www.youtube.com/watch?v=VIED5L0geLI). A set of photos is also available Online.⁹

⁸ Rules and definitions are provided in a 66-page document, available Online at : <http://behavioralresearchlab.essec.edu/research/research-topics/results>.

⁹ See <http://behavioralresearchlab.essec.edu/research/research-topics/results>

At the very beginning of the game, students are required to work on a test decision that will be debriefed with the administrators, but will not be recorded. Then they move to the regular rounds of the “real” game. On average, the decision time per round is about two hours, followed by one hour where the administrators run the simulation and display the results.

The decision horizon comprises eight successive rounds for the MiM program and five rounds for the BBA students. At the beginning of the game ($t=1$), all firms have a similar “history”, i.e. they are identical in all respects: they have a similar balance sheet and a similar stock of inventories. In particular, they have a product (“skin cream”) of a relatively modest quality index ($q=3$) in stock. During a decision-making round, students must make a large number of decisions. For each product, they must make five specific decisions (procurement volume, selling price, commercial discount, referencing budget, and product-specific advertising expenses) and an additional 11 general decisions at the “firm level” (including general advertising and brand management, sales staff, R&D investment, short-term loans, long-term loans, trade credit, etc.).

Teams can launch new products, knowing that they are allowed to manage at most three products simultaneously. For each new product, the management team can choose a quality index as an integer between 1 and 15. Investment in R&D is needed to launch any new product in the next round. However, once the development phase is completed, the firm will “buy” the product from an external manufacturer that will use its design.¹⁰ The firm must pay a higher price to acquire a higher quality product.

At the end of each round teams are provided with comprehensive feedback about the consequences of their decisions. A key piece of information is the number of items sold: given the posted price and various fixed and variable costs, this ultimately determines profit and loss. After each round, firms also learn what products were brought to market by their rivals, their sales, price, total marketing spending, and market share. Turnover, net returns and equity of all firms are displayed on a large electronic board after each round.

In each Universe of five firms, the total demand varies over time, with certain decisions boosting total demand (e.g., product diversification or total advertising has a positive impact on total demand). For each product, the demand addressed to one specific firm depends on total market demand and on the price and marketing strategies of this firm, relative to the price and marketing strategies of its four rivals. The game allows for a large number of advertising levers (at least six), all having a positive and different impact on demand via the “attractiveness” of the product, but which all come with a cost which must be taken into account. Launching a new product, with an optimal

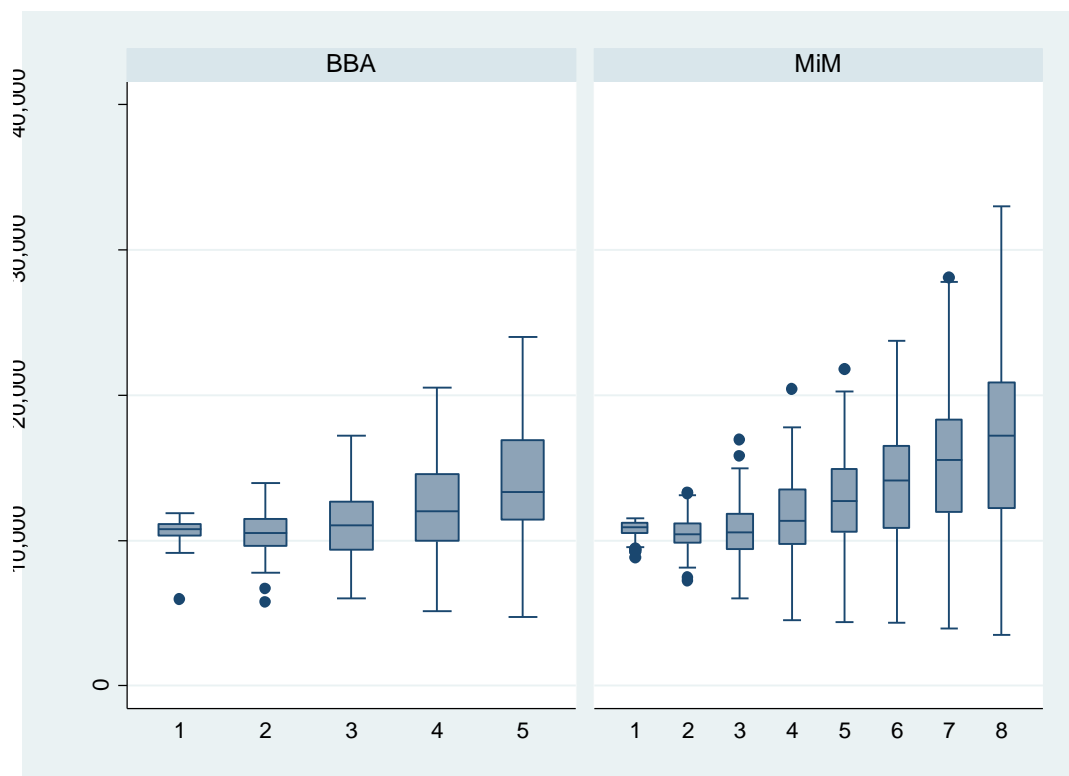
¹⁰ By “externalizing” the production process, the game allows for a simple production decision to be made.

combination of general and specific advertising helping to create its brand identity, and being sold at the “right price” are the keys to success.

As mentioned above, *Kallystée* involves several financial decisions. Launching a new product requires investment in R&D and several sources of funding are available. Firms which choose the best financing combination will have lower financial costs. The management of liquidity is also important, and experience shows that this is a difficult topic for first-year students. Poor financial management is often responsible for large losses.

At the beginning of the game, all firms have the same equity. Losses reduce equity, and net profits are reinvested in the firm. No dividend is distributed.

To bring some additional intuition, Figure 1 displays the evolution of the firms’ total equity, as recorded during our experiment. The left-hand graph applies to BBA students, who play the game for five rounds, the right-hand graph to MiM students, who play the game for eight rounds. The box plot representation highlights that the economic performance is quite diverse, with some firms doing very well, while others are close to bankruptcy. The performance gap widens over time.



The box indicates the 75% percentile as the upper hinge, the 25% percentile as the lower hinge and the median; the other elements are the upper / lower adjacent lines, dots are outliers.

Figure 1. The evolution of total equity, BBA (80 firms) and MiM (140 firms)

In this context, it is common knowledge that the key economic performance indicator is total equity at the end of the game (i.e., the cumulated operating profit). Furthermore, in each market there is only one award winner, normally the firm with the highest equity. At the end of the game, winning teams will present their firm performance and strategy, in a four-minute talk, before all colleagues, the professors and the *l'Oréal* representatives. They also receive a bundle of *l'Oréal* high-end, expensive products. In this respect, incentives to perform well as a team are quite strong.

3. The empirical analysis

3.1. The data

The database was constructed by merging firm-level data from *Kallystée* with individual-level data from a personal survey administered during the game to all the individual members of firms. We complemented this individual-level data with ESSEC administrative data.

Individual data consisted of 1100 students. The mean age was 19.25 year old (19.8 for MiM students and 18.0 for BBA students). For 85.3% of them, the father's education level was higher than secondary education (85.9%, and 83.8% in the MiM and BBA programs respectively); for 82% of them, the mother's education level was higher than secondary education (83.1%, and 80.7% in the MiM and BBA programs respectively). The difference between the father's education levels of students enrolled in the MiM and students enrolled in the BBA programmes was not statistically significant ($p = 0.39$), nor was statically significant the difference in mothers' education levels ($p = 0.37$) between MiM and BBA students.

We collected firm level data for 44 Universes (markets) with five companies in each market, for a total of 220 firms. There were 140 firms in the MiM program and 80 firms in the BBA program. The gender composition of companies in our sample, as resulted for the random allocation of the students to the firms, is displayed in Table 1, which present overall data and data split by academic year and education programme. The percentage of companies with 0W, 1W, 2W, 3W, 4W and 5W were respectively 17,7%, 20,9%, 13,2%, 11,8%, 17,3% and 19,1%. The distribution of firms by gender composition was not significantly different between academic years ($p = 0,34$) and between programs ($p = 0,65$).

Nb. of women in the firm	Full sample		Academic year				Program			
	n	%	2012		2013		MiM		BBA	
			n	%	n	%	n	%	n	%
0	39	17,73	19	16,52	20	19,05	24	17,14	15	18,75
1	46	20,91	25	21,74	21	20,00	28	20,00	18	22,50
2	29	13,18	20	17,39	9	8,57	20	14,29	9	11,25
3	26	11,82	15	13,04	11	10,48	20	14,29	6	7,50
4	38	17,27	18	15,65	20	19,05	24	17,14	14	17,50
5	42	19,09	18	15,65	24	22,86	24	17,14	18	22,50
Nb. Obs.	220		115		105		140		80	

Table 1. Number and distribution of firms with respect to gender composition

The background characteristics of firms (i.e., average age of firm members, percentage of firm members whose father's education level is higher than secondary education, percentage of firm members whose mother's education level is higher than secondary education) do not differ between firms with different gender composition (5M, 1W, 2W, 3W, 4W and 5W) (Table 2), which points out that the randomization procedure was applied properly.

Nb. of women in the firm	% of firm members whose father 's education level > secondary education		% of firm members whose mother 's education level > secondary education		Average age	
	mean	std	mean	std	mean	std
0	0,84	0,23	0,85	0,18	19,26	0,90
1	0,85	0,18	0,83	0,18	19,07	1,06
2	0,84	0,19	0,80	0,20	19,35	0,91
3	0,84	0,20	0,84	0,19	19,33	0,75
4	0,87	0,17	0,82	0,19	19,06	0,83
5	0,85	0,17	0,86	0,15	19,02	1,04
Nb. obs.	220		220		220	

Table 2. Background characteristics of the firms by gender composition

Before moving to our main analyses on performance and risk-taking, conducted at the firm level, we present the results pertaining to tolerance to risk, as observed at the individual level.

3.2. Individual tolerance to risk

Individual tolerance to risk was measured through an internet-administered survey which all individual participants had to fill in at the fourth round of the game. All students ($n=1,100$) were asked the following question: *How do you see yourself? Are you generally a person fully prepared to take risks or do you avoid taking risks?* Please tick a box on this 10-point scale, where the box number 1 is "Unwilling to take risks" and box number 10 is "Fully prepared to take risks". This measure of tolerance to risk was introduced by Dohmen et al. (2011), who also showed that this survey measure correlates well with standard incentivized measures of tolerance to risk (see also Both and Nolan (2012) and Vieder et al. (2014)).

The survey answering rate was 95.5% for the MiM program (in both 2012/2013 and 2013/2014 sessions) and 72.7% for the BBA program (respectively 74.7% and 70.3% in 2012/2013 and 2013/2014 sessions). The percentage of missing answers did not significantly differ between male respondents (14%) and female respondents (11.5%) ($p = 0.22$). Furthermore there were no significant differences by group gender composition at the firm level, with the percentage of missing answers ranging from 11.6% to 15.9% ($p = 0.60$).

Women appeared to be significantly ($p < 0.001$) more risk-averse than men, with mean tolerance to risk rates of 5.78 and 6.43 for women and men, respectively (a higher rate corresponding to a higher tolerance to risk).

This result also held when we studied the relationship between tolerance to risk and gender, while controlling for individual characteristics including age, father's education level, mother's education level, type of program attended (MiM or BBA), academic year (2012/2013 or 2013/2014) and place of residence during high school.

Table 3 reports the output of a simple OLS regression model with "tolerance to risk" (as self-reported by participants on the 10-point scale measure - from (1) "Unwilling to take risks" to (10) "Fully prepared to take risks" - as the dependent variable. The coefficient of the dummy variable (1 if the subject is female) is large, negative, and statistically significant.

	Coef
Female	-0,632***
Age	0,054
Father 's education level: > secondary education	0,033
Mother 's education level: > secondary education	0,000
Attends MiM program (versus BBA program)	-0,270
Year 2013	-0,346***
Number of observations	958

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

The regression also included dummies for place of residence during high school

Table 3. Regression on individual tolerance to risk.

3.3. Moving from individual to group tolerance to risk

Our analysis requires a measure of the tolerance to risk of the group. There is no definitive theoretical model about how groups make their decisions. Various voting models and bargaining models exist, each with its own predictions. One natural proxy for the tolerance to risk of the group was the total group tolerance to risk, obtained by summing up individual tolerances to risk. In order to normalize it, we divided it by five, and obtained the average tolerance to risk of the group. Missing individual values for female (respectively male) respondents were replaced by the average values computed for female (respectively male) respondents in the same academic year (2012/2013 or 2013/2014) and in the same program (MiM or BBA).

Certainly, other measures could also be considered, for example a weighted average. However, in the absence of a dominant theory of preference aggregation, the average tolerance would appear to be the most intuitively appealing measure. Indeed, using only this measure is in line with the current policymakers' beliefs, according to which groups including more women should present a lower tolerance to risk. In our sample, this relationship between the number of women and tolerance to risk of the group is a mechanical consequence of the fact that women present a lower individual tolerance to risk than men.

Before investigating the relationship between gender composition, economic performance and group tolerance to risk, we first checked that gender composition was indeed related to the tolerance to risk of the groups.

Table 4 presents the output of a regression model with group tolerance to risk as the dependent variable. As we can see, a significant relationship exists between gender composition and group tolerance to risk, with groups comprising a majority of men being significantly less risk-averse. 5M,

1W and 2W groups had a significantly higher tolerance to risk than the reference 5W groups. 4W groups were not significantly different from their 5W counterparts in terms of average tolerance to risk. 3W groups exhibited a moderate tolerance to risk and were more tolerant to risk than 5W groups at a 10% significant level.

	Coef
Number of women in the firm: 0	0,518**
Number of women in the firm: 1	0,518***
Number of women in the firm: 2	0,486**
Number of women in the firm: 3	0,337*
Number of women in the firm: 4	-0,124
Number of women in the firm: 5	<i>ref</i>
% of firm members whose father 's education level : > secondary education	0,326
% of firm members whose mother 's education level : > secondary education	-0,097
Average age in the firm	-0,015
MiM program	0,029
Year 2013	-0,189*
Number of observations	220

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 4. Relationship between group gender composition and average tolerance to risk (OLS)

3.4. The economic performance equation

As explained above, the main criterion for success in *Kallystée* is to achieve the highest level of equity at the end of the game (within each Universe), in a context where firms compete strategically against each other.

The 140 companies from the MiM played the game for 8 rounds, while the 80 companies from the BBA played 5 rounds (See Figure 1). Hence our dataset was made of 1,520 firm-level observations with a three-level hierarchical structure. Firms' decisions were observed at several rounds (therefore resulting in variables being correlated with one another for a given firm) and firms were nested within Universes that may have had specific features. In particular, as mentioned above, the competitive dynamics can vary from one Universe to another. In "cooperative" Universes, the ranking of companies in terms of equity levels is expected to be relatively stable over time. Ranking reversals are expected in more competitive Universes.

With e_{tiu} the equity level at time t for firm i in universe u , we estimated the following equation:

$$e_{tiu} = g'_{tiu}\alpha + x'_{tiu}\beta + \mu_u + v_{iu} + \varepsilon_{tiu} \quad (1)$$

where g_{tiu} is a vector of gender composition dummies, and x_{tiu} is a vector of covariates. Error terms are broken down into normally distributed universe-specific effects μ_u , firm-specific effects v_{iu} and time-specific chance events ε_{tiu} .

In the next step we estimated the augmented equation:

$$e_{tiu} = g'_{tiu}\alpha + x'_{tiu}\beta + a_{iu}\gamma + \mu_u + v_{iu} + \varepsilon_{tiu} \quad (2)$$

where a_{iu} is the average tolerance to risk of the group.

In this second model, the vector of coefficients α captures the partial effect of gender composition *after controlling for average tolerance to risk*. If α coefficients in model (2) are attenuated relative to corresponding coefficients in model (1), this would hint that group tolerance to risk is a mediating factor in explaining the overall gender composition effect.

Table 5 presents the relationship between gender composition of teams and economic performance (expressed as equity level). We chose the all-women groups as the reference groups, in order to facilitate comparison of results with Apesteguia et al. (2012) who also adopted this convention. Estimates were performed using the *gllamm6* routine in *Stata*, a powerful method for fitting a wide range of multilevel models.¹¹

First note that firm-level and universe-level random-effects are statistically significant, which validates our estimation strategy of using a hierarchical random effects model with firm effects and universe effects.

Output estimates of Equation 1 (Table 5, first column) show that all-men (5M) teams and 4W teams performed significantly better than all-women teams. We can notice that all-women teams perform worse than all other group combinations, but the difference is not statistically significant as compared with 1W, 2W and 3W teams. In this respect, our result would qualify without rejecting the result by Apesteguia et al. (2012) according to whom all-women teams perform significantly worse than all other teams.

There is another important difference with the findings by Apesteguia et al. (2012). In their analysis, mixed groups with a dominant male composition (i.e., two men and one woman) performed best. In our analysis, mixed groups with a dominant female composition (4W) appear to be the best performers. This result is more in line with Hoogendoorn et al. (2013) who also pointed out the strong performance of equally mixed gender teams and suggested that, in their sample, teams with a majority of women might perform even better.

¹¹ See for an introduction to these Generalized Linear Latent and Mixed Models (GLLAMM) the text by Rabe-Hesketh S, Skrondal A, and Pickles A. (2004).

	Equation (1) Coef	Equation (2) Coef
Number of women in the firm: 0 (5M)	1171** ^a	441 ^b
Number of women in the firm: 1	362	262
Number of women in the firm: 2	273	179
Number of women in the firm: 3	342	328
Number of women in the firm: 4	1291** ^a	1270** ^b
Number of women in the firm: 5	<i>ref</i>	<i>ref</i>
% of firm members whose father 's education level : > secondary education	368*	367*
% of firm members whose mother 's education level : > secondary education	324*	282*
Average age of individuals in the team	124	119
Year 2013	-793**	-731***
MiM program	2098**	1991***
Round 1	<i>ref</i>	<i>ref</i>
Round 2	-234	-234
Round 3	139	139
Round 4	1114***	1114***
Round 5	2554***	2554***
Round 6	3101***	3101***
Round 7	4564***	4564***
Round 8	6311***	6311***
Average risk self-assessment		806***
Variances and covariances of random-effects		
level 1	5184685 (201983)	5116560 (197190)
level 2 (firm)	6226242 (626474)	6483597 (564633)
level 3 (universe)	311600 (32578)	385175 (28634)
Number of observations	1520	1520

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively

a) Wald test of H0: the coefficients of 5M and 4W dummies are equal; p = 0,42

b) Wald test of H'0: the coefficients 5M and 4W dummies are equal; p = 0,03

Table 5. Association between group gender composition and economic performance

The last column in Table 5 presents output estimates of Equation 2; the set of control variables includes now the group (average) tolerance to risk. First, we notice that group tolerance to risk had a significant positive impact on economic performance. This result is not surprising: if groups with a higher tolerance to risk take more risks, economic performance improves. Second, when controlling for group tolerance to risk (increasing in the number of men in the group), 5M teams no longer perform significantly better than 5W teams (the coefficient becomes insignificant). Moreover, the

estimated coefficient of the 5M dummy was significantly cut down ($p < 0,01$), thereby suggesting that average tolerance to risk is one important mechanism through which gender composition impacts economic performance. This suggests that all-men groups perform better mostly because they were on average more tolerant to risk.

However, after controlling for group tolerance to risk, 4W groups still performed significantly better than 5W groups. Actually, the coefficient on 4W group was not attenuated when including the new control variable.¹² Our results suggest that, for a given level of risk aversion, 4W teams performed better. This finding points out some hidden “performance enhancing mechanism” that might have been at play in 4W groups.

Gender interaction in balanced groups might well entail a more positive group dynamic or preference shift, leading to higher quality decision making (Azmat, 2014; Hoogendoorn, 2013). Unfortunately, our data do not allow us to dig further in the psychological determinants of this outcome. However, by analyzing the actual risk taking behavior in this game we can infer whether this “abnormally” good performance can be connected to risk taking or not (see section 3.5 below).

Other results in Table 5 show that equity levels are higher in firms whose members had parents with higher education level. Furthermore, as expected, equity levels significantly increased over time. Average age of individuals in teams was not significantly associated with increased performance.

Our performance regression analysis might be criticized on ground that the number of control variables is small; however, if in a resource-free world we could gather more data, such as individuals’ management skills or IQ, we must keep in mind that our firm data resulted from a randomized allocation of a relatively homogenous population of students across firms, which normally should rule out or at least contain any systematic bias.

As a robustness check, we also run a performance regression model using as a measure of performance the equity rank of the firm within each market of five firms (instead of the equity level). Results obtained from a categorical data regression model (with the firm rank as the dependent variable) were not qualitatively different from those presented in Table 5.

3.5. Association between gender composition and risk-taking behavior

In this section we used both a direct and an indirect measure of actual risk-taking behavior to study the impact of group gender composition on actual risk-taking behavior.

Launching a new product is a very challenging decision in *Kallystée*. It requires a realistic forecast of future sales, many calculations to determine the expected unit cost, and a clever pricing strategy. In general, teams launch at most one or two new products over the eight rounds.

¹² The coefficient of the 4W dummy variable is now significantly different from the coefficient of the 5M (or 0W) dummy variable (see Wald test in Table 5), while they were similar when we did not control for the risk variable.

In Figure 2, we present the evolution of the average number of products and of the degree of complexity for the MiM simulation. At the second round the average number of products was lower than two, showing that not all firms had launched a second product. After round six (i.e. MiM only) firms no longer launched new products, expecting that they would not have enough time left to reap any benefit. The average quality index rose over time.

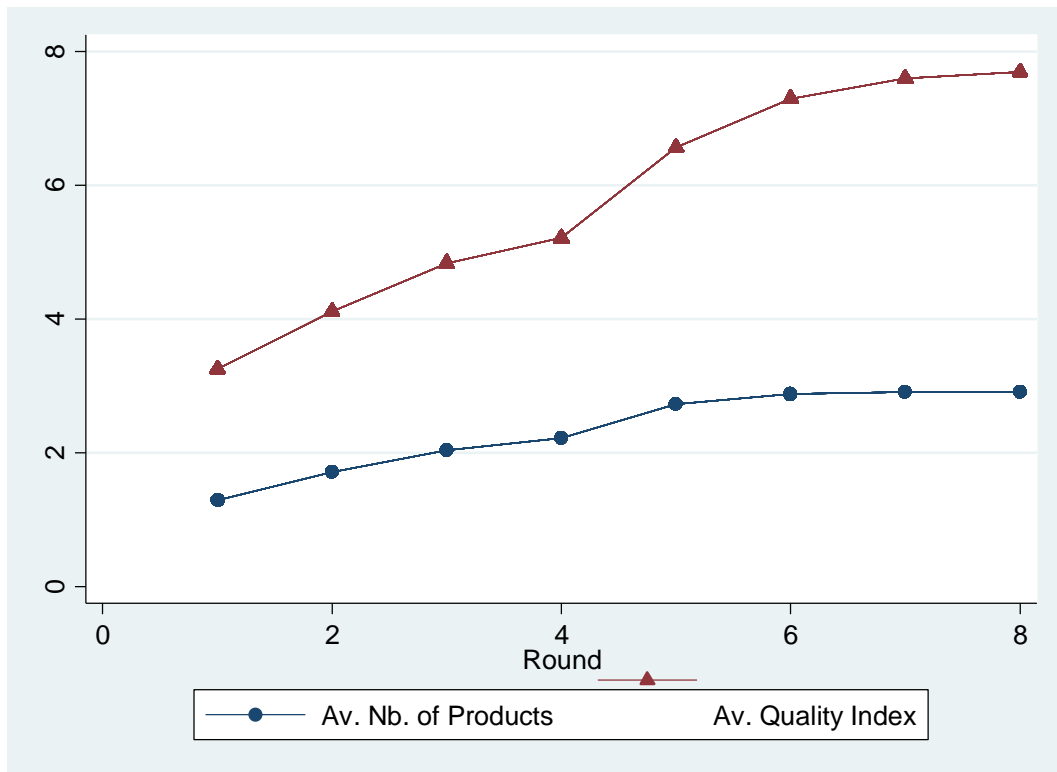


Figure 2. Average number of products and average quality index over time (MiM sample)

For a first mover, launching a new product comes with a strategic risk, because a competitor can simultaneously bring an identical product to the market. In this case both firms would incur losses, because they must share the market and might not be able to cover the development cost of the new product. However, being the first to launch an original high-quality product is clearly a successful strategy in this game (and probably in real life too). Hence, launching a new complex product at round 2 is clearly a risky decision. Launching a third product early in the game can also be seen as a risky decision, for the same reasons invoked above, but the strength of the test is weaker than for the second product (only firms that have already launched a second product at round 2 can subsequently launch a third product). This definition of “risk-taking” is largely shared by participants. In the survey (see above) administered at the fourth round, we asked participants what, in their opinion, a risky decision in this game was. The majority referred to "launching a complex product quickly".

We therefore created two dummy variables as direct measures of risk-taking behaviors: the first takes the value 1 if the firm launched a product with a quality index higher than 7, at round 2 (we remind the reader that the basic product the firm has already been producing has a quality index $q=3$). The second variable takes the value 1 if the firm launched a third product with a quality index higher than 7 at round 3.

Table 6 presents the output of the regressions with the two dummies as dependent variables, and the group composition dummies as main independent variables. Results in the first two columns refer to Model 1 where the dependent variable is “launch a complex new product in period 2”, and results in the last two columns refer to Model 2, where the dependent variable is “launch a third complex product in period 3”. Note that, for these cross-section estimations our sample is reduced to 220 observations (one observation per firm) and the structure of the regression is a two-level hierarchical model with a universe specific error term.

	Model (1)		Model (2)	
	(a)	(b)	(a)	(b)
	Coef	Coef	Coef	Coef
Number of women in the firm: 0	0,994**	0,582**	0,311	0,225
Number of women in the firm: 1	0,678*	0,567*	0,291	0,204
Number of women in the firm: 2	0,674	0,565	-0,075	-0,067
Number of women in the firm: 3	0,509	0,424	0,254	0,205
Number of women in the firm: 4	0,454	0,459	0,648**	0,645**
Number of women in the firm: 5	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>
% of firm members whose father 's education level : > secondary education	0,830	0,83	2,137**	2,109**
% of firm members whose mother 's education level : > secondary education	-0,227	-0,266	-0,622	-0,598
Average age of individuals in the team	-0,060	-0,064	0,077	0,084
MiM program	-0,079	-0,063	-0,544	-0,57
Year 2013	-0,018	0,013	-0,865	-0,862
Average risk self-assessment		0,487**		0,153**
Nmber of observations	220	220	220	220

(1) Launch of a second complex product in period 2 (yes/no)

(2) Launch of a third complex product in period 3 (yes/no)

(a) without average risk self-assessment (b) including average risk self-assessment

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 6. Association between group gender composition and launching a new high quality product (random effects probit models)

As expected, in this “real” decision-making context, all-women groups took the least risks, although the difference was not statistically significant with groups where the number of women was bigger than two. At round 2, all-men groups and groups with a large majority of men (i.e. with only one woman) would be the most “aggressive” in launching new products, as shown by the respective coefficients in Model 1a. Model 1b shows that for these groups, this “first-mover” attitude goes beyond what average tolerance to risk would allow to foresee, as the group gender coefficients stay significant (but smaller) after introducing the average tolerance to risk control. The 4W groups (shown to have the best economic performance) were the most likely to launch a third high-quality product in the third period, in a subtle mix of prudence and risk taking.

The significant coefficient of the average tolerance to risk (in both (b) specifications) confirm that teams who were more tolerant to risk were more likely to take risks in launching new products at an early stage of the game.

Since firms aiming to launch new products must first invest in R&D, and as the volume of R&D is related to the quality of the product to be launched, R&D investment is a good *indirect* measure of risk-taking behavior.

Table 7 presents the estimates of an “investment equation” investigating the relationship between the teams’ gender composition and the amount of R&D investment. Estimates in columns 1 and 2 used the full panel dataset (with and without the group tolerance to risk). Because investment naturally declines before the end of the game, the last column presents estimates for the first 5 rounds only for MIM, and 2 rounds for BBA.

Following the pattern put forward in the product launch analysis, all-men and 1W groups carried out significantly more R&D than all-women groups. We also notice that 4W groups invested significantly more in R&D than all-women groups (in line with their decision to launch a third high-quality product in the third round).

Both the analyses of product launching and of R&D investment suggest that 4W teams (as well as male dominated groups) appear to take risks beyond what their average tolerance to risk as a group would suggest. Evidence for the “risk-shift” phenomenon in decision groups, whereby people in groups tend to adopt a riskier course of action than if they had to make decisions on an individual basis, was provided by psychologists some decades ago (inter alia: Wallach et al., 1962; Wallach and Kogan, 1965; Clark, 1971).

In turn, this “fighter” or “first-mover” attitude of 4W teams is probably justifying the “abnormal” strong performance of these teams as revealed by the performance analysis in the previous section.

	(1) Coef	(2) Coef	(3) Coef
Number of women in the firm: 0	18,691**	23,863**	18,801**
Number of women in the firm: 1	17,624**	20,704**	17,583**
Number of women in the firm: 2	13,414	16,446*	14,076
Number of women in the firm: 3	12,281	14,451	12,803
Number of women in the firm: 4	16,645**	15,668**	16,528**
Number of women in the firm: 5	<i>ref</i>	<i>ref</i>	<i>ref</i>
% of firm members whose father 's education level : > secondary education	23,899*	25,845*	29,773*
% of firm members whose mother 's education level : > secondary education	9,325	8,494	7,484
Average age of individuals in the firm	9,19	9,125	9,79791
Year 2013	5,957	4,521	5,459
MiM program	15,866	16,013	15,357
Round 1	<i>ref</i>	<i>ref</i>	<i>ref</i>
Round 2	-41,622	-41,622	-41,622
Round 3	-42,386	-42,386	-42,642
Round 4	-44,409**	-44,409**	-41,857
Round 5	-26,363**	-26,363**	-22,0364
Round 6	-44,996**	-44,996**	
Round 7	-58,998**	-58,996**	
Round 8	-57,053**	-57,053**	
Average risk self-assessment	8,528**		8,599***
Variances and covariances of random-effects			
level 1	11193 (406)	11215 (406)	15218 (733)
level 2 (firm)	11881 (442)	11727 (423)	13954 (564)
level 3 (universe)	1867 (90)	1985 (98)	2231 (104)
Number of observations	1520	1520	860

(1) Full sample

(2) Full sample (without average risk self-assessment)

(3) rounds 1-5 for MimM and rounds 1-2 for BBA

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 7. Association between group gender composition and R&D investments (3-level hierarchical linear regression model)

As mentioned above, tolerance to risk was measured using an online test administered at the fourth round of the game. At that time, students had already taken the most critical decisions, in particular whether to launch new products, and what the quality of products should have been. In the same survey, subjects were asked to answer the following question: “with respect to decisions

taken so far by your team in the *Kallystée* business game, did the team take more risks than you would have taken on your own?”. They could answer on an increasing scale from 1 to 5, where values 1, 3 and 5 were “less risk”, “same risk” and “more risk” (5), respectively. We collected 958 answers with 35% percent of the population giving scale values of 4 and 5. This question provided us with an additional check for our risk-shift hypothesis in 4W groups.

We built an indicator variable taking the value 1 for scale answers 4 and 5 (the individual declared that the group took more risk than he/she would have personally taken), and 0 for the remaining answers. Table 8 presents the estimation output of a Probit model, with this indicator as the dependent variable and the group composition dummies as covariates, as well as other controls.

	Coef
Female	0,386***
Age	<-0.001
Father 's education level: > secondary education	-0,031
Mother 's education level: > secondary education	0,329***
Attends MiM program (versus BBA program)	-0,092
Year 2013	-0,281***
Number of women in the firm: 0	0,172
Number of women in the firm: 1	-0,005
Number of women in the firm: 2	0,156
Number of women in the firm: 3	-0,076
Number of women in the firm: 4	0,283**
Number of women in the firm: 5	<i>ref</i>
Number of observations	958

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Table 8. Probability of individuals declaring that the group took more risk than they would have personally taken by themselves

Among the group composition dummies, 4W groups distinguish themselves by a significant positive coefficient. Individuals in 4W groups were significantly more likely (than 5W groups) to declare that the group took more risk than they would have taken on their own, which is consistent with the risk-shift assumption expressed above. Interestingly, this result holds even when controlling for the respondent’s gender, with our results showing that female respondents were more likely to declare that the group took more risks than they would have taken on their own.

4. Conclusion

This paper analyzed the relationship between the gender composition of a decision group on economic performance and risk taking behavior, using data collected in 2012 and 2013 from an original business game developed for the ESSEC Business School. Certainly, results from the analysis of a business game using student subjects should be taken with extreme caution when looking for policy implications and generalizations. In particular, the fact that the business game was played by participants without managerial experience might be a limitation; it would be interesting to see if the same results hold for experienced managers playing the game.

The observed behavior is as much related to preferences and roles, as it is to the reading of the sometimes complex game rules by different individuals. Some noise in the observed data is inherent to such “open-space” three-day experiment since subjects can interact during the game, although rules forbid it. We attempted to deal with this difficulty by collecting a relatively large number of observations, and choosing an estimation technique – three-level hierarchical regression for panel data – which allows us to contain estimation biases. The randomized allocation of students into various groups also helped us to rule out any would-be self-selection bias.

Our analysis of economic performance corroborates but also qualifies to some extent the early findings by Apesteguia et al. (2012). They showed that all-women groups performed significantly worse than groups of other gender combinations; we also find a poor performance of all-women groups, but this poor performance is not statistically different from the performance of some mixed groups (1W, 2W, 3W). Like in Apesteguia et al (2012), in our analysis too mixed groups performed the best. Unlike their analysis where mixed groups with a majority of men performed the best, in our data the best performers are mixed groups with a strong majority of women (4W), a result closer to that of Hoogendoorn et al. (2013).

Moving beyond the sheer performance analysis, we carried out a joint analysis of group economic performance and tolerance to risk. The performance analysis has revealed that all-men teams and 4W teams perform significantly better than all women teams. However, when controlling for group tolerance to risk, the performance premium of all-men groups vanished, while the performance premium of all other gender combination teams diminished. It turns out that group tolerance to risk has an important mediating effect on economic performance.

Even when controlling for average tolerance to risk, 4W teams perform significantly better than all-women teams. In order to dig further in the determinants of this “abnormal” performance, we analyze more in depth the actual risk-taking decisions. We found that men dominated teams adopt aggressive “first-mover” strategies, by launching new products and investing heavily in R&D. Mixed 4W teams do also take risks, and take risks more than the average tolerance to risk would indicate us

as if these groups develop some specific form of “risk-shift” mechanism. An opinion survey administered during the game corroborated this important finding, with a significant number of individuals belonging to 4W groups declaring that the group took more risks than they would have taken by themselves.

Further research is needed to fully understand to what extent group interaction may lead to higher performance in groups with gender diversity. In the meantime, our preliminary findings support the call for increasing board gender diversity, as the best performance is achieved by mixed teams, true, not without taking risks.

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