3-1-2017

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International Center for Public Policy

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Working Paper 17-04
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Regulatory Protective Measures and Risky Behavior: Evidence from Ice Hockey

Alberto Chong and Pascual Restrepo*

March 25, 2017

Abstract

We provide evidence supporting the Peltzman effect, by which individuals required to wear protective gear end up taking additional risks that potentially offset the intended aim of the device. We take advantage of the fact that wearing a visor—a protective device in Ice Hockey—is mandatory in European, minor, and junior leagues but not in the NHL. This allows us to estimate the impact of wearing a visor by comparing the behavior in the NHL and other leagues of players who always wear a visor with that of players who wear one only when it is required. We find that when players are forced to wear a visor their behavior becomes more risky, earning an additional 0.19 penalty in minutes per game (compared to the average 1.14 penalty in minutes in our sample). We estimate an even larger effect of visors when we focus on players who were forced to use one during the 2004 season, when the NHL canceled its regular season and players had to move to European leagues temporarily. These estimates are not driven by players' observable attributes, playing style, or other differences across leagues.

JEL Classification: K32, K23, H40

Keywords: Peltzman Effect, Protective Measures, Risky Behavior

The effectiveness of safety and protective devices, such as seatbelts in cars, helmets for bicycle riders, or hormonal injections to prevent pregnancies, requires that the behavior of individuals remains constant regardless of the use of such devices. However, it is unclear whether this is the case, or whether people adapt to the additional protection by taking more risks, in which case the intended effect may end up being diluted or even negated. The use of protective devices reduces the cost of risky behavior and could increase aggressiveness and risk-taking. This behavioral response not only dampens the effectiveness of the device

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but may also create negative spillovers on others. For example, risky driving endangers the driver, and it imperils pedestrians and other passengers. The existence of this compensating behavior, widely known as the *Peltzman Effect*, could have vast implications for government intervention and regulation in the economy (see Peltzman, 1975).

Despite its relevance, the existing empirical evidence on compensating behavior remains scant and inconclusive. Researchers have tested for the Peltzman Effect by measuring the impact of seatbelt laws on fatalities among car occupants and pedestrians. Using time-series or cross-sectional variation, Harvey and Durbin (1986); Asch et al. (1991); Garbacz (1992); Risa (1994); Loeb (1995) find an increase in accidents or non-occupant fatalities following the introduction of seatbelt laws. But it is hard to take this evidence as causal given that it relies only on cross-sectional or time-series variation—a fact that raises concerns about omitted variables bias. In one notable exception, Cohen and Einav (2003) use within-state variation and find no evidence of compensatory behavior following the staggered introduction of seatbelt laws across US states. In addition to its lack of natural experiments to exploit, the empirical literature's main shortcoming is that it focuses on aggregate, imprecise, and indirect proxies of behavior.[1] The use of aggregate data is likely to attenuate the estimates because compensating behavior only arises from people for whom the regulation was binding—the compliers. Moreover, aggregate outcomes can be contaminated by other policies. In the seatbelt case, safety awareness campaigns are typically implemented along with seatbelt regulation.

In this paper we exploit a natural experiment from Ice Hockey that addresses these shortcomings and provides robust evidence of the Peltzman effect. We take advantage of the fact that wearing a visor—a protective device in Ice Hockey—is mandatory in European, minor, and junior leagues but not in the NHL. We identify compliers by checking which players did not use a visor in the NHL—where it is up to the players to decide if they want to use a visor or not. This allows us to estimate the impact of wearing a visor by comparing the behavior in the NHL and other leagues of *always wearers*—players who willingly wear a visor—with that of *compliers*—players who only wear one when it is mandatory. Peltzman's theory suggests that wearing a visor provides players with additional protection and an extra sense of safety, which translates into more aggressive skating. We measure this behavioral response at the individual level using *penalty in minutes per game*, a commonly accepted variable in Ice Hockey that reflects aggressiveness and risky behavior(see Ashare, ed, 2000). Players earn penalty minutes for boarding, charging, checking, and related behavior that imposes risk not only on their selves but, more importantly, on other players, too.

We focus on the universe of players who skated in the NHL during the 2001 to 2006 regular seasons, for whom we obtained detailed individual data on personal characteristics and game-play statistics for the NHL 2001-2006 seasons and seasons during which they skated in European, minor pro, or junior leagues, all of which mandate visor use. In addition, for every player we collect data on whether he wore a visor willingly while playing in the NHL 2001-2006 seasons. We estimate the behavioral effect of

[1] Besides the literature on seatbelt regulation, our paper is related to recent contributions that investigate the existence of the Peltzman effect in sports. Pope and Tollison (2010) and Sobel and Nesbit (2007) use data from competitive car racing, in which compliance and enforcement are automatic. Although these studies find evidence of compensating behavior, they rely on imperfect proxys for risk taking and cannot account for trends in racing accidents that could compromise the interpretation of their results.

requiring a player to wear a visor by comparing the differences in penalty in minutes per game between compliers and always wearers in the NHL 2001-2006 regular seasons—where only always wearers skate with a visor—with the difference in leagues that require both type of players to wear a visor. We also exploit the fact that there was no 2004 season in the NHL. The lockout led to an exogenous and temporary exodus of players to European and minor pro leagues, where compliers were required to wear a visor. Both empirical strategies identify the effect that wearing a visor has on compliers, when due to league regulation they are forced to wear one.

Unlike most of the existing empirical evidence, we find that there is significant compensating behavior among hockey players when they are required to wear a visor. We estimate that whereas the average penalty in minutes per game is 1.13, mandatory visor wearing produces a substantial increase of 0.19 penalty in minutes per game. We also find that wearing a visor has a small, negative effect on performance, measured by goals per game, which is consistent with players claims that visors tend to reduce vision (although the fact that these effects are not very robust and are small suggests that some of these claims may be exaggerated). We obtain very similar results when we focus on the 2004 lockout. We find that while compliers and always wearers behaved similarly during the 2001-2003 NHL seasons, compliers earned 0.4 more penalty minutes than always wearers during the lockout in 2004 when they had to play in other leagues that require visor use. Reassuringly, when players returned to the NHL in 2005 and 2006 this difference between compliers and always wearers vanished. Finally, we provide evidence that suggests that our results are not driven by compliers being differentially affected by other league characteristics or by observable differences across players that could determine whether they adapt differently to certain leagues.

The rest of the paper is organized as follows. In section 1 we explain in detail the institutional features of Ice Hockey, and we describe our data and our identification strategy. In section 2 we present our results and provide evidence that supports our causal interpretation of the estimates. We conclude in section 3.

1 Empirical strategy and data

An on-going controversy in the National Hockey League (NHL), which is the top professional Ice Hockey league in the world, is whether wearing a visor should be voluntary. Visors are strong transparent fiber shields designed to protect a players' eyes and face. During our period of study, from 2001 to 2006, only one third of hockey players in the NHL wore a visor. This number appears to be exceedingly given that year after year there are horrifying and high-profile cases of players who did not wear a visor and were gravely injured. Two reasons are commonly cited to explain this behavior. First, hockey players believe that their performance can be compromised by a visor; sweat and dirt on the visor can interfere with the player?s vision.[2] Second, Ice Hockey is associated with a macho subculture within which players believe it is important to send the signal that they have the courage not to wear a visor.

[2] A related view is that, if visors affect the relative performance of players, its use would involve strategic considerations. In this case, requiring the use of a protective measure may improve the well-being of individuals (see Schelling (1978)).

To investigate the impact of visors on game-play, we collect data on 833 players who were active in the NHL during the 2001-2006 seasons. During these NHL seasons players could decide whether or not to wear a visor. Using data collected by Cullen (2006), we identify 268 players who wore a visor in the NHL during these seasons when it was not required—the always wearers. The remaining 565 players—the compliers—did not wear a visor in the NHL during these seasons.[3] We complement these data with detailed playing statistics for regular seasons played in other leagues that required all players to wear a visor. These include: professional European leagues; feeder leagues, including minor-pro leagues in North America and major-junior leagues in Canada; and junior or college leagues in North America.[4] Our choice of sample guarantees that always wearers use a visor in all leagues in our sample (hence the label), while compliers only use one in the leagues that have a mandatory visor requirement (European, minor pro and junior leagues).

Table 1 summarizes the game-play statistics for always wearers and compliers when they skate both in the NHL (seasons 2001 to 2006) or in leagues that require visors. We have a total of 8,053 player/season cells. Always wearers totaled 1,262 seasons in the NHL (from 2001 to 2006) and 1,259 seasons in other leagues. Compliers totaled 2,460 seasons in the NHL (from 2001 to 2006) and 3,072 seasons in other leagues. The bottom rows of Table 1 display summary statistics for players' observable characteristics, including their birth year, birth place, weight and height.

We use Penalties in Minutes (PIM) per game to measure players' risky behavior on the ice. This statistic represents the average time in minutes that a player remains penalized during a game. Players earn penalty minutes for behavior that endangers themselves and other players, such as charging, boarding, elbowing, kicking, attempting to injure other players, fighting, cross-checking, and hitting an opponent with the head. The Online Appendix presents a list of the main actions for which players earn penalties. The most common types of penalties in the National Hockey League are hooking, holding, and interfering, which represent around forty-five percent of total penalties. Other common penalties are slashing, tripping, roughing, high-sticking, and cross-checking, which represent about thirty percent of infractions.

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[3] Our data on visor use was provided by an NHL analyst (Cullen, 2006) who collected player-level information on visor use. For the NHL, we have visor use data only for the 2001-2006 seasons; thus, we do not use playing statistics from other NHL seasons. We take a conservative approach and only code a player as a complier if he never used a visor during these seasons. Our coding scheme guarantees that, although some players switched to wearing a visor during the NHL 2001-2006 seasons, we do not exploit this potentially endogenous variation. In any case, during our period of study it was exceedingly rare that visor wearers would become non-wearers and vice-versa. The rare exceptions are six players who changed from non-wearers to wearers, mostly after suffering serious eye or head injuries. Half of these players eventually went back to non-wearing status. Not surprisingly, coding these players as compliers does not change our findings.

[4] We exclude non-NHL leagues data for seasons when it was not mandatory to wear a visor. We do so because in those cases we are unable to determine which players wore a visor. As an illustration, visor wearing became mandatory in the American Hockey League (AHL) in 2006. In this case we do not include any of the seasons in this league before 2006 because we do not know whether or not players wore a visor. In addition, some leagues introduced mandatory visors with a "grandfather clause," which allowed some players to skate without wearing a visor. We exclude the corresponding data for the exempted players in these leagues, as we do not know whether or not they wore a visor. The Online Appendix contains a full description of the leagues in our sample.

We believe that penalties in minutes per game provide a useful measure of risky behavior for several reasons. First, it measures individual behavior in a frequent, transparent, precise and comparable manner. Second, although players also earn penalty minutes for inappropriate behavior unrelated to their risk-taking, such as making obscene gestures or delaying the game, these non-contact infractions represent less than five percent of the total number of infractions Lopez (2015). Third, penalty minutes per game remain a widely accepted proxy for risky behavior and aggressiveness by offending players (see Ashare, ed, 2000). Fourth, penalties in minutes per game capture a key aspect of the Peltzman effect: the possibility that the additional risk-taking not only reduces the effectiveness of wearing a visor in preventing injuries but can endanger other players and bystanders. In a world in which players behave optimally, only these negative spillovers have a first-order effect on welfare. The spillovers—reflected in an increase in penalties in our context—might be the most consequential component of Peltzman's theory.

Our key premise is that by reducing the cost of risk and providing players with an additional sense of safety, wearing a visor could encourage compliers to skate more fiercely, take more risks, and as a result earn more penalties, even though not all types of penalties will increase as a consequence. This aggressiveness is observed in the all-around game of the player, in the way he takes risks, the way he faces other players, and the way he deals with the puck. Penalized actions such as tripping, slashing, elbowing, and charging are all part of this more aggressive behavior. Our premise is consistent with evidence related to the use of helmets in other sports, such as skiing, in which ski patrollers strongly believe that helmets encourage recklessness (Evans et al., 2009). It is also plausible that wearing a visor may prime players for risk-taking, even in situations in which the visor does not grant additional protection (see Gamble and Walker, 2016, for experimental evidence regarding bicycle helmets).

To estimate the effect of mandatory visor wearing, we compare the behavior of always wearers to that of compliers in leagues in which both were required to wear a visor against their behavior in the 2001-2006 NHL seasons, when compliers did not wear a visor but always wearers did. Table 1 anticipates our main result. As always wearers move from the NHL to leagues that require visor use, they receive 0.52 additional penalties in minutes per game, while compliers receive 0.67 additional penalties in minutes per game. Our strategy attributes the 0.15 difference in penalties in minutes per game to the mandatory use of visors. The table also shows that both types of players are frequently penalized: in the NHL, always wearers earn 0.64 penalties in minutes per game, while compliers earn 0.93 penalties in minutes per game.

2 The impact of visors on penalties

To investigate the impact of wearing a visor, we estimate the model

$$PIM_{isl} = \alpha_i + \theta_l + \kappa_s + \beta C_i \times M_l + \varepsilon_{isl}. \quad (1)$$

Here PIM_{isl} are the penalty in minutes per game given to player i during season s in league l. Also, C_i is a dummy that takes the value 1 for compliers and 0 for always wearers, and M_l is a dummy that takes the value 0 in leagues in which visors are not mandatory (NHL) and 1 in which they are (European, minor pro, and junior leagues). We estimate the model with a full set of player, season, and league fixed effects (α_i, κ_s, and θ_l), which control for player heterogeneity, trends in Ice Hockey, and differences across leagues that affect all players equally. ε_{isl} is a random error term orthogonal to the left hand side variables. For inference we focus on standard errors that are robust to heteroskedasticity and serial correlation within individual players. Finally, we weight each observation by the number of games played in the season so that our estimates reflect actual behavior during the games played.

Our choice of sample guarantees that whenever we observe a player in a league with $M_l = 1$, we are certain that he was wearing a visor because enforcement is automatic. Thus, the interaction term $C_i \times M_l$ captures variation in the use of visors that stems uniquely from differences in league regulation and that affects only compliers. We will interpret β as the causal effect of being required to wear a visor. Below we provide evidence in support of our interpretation.

We estimate equation (1) via OLS and report our findings in Panel A of Table 2. Column 1 presents estimates in which we control only for season dummies, a dummy for leagues that have mandatory visors, a dummy for compliers, and the interaction term $C_i \times M_l$. We estimate that mandatory visor wearing increases penalty in minutes by 0.158 (standard error=0.056 in parenthesis), which roughly matches our calculations using the summary statistics. This is a sizable effect compared to the average 1.13 penalty in minutes per game in our sample. The coefficient on the compliers' dummy suggest that this group is on average more aggressive than always wearers, independent of whether or not they wear a visor. Because more aggressive players are less likely to wear visors in the NHL, crosssectional estimates would mistakenly conclude that not wearing a visor makes players skate fiercely, which underscores the value of our approach. The coefficient on the leagues that have mandatory visors suggest either that players in these leagues are more aggressive or that these leagues have tougher penalization standards.

The additional columns show that our basic result does not change when we include additional covariates. In column 2 we include player characteristics such as position, age, experience, dummies for year of birth, dummies for country of birth (state of birth for Americans and province of birth for Canadians), weight, and height. In column 3 we also control for a full set of league effects (here we cannot estimate the coefficient for mandatory leagues). In column 4 we go one step further and control for season×league effects (using the leagues reported in the Online Appendix). This specification controls flexibly for overtime changes in leagues, provided that these affect all players equally. Finally, in column 5 we include a full set of player fixed effects (here we cannot estimate the coefficient for compliers). These dummies control flexibly for cross-sectional differences between players, and they guarantee that we identify the effect of visors only from within-player variation. In this demanding specification, which is also our preferred specification, we find that wearing a visor raises penalties in minutes per game by 0.188 (standard error=0.048). This effect is statistically significant at the 1% level, and it is fairly stable across specifications.

With regards to our findings, one potential is how we conducted our inference. Although we included a full set of league×season dummies in columns 4 and 5, it is possible that some residual correlation remains in the error term of players who skate in the same league and during the same season. We address this concern by computing standard errors that are robust to clustering within players and within league×season, as described in Cameron et al. (2011). Because we have 833 players and 293 league×season cells (reported in the bottom rows), the two-way clustering provides valid inference. Reassuringly, the new set of standard errors—reported in square brackets below each estimate—are only slightly larger than or are comparable to our baseline ones—reported in parenthesis below each estimate.

Our estimates in Panel A exploit the fact that before (or after) skating in the NHL, players also participate in European, minor pro, and junior leagues that sanction the use of visors. Although these movements across leagues occur naturally and frequently as players advance in their careers, one might be concerned that players sort non-randomly into leagues that mandate visor use.[5]

To address the nonrandom movement of players across leagues and complement our initial findings, we exploit a sharp natural experiment: the 2004 NHL lockout. The lockout, which started due to salary disagreements between the NHL and the players' union (NHLPA), led to the cancellation of the 2004 regular season. As a result, a large number of players moved to other professional leagues that during season, many of which are located Europe. We investigate the consequences of the lockout by focusing on 236 players who were active in the NHL from 2001 to 2003, but in 2004 had to move to an European league or a minor pro league which mandated visor use. We then estimate equation (1) only for these players and compare their statistics for the 2001, 2002, 2003, 2005 and 2006 NHL seasons to the 2004 season in European or minor-pro leagues. By construction, the players in this subsample only wore a visor during the 2004 lockout. The advantage of this experiment is that the movement from the NHL was only temporary and induced by the exogenous lockout of the NHL during the 2004 season.[6]

The bottom panel of Table 2 presents our estimates when we exploit the variation in leagues induced by the 2004 lockout. Although this is a smaller sample and our estimates are more noisy, we find in column 1 that during the lockout, mandatory visors raised the penalties in minutes per game of compliers by 0.365 (standard error=0.121). The remaining columns show that this estimate remains roughly unchanged when we control for player heterogeneity, trends in Ice Hockey, and differences across leagues that affect all players equally. In our preferred specification in column 5 we find an estimated effect of visors on penalties of 0.438 (standard error=0.133). Reassuringly, in this sample we find that once we account for players' observable attributes, there is no difference in the behavior of compliers and always wearers in the NHL (compliers earn 0.061 more penalties in minutes per game than always wearers, a small and not-statistically significant effect). Thus, in the sample of players affected by the 2004 lockout, always wearers provide a suitable control group for compliers. (We do not report the mandatory league effect because it is collinear with the season dummies.)

Besides the two sets of standard errors reported in Panel A, in Panel B we also take an

[5] Although our strategy of exploiting the 2004 lockout deals partly with this concern, we believe that selection does not affect our estimates in Panel A for two related reasons. First, players switch leagues at high frequencies, in contrast to league rules and characteristics, which remain largely unchanged. In our sample, players change leagues 37.5% of the time at the end of the current season. This fact suggests that players are churning more than they are sorting, and the churning seems unrelated to league characteristics. Second, before reaching the NHL, players must have skated in some feeder leagues that mandate visors. Players cannot selectively avoid these feeder leagues.

[6] There might still be some selection in this sample given that the decision to participate in professional ice hockey during the lockout is not random. We thank the editor for bringing this to our attention.

alternative approach to inference. Because in these models we only have 15 season× league cells, the asymptotic limits that justify our inference may not hold. To address this concern, below each model we report the p–value for a Wild Bootstrap test of the null that β = 0 (see Cameron et al., 2008). This procedure provides valid inference when the error terms are correlated within players and for players in the same league and season, even if the number of clusters becomes small. In all cases we reject the null that β = 0 at conventional levels.

One additional advantage of the 2004 lockout is that we can trace the changhe over time in the difference in penalties between compliers and always wearers. Figure 1 illustrates this feature by plotting the estimated difference between compliers and always wearers from 2001 to 2006. These differences are obtained by estimating a version of equation (1) in which we interact the dummy for compliers with the season dummies, while simultaneously controlling for players' observable attributes and league effects. The figure shows that compliers were slightly more violent during the 2001, 2002, 2003 and 2005 seasons, and equally violent during the 2006 season. Until the 2003 season, both groups of players obtained a similar amount of penalty minutes. However, during the 2004 lockout, when compliers were required to wear a visor, they became significantly more violent, earning 0.45 penalties in minutes per game more than always wearers. This difference disappeared when the players moved back to the NHL in 2005—at which point compliers stopped wearing visors. This is exactly the pattern one would expect if mandatory visor rules made compliers more violent during the 2004 lockout.

2.1 Controlling for other differences between leagues

Our interpretation of β as the causal effect of wearing a visor hinges on the assumption that league characteristics other than visor regulation do not differentially affect compliers. (This is analogous to the equal-trends assumption used in difference in differences designs.) We now explore if this assumption is plausible and whether we can relax it by controlling for observed differences among players and leagues.

As Table 1 summarizes, there are marked observable differences between the NHL and leagues that mandate visor use. Both players earn more penalties in leagues that mandate visor use, which probably reflects differences in penalization standards. These differences could bias our results if penalization standards have a disproportionate effect on compliers, who are inherently more aggressive. If stricter penalization does not significantly modify behavior, then compliers would mechanically have higher penalties in minutes in leagues that mandate visor use, which would lead to an upward bias in our estimate. On the other hand, stricter penalization standards could have a stronger dissuasive effect on aggressive players, implying a downward bias in our estimates. Another possibility is that compliers and always wearers adapt differently to more competitive leagues, like the NHL.

As a first step towards exploring the role of league differences and their impact on compliers, we estimate (1) for our full sample of players but we allow the effect of wearing a visor to vary by league. In particular, we estimate separately the effect that wearing a visor has in US college leagues, junior leagues (in both Canada and the US), the major-junior leagues in Canada, minor-pro leagues, and European leagues. Figure 2 plots the estimates and their respective confidence intervals, sorting the leagues from left to right according to how competitive they are. For all leagues we find a positive effect of mandatory visor.

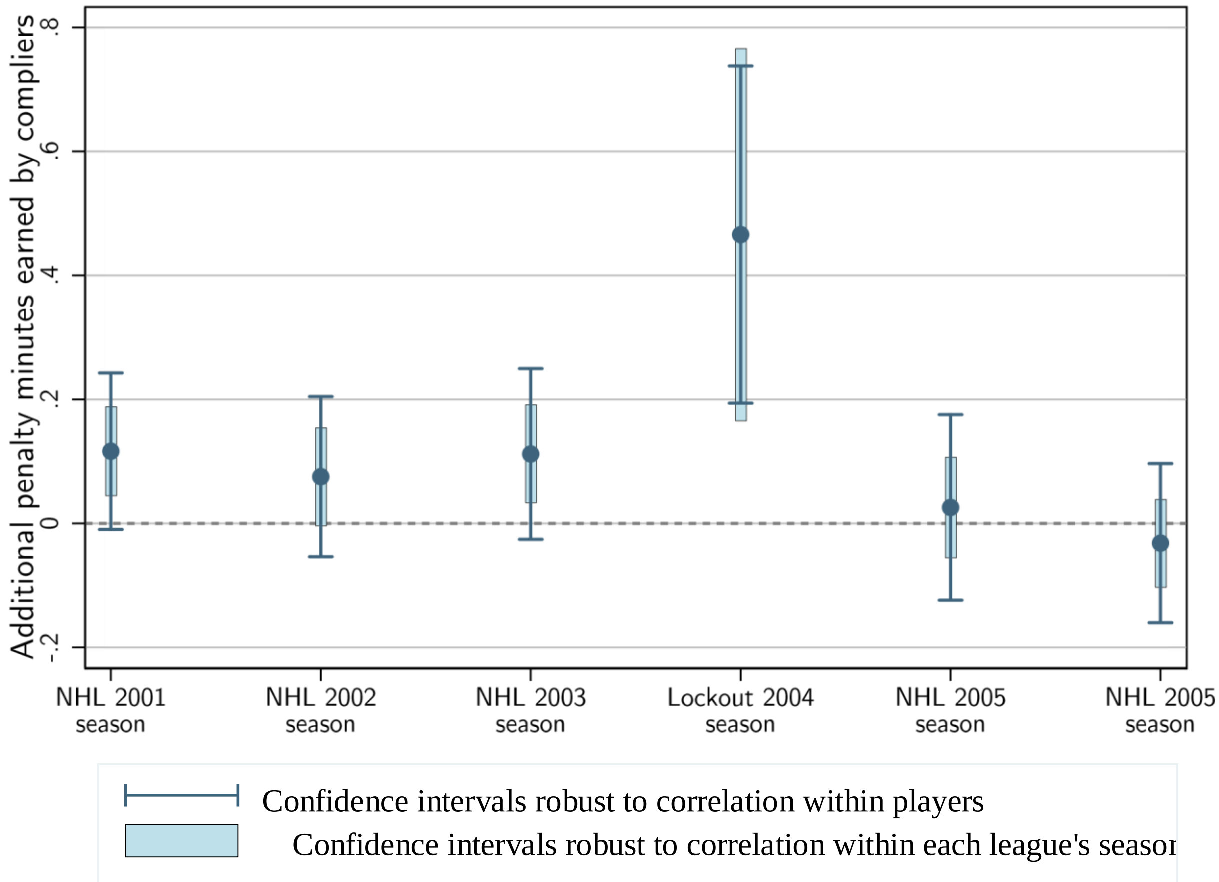

Figure 1: This figure plots estimates of the difference in penalty in minutes per game earned by compliers—players who do not wear visors when allowed to in the NHL—and those earned by always-wearers—players who always wear a visor. We plot these differences for all seasons from 2001 to 2006 for the set of player who were active in the NHL during the 2003 season but had to move during the 2004 lockout to a different league that mandated the use of visors wearing with a similar point estimate. This finding shows that our results are not driven by European leagues, and thus they cannot be explained by a different adaptation of compliers to European hockey. Furthermore, our results are not driven by minor leagues only, and thus they cannot be explained by a different adaptation of compliers to more competitive league.

The small differences in the behavior of compliers across leagues that mandate visor use do not seem to correlate with how competitive leagues are. Excluding the NHL, European leagues are arguably the most competitive and college and junior leagues the least, and yet we find a large and comparable effect of visors in these leagues. Nor do the small differences in point estimates seem to reflect stricter penalization standards or tolerance towards violence. The figure also plots the average penalties in minutes that players get in each league, and these seem unrelated to our point estimates. Canadian major-junior

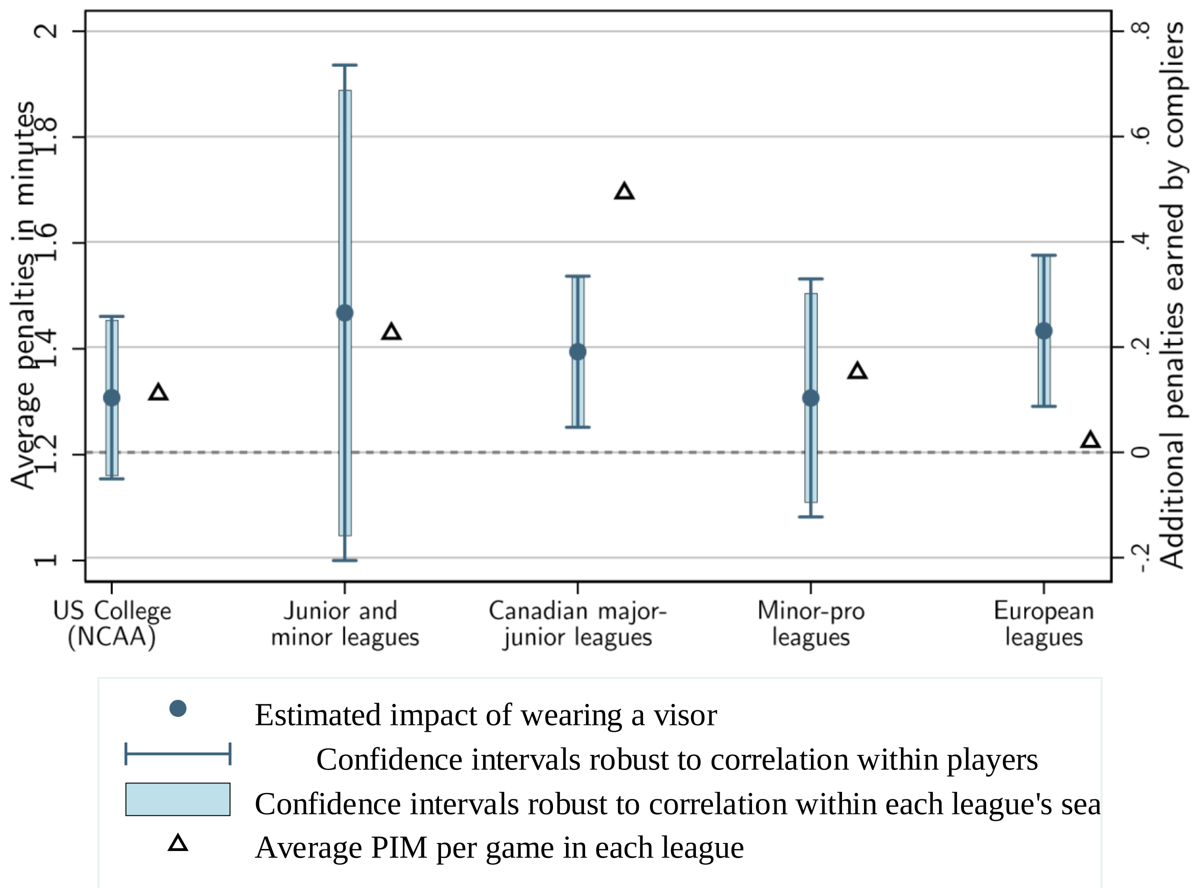

Figure 2: This figure plots estimates of the effect of visors on penalties in minutes per game. We plot the estimates separately for the leagues indicated in the horizontal axis, and we sort from left to right from the most to the least competitive. We also plot in the left vertical axis the average penalties in minutes per game earned by players on each league. Leagues grant 1.7 penalties in minutes per game to players and are seen as highly tolerant of violence, while European leagues only grant 1.2 minutes per game and are believed to be less tolerant of violence. Yet, their point estimates are roughly equal.

As a placebo test, we can also compute how penalties change when compliers move across leagues that mandate visor use. We estimate no difference in behavior between compliers and always wearers as they move from junior and college leagues in North America to feeder leagues (Canadian major-junior and minor-pro leagues), or when they move from feeder leagues in North America to professional leagues in Europe. Compared to always wearers, compliers only earn 0.050 additional penalties in minutes per game in the feeder leagues relative to junior and college leagues (standard error=0.1) and 0.051 additional penalties in minutes per game in European leagues relative to feeder leagues (standard error=0.09). Overall, we find that these movements across leagues that require players to wear a visor do not affect compliers disproportionately.

In Figure 3 we go one step further and estimate the impact that wearing a visor has on compliers separately for each of the leagues that mandate visors. This yields the set of 24 estimates plotted in the figure, together with their average—depicted by the dashed line—and their smoothed density—in black. (We lose 4 small leagues for which we only observe one type of player.) The figure shows that compliers systematically earn more penalty minutes in almost all leagues that mandate visor use. The only exceptions are two small leagues: the Central Junior A Hokey League and the Central Collegiate Hockey Association. Despite the fact that the variation in this figure also contains estimation error, most of our estimates are clustered around the mean, which suggests that our findings are common to most leagues, and that league differences—other than visor regulation—do not affect compliers in a consequential way.

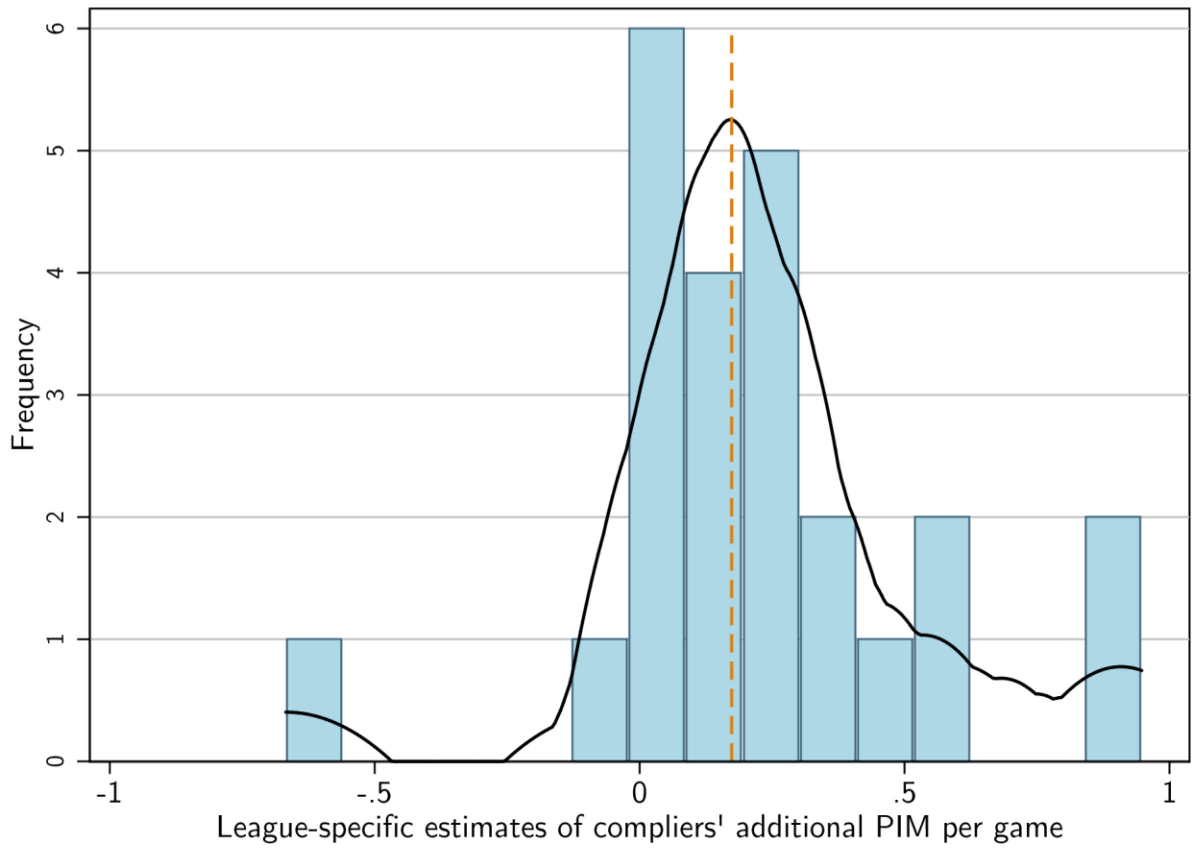

Figure 3: This figure plots the frequency histogram for the estimates of the effect of visors on penalties in minutes per game in each of the 24 leagues that mandate visor use. The dashed orange line represents the average of these estimates and the solid black line their smoothed density.

As a second step to explore the role of league differences and their impact on compliers, we present in Table 3 estimates of an augmented version of equation (1) in which observable league characteristics can differentially impact compliers. For comparison, in column 1 we reproduce our baseline estimates, which control for player and league×season fixed effects. Because we obtain similar standard errors using different assumptions, in this exercise and what follows we only report standard errors robust against heteroskedasticity and serial correlation within players.

In columns 2 to 4 we explore whether the behavior of compliers changes when they skate in leagues that have stricter penalization standards or in more competitive leagues. We use the average penalty minutes earned by always-wearers as a proxy for a league?s penalization standards, although in practice the response of players to different standards and differences in league tolerance towards violence make this proxy imperfect. (We lose 4 observations because in some small leagues we do not observe always-wearers.) Also, following the view of most hockey experts, we rank the NHL as the most competitive league, followed by European leagues, minor pro-leagues, Canadian minor leagues, junior leagues, and finally college leagues, and we use the rank of each league as a proxy for how competitive it is. When we include the interactions between compliers and our proxy for penalization standards and competitiveness, we find that compliers earn fewer penalties in leagues that have stricter penalization standards and more penalties in more competitive leagues. As anticipated by our discussion of Figure 2, the estimated interactions are quantitatively small and not significant. More importantly, once we account for these differences we estimate an even larger effect of wearing a visor on penalties in minutes per game. In columns 5 and 6 we present a similar exercise that focuses on the sample of players affected by the 2004 lockout. In this case we cannot separately identify the effect of compliers moving to more competitive leagues (most players moved to European leagues during the lockout), so we focus on the interaction between compliers and league penalization standards. As we found in the full sample, differences in penalization standards do not seem to affect our estimates of the impact of wearing a visor.

In column 7 of Table 3 we estimate our model separately for professional leagues (only European leagues and the NHL). This model shows first, that our findings hold when we focus only on professional hockey and, second, that we are not capturing differences between amateur and professional players. In addition, in column 8 we estimate our model separately for the NHL and its main feeder leagues in North America (the minor-pro leagues and Canada major-junior leagues). This model exploits the fact that before skating in the NHL, many players went through feeder leagues in North America. The latter share a common culture, similar attitudes and playing style to the NHL, but differ in that they require players to wear a visor. When we focus on this sample we still find that, relative to always wearers, compliers earn more penalties when forced to wear a visor in feeder leagues than they do in the NHL.

The above evidence suggest that, besides the regulations that govern visor use, *observable* league differences do not affect compliers disproportionately, and hence they do not pose a treat to our identification strategy. We now investigate a related albeit different concern: the possibility that *unobserved* league differences—those not captured by the average penalties in the league or its rank in the competitive scale—affect players with some observable attributes differentially. For example, league rules could have different impacts on players in some positions; league rules also could have a disproportionate effect on players who typically earn more penalties; or the NHL playing style and culture could affect European players. Such differences could bias our estimates if compliers and always wearers differ in their observable attributes.

To address this concern, we extend the specification in equation (1) by allowing mandatory leagues to have a differential impact that varies depending on observable player attributes. In particular, we estimate the model

$$PIM_{isl} = \alpha_i + \theta_l + \kappa_s + \beta C_i \times M_l + \gamma X_i \times M_l + \varepsilon_{isl}, \qquad (2)$$

in which the interaction term $X_i \times M_l$ controls for differences in the behavior of players who have attributes X_i when they skate in a league that requires visor use.

Table 4 presents our estimates for this extended model. Panel A presents our results for our full sample, while Panel B focuses on the players affected by the 2004 lockout. For comparison, we present our baseline estimates with player and season× league effects. In the remaining columns we control gradually for interactions between leagues that mandate visors and observable player characteristics. The first row presents the estimated effect of visors; the bottom rows presents the interactions. In column 2 we allow players born in different years and who belong to different NHL cohorts to behave differently in leagues that require visor use. In column 3 we allow players in different positions to behave differently in leagues that mandate visor use (the excluded category are defenders, who happen to be the players who earn the most penalty minutes). This test is important because visor use is not equal across positions. In column 4 we allow players of different heights and weights to behave differently in leagues that mandate visor use. In column 5 we allow US and Canadian players to behave differently in leagues that mandate visor use, which is relevant given that players born in Europe are more likely to wear visors. Overall, we find that controlling for any potential differences in behavior explained by observable player attributes has a modest impact on our estimates of the effect of visors. This occurs despite the fact that the observable attributes that we include explain about 50% of the cross-sectional difference in playerpenalties. For our full sample, we estimate in column 5 that players forced to wear a visor earn 0.146 additional penalties in minutes per game as a result (standard error=0.047). For the lockout sample, we estimate in column 5 that players forced to wear a visor earn 0.403 additional penalties in minutes per game as a result (standard error=0.131). Both estimates are slightly smaller but comparable to our baseline estimates, which are shown in column 1. Although players that have some attributes behave differently in the NHL relative to leagues that mandate visor use, these differences do not seem to be quantitatively important nor do they introduce a significant source of bias in our estimates.

As shown in Table 1, compliers are inherently more aggressive and are penalized more often than always wearers. This raises the possibility that our results may be driven by a differential impact of league differences on more aggressive players—independently of whether or not these players are compliers. Bias could arise if leagues that mandate visor use have different penalization standards (assuming these are not captured by the average penalties in each league), less tolerance towards violence, or different game styles, and if these differences affect the behavior of aggressive players disproportionately. In columns 6 and 7 we address this possibility by controlling for interactions of our dummy for leagues that mandate visor use and two measures of individual player aggression. In column 6 we proxy aggressiveness by the penalties in minutes per game obtained by each player during the previous season. This measure has the advantage of being predetermined, but we lose data for the first season in which each player skated. In column 7 we proxy aggressiveness by a jackknifed average of the penalties in minutes per game obtained by each player in all NHL seasons except the current one.[7] Both

[7] We use a jackknifed average to exclude data from the current season to form our regressors. Otherwise, we would mechanically introduce some attenuation bias to our estimates of the effect of visors. In addition, we use only the penalty minutes earned in the NHL to construct our measure because game-play statistics for these seasons are comparable for all players. Although not reported to save space, we obtained similar results when we used a jackknifed average of penalties over all seasons to form our proxy for aggressiveness.

proxies have great explanatory power: in a regression that explains current penalties, both proxies have *t*−statistics above 100. Using both measures we find that more aggressive players earn more penalties in leagues that mandate visor use. The estimated differences are significant and now the effect of visors falls from 0.14 to 0.1 (standard error=0.044) in the top panel and from 0.4 to 0.36 (standard error=0.12) in the bottom panel. Overall, this exercise suggests that although there are significant differences for more aggressive players, explicitly controlling for such differences does not affect our conclusions. This is especially the case when we focus on the 2004 lockout. As observed before, once we control for players' attributes, compliers do not differ from always wearers in terms of their penalty minutes before the lockout (or after), and thus differences in aggressiveness among players cannot explain the large effects that we estimate in the lockout sample. In the case of our full sample, aggressiveness does play a more important role. But our results in Panel A show that we still find that visor use has a significant and large impact when we control in various ways for differences in player aggressiveness and observable attributes.

2.2 Do visors reduce performance?

We now turn to the question of whether visor use affects performance, as measured by goals, assists, and points per game. Table 5 presents our estimates. The left panel presents results for our full sample, while the right panel focuses on the sample of players affected by the 2004 lockout. We focus on the specification with player and season×league fixed effects, and we report standard errors that are robust against heteroskedasticity and serial correlation within players. Overall, we find a negative effect of wearing a visor on performance, although it is only statistically significant at traditional levels for goals and points per game in our full sample. Our point estimates in columns 1 to 3 suggest that visors reduce goals per game by 0.025, assists per game by 0.019, and points per game by 0.044. These effects are rather small once we compare them to an average of 0.24 goals, 0.38 assists, and 0.62 points per game in our sample. Moreover, our confidence intervals cannot rule out very small (or zero) effects. We view these results as consistent, but not entirely supportive, of players' complaints that visors reducing their vision and performance because they become fogged and are uncomfortable to wear.[8]

3 Concluding remarks

This paper shows that when forced to wear a visor, ice hockey players earn more penalties. We interpret the increase in penalties as evidence of the Peltzman effect: by reducing the cost of risk-taking and providing players with an additional sense of security, visors induce players to skate more fiercely and aggressively. The resulting behavior not only reduces the effectiveness of visors, it also raises the potential for injuries that visors do not prevent. More importantly, the risky behavior of players endangers both their-selves and other players.

To estimate the impact of visors on players behavior we compare compliers—players who only wear a visor when mandated—with always wearers—players who wear a visor willingly—as they move from

[8] Interestingly, because compliers tend to perform worst than always-wearers, a cross-sectional estimate would mistakenly suggest that visors improve performance.

leagues that require visor use to the NHL, in which visor use is not mandatory. This comparison suggests that mandatory visors caused compliers to earn 0.19 additional penalties in minutes per game. We estimate an even larger effect of visors when we focus on the NHL players who were forced to wear one during the 2004 season, when the NHL canceled its regular season and players migrated to European leagues or minor-pro leagues that required the use of visors.

We interpret our findings as the causal effect of visors, and provide evidence to support our interpretation. In particular, we provide evidence that our results are not driven by differential effects of league characteristics on players. Four arguments support this point: First, we find positive and similar point estimates of wearing a visor on compliers for all leagues that mandate visor use. Despite the differences across these leagues, it is their common characteristic of mandatory visor use that seems to drive our estimates. Second, leagues' geographic location, how competitive they are, or differences in penalization standards do not drive our results. In particular, controlling directly for the differential impact of these observable league characteristics on compliers did not change our results. Fourth, although we find that players that differ in observable attributes (how aggressive they are or their birthplace) behave differently in leagues that mandate visor use, accounting for such differences does not affect our results, especially in the sample of players affected by the 2004 lockout.

We believe our results are not unique to Ice Hockey. Concerns about the Peltzman effect frequently arise in discussions of sports and safety equipment. A series of pieces in the New York Times that described the use of protective gear in female Lacrosse voiced the concerns of coaches who worried about the "gladiator effect," or the possibility that headgear could foster fiercer play (see Schwarz, 2011; Pennington, 2015, 2016). When discussing the use of full face masks in College Ice Hockey, an article in USA Hockey magazine also referenced the gladiator effect, asserting that "The coaches' position is the full cage gives kids kind of a gladiator effect, a feeling of invincibility that leads them to play the game in a more reckless manner" (see Myers, 2012). In the case of American Football, the chairman of the NFL Competition Committee voiced a similar concern: that "as helmets have gotten bigger, harder and better at protecting players' heads from injuries, the unintended consequence has been that players are more confident in their helmets—and therefore more willing to launch themselves headfirst into opposing players" (see Smith, 2011). Jim McKenna, a rugby coach featured in an article published in the Guardian, claimed that "American footballers tackle with their heads, butting each other in a way seldom seen in rugby." He concludes that helmets are partly to blame, as they only encourage football players to use more force (see Bodenner, 2016; Khaleeli, 2013). In the case of skydiving, 'Booth's rule #2,' which is attributed to famous skydiver Bill Booth, states that "the safer skydiving gear becomes, the more chances skydivers will take, in order to keep the fatality rate constant" (Zolli and Healy, 2013) These concerns also have influenced the debate on whether cities should make bicycle helmet use mandatory, with some arguing that "Cyclists with helmets are liable to take more risks because they consider themselves safe" (see van der Zee, 2015).

The insights of our research are related to other settings outside sports in which there is an active debate on whether insurance or protective gear encourage risk taking, or if on the contrary they could make risk more salient and reduce risk taking. Medical providers and health care professionals worry about "risk compensation:" the possibility that better treatments or prevention technologies could encourage people to take more risks. For example, HIV treatments or methods that reduce its rate of contagion—male circumcision, drugs, or easier access to condoms—could also encourage a more risky sexual behavior (the evidence remains mixed. See de Walque et al., 2012; Wilson et al., 2014). More generally, concerns about moral hazard—the possibility that once insured individuals will take more risks—plague insurance markets (Cummins and Tennyson, 1996; Cohen and Dehejia, 2004; Einav et al., 2013). Similarly, in climate science, there are concerns that the more people learn about technologies to adapt to climate change, the less they will support policies to mitigate it (even though Carrico et al., 2015, find no evidence of this effect). Our paper shows that in the particular context of Ice Hockey, players respond to a decline in the cost (or perceived cost) of risk by engaging in more risky behavior. Mandatory visors do not seem to encourage less risk taking by raising awareness or making risk more salient.

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Table 1: Summary statistics.

	Always wearers ($C_i = 0$)		Compliers ($C_i = 1$)	
	NHL visors	Leagues with mandatory visors 2001-2006	NHL visors 2001-2006	Leagues with mandatory visors 2001-2006
Games played	56.84	40.55	47.16	41.31
	(25.28)	(19.28)	(28.26)	(20.37)
Goals per game	0.20	0.36	0.13	0.30
	(0.14)	(0.26)	(0.12)	(0.24)
Assists per game	0.34	0.54	023	0.47
	(0.19)	(0.33)	(0.15)	(0.30)
Penalty minutes per game	0.64	1.16	0.93	1.60
	(0.38)	(0.89)	(0.66)	(1.17)
Number of seasons	N = 1,262	N = 1,259	N = 2,460	N = 3,072

	Always wearers ($C_i = 0$)	Compliers ($C_i = 1$)
Birth year	1976.27	1976.48
	(4.29)	(4.12)
Born in Canada	0.42	0.62
	(0.49)	(0.49)
Born in Europe	0.46	0.20
	(0.50)	(0.40)
Born in U.S.	0.12	0.18
	(0.32)	(0.38)
First season	1997.31	1997.89
	(4.47)	(4.43)
Weight	200.09	204.72
	(13.31)	(15.51)
Height	5.80	5.83
	(0.39)	(0.37)
Number of players	N = 268	N = 565

Notes: The table presents summary statistics for the main variables used in the paper. For each variable we report its mean and standard deviation in parenthesis. We report the statistics separately for compliers—players who only wear a visor when mandatory—and always wearers—players who always wear a visor. For each type of player we report separately his game-play statistics for the NHL 2001 to 2006 seasons and seasons in leagues that mandate visor use. See the text for a detailed description of the variables.

Table 2: Estimates of the impact of mandatory visors on penalty minutes per game

	Penalty minutes per game				
	(1)	(2)	(3)	(4)	(5)
	Panel A. Full sample of leagues and seasons				
Compliers in league that mandates visor use	0.137**	0.167***	0.186***	0.177***	0.188***
	(0.057)	(0.050)	(0.055)	(0.057)	(0.048)
	[0.061]	[0.059]	[0.060]	[0.060]	[0.049]
Compliers	0.304***	0.171***	0.160***	0.154***	
	(0.033)	(0.038)	(0.038)	(0.039)	
	[0.046]	[0.042]	[0.042]	[0.042]	
Leagues that mandate visor use	0.478***	0.605***			
	(0.066)	(0.055)			
	[0.075]	[0.099]			
Mean of the dependent variable	1.138	1.138	1.138	1.138	1.138
R-squared	0.166	0.337	0.364	0.390	0.737
Observations	8053	8053	8053	8053	8053
Number of players	833	833	833	833	833
Number of seasons × leagues	293	293	293	293	293
	Panel B. Estimates using the 2004 lockout of the NHL				
Compliers in league that mandates visor use	0.365***	0.429***	0.406***	0.406***	0.438***
	(0.121)	(0.116)	(0.127)	(0.127)	(0.133)
	[0.140]	[0.112]	[0.140]	[0.140]	[0.150]
Wild bootstrap p-value	0.064	0.023	0.074	0.074	0.063
Compliers	0.215***	0.056	0.061	0.061	
	(0.056)	(0.059)	(0.059)	(0.059)	
	[0.055]	[0.052]	[0.051]	[0.051]	
Mean of the dependent variable	0.806	0.806	0.806	0.806	0.806
R-squared	0.205	0.471	0.475	0.475	0.729
Observations	1344	1344	1344	1344	1344
Number of players	236	236	236	236	236
Number of seasons × leagues	15	15	15	15	15
Included covariates:					

Season effects	X	X	X	X	X
Player attributes		X	X	X	X
League effects			X	X	X
Season × league effects				X	X
Player fixed effects					X

Notes: The table presents estimates of the effect of mandatory visors on penalties in minutes per game. Panel A presents estimates for the full set of players who were active in the NHL from 2001 to 2006. Panel B focuses on the 2001 to 2006 seasons and the set of players who were forced to move to European or minor-pro leagues during the 2004 NHL lockout. Each column presents results from a different model and the bottom rows report the covariates included in each model. Player attributes include dummies for year and place of birth, position, weight and height. We provide two sets of standard errors. In parenthesis we present standard errors robust to heteroskedasticity and serial correlation within players. In square brackets we report standard errors that are also robust to serial correlation within season×league cells. In Panel B we also report the p–value for a test of the null hypothesis that visors have no effect on penalties, computed using a wild bootstrap procedure. This test is robust to serial correlation within individuals and within season×league cells. For the reported coefficients, those with *** are significant at the 1% level; those with ** are significant at the 5% level; and those with * are significant at the 10% level. In all cases these tests of significance are computed using the standard errors in parentheses.

Table 3: Estimates of the impact of mandatory visors on penalty minutes per game controlling for interactions between league attributes and player type.

	Penalty minutes per game							
	Full sample of leagues and seasons				*NHL lockout in 2004*		*Pro leagues*	*American leagues*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Compliers in league that mandates visor use	0.188***	0.271**	0.250***	0.282**	0.438***	0.656**	0.201***	0.186***
	(0.048)	(0.118)	(0.086)	(0.121)	(0.133)	(0.277)	(0.072)	(0.070)
Compliers in leagues with more PIM		-0.149		-0.092		-0.656		
		(0.210)		(0.230)		(0.761)		
Compliers in competitive leagues			0.023	0.016				
			(0.027)	(0.029)				
Mean of the dependent variable	1.138	1.137	1.138	1.137	0.806	0.806	0.908	1.105
R-squared	0.737	0.737	0.737	0.737	0.729	0.729	0.741	0.780
Observations	8053	8049	8053	8049	1344	1344	5261	5820
Number of players	833	833	833	833	236	236	833	833

Notes: The table presents estimates of the effect of mandatory visors on penalties in minutes per game. Columns 1 to 4 present estimates for the full set of players who were active in the NHL from 2001 to 2006. Columns 5 to 6 focus on the 2001 to 2006 seasons and the set of players who were forced to move to European or minor-pro leagues during the 2004 NHL lockout. Column 7 presents estimates for the sample of professional leagues; while column 8 presents results for the sample of the NHL and its feeder leagues (minor-pro and major-junior leagues in Canada). All models include a full set of player and season×league fixed effects. In columns 2, 4, and 6 we include interactions between compliers and the average penalties in minutes per game earned in each league (computed only from always wearers). In column 3 and 4 we include interactions between compliers and a measure of the competitiveness of each league (see the main text for details). In parentheses we present standard errors robust to heteroskedasticity and serial correlation within players. For the reported coefficients, those with *** are significant at the 1% level; those with ** are significant at the 5% level; and those with * are significant at the 10% level.

Table 4: Estimates of the impact of mandatory visors on penalty minutes per game controlling for interactions between player attributes and league type.

	Penalty minutes per game						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Panel A. Full sample of leagues and seasons						
Compliers in league that mandates visor use	0.188***	0.193***	0.189***	0.166***	0.146***	0.099**	0.100**
	(0.048)	(0.047)	(0.047)	(0.048)	(0.047)	(0.041)	(0.044)
NHL cohort × league that mandates visor use		-0.042***	-0.048***	-0.047***	-0.047***	-0.040***	-0.055***
		(0.014)	(0.014)	(0.014)	(0.014)	(0.012)	(0.014)
Birth cohort × league that mandates visor use		-0.017	-0.010	-0.011	-0.010	0.030***	-0.002
		(0.013)	(0.014)	(0.014)	(0.014)	(0.011)	(0.013)
Centers in league that mandates visor use			-0.220***	-0.176***	-0.183***	-0.032	-0.153***
			(0.050)	(0.054)	(0.055)	(0.050)	(0.053)
Left wings in league that mandates visor use			-0.056	-0.040	-0.036	-0.017	-0.063
			(0.067)	(0.067)	(0.067)	(0.063)	(0.065)
Right wings in league that mandates visor use			0.040	0.066	0.076	0.086	0.062
			(0.072)	(0.072)	(0.072)	(0.056)	(0.067)
Height × league that mandates visor use				-0.118*	-0.105	-0.020	-0.079
				(0.067)	(0.067)	(0.061)	(0.066)
Weight × league that mandates visor use				0.006***	0.006***	0.003	0.001
				(0.002)	(0.002)	(0.002)	(0.002)
Canadians in league that mandates visor use					0.173**	0.069	0.095
					(0.070)	(0.064)	(0.066)
US players in league that mandates visor use					0.198**	0.138*	0.172**
					(0.082)	(0.076)	(0.078)
PIM in last season × league that mandates visor use						0.261***	
						(0.023)	
PIM in NHL × league that mandates visor use							0.304***
							(0.065)
Mean of the dependent variable	1.138	1.138	1.138	1.138	1.138	1.138	1.138

R-squared	0.737	0.741	0.743	0.744	0.744	0.787	0.749
Observations	8053	8053	8053	8053	8053	7183	8053
Number of players	833	833	833	833	833	832	833

Panel B. Estimates using the 2004 lockout of the NHL

Compliers in league that mandates visor use	0.438***	0.444***	0.441***	0.427***	0.403***	0.328***	0.358***
	(0.133)	(0.135)	(0.134)	(0.131)	(0.125)	(0.122)	(0.120)
NHL cohort × league that mandates visor use		-0.019	-0.020	-0.011	-0.009	-0.013	-0.008
		(0.029)	(0.029)	(0.030)	(0.030)	(0.029)	(0.029)
Birth cohort × league that mandates visor use		0.015	0.017	0.009	0.008	0.013	0.009
		(0.029)	(0.029)	(0.032)	(0.033)	(0.030)	(0.031)
Centers in league that mandates visor use			-0.041	0.063	0.059	0.088	0.138
			(0.170)	(0.189)	(0.189)	(0.180)	(0.188)
Left wings in league that mandates visor use			-0.026	-0.010	0.004	0.029	0.046
			(0.203)	(0.195)	(0.196)	(0.185)	(0.186)
Right wings in league that mandates visor use			-0.021	0.011	0.001	0.005	0.043
			(0.182)	(0.182)	(0.185)	(0.172)	(0.177)
Height × league that mandates visor use				0.164	0.198	0.250	0.234
				(0.219)	(0.216)	(0.212)	(0.212)
Weight × league that mandates visor use				0.003	0.003	-0.004	-0.005
				(0.005)	(0.005)	(0.005)	(0.006)
Canadians in league that mandates visor use					0.104	0.010	0.003
					(0.177)	(0.176)	(0.182)
US players in league that mandates visor use					0.424	0.428	0.391
					(0.313)	(0.295)	(0.300)
PIM in last season × league that mandates visor use						0.599***	
						(0.219)	
PIM in NHL × league that mandates visor use							0.648**
							(0.280)
Mean of the dependent variable	0.806	0.806	0.806	0.806	0.806	0.809	0.806
R-squared	0.729	0.729	0.729	0.731	0.733	0.745	0.742
Observations	1344	1344	1344	1344	1344	1330	1344
Number of players	236	236	236	236	236	236	236

Notes: The table presents estimates of the effect of mandatory visor use on penalties in minutes per game. Panel A presents estimates for the full set of players who were active in the NHL from 2001 to 2006. Panel B focuses on the 2001 to 2006 seasons and the set of players who were forced to move to European or minor-pro leagues during the 2004 NHL lockout. All models include a full set of player and season×league fixed effects. Each column includes the interactions between the player attributes reported in the table and leagues that mandate visor use. In columns 6 and 7 we use a measure of players' penalties in the last season or a jackknifed average of his penalties in the NHL as proxies for his aggressiveness (see the main text for details on these measures). In parentheses we present standard errors robust to heteroskedasticity and serial correlation within players. For the reported coefficients, those with *** are significant at the 1% level; those with ** are significant at the 5% level; and those with * are significant at the 10% level.

Table 5: Estimates of the impact of mandatory visor use on performance.

	Measures of performance per game					
	Full sample of leagues and seasons			*NHL lockout in 2004*		
	Goals per game	Assists per game	Points per game	Goals per game	Assists per game	Points per game
	(1)	(2)	(3)	(4)	(5)	(6)
Compliers in league that mandates visor use	-0.025**	-0.019	-0.044*	0.003	-0.021	-0.018
	(0.013)	(0.015)	(0.025)	(0.019)	(0.028)	(0.039)
Mean of the dependent variable	0.237	0.380	0.617	0.193	0.317	0.510
R-squared	0.683	0.684	0.712	0.728	0.740	0.777
Observations	8053	8053	8053	1344	1344	1344
Number of players	833	833	833	236	236	236

Notes: The table presents estimates of the effect of mandatory visors on players' performance. Each column indicates the measure of performance used as the dependent variable. Columns 1 to 3 present estimates for the full set of players who were active in the NHL from 2001 to 2006. Columns 4 to 6 focus on the seasons from 2001 to 2006 and the set of players who were forced to move to European or minorpro leagues during the 2004 NHL lockout. All models include a full set of players and season×league fixed effects. In parentheses we present standard errors robust to heteroskedasticity and serial correlation within players. For the reported coefficients, those with *** are significant at the 1% level; those with ** are significant at the 5% level; and those with * are significant at the 10% level.

Online Appendix: infractions that result in penalty in minutes

- Abuse of officials: Arguing with, insulting, using obscene gestures or language directed at or in reference to, or deliberately making violent contact with any on or off-ice official.

- Aggressor penalty: Assessed to the player involved in a fight who was the more aggressive during the fight. This is independent of the instigator penalty, but both are usually not assessed to the same player (in that case the player's penalty for fighting is usually is escalated to deliberate injury of opponents, which carries a match penalty). • Attempt to injure: Deliberately trying to harm an opponent.

- Boarding: Pushing an opponent violently into the boards while the player is facing the boards.

- Butt-ending: Jabbing an opponent with the end of the shaft of the stick. It carries an automatic misconduct.

- Charging: Taking more than three strides or jumping before hitting an opponent.

- Checking from behind: Hitting an opponent from behind. It carries an automatic minor penalty and misconduct, or a major penalty and game misconduct if it results in injury. Illegal check to the head: Lateral or blind side hit to an opponent, wherein the player's head is targeted and/or is the principal point of contact

- Clipping: Delivering a check below the knees of an opponent. If injury results, a major penalty and a game misconduct will result.

- Cross-checking: Hitting an opponent with the stick when it is held with two hands and no part of the stick is on the ice. Delay of game: Stalling the game.

- Diving: Falling to the ice in an attempt to draw a penalty.

- Elbowing: Hitting an opponent with the elbow.

- Fighting: Engaging in a physical altercation with an opposing player, usually involving the throwing of punches with gloves removed or worse.

- Goaltender Interference: Physically impeding or checking the goalie.

- Head-butting: Hitting an opponent with the head. A match penalty is called when this occurs.

- High-sticking: Touching an opponent with the stick above shoulder level. A minor penalty is assessed to the player. If blood is drawn, a double-minor is usually called. Referees may use their discretion to assess only a minor penalty even when blood was drawn. They may also assess a double-minor when blood is not drawn, but he believes that the player was sufficiently injured or that the offending player used excessively reckless action with his stick.

- Holding: Grabbing the body, equipment, or clothing of an opponent with hands or stick.

- Holding the stick: Grabbing and holding an opponent's stick. Also called when a player deliberately wrenches a stick from the hands of an opposing player or forces the opponent to drop it by any means that is not any other penalty, such as Slashing.
- Hooking: Using a stick as a hook to slow an opponent, no contact is required.
- Instigator penalty: Being the obvious instigator in a fight. Called in addition to the five minute major for fighting.
- Interference: Impeding an opponent who does not have the puck, or impeding any player from the bench.
- Joining a fight: Also called the ?3rd man in? rule, the first person who was not part of a fight when it broke out but who participates in said fight once it has started for any reason (even to pull the players apart). This player is charged with an automatic game misconduct as well as any other penalties they receive for fighting.
- Kicking: Kicking an opponent with the skate or skate blade. Kicking carries a match penalty if done with intent to injure; otherwise it carries a major penalty and a game misconduct.
- Kneeing: Hitting an opponent with the knee.
- Roughing: Pushing and shoving after the whistle has been blown or checking an opponent with the hands in his face.
- Slashing: Swinging a stick at an opponent; no contact is required.
- Slew Footing: Tripping an opponent with your feet.
- Spearing: Stabbing an opponent with the stick blade.
- Starting the wrong lineup: When the offending team fails to put the starting lineup on the ice at the beginning of each period.
- Substitution infraction: When a substitution or addition is attempted during a stoppage of play after the linesmen have signaled no more substitutions or if a team pulls its goalie and then attempts to have the goalie re-enter play at any time other than during a stoppage of play.
- Too many men on the ice: Having more than six players (including the goalie) on the ice involved in the play at any given time.
- Tripping: Using a stick or one's body to trip an opponent.
- Unsportsmanlike conduct Arguing with a referee; using slurs against an opponent or teammate; playing with illegal equipment; or making obscene gestures or otherwise abusing an official.

Table A1: HOCKEY LEAGUES AND VISOR WEARING REGULATION.

Name	Short name	League type	Face protection
National Hockey League	NHL	Pro	Visors are non-mandatory
United Hockey League	UHL	Minor pro	Mandatory since 2004
American Hockey League	AHL	Minor pro	Mandatory since 2006
East Coast Hockey League	ECHL	Minor pro	Mandatory since 2003
Central Hockey League	CHL	Minor pro	Mandatory since 2004
Western hockey league	WHL	Major junior (CA)	Mandatory since 1976
Ontario hockey league	OHL	Major junior (CA)	Mandatory since 1976
Quebec Major junior hockey league	QMJHL	Major junior (CA)	Mandatory since 1976
British Columbia Junior Hockey League	BCJHL	Junior (CA)	Mandatory since 1981
Ontario Provincial Junior A Hockey League	OPJHL	Junior (CA)	Mandatory since 1981
British Columbia Hockey League	BCHL	Junior (CA)	Mandatory since 1981
Saskatchewan Junior Hockey League	SJHL	Junior (CA)	Mandatory since 1981
Atlantic Junior Hockey League	AJHL	Junior (CA)	Mandatory since 1981
Metropolitan Junior Hockey League	MetJHL	Junior (CA)	Mandatory since 1981
Ontario Junior Hockey League	OJHL	Junior (CA)	Mandatory since 1981
Canadian Junior Hockey League	CJAHL	Junior (CA)	Mandatory since 1981
United States Hockey League	USHL	Junior (U.S.)	Always been mandatory
North American Hockey League	NAHL	Junior (U.S.)	Always been mandatory
Western Collegiate Hockey Association	WCHA	College (NCAA)	Mandatory since 1980
Central Collegiate Hockey Association	CCHA	College (NCAA)	Mandatory since 1980
NCAA East Division	H-East	College (NCAA)	Mandatory since 1980
Eastern College Athletic Conference	ECAC	College (NCAA)	Mandatory since 1980
National Collegiate Athletic Association	NCAA	College (NCAA)	Mandatory since 1980
College Hockey Association	CHA	College (NCAA)	Mandatory since 1980
Sweden Elitserien	SEL	European elite	Mandatory since 1969
Finland SM-liiga	FNL	European elite	Mandatory since 1988
Russian Elite League	KHL	European elite	Mandatory since 1994
Switzerland National League A	Swiss-A	European elite	Mandatory by 2004
Deutsche Eishockey League	DEL	European elite	Mandatory since 1998

Notes: The table reports the leagues used in our study, as well as their respective regulation regarding visors and face protection. In college leagues, players are required to use a full cage if they are under 18, and they may choose between full cage or a visor if they are older. Mandatory visor wearing was introduced in European and international leagues with a "grandfather clause" that exempted some players from wearing a visor.