

Divergence of Mathematical Knowledge and Self-Assessment

A Longitudinal Study from 2008 to 2024

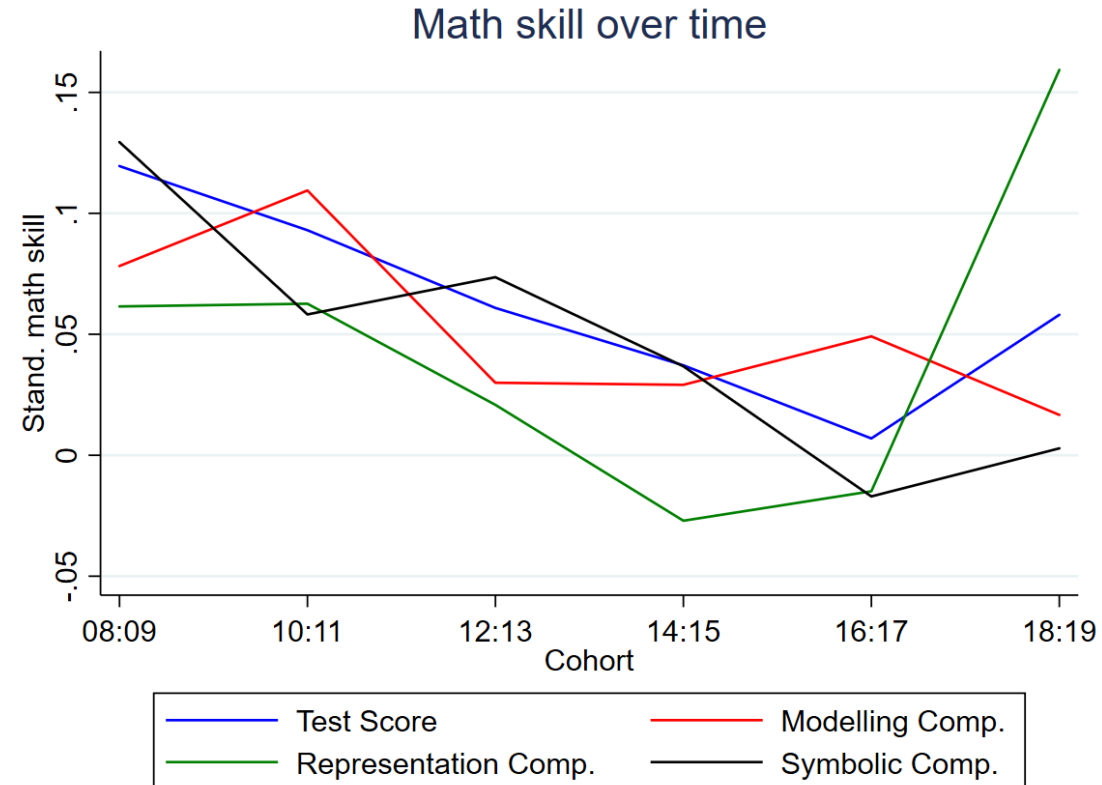
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Motivation

- Continuing existing timeline 2019 (Büchele & Feudel 2023)



- How did COVID Influence math skills and students' self-assessment?

Theoretical Background – Self-view and math skills

- **Self-Assessed Skills and Mathematical Self-Concept**
 - The subjective evaluation of one's mathematical abilities is closely related to actual performance, with positive self-efficacy beliefs fostering increased engagement and persistence in mathematical tasks (Bandura, 1997; Pajares, 1996).
- **Mathematical Self-Concept**
 - A positive mathematical self-concept is associated with higher motivation, improved problem-solving skills, and overall better performance in mathematics (Marsh, 1990; Wigfield & Eccles, 2000). Therefore, it also influences the willingness to engage in complex learning processes.
- **Locus of Control**
 - Learners with an internal locus of control—believing that their own actions determine mathematical outcomes—tend to demonstrate better performance and a more robust mathematical self-concept (Findley & Cooper, 1983; Drago et al. 2016).
- **Math Anxiety and Its Relationship with Self-Perception**
 - Negative self-perceptions and an external locus of control can contribute to the development or intensification of math anxiety, which in turn adversely affects performance (Ashcraft & Krause, 2007).

Theoretical Background – Developments after COVID

- **Mathematical Skills Development Post-COVID**

- **Learning Loss:** Research shows that COVID-19 school closures have resulted in significant learning losses in mathematics. For instance, Engzell, Frey, & Verhagen (2021) estimate an average loss equivalent to several months of learning in math achievement.
- **Disparities:** The decline in math skills has been more pronounced among socio-economically disadvantaged students, potentially exacerbating pre-existing educational inequalities.
- **Projections:** Projections by Kuhfeld et al. (2020) suggest that these learning losses could have lasting implications on academic trajectories, especially in subjects like mathematics.

- **Self-Assessment Development Post-COVID**

- No comprehensive study found (yet). However, the shift to remote learning during COVID-19 limited the opportunity for immediate, in-person feedback—a critical component for accurately calibrating students' self-assessment of their mathematical abilities (Bao, 2020).

- **Research Question:** How have students' mathematics skills and self-view evolved in the aftermath of the COVID-19 pandemic?

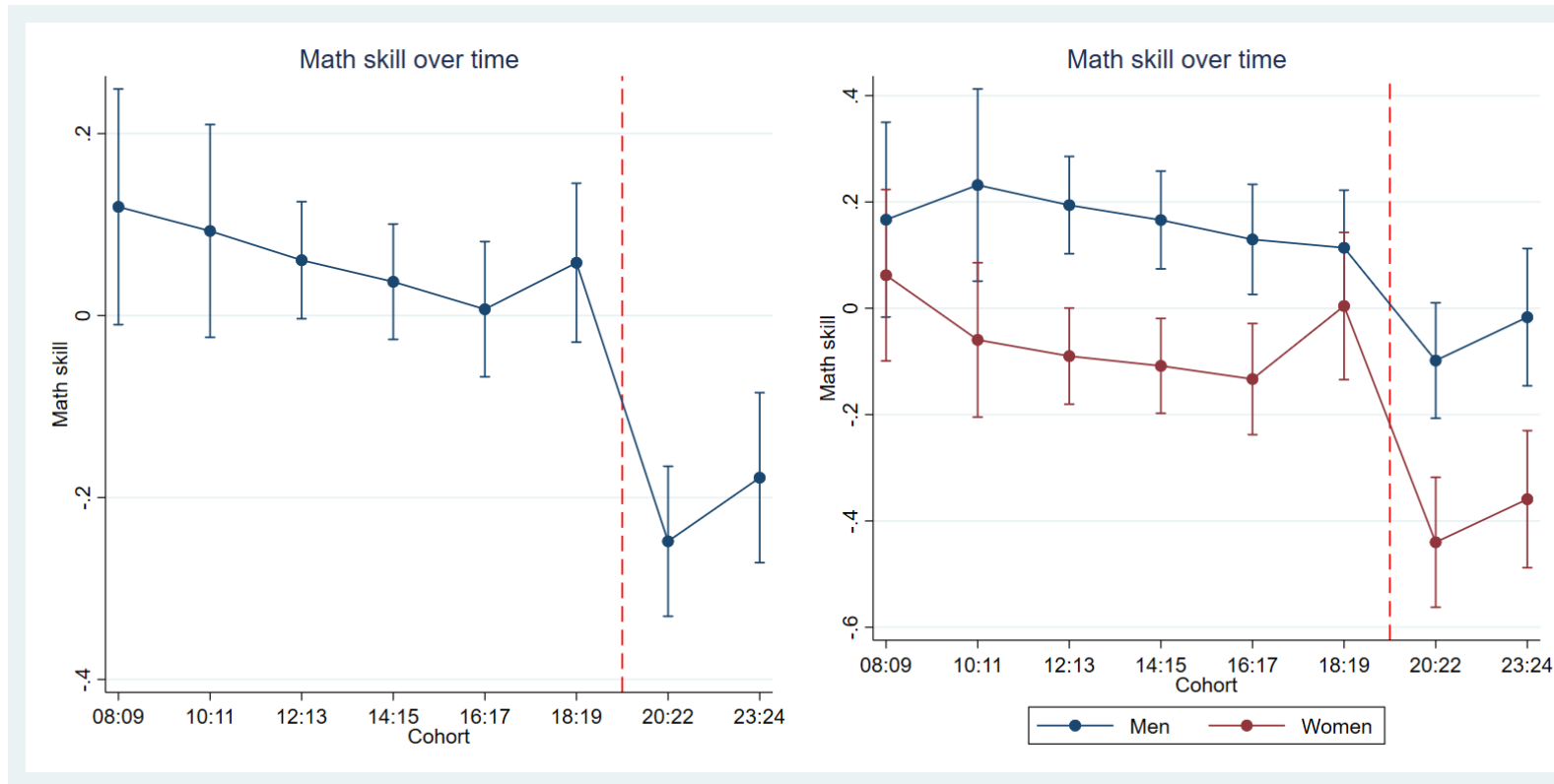
Method - Sample

- **Sample Size and Time Frame:** A total of 3,116 first-year students were enrolled in economics and business administration programs from 2008 to 2024
- **Grouping Criterion:** Students were categorized based on the year they obtained their high school diploma
- **Pre- and Post-COVID Distribution:** Of the total sample, 2,688 students completed high school before the COVID-19 pandemic, and 606 students did so after the onset of COVID-19
- **Gender Representation:** Female students comprise 47.13% of the sample

Method – Variables and Measurement

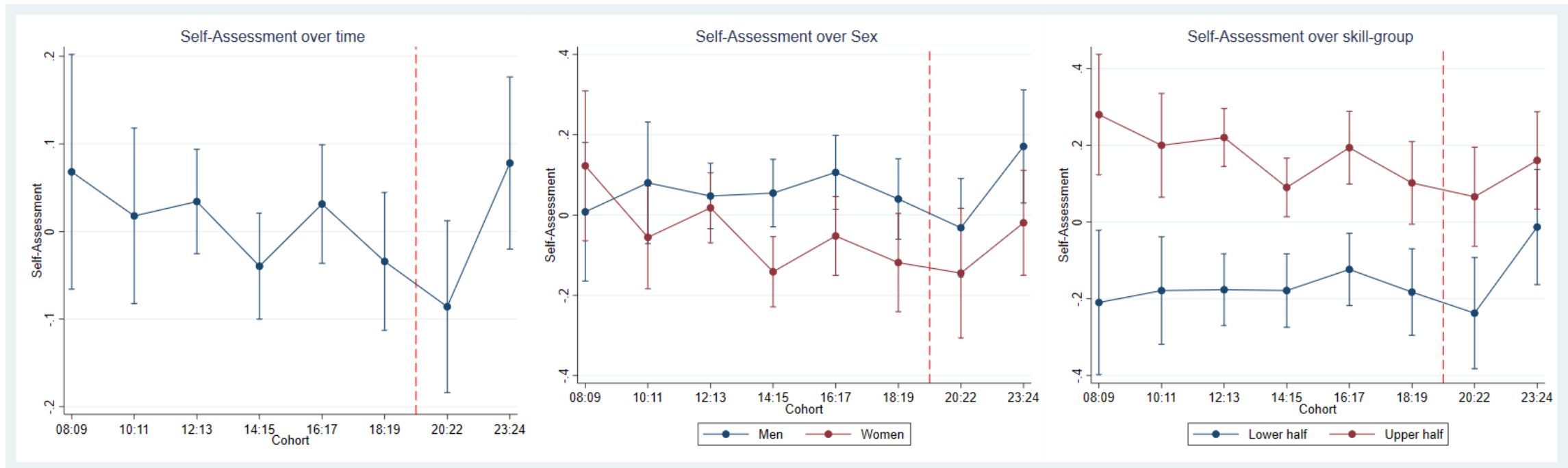
- **Math Skill:** Assessed via a non-standardized math skill test (see Büchele & Feudel, 2023)
- **Math Self-Assessment:** Measured by a single-item, 5-point scale asking students to rate their overall math proficiency
- **Math Self-Concept:** Assessed with 3 items on a 6-point scale (Laging & Voßkamp, 2017)
- **Locus of Control:** Measured with 4 items on a 6-point scale (Laging & Voßkamp, 2017)
- **Math Anxiety:** Assessed with 4 items on a 6-point scale (Laging & Voßkamp, 2017)
- **Controls:** Prior GPA, Type of School, Education Gap, Participation in Preparatory Courses, Study Program, and Math Grade in High School.

Results – Math skill development



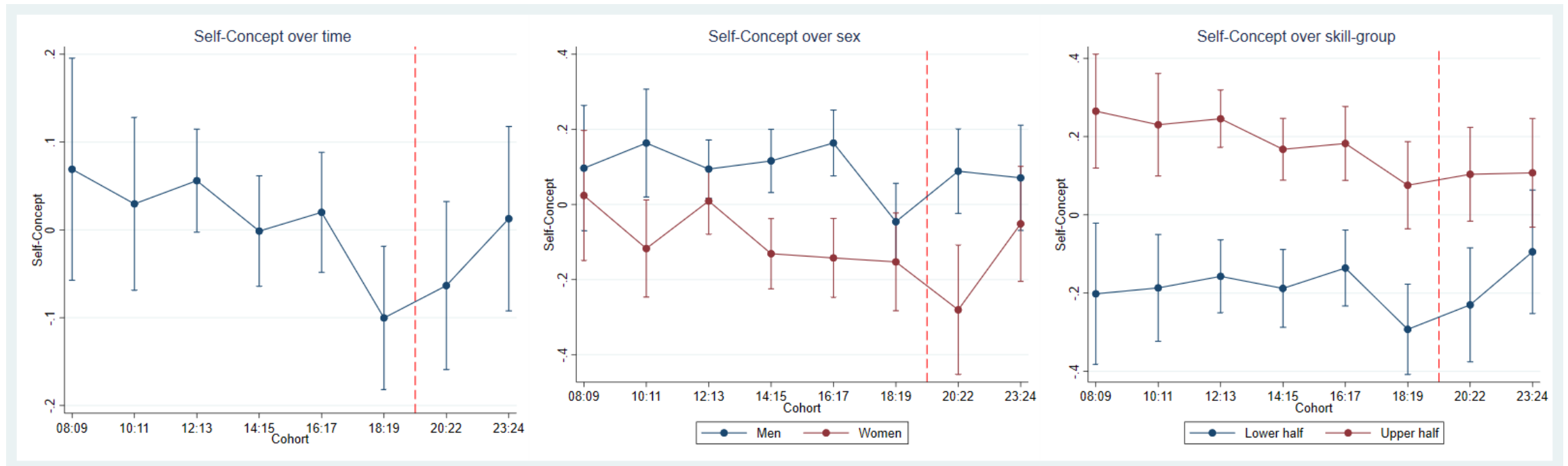
- Major decline in math skills after 2019 with no compensation until 2024
- Significant ($p < 0.1$) divergence between Men and Women after COVID

Results – Math self-assessment development



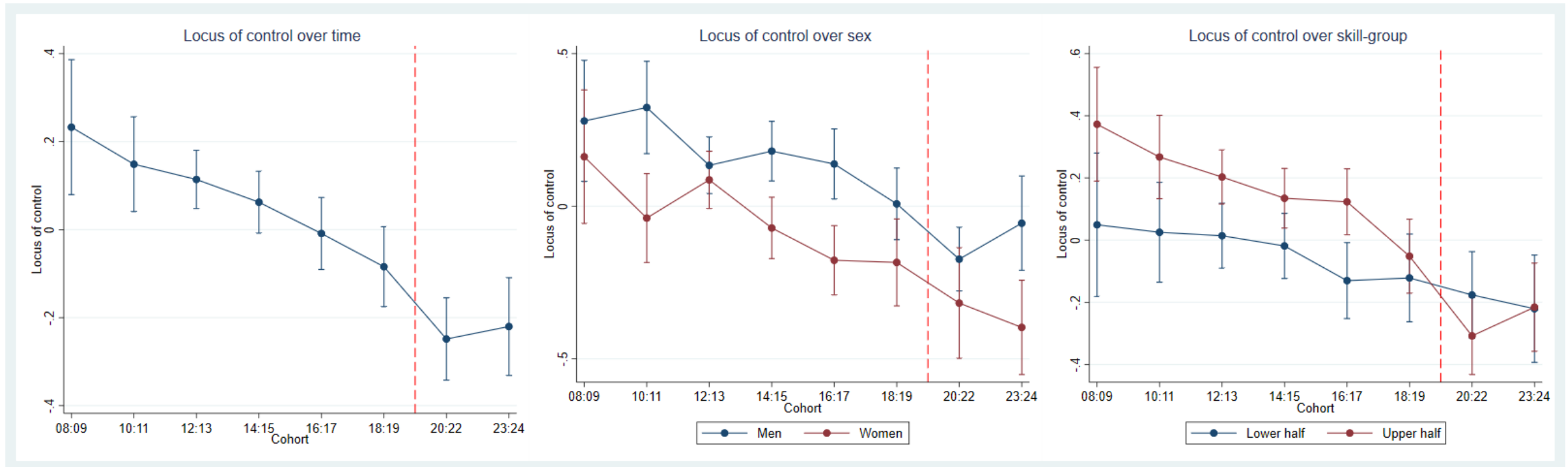
- While math skill declines, self-assessment remains stable
- Particularly lower skilled students have a rise in self-assessed math skills

Results – Math self-concept development



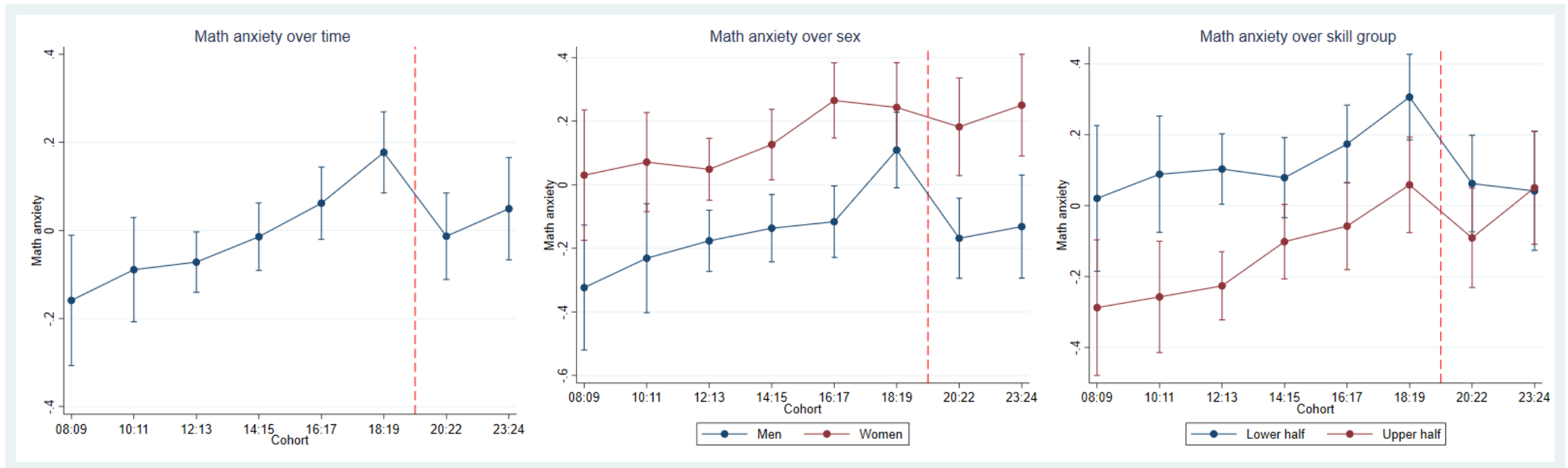
- While math skill declines, self-concept remains stable (slight decline before COVID)
- Particularly lower skilled students have a rise in their math self-concept

Results – Locus of control development



- Locus of control stabilizing after COVID (declining before COVID)
- General decline is mainly driven by higher-skilled students

Results – Math anxiety development



- Incline of math anxiety stabilized after COVID
- Again: compensation and convergence by lower skilled students

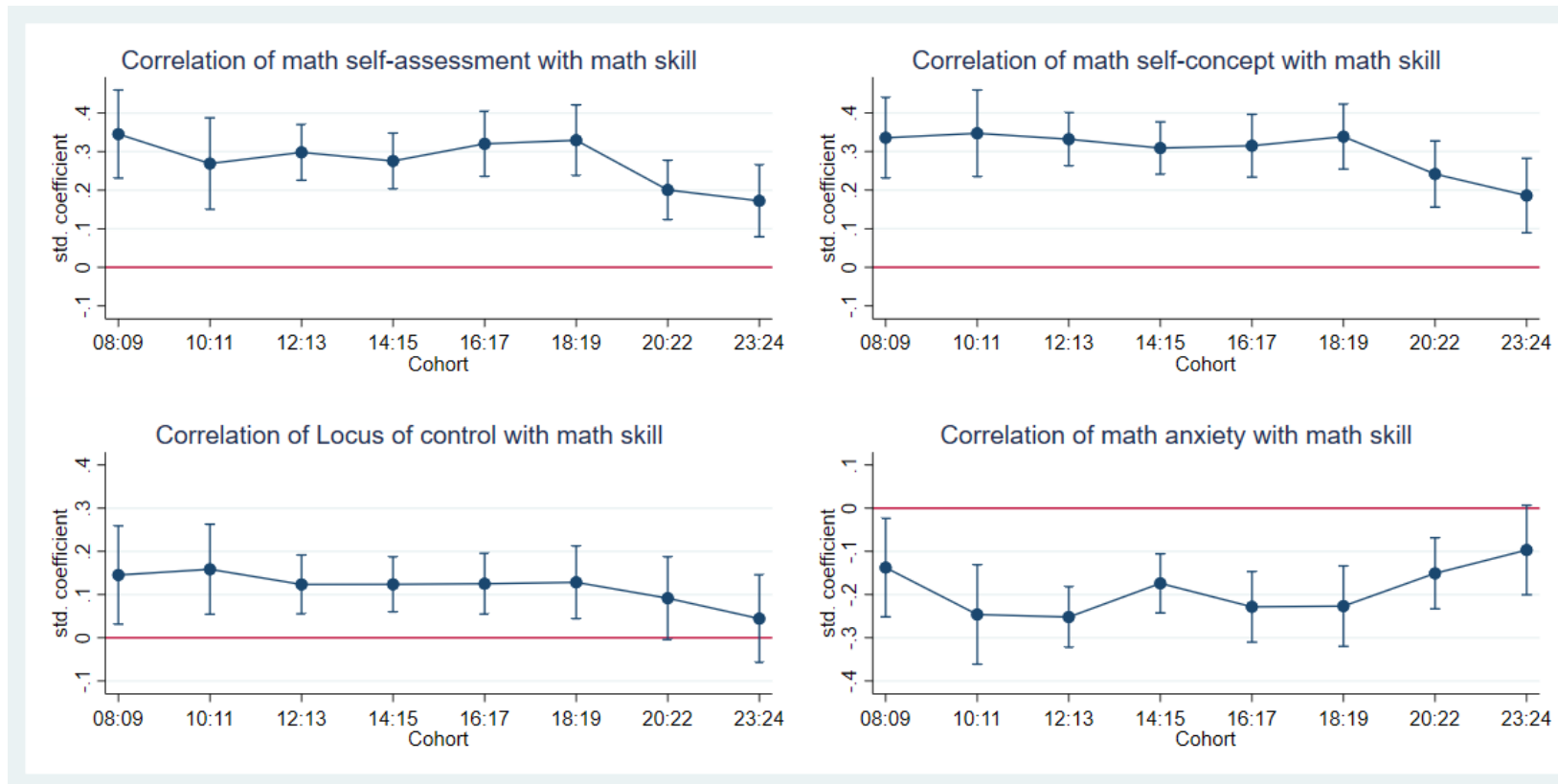
Resulting Problems for students' learning – False self-view of students

- **Reduced Accuracy in Self-Evaluation (Illusions of Competence)**
 - When students' self-assessments do not align with actual performance, they may develop an "illusion of competence." This discrepancy can inhibit the recognition of real skill deficits, thus limiting students' motivation to seek help or adjust their study strategies (Dunning 2011)
- **Impact on Motivation and Goal-Setting**
 - A stable or inflated self-concept, despite declining skills, may lead to setting goals that are not aligned with actual competence levels. Students might overestimate their readiness, increasing the likelihood of frustration or failure down the line (Schunk & DiBenedetto 2020), and the inflated self-concept may prevent students from acknowledging areas needing improvement, reducing engagement in remedial work (Martin & Harsh 2006).

Implications I

- **Need for Enhanced Feedback Mechanisms**
 - The observed divergence highlights the importance of providing regular, high-quality feedback. Formative assessments and structured peer or instructor feedback can help recalibrate students' self-views to better reflect their actual skill levels (Hattie & Timperley, 2007)
 - Educators and policymakers may need to adopt strategies that simultaneously bolster actual math competencies (e.g., targeted remediation) and refine students' self-assessment skills (e.g., through metacognitive training) (Pintrich, 2004)

Implications II – Predictability of Math skills



- Lower predictability of these general predictors for math skill
- Particularly locus of control and math anxiety lose predictable value

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Thank you very much! Any questions?