Education, Expectations, and the Economy: Four Essays in Education and Labor Economics

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Und jetzt kommst du aus der Provinz,
Und wenn auch jeder sagt du spinnst,
Du wirst es genauso bringen.
Mach's auf die charmante Art,
Mal elastisch, manchmal hart,
Manchmal musst du das Glück auch zwingen.
"Mein Ding" – Udo Lindenberg

Danksagung

In erster Linie möchte ich mich bei Katharina Spieß für eine herausragende Betreuung bedanken. Trotz schwieriger institutioneller Umstände hatte ich immer das Gefühl, wahrgenommen, ernstgenommen und aufrichtig geschätzt zu werden. Ich bin froh über unsere vertrauensvolle Zusammenarbeit und dankbar, dass ich von Anfang an ins BiFa-Team integriert wurde. Vor allem bin ich dankbar, dass ich an mancher Stelle auch den nötigen Stups bekommen habe. Diese Hilfe hat mir viele Türen geöffnet und ich habe inhaltlich und menschlich viel lernen dürfen.

Als ich durch die Corona-Pandemie direkt am Anfang meiner Dissertation auf einmal in einem leeren Bürogebäude im herbstlichen Berlin Mitte vor den verschlossenen Türen des Forschungsdatenzentrums stand, gab es außer Katharina einige weitere Leute, die mir extrem geholfen haben. In der Anfangszeit haben mir sowohl Jan Marcus als auch Frauke Peter in unseren jeweiligen Projekten in vielen Telefonaten und Zoomcalls eine klare Richtung vorgegeben und mich unterstützt.

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Berlin | 28. April 2024
Andreas Leibing

Inhaltsverzeichnis

Erklärung zu Koautorenschaften

Diese Dissertation besteht aus vier (Arbeits-)Papieren, davon drei in Koautorenschaft:

1. Andreas Leibing, Frauke Peter, Sevrin Waights und C. Katharina Spiess:
   "Gender Gaps in Early Wage Expectations"

2. Andreas Leibing:
   "Local Labor Markets and Postsecondary Education"

3. Andreas Leibing und Felix Weinhardt:
   "Lost Potential? Student Sorting in German Higher Education"

4. Jan Bietenbeck, Andreas Leibing, Jan Bietenbeck und Felix Weinhardt:
   "Tuition Fees and Educational Attainment"

Erklärung zu Vorarbeiten

Ich weise darauf hin, dass sich meine Masterarbeit an der Ludwig-Maximilians-Universität München mit dem Titel "Impacts of Recessions on College Enrollment, Field of Study Choice and Job Market Outcomes" ebenfalls den Einfluss von Arbeitsmarktbedingungen zum Zeitpunkt des Abiturs auf Studienentscheidungen untersucht. Dabei unterscheidet sich **Kapitel 2** dieser Dissertation allerdings deutlich von der Vorarbeit und geht an mehreren Punkten weit über sie hinaus. Zum einen nutzt es administrative Daten aus der Statistik der Studierenden und der Statistik der Prüfungen des Statistischen Bundesamtes, sowie mehrere zusätzliche administrative Datensätze und Surveydatensätze. Zum anderen unterscheidet sich der thematische Fokus deutlich. Statt sich auf die Studienfachwahl zu konzentrieren, stellt das Kapitel eine den Einschreibungseffekten zugrundeliegende Substitution hin zu firmenspezifischem Humankapital fest und beleuchtet diese im Detail. Statt Variation in der nationalen Arbeitslosenquote zu nutzen, konzetriert es sich auf Variation in lokalen Arbeitslosenquoten. Ein theoretisches Modell und zahlreiche weiterführende Analysen zu Effektheterogenitäten, Effektmechanismen und zahlreiche Robustheitschecks grenzen die Arbeit umfassend ab.

Ferner weise ich darauf hin, dass **Kapitel 1** dieser Arbeit in seinen Grundzügen auf Vorarbeit von Vaishali Zambre-Rehbein beruht. Das entsprechende Projekt "The Gender Gap in Wage Expectations: Do Young Women Trade off Higher Wages for Lower Wage Risk?" wurde im Jahr 2017 als Teil ihrer Dissertation "Determinants of College Enrollment: Three Empirical Essays in the Economics of Education" an der Freien Universität Berlin verwendet und 2018 als *DIW Discussion Paper* veröffentlicht (siehe Liste der Vorveröffentlichungen). Nach anfänglicher Zusammenarbeit schied Vaishali im Einvernehmen aller Parteien aus dem Projekt aus. Ich danke Vaishali für ihre Vorarbeit und verweise auf die inhaltliche Neuausrichtung des Projekts, welches in seiner neuen Form bereits erfolgreich dem peer-review Prozess beim *Economics of Education Review* unterlag (siehe ebenfalls Liste der Vorveröffentlichungen).

Liste der Vorveröffentlichungen

Publikationen in referierten Fachzeitschriften

- **Vorpublikation von Kapitel 1:**
  - Leibing, A., Peter, F., Waights, S., & Spiess, C. K. (2023). Gender gaps in early wage expectations. *Economics of Education Review*, 94, 102398. https://doi.org/10.1016/j.econedurev.2023.102398
- **Vorpublikation von Kapitel 4:**
  - Bietenbeck, J., Leibing, A., Marcus, J., & Weinhardt, F. (2023). Tuition fees and educational attainment. *European Economic Review*, 154, 104431. https://doi.org/10.1016/j.euroecorev.2023.104431

Beiträge zur Politikberatung

- **Basierend auf Kapitel 1 ist erschienen:**
  - Leibing, A., Peter, F., & Spieß, C. K. (2022). Gender Gap bei Einkommenserwartungen: Schon kurz nach dem Abitur rechnen Frauen mit niedrigerem Gehalt als Männer. *DIW Wochenbericht*, 89(42), 539-545.
- **Basierend auf Kapitel 4 ist erschienen:**
  - Bietenbeck, J., Marcus, J., & Weinhardt, F. (2021). Temporäre Erhebung allgemeiner Studiengebühren: Mehr Studierende schlossen ihr Studium ab, aber weniger schrieben sich neu ein. *DIW Wochenbericht*, 88(15), 252-259.

Arbeitspapiere

- **Vorpublikationen von Kapitel 1:**
  - Leibing, A., Peter, F., Waights, S., & Spiess, C. K. (2022). Gender gaps in early wage expectations. *IZA Discussion Paper*, 15281.

  - Zambre, V. (2018). The Gender Gap in Wage Expectations: Do Young Women Trade off Higher Wages for Lower Wage Risk?. *DIW Discussion Paper*, 1742.

- **Vorpublikationen von Kapitel 4:**
  - Bietenbeck, J., Leibing, A., Marcus, J., & Weinhardt, F. (2022). Tuition Fees and Educational Attainment. *CEP Discussion Paper*, 1839.
  - Bietenbeck, J., Marcus, J., & Weinhardt, F. (2020). Tuition Fees and Educational Attainment. *IZA Discussion Paper*, 13709.
  - Bietenbeck, J., Marcus, J., & Weinhardt, F. (2020). Tuition Fees and Educational Attainment. *DIW Discussion Paper*, 1900.

Rechtliche Erklärung

Erklärung gem. §4 Abs. 2 (Promotionsordnung)

Hiermit erkläre ich, dass ich mich noch keinem Promotionsverfahren unterzogen oder um Zulassung zu einem solchen beworben habe, und die Dissertation in der gleichen oder einer anderen Fassung bzw. Überarbeitung einer anderen Fakultät, einem Prüfungsausschuss oder einem Fachvertreter an einer anderen Hochschule nicht bereits zur Überprüfung vorgelegen hat.

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Erklärung gem. §10 Abs. 3 (Promotionsordnung)

Hiermit erkläre ich, dass ich für die Dissertation folgende Hilfsmittel und Hilfen verwendet habe:

- Software:
  - Stata Versionen 14 bis 18
  - LaTeX mit Overleaf
  - Microsoft Office
- Literatur: siehe Literaturverzeichnis

Auf dieser Grundlage und in Zusammenarbeit mit meinen Koautoren habe ich die Arbeit selbstständig verfasst.

Berlin | 28. April 2024
Andreas Leibing

Zusammenfassung

Diese Dissertation umfasst vier eigenständige Kapitel, die zur Literatur in der Bildungs- und Arbeitsmarktökonomie beitragen. Sie zeigen auf, welche Determinanten zu den Lohnerwartungen von Abiturienten beitragen (**Kapitel 1**) und wie diese Erwartungen zusammen mit Arbeitsmarktbedingungen zum Zeitpunkt des Abiturs (**Kapitel 2**), Studiengangsrankings (**Kapitel 3**) und Studiengebühren (**Kapitel 4**) nachschulische Humankapitalinvestitionen beeinflussen. Eine umfassende Einleitung und eine Zusammenfassung bilden den Rahmenteil.

Kapitel 1 zeigt anhand detaillierter Befragungsdaten unter deutschen Abiturienten, dass Frauen bereits kurz nach dem Abitur im Schnitt 15% niedrigere Einkommenserwartungen haben als Männer. Eine Dekomposition dieser frühen Geschlechtsunterschiede zeigt, dass insbesondere gruppenspezifische Korrelationen einzelner Merkmale mit den Einkommenserwartungen, statt die Häufigkeit der Merkmalsausprägungen selbst, eine große Rolle spielen. Insbesondere eine Präferenz für ausreichend Zeit mit der Familie und ein Erstakademikerstatus, sind mit geringeren Lohnerwartungen von Frauen verbunden. Dies gilt vor allem für potentiell höhere Karrierepfade. Bei Frauen hängen niedrige Einkommenserwartungen außerdem statistisch mit weniger Hochschuleinschreibungen zusammen, womit sich Geschlechterunterschiede im tatsächlichen Einkommen später verwirklichen könnten.

Kapitel 2 kontrastiert die vorherrschende Evidenz zur Rolle von Arbeitsmarktbedingungen bei nachschulischen Bildungsentscheidugungen. Gilt die herkömmliche Logik antizyklischer Hochschuleinschreibungen auch in einem Kontext, in dem eine duale Ausbildung die Hauptalternative zu einem Studium darstellt? Anhand von Daten des Deutschen Hochschulregisters zeigt diese Studie, dass eine geringere lokale Arbeitsnachfrage zum Zeitpunkt des Schulabschlusses die Zahl der Studienanfänger und -absolventen betroffener Jahrgänge reduziert. Mehr Abiturienten entscheiden sich für praxisorientierte Hochschulen oder beginnen eine Ausbildung statt ein Studium an klassischen Universitäten aufzunehmen. Abhängig von Zeit- und Risikopräferenzen finden sich umgekehrte Effekte bei Absolventen aus Akademikerfamilien. Befragungsdaten zeigen außerdem,

dass männliche Schüler mit unterdurchschnittlichen Noten in Rezessionen höhere relative Erträge aus beruflichen Abschlüssen erwarten. Die Ergebnisse deuten darauf hin, dass firmenspezifisches Humankapital von einigen Absolventen als Absicherung gegen ökonomische Unsicherheiten gesehen wird.

Kapitel 3 geht der Frage nach, wie sich öffentliche Informationen über die Qualitätsverteilung von Universitäten innerhalb eines Studienbereichs auf die Hochschulwahl auswirken. Wir kombinieren ein von der deutschen Zeitung "Die Zeit" veröffentlichtes ordinales Ranking und die amtliche Statistik der Studierenden. Differenzen-in-Differenzen-Schätzungen zeigen, dass eine Platzierung in der Spitzengruppe die durchschnittliche Entfernung, die Studienanfänger innerhalb eines Studiengangs zurücklegen, um über 7% erhöht. Die Ergebnisse sind größer in dynamischen Spezifikationen und robust gegenüber dem lokalen Mietniveau als Kontrollvariable. Ranglisten, die auf Empfehlungen von Lehrkräften beruhen, sind insgesamt weniger effektiv. Wir diskutieren wie Informationen über Studiengangsqualität sowohl die Passung von Studiengängen und Studierenden, als Bildungsungleichheiten beeinflussen können.

Kapitel 4 analysiert, wie Studiengebühren nicht nur Universitätseinschreibungen, sondern auch Abschlussquoten beeinflussen. Nach einem Gerichtsurteil des Bundesverfassungsgerichts im Jahr 2005 begannen mehr als die Hälfte der deutschen Universitäten, Studiengebühren zu erheben, welche später stufenweise abgeschafft wurden. Wir nutzen die Tatsache, dass selbst bereits eingeschriebene Studierende Gebühren zahlen mussten. Zwar erhöhen Gebühren unter diesen Studierenden den Lernaufwand und die Wahrscheinlichkeit eines Studienabschlusses, allerdings verringern sie auch die Ersteinschreibungsquote an Universitäten. Insgesamt hatten geringfügige Studiengebebühren also nur wenig Einfluss auf den gesamten tertiären Bildungserwerb. Wir raten von einer generellen Abschaffung von Studiengebühren ab und erörtern Möglichkeiten der Hochschulfinanzierung, welche die diskutierten Effekte berücksichtigen.

Abstract

This dissertation comprises four independent chapters contributing to the literature on the Economics of Education and Labor Economics. They shed light on the determinants of high school graduates' wage expectations (**Chapter 1**) and how these expectations, along with the labor market conditions at graduation (**Chapter 2**), program rankings (**Chapter 3**), and the direct costs of studying (**Chapter 4**), affect postsecondary human capital investment. A comprehensive introduction and conclusion precede and close the individual contributions.

Chapter 1 uses detailed data from a unique survey of high school graduates in Germany, and documents a gender gap in expected full-time earnings of more than 15%. We decompose this early gender gap and find that especially differences in coefficients help explain different expectations. In particular, the effects of having time for family as a career motive and being a first-generation college student are associated with large penalties in female wage expectations exclusively. This is especially true for higher-expected career paths. Resulting expected returns to education are associated with college enrollment of women and could thus entrench subsequent gaps in realized earnings.

Chapter 2 asks if countercyclical college-going, a stylized fact in economics, holds with a dual education system as an outside option. This study uses German register data to show that reduced local labor demand at high school graduation decreases college enrollment and attainment. More students choose vocationally oriented colleges and apprenticeships instead of traditional universities. Conditional on economic preferences, these effects are reversed for high SES graduates. Survey data further reveals that low-achieving young men expect higher relative returns to vocational education during recessions. The findings suggest that investment in firm-specific human capital is perceived as an insurance mechanism.

Chapter 3 asks how public information on the within-field-of-study quality distribution of universities affects college choice. We combine an ordinal tier ranking published by the German newspaper "Die Zeit" and register data on higher education students. Differences-in-differences estimates show that being ranked in the top tier increases the average distance traveled by freshmen within a program by over 7%. The results are larger in dynamic specifications and robust to controlling for the local rent level. Rankings based on recommendations by faculty are overall less effective. We discuss how information provision on program quality can affect educational mismatch and implications for inequality.

Chapter 4 analyzes how tuition fees affect not only university enrollment but also completion rates. Following a landmark court ruling in 2005, more than half of Germany's universities started charging tuition fees, which were later abolished in a staggered manner. We exploit the fact that even students who were already enrolled had to start paying fees. We show that fees increase study effort and degree completion among these students. However, fees also decrease first-time university enrollment among high school graduates. Combining this enrollment impact with the effect on completion, we find that fees around the zero-price margin have only little effect on overall educational attainment. We conclude by discussing policies targeting the separate effect margins of fees and caution against a general abolition.

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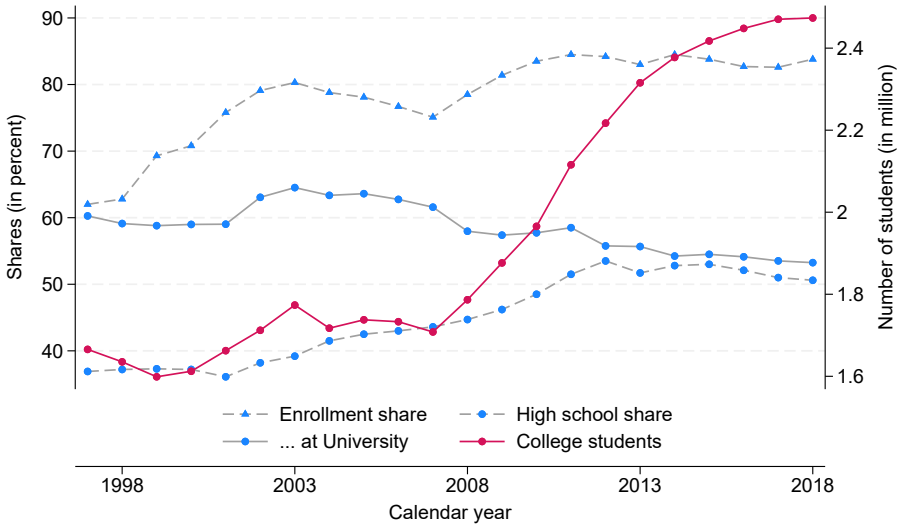
Introduction

I.1 Motivation

Over the past decades, Germany has experienced a remarkable educational expansion, with an increasing share of young adults graduating from high school and an increasing share of high school graduates enrolling in college. Consequently, the demand for higher education rose tremendously from around 1.6 million college students in 1999 to around 2.5 million in 2018. At the same time, the share of college students enrolled at traditional universities has been continuously decreasing (see Figure I.1). What policies have contributed to this development, and what makes the German postsecondary education system such an interesting case to study?

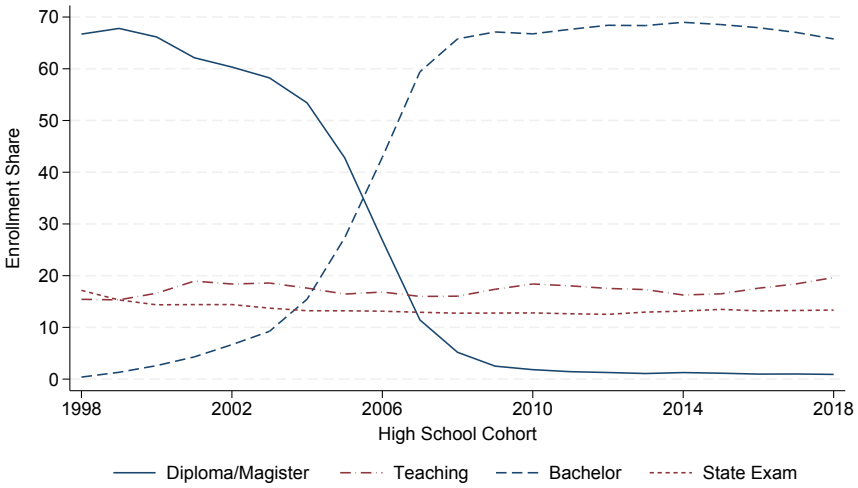
Figure I.1: Higher Education Expansion in Germany.



Notes: Share of 18–21-year-olds with a university entrance qualification (*High school share*), share of high school graduates enrolling at college within one year of graduation (*Enrollment share*), number of German students enrolled at college (*College students*), and share of German college students enrolled at a college with the right to award doctorates (*... at University*). *Source*: Federal Statistical Office (Student Register) and DZHW calculations (see Datenportal des BMBF (Tabelle 2.5.85)).

One starting point is the Bologna Process during the 2000s, with the goal of harmonizing the higher education system across 49 member states of the European Higher Education Area (EHEA). One main consequence in Germany was the shift from a one-tier structure with degrees of around five years of nominal study duration (e.g., *Diplom*, or *Magister*) to a two-tier structure with Bachelor's (three) and Master's degree (two years of nominal study duration). An arguably less time-consuming investment. Despite its media attention, the Bologna Process is surprisingly understudied in Economics, but papers suggest a positive influence on college enrollment (e.g., Cappellari and Lucifora, 2009; Kroher et al., 2021). Figure I.2 shows that the rapid shift in degree structures precedes the rise in college students and relative decline at universities.

Figure I.2: Bologna Reform and Degree Choice of Freshmen.

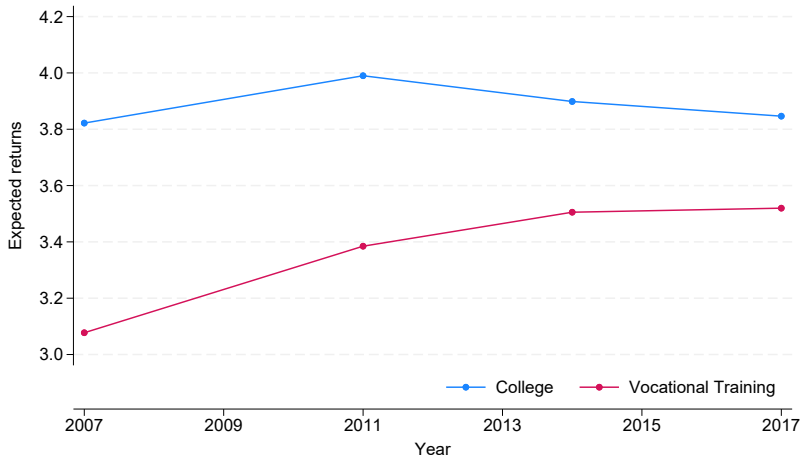


Notes: Share of first-year university students enrolling across degree types. *Source*: Federal Statistical Office (Student Register).

A more indirect change brought about by the Bologna Process was the blurring of the boundary between academic education and vocational education and training. While the one-tier distinguished between a *Diplom* from a traditional university and a *Diplom FH* from a University of Applied Sciences (UAS, *Fachhochschule)*, Bachelor's degrees from both institutions are formally equivalent. In an attempt to alleviate skill shortages by making vocational training more attractive, the Federal Ministry of Education and Research recently approved the *Bachelor Professional* and *Master Professional* as designations of vocational degrees, such as the *Meister* (BMBF, 2020). Following the European Qualification Framework (EQF), the *Meister* itself is equivalent to a Bachelor's degree and allows one to enroll in college. Increasingly, traditional universities offer dual degrees, i.e., Bachelor's degrees that integrate vocational training at a firm, which used to be typical for UAS.

On the supply side, one possible effect of shortened degrees and the simultaneous diversification and formal equalization of degrees across institutional types is the opening of new vocationally oriented colleges. During the Bologna Process, the number of vocational colleges in Germany rose from 174 in 2000 to 247 in 2012. Some vocational colleges reported that the Bologna Process simplified the creation of new degrees (see, e.g., Schick, 2005). So far, however, there is no causal evidence on the supply side. A small emerging literature studies the effect of labor market shocks on the programs offered by existing colleges (Conzelmann et al., 2023; Carranza et al., 2023), but little is known about the creation of new colleges.

Figure I.3: Expected Returns to Academic and Vocational Education.



Notes: Average expected labor market opportunities of high school students (N=131,810) in their final year for graduates with a college degree and with vocational training (1=very low, 5=very high). *Source*: DZHW Panel Study of School Leavers with a Higher Education Entrance Qualification.

On the demand side, with its increasing overlap of vocational and academic education, the Bologna Process was followed by a decrease in the expected relative returns to college. Figure I.3 shows that since 2007, the expected value of a college degree has remained relatively stable, while the expectations of high school students for vocational training have continuously increased. Undoubtedly, the increasing share of young adults graduating from high school described earlier, coupled with changes in the sociodemographic composition of high school students, could largely account for changes in the expected relative returns to college. However, the convergence in expected returns to academic and vocational education well reflects the convergence of academic and vocational education itself. Related to this, **Chapter 1** asks what factors contribute to (gender gaps in) wage expectations associated with different degree types. **Chapter 2** further analyzes how economic conditions at high school graduation affect the expected returns to college education and vocational training.

Besides the Bologna Process, other policies have markedly changed the German higher education landscape. First, the emergence of college rankings in Germany in the early 2000s, e.g. by the Centre for Higher Education (CHE), might have influenced students' perceptions and institutional and program choices. The CHE Ranking compares college programs within different fields of study and institutional types. Its introduction thus offered public information on what used to be rather tacit knowledge and made traditional universities and UAS more comparable. **Chapter 3** analyzes if and how students' enrollment decisions react to the CHE Ranking. Second, the introduction of tuition fees in certain federal states during the 2000s sparked debates about the accessibility and affordability of higher education and led to their swift abolition. Interestingly, fees were levied for freshmen and incumbent students. **Chapter 4** uses quasi-experimental variation in the timing of fees for incumbent students, looking beyond enrollment effects and estimating effects on completion rates. Even though fees were modest and could also be levied by Universities of Applied Sciences, they could have contributed to the shift away from traditional universities.

In contrast to the fundamental changes in the higher education system is the dual education system in Germany. Apprenticeships, the second key element of postsecondary education, have been spared from larger reforms and are an established outside option for high school graduates. They are highly subsidized by the state, combine on-the-job training at a firm with a schooling component, and focus on skills needed in specific occupations. Hence, apprenticeships generate firm- and occupation-specific human capital, allowing for a smooth school-to-work transition (Jovanovic, 1979; Hanushek et al., 2017), at the risk of becoming obsolete in the long-run (Deming and Noray, 2020). Currently, the rise of AI creates uncertainty in the demand for different skills (Frank et al., 2019), understanding the flexibility of the German dual education system in reacting to skill demand is more relevant than ever. **Chapter 2** studies how high school graduates substitute applied skills for general skills during economic downturns.

The many reforms in German higher education and its established apprenticeship system make Germany an interesting case for studying the substitution of vocational for general education. The Bologna Process, tuition fees, and Universities of Applied Sciences as hybrids of academic and vocational education have contributed to shifts in enrollment patterns among students. Understanding how these factors interact and influence individuals' choices between vocational and academic paths provides valuable insights into the optimal allocation of human capital and labor market dynamics. Moreover, in an era marked by technological advancements and evolving skill requirements and shortages, the German experience offers lessons on how education systems can adapt to meet changing demands and ensure a skilled workforce.

I.2 Overview and Summary

This dissertation contains four empirical chapters attempting to contribute to the abovementioned agenda. They all use combinations of different data sources and methods to causally and descriptively answer clear research questions to contribute to a better understanding of postsecondary human capital investments. Table I.1 gives an overview of the main content of each chapter, summarized in this section. Joint contributions are highlighted in Section I.3.

Table I.1: Overview and Summary of Dissertation Chapters

	Chapter 1	**Chapter 2**	**Chapter 3**	**Chapter 4**
Title	Gender Gaps in Early Wage Expectations	Local Labor Markets and Postsecondary Education	Lost Potential? Student Sorting in German Higher Education	Tuition Fees and Educational Attainment
Question	What determines high school graduates' wage expectations?	How do human capital investments react to economic conditions?	What is the effect of university rankings on student-to-college matching?	How do tuition fees affect college enrollment and completion rates?
Main finding	Women have lower expectations and anticipate large family penalties.	Local shocks induce substitution of vocational for general education.	Highly ranked programs experience an inflow of more mobile students.	Positive effect on completion cancels out negative effects on enrollment.
Data	Best Up, *Microcensus*, SOEP.	Student and Exams Register, BA, DZHW, SOEP, NEPS, *Regionaldatenbank*.	Student Register, CHE Ranking, *Regionaldatenbank*, RWI-GEO-REDX, *Hochschulkompass*, DZHW.	Student and Exams Register, *Regionaldatenbank*, German Student Survey, *Microcensus*.
Methodologies	Oaxaca-Blinder and RIF Decomposition, Linear Probability Model (LPM)	Two-Way-Fixed-Effects (TWFE), LPM	Difference-in-differences (TWFE DiD, DID_M, DID_ℓ, Event Studies)	Difference-in-differences (TWFE DiD, DID_M, DID_ℓ, Event Studies)

Notes: BA= Federal Employment Agency, covering administrative data on apprenticeships (*Ausbildungsmarktstatistik*) and regional unemployment rates, Best Up= *Berliner-Studienberechtigten-Panel*, DZHW= German Centre for Higher Education Research and Science Studies, covering Panel Study of School Leavers with a Higher Education Entrance Qualification, *Hochschulkompass*= College addresses of German Rectors' Conference (HRK), *Microcensus*= Census sample of the Federal Statistical Office, NEPS= National Educational Panel Study of LIfBi Bamberg, *Regionaldatenbank*= Regional indicators, including number of high school graduates, of the Federal Statistical Office, RWI-GEO-REDX= rental price indices of RWI Essen, SOEP= Socio-economic Panel of DIW Berlin, Student Register and Exams Register= *Statistik der Studierenden* and *Statistik der Prüfungen* of the Federal Statistical Office. Data sources apply to the German context.

Chapter 1 is a joint project with Frauke Peter (DZHW Hannover), Sevrin Waights (formerly DIW Berlin) and Katharina Spiess (Bundesinstitut für Bevölkerungsforschung Wiesbaden and Johannes Gutenberg-Universität Mainz) published in the *Economics of Education Review* (Leibing et al., 2023). The paper documents significant gender gaps in the wage expectations of German high school graduates associated with different degrees. We use data from the Berliner-Studienberechtigten-Panel (Best Up) and show that the average gender gap in wage expectations associated with a tertiary degree (i.e.,

Bachelor's or Master's) amounts to 15.7 percent. An Oaxaca-Blinder Decomposition reveals that implicitly expected family commitments of women can account for about 40 percent of these gaps. Women with a preference for time for family commitments have lower expected earnings than women without this preference. For men, however, there is no such difference. We find higher gender gaps for maximum expected earnings and use recentered influence functions (RIF Decomposition) to highlight that the part of the gender gap attributable to family considerations is largest for upper parts of the expected earnings distribution, indicating that female high school graduates implicitly expect having to give up leadership positions to exert care work. We show that lower wage expectations are associated with lower college enrollment for women and conclude that (information on) policies that allow the reconciliation of career and family can help to close gender gaps in wage expectations and associated outcomes.

Chapter 2 studies how local labor market conditions at high school graduation affect postsecondary human capital investments. Using administrative data from the German student register from 1998 to 2017, I show that economic shocks at high school graduation reduce overall first-time enrollment and cause a shift towards more applied skill investments. Instead of enrolling in college, more graduates start an apprenticeship, which serves as a business cycle-proof outside option. The overall reduction in college enrollment is driven by lower enrollment at public universities focusing on general human capital. Conversely, a higher share of high school graduates enroll at more vocationally oriented colleges, such as Universities of Applied Sciences, during recessions. Enrollment effects carry over to changes in educational attainment and imply an overall substitution of investment in vocational for general education. Another implication of my findings is that high school graduates displace graduates with lower school-leaving degrees from apprenticeships. My findings contrast with a vast literature from the U.S. that finds countercyclical college-going and informs policymakers who want to import the dual education system.

Chapter 3, jointly with Felix Weinhardt (European University Viadrina Frankfurt (Oder) and DIW Berlin), investigates the effect of information provision on the within-field-of-study quality distribution of study programs via university rankings of the German Centre for Higher Education (CHE) on student-to-degree matching patterns. Combining data from the German student and exams register, rent-level data from RWI-GEO-RED/X, and data from the CHE Ranking, we find that being ranked in the top group of the ranking increases the number of students and the average distance between their county of high school graduation and the eventual university of first-time enrollment significantly. Mobility effects across different difference-in-differences estimators are large and more pronounced for ranking categories based on

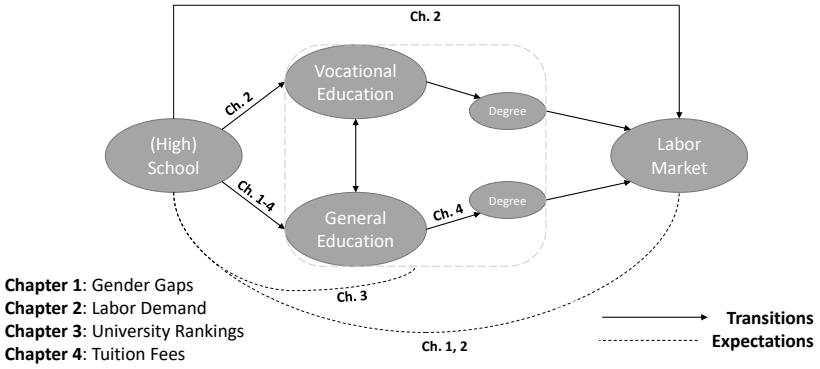
student satisfaction rather than recommendations by faculty. We argue that especially high-achieving, well-informed graduates react to rankings and discuss further steps to analyze information provision's equity and efficiency effects on program quality.

Chapter 4, jointly with Jan Bietenbeck (Lund University), Jan Marcus (Freie Universität Berlin), and Felix Weinhardt (European University Viadrina Frankfurt (Oder) and DIW Berlin), published in the *European Economic Review* (Bietenbeck et al., 2023) studies the effects of the introduction and staggered abolition of tuition fees on educational attainment in Germany. We use different difference-in-differences estimators to show that while even a small fee around the zero price margin (500 EUR per semester) reduced enrollment at public universities, tuition fees increased the degree completion of incumbent students and cohorts who enrolled in a fee regime. We show that combined extensive and intensive margin effects have zero impact on overall attainment. Given the zero net impact of tuition fees, we caution against a general abolition of tuition fees.

I.3 Joint Contributions

Figure I.4 illustrates that all of these chapters evolve around the postsecondary education sector, i.e., as modeled in economics, the intermediate step between secondary education and entering the labor market. However, this boundary is fluid in the case of a dual education system. In what follows, I will situate the chapters of this dissertation in the larger context of transitions from high school to college and to the labor market. In doing so, I will highlight connections between the chapters and their joint contributions.

Figure I.4: Education, Expectations, and the Economy.



Notes: Four essays in Education and Labor Economics. *Source*: Own illustration.

I.3.1 Expectations and Information

Chapter 1 contributes to a better understanding of gender gaps in wage expectations and the interplay between educational investments and family and career considerations (see, e.g., Reuben et al., 2017; Wiswall and Zafar, 2018) at an early age. It combines and extends several aspects of existing studies and is the first paper to analyze determinants of the gender gap in earnings expectations of individuals before their decision to invest in higher education, to carry out detailed decompositions at different margins explicitly, and to track students over time and assess the association of wage expectations with college enrollment. Unlike most other studies, we consider different noncognitive abilities and career motives, such as *time for family*, as potential drives of the gender gap.[1] Closely related are Eliophotou-Menon (1997a,b) for secondary school students in Cyprus, Attanasio and Kaufmann (2017) for Mexico, and Boneva et al. (2022) for Germany, none however decomposes the gender gaps in wage expectations.

Chapter 2 exploits large-scale survey data to estimate the effect of economic shocks on the expected relative returns to college education. While it finds no average effect on the expected returns to college, shocks reduce the expected returns to vocational training significantly. However, low-achieving young men show an increase in their expected relative returns to apprenticeships vs. college education, which can at least partly explain the procyclical pattern in college enrollment. The literature on expectations in education has not yet studied the effect of economic shocks on the expected risk and return of college at high school graduation (see Giustinelli, 2023, for an overview).

Chapter 3 contributes to the literature on university rankings as a factor in students' human capital investments by estimating causal effects for actual enrollment and student mobility. It uses mobility measures to conclude students' university choices while circumventing measurement problems that arise in oversubscribed programs. Previous studies using rankings based on student satisfaction have focused on university applications instead of studying actual enrollment (Soo, 2013; Luca and Smith, 2013; Gibbons et al., 2015). Related to this chapter, Horstschräer (2012) combines data from the CHE ranking with administrative data on applications at German medical schools (2003–2008) and finds small positive effects of a green rating based on student satisfaction.

[1] Most existing studies on earnings expectations focus on averages (for overviews, see, e.g., Brunello et al., 2004; Manski, 2004; Giustinelli, 2022), focus on college students or applicants (Manski, 1993; Betts, 1996; Wolter, 2000; Carvajal et al., 2000; Wolter and Zbinden, 2002; Delaney et al., 2010; Huntington-Klein, 2015; Alonso-Borrego and Romero-Medina, 2016; Ehrmantraut et al., 2020; Briel et al., 2022; Kiessling et al., 2024), or do not estimate gender gaps (e.g. Dominitz and Manski, 1996; Wolter, 2000; Attanasio and Kaufmann, 2014; Hastings et al., 2015, 2016; Schweri and Hartog, 2017).

I.3.2 College Enrollment and Institutional Choice

Chapter 2 contrasts the conventional wisdom of countercyclical college-going (see, e.g., Betts and McFarland, 1995; Hazarika, 2002; Dellas and Koubi, 2003; Dellas and Sakellaris, 2003; Christian, 2007; Hillman and Orians, 2013; Johnson, 2013; Long, 2014; Sievertsen, 2016; Graves and Kuehn, 2022). It shows that local labor market shocks reduce overall first-time enrollment. In contrast to previously studied Anglo-Saxon countries, Germany represents a large set of countries that fund higher education institutions rather than individuals and has higher levels of employment protection and, thus, less cyclical labor markets. Apprenticeships off an arguably business cycle-proof outside option. Similarly to Charles et al. (2018), it confirms that changes in enrollment rates translate into later educational attainment of affected cohorts.

Chapter 3 contributes to the active literature on student-college matching. Prior research has focused on other factors influencing matching, such as learning externalities (MacLeod and Urquiola, 2015) and the impact of college reputation on job outcomes (MacLeod et al., 2017). This chapter examines, how public information on university quality, and thus reputation, affects student mobility and enrollment. Our findings align with studies highlighting the importance of information in guiding students' decisions (Dillon and Smith, 2017) and contribute to ongoing discussions on inequalities in student-program matching (Campbell et al., 2022) and what measures can improve both equity and efficiency (Black et al., 2023). Moreover, it contributes to research on the role of distance (e.g. Spiess and Wrohlich, 2010) and the housing market for college enrollment (Charles et al., 2018; Goehausen and Thomsen, 2024).

I.3.3 Direct Costs and Credit Constraints

In contrast to the existing literature on tuition fees (see, e.g., Dynarski, 2003; Kane, 2003; Cornwell et al., 2006; Barr, 2015; Castleman and Long, 2016), **Chapter 4** estimates causal impacts of tuition fees, not only at the extensive but also at the intensive margin. Other research focuses on identifying pure intensive margin effects, mostly for specific universities (Garibaldi et al., 2012; Fricke, 2018; Murphy and Wyness, 2023) or specific types of students (Barr, 2019; Denning, 2019). Yet other studies estimate the effects of a combination of aid and tuition fees on degree completion. Because such changes in the net cost of higher education usually affect enrollment, most of these estimates reflect a combination of extensive and intensive margin effects, which are difficult to disentangle (Dynarski, 2003; Fack and Grenet, 2015; Angrist et al., 2016; Castleman and Long, 2016; Deming and Walters, 2018a; Denning et al., 2019). The

introduction of fees is more salient than variation in financial aid, for which information costs play a key role (e.g. Bettinger et al., 2012a; Barr and Turner, 2018; Dynarski et al., 2018). We contribute by identifying the causal effect on educational attainment for the population of students in an entire country. Even though the effects of tuition fees on college enrollment and college completion in Germany are moderate, **Chapter 2** finds no significant effect of household income shocks on college-going.

I.3.4 Behavioral Aspects

Chapter 2 contributes to a more general understanding of how economic conditions affect the skill content of human capital investment. Apprenticeships and dual studies offer recession-proof outside options that focus on applied skills. Other work has focused on on-the-job training (Fukao and Otaki, 1993; Méndez and Sepúlveda, 2012) or on an intensive margin: Gilpin et al. (2015); Acton (2021); Grosz (2022); Weinstein (2022); Bütikofer et al. (2023) find that major choice adapts to occupation-specific shocks in local labor demand. I show that recessions can shift investment towards firm-specific human capital, which might be perceived as an insurance mechanism against unemployment risk after graduation (Jovanovic, 1979).

Chapter 2 further integrates the literature on economic preferences. Patience and risk-taking may significantly account for cross-country differences in human capital investments (Hanushek et al., 2022), but the literature on the effect of economic shocks on college-going widely disregards them.[2] Labor market shocks at high school graduation offer arguably exogenous variation in uncertainty associated with different skill investments and may tighten credit constraints. Effects on skill investments thus potentially depend on high school graduates' economic preferences.[3] Preferences moderate the effect of labor market shocks on human capital investments but cross-country differences in patience and risk-taking are unlikely to explain effect differences across countries.

Lastly, increased completion rates and study effort found in **Chapter 4** are consistent with the literature studying sunk-cost effects. Already enrolled students had "skin in the game" and thus psychic cost of failing, motivating them to study harder (Thaler, 1980; Arkes and Blumer, 1985; Ketel et al., 2016). Also, effects around the zero price margin are consistent with zero as a "special price" (Shampanier et al., 2007).

[2]While the predicted effect of time preferences on college enrollment is negative, the effect of risk aversion is ambiguous. On the one hand, recessions increase the wage risk associated with apprenticeships. On the other hand, education is a risky investment with uncertain payoffs (e.g., Kodde, 1986; Brodaty et al., 2014; Nielsen and Vissing-Jorgensen, 2006; Belzil and Leonardi, 2013).

[3]Reversely, education might also affect the formation of risk (e.g., Black et al., 2018) and time preferences (e.g., Perez-Arce, 2017), which are often measured after schooling decisions are already made.

CHAPTER 1

Gender Gaps in Early Wage Expectations*

For copyright reasons, this chapter is not included in the online version of this dissertation. It is published as: *Leibing, A., Peter, F., Waights, S., & Spiess, C. K. (2023). Gender gaps in early wage expectations. Economics of Education Review, 94, 102398.*

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CHAPTER 2

Local Labor Markets and Postsecondary Education*

2.1 Introduction

A large body of research studies the impact of economic fluctuations on college-going.[1] As a stylized fact, enrollment in higher education is countercyclical, and especially community colleges serve as *safe port in a storm* (Betts and McFarland, 1995). This aligns with classic economic theory, which emphasizes the relative returns to schooling and thus its outside options (e.g., Becker, 1962). On the other hand, recessions can induce credit constraints and might increase uncertainty in the returns to college. Hence, their effect on enrollment depends on whether the cyclicality of labor markets dominates.

Figure 2.1 shows two types of countries: Those with highly regulated labor markets and direct college funding and those with more fluid labor markets and a more market-based higher education system. So far, the empirical evidence stems almost exclusively from Anglo-Saxon countries, where students bear the risk of human capital investment and may thus be more dependent on outside options. For the first, more homogeneous

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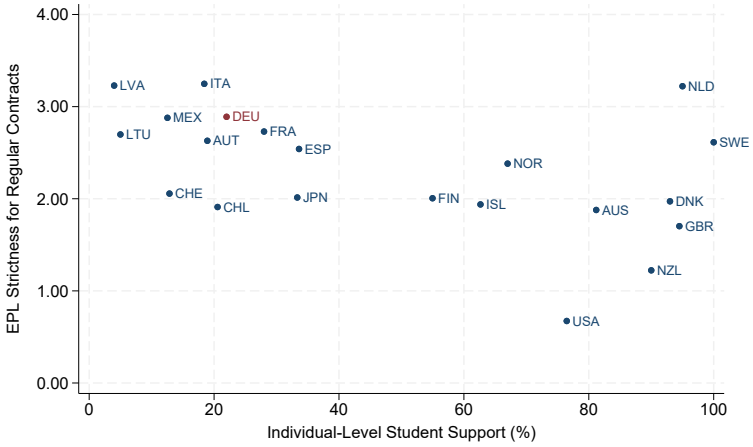
[1] These studies often use variation in macroeconomic measures to study the effects on college enrollment (e.g., Betts and McFarland, 1995; Hazarika, 2002; Dellas and Koubi, 2003; Dellas and Sakellaris, 2003; Christian, 2007; Hillman and Orians, 2013; Johnson, 2013; Long, 2014; Sievertsen, 2016; Graves and Kuehn, 2022), major choice (Liu et al., 2019; Ersoy, 2020; Han and Winters, 2020; Blom et al., 2021), or later skills (Hampf et al., 2020; Arellano-Bover, 2022) and earnings (Bičáková et al., 2021, 2023).

Figure 2.1: Labor Market and Higher Education Institutions in the OECD.



Notes: Share of college students benefiting from student loans or grants and the summary indicator for individual and collective dismissal of regular workers (1998-2018 average) as a determinant for labor market cyclicality (Blanchard and Wolfers, 2000).
Source: OECD Employment Protection Legislation Database (2020), OECD Education at a Glance (2011, 2022)

set of countries, the cyclicality of college enrollment is unclear.[2] Even less is known about how economic shocks affect substitution between general vs. firm-specific human capital, which may ease the school-to-work transition (Jovanovic, 1979; Hanushek et al., 2017) and thus may be seen as an insurance mechanism against recessions.

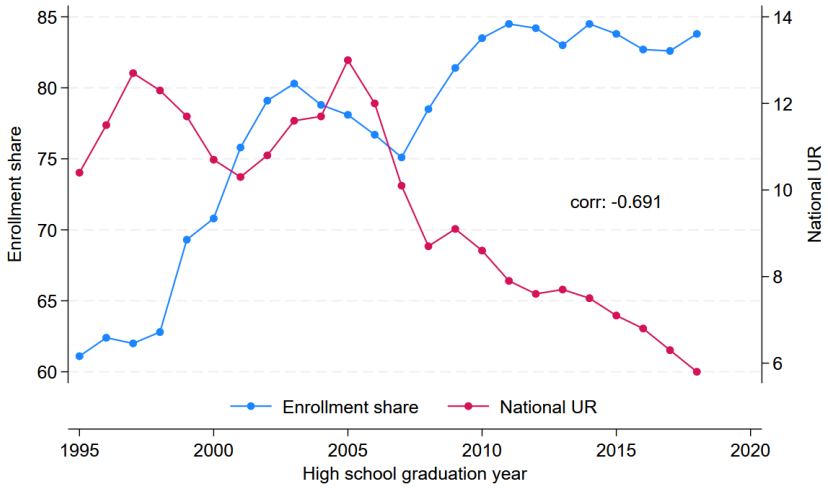
This article studies the causal effect of economic shocks on college-going and the skill content of human capital investment. It exploits within-region across-time variation in unemployment and administrative data on German higher education and finds that economic shocks reduce overall college-going, contrasting conventional wisdom. Figure 2.2 shows that college enrollment in Germany is indeed procyclical. Instead of enrolling at traditional universities, more graduates choose universities of applied sciences and apprenticeships. Survey data suggest that economic preferences moderate the effects and that economic shocks affect students' expected returns to different educational degrees, while credit constraints play a negligible role.[3]

I embed the empirical analysis in a Roy model of postsecondary skill investments. The model builds on Charles et al. (2018) and considers three alternatives for high

[2]Modrego (1988); López-Valcárcel and Quintana (1998); Albert (2000) find mixed effects of economic shocks on college-going in Spain. Giannelli and Monfardini (2003); Becker et al. (2010) find that job insecurity reduces the coresidence of high school graduates and parents in Italy.

[3]The evidence on credit constraints is mixed: Cameron and Taber (2004); Hilger (2016) find that most individuals with enrollment intentions are not liquidity constrained; Bulman and Hoxby (2015) detect only small effects of tax credits on college-going. Bulman et al. (2021) find that only large lottery wins have a small positive impact. However, Lovenheim (2011); Manoli and Turner (2014); Pan and Ost (2014) find significant effects of increases in housing wealth, tax refunds, and parental layoff on enrollment, respectively.

Figure 2.2: Procyclical College Enrollment in Germany (1995-2018).



Notes: National share of high school graduates with *Abitur* from a given year (1995-2018) enrolling at any college within one year of high school graduation. *Source*: Student register, Federal Employment Agency, *Regionaldatenbank*, years 1998–2017

school graduates: starting an apprenticeship (applied) or pursuing either type of college education (applied vs. general education). Economic shocks affect investment choices via their effect on outside options, credit constraints, and the relative uncertainty of general vs. applied skill investments. During economic downturns, credit-constrained graduates and those with a high time preference will invest in applied skills, as they come with direct remuneration. If economic shocks increase apprenticeship's perceived relative risk, risk-averse individuals will invest in more general skills. Under stable outside options, economic shocks can reduce overall college-going and cause a shift to more applied skill investments.

To test the model's predictions, I use administrative microdata on German higher education. I construct a regional-level panel containing economic indicators and the share of high school graduates (cohorts 1998–2017) that enroll in and graduate from different college types. A one percentage point (pp) increase in the local unemployment rate (UR) at graduation reduces first-time college enrollment by 1.7 percent and attainment by 0.7 percent. The enrollment effect is concentrated at public universities (-3.2 percent). Instead, economic shocks induce a shift towards applied skills: Enrollment at vocationally oriented colleges increases by 2.8 percent. They increase enrollment shares in STEM, particularly in applied majors like Computer Sciences (5.2 percent) and Engineering (1.9 percent). Administrative data from the German Federal Employment Agency (BA) on apprenticeships shows that a one pp increase in the state UR

increases the share of high school graduates among new apprentices by 7.1 percent. Effects are more pronounced for women and graduates from low-income regions.

Survey data from the German Socioeconomic Panel (GSOEP v38) suggests a negligible role of liquidity constraints. but considerable SES differences in the response to economic shocks. In contrast to first-generation students, high-SES students increase their college enrollment during recessions. This is conditional on economic preferences, which moderate the effects. Survey data from the German Centre for Higher Education Research (DZHW) on over 100,000 high school graduates in 2008-2017 suggest changes in economic expectations as a partial mechanism. Economic shocks increase low-achieving young men's expected relative returns to vocational education.

This paper makes four main contributions. First, it contrasts the conventional wisdom of countercyclical college-going. I find that local labor market shocks reduce overall first-time enrollment. In contrast to previously studied Anglo-Saxon countries, Germany represents a large set of countries that fund higher education institutions rather than individuals and has higher levels of employment protection and, thus, less cyclical labor markets. Its dual education system offers an arguably business cycle-proof outside option: apprenticeships. Similarly to Charles et al. (2018), I confirm that changes in enrollment rates translate into later educational attainment of affected cohorts.

Second, this paper contributes to a more general understanding of how economic conditions affect the skill content of human capital investment. Apprenticeships and dual studies offer recession-proof outside options that focus on applied skills. Other work has focused on on-the-job training (Fukao and Otaki, 1993; Méndez and Sepúlveda, 2012) or on an intensive margin: Gilpin et al. (2015); Acton (2021); Grosz (2022); Weinstein (2022); Bütikofer et al. (2023) find that major choice adapts to occupation-specific shocks in local labor demand. I show that recessions can shift investment towards firm-specific human capital, which might be perceived as an insurance mechanism against unemployment risk after graduation (Jovanovic, 1979).

Third, this paper integrates the literature on economic preferences. Even though patience and risk-taking may significantly account for cross-country differences in human capital investments (Hanushek et al., 2022), the literature on the effect of economic shocks on college-going widely disregards them.[4] Local labor market shocks at high school graduation offer arguably exogenous variation in uncertainty associated with

[4]While the predicted effect of time preferences on college enrollment is negative, the effect of risk aversion is ambiguous. On the one hand, recessions increase the wage risk associated with apprenticeships. On the other hand, education is a risky investment with uncertain payoffs (e.g., Kodde, 1986; Brodaty et al., 2014; Nielsen and Vissing-Jorgensen, 2006; Belzil and Leonardi, 2013).

different skill investments and may tighten credit constraints. Their effects on skill investments thus potentially depend on high school graduates' economic preferences.[5] I show that economic preferences moderate the effect of local labor market shocks on human capital investments but that cross-country differences in patience and risk-taking are unlikely to explain effect differences across countries.

Lastly, this paper exploits large-scale survey data to estimate the effect of economic shocks on the expected relative returns to college education. While economic shocks have no average effect on the expected returns to college, they reduce the expected returns to vocational training significantly. However, low-achieving young men show an increase in their expected relative returns to apprenticeships vs. college education, which can at least partly explain the procyclical pattern in college enrollment. The literature on expectations in education has not yet studied the effect of economic shocks on the expected risk and return of college at high school graduation (see Giustinelli, 2023, for an overview).

2.2 Institutional Background

High school graduates in Germany can choose between an extensive range of postsecondary institutions that offer formally equivalent bachelor's degrees. Classic public universities focus on general skills, while private universities and universities of applied sciences focus on more applied skills. The outside option to college education typically is to start an apprenticeship at a firm.[6] Apprenticeships are highly firm- and occupation-specific and thus the most applied. Hence, there are three main options for high school graduates:

1. **University**: Public universities in Germany offer a wide range of academic programs and are known for providing a comprehensive and theoretical education. University degrees are typically full-time and focus on acquiring general skills (critical thinking, problem-solving, etc.). Internships are allowed but usually not mandatory. There is, hence, little focus on applied human capital.
2. **Other colleges**: Private universities and Universities of Applied Sciences offer a more practice-oriented education. They focus on engineering, business, design, media, and technology programs. Their curriculum often includes internships,

[5] Reversely, education might also affect the formation of risk (e.g., Black et al., 2018) and time preferences (e.g., Perez-Arce, 2017), which are often measured after schooling decisions are already made. I discuss the implications for my analysis in Section 2.4.3.

[6] Due to Germany's dual system, apprenticeship has a schooling component and can thus be interpreted as continued secondary schooling.

projects, and practical assignments collaborating with industry partners. These colleges often offer to obtain a bachelor's degree in dual study programs, where students spend much of their studies in paid on-the-job training. Depending on the degree type chosen (dual vs. full-time) there is a stronger focus on applied skills.

3. **Apprenticeship**: High school graduates who enter the labor market typically start an apprenticeship at a firm. Apprenticeships combine on-the-job training at the firm with theoretical education at a vocational school (*Berufsschule*). These vocational training programs cover various occupations, e.g., traditional crafts, technical fields, and healthcare. By nature, apprenticeships are highly applied.

Different high school degrees in Germany qualify for studying at different colleges. Students obtaining the highest leaving qualification (*allgemeine Hochschulreife*, or: *Abitur*), after typically 12–13 years of schooling, represent the largest subgroup, with about 75 percent of all high school graduates and 40 percent of the population aged 18–19. Graduates with *Abitur* have the full choice set: They can enroll at any institution, in any degree, and, depending on their GPA, in any major. Hence, I focus on this set of high school graduates in my analysis.[7]

Higher education comes with little direct costs, as no general tuition fees exist in Germany.[8] A means-tested federal aid program (*BAFöG*) supports around 25 percent of full-time students. However, only 28 percent of potentially eligible students (i.e., those under 30) receive any *BAFöG* (Fidan and Manger, 2022). Similarly, only five percent of students take on a private loan. Parental allowances constitute 66 percent of the average monthly income of students under 21. Another 13 percent are independent earnings, twelve percent stem from federal aid *BAFöG*, and nine percent from other sources (Middendorff et al., 2017).

2.3 Roy-type Conceptual Framework

To guide the empirical analysis, I extend a model from Charles et al. (2018) considering all high school graduates i with academic ability $\theta_i \in [0, 1]$ that maximize their lifetime

[7] To test the robustness of my estimates, I later estimate the effects on college enrollment of all young individuals aged 18–19 in a region.

[8] Between 2007 and 2014, some states introduced minor tuition fees (500 EUR per semester) with little effect on overall attainment (Bietenbeck et al., 2023). Private institutions can still charge tuition fees depending on the program. The share of private institutions has been rising from around one percent in 1998 to over ten percent in 2020. Most private institutions are universities of applied sciences. They have been expanding in higher-income areas, where firms generally have more capacities to invest in training. Separate linear time trends account for possible differences in the roll-out of different college types across regions.

payoff by choosing between three postsecondary options: enrolling at a public university (college type $c = B$, general skills), enrolling at other colleges (college type $c = A$, skill mix), or starting an apprenticeship (no college $c = 0$, applied skills), before working until retirement L. General skills come with higher returns for high-ability graduates but are also subject to higher uncertainty. My model highlights the effect of economic shocks on the expected risk and return of educational investments with a different skill content.

Students finance their studies via parental income ω_i.[9] If the annual monetary costs of college F_c (e.g., fees and moving costs) exceed (maintain) the disposable parental income, students can borrow (save) the difference on the capital market. The higher the individual risk aversion γ_i, the higher the additional psychic costs (returns) of borrowing (saving). The higher the time preference, the more attractive the consumption of exceeding funds.[10] As college type A allows one to allocate more time to work besides studying (e.g., via dual studies), its average monetary net costs are lower ($F_B > F_A$). At college, potential students also face psychic costs of learning κ_c. The curriculum at college type B focuses on general skills and is thus more challenging ($\kappa_B > \kappa_A$) - especially for students with lower academic ability.

The expected college premium at current period t for type-c college graduates equals $\pi_t^c = Y_t^c - Y_t^0 \geq 0$, where Y_t^c and Y_t^0 denote fluctuating earnings of college and non-college educated workers, respectively. It is discounted by time preferences $\delta_i \in [-1, 1]$ and uncertain due to, e.g., unforeseeable technological change and college completion (e.g., Altonji, 1993). Economic shocks at high school graduation may affect uncertainties in the relative returns to college ($\text{Var}[\pi_t^c]$), which induces additional psychic costs of college, depending on the level of risk aversion. The lifetime payoff at period t from attending a type-c college thus equals:

$$R_i^c(\theta_i, \gamma_i, \delta_i, w_i) = (1-\delta_i) \sum_{k=1}^{L-t} E_t[\pi_{t+k}^c] - (1+\gamma_i) \sum_{k=1}^{L-t} \text{Var}_t[\pi_{t+k}^c] - (1+\gamma_i)(F_c - \omega_i) - \kappa_c(1-\theta_i) - Y_t^0. \tag{2.1}$$

When the payoff of the outside option, apprenticeships, R_i^0, is normalized to zero, the enrollment decisions can be characterized as follows:

[9] Parental transfers constitute 66% percent of the average monthly income of a first-year student in Germany (Middendorff et al., 2017). See Section 2.2 for an overview of student finances.

[10] Given that federal aid is interest-free and under the assumption that local labor market shocks do not affect national capital markets, I treat the interest rate as exogenous.

$$\text{if } \begin{cases} R_i^A < R_i^B < 0 & \text{apprenticeship,} \\ R_i^A > R_i^B > 0 & \text{enroll at type A,} \\ 0 < R_i^A < R_i^B & \text{enroll at type B,} \end{cases}$$

where:

$$\begin{aligned} 0 &> R_i^A(\theta_i = 0) > R_i^B(\theta_i = 0), \\ 0 &< R_i^A(\theta_i = 1) < R_i^B(\theta_i = 1), \\ \bar{R} &= R_i^A(\theta^{AB}) = R_i^B(\theta^{AB}) > 0. \end{aligned}$$

Hence, low-ability graduates always choose apprenticeships, while high-ability individuals always enroll at university. Under the assumption that fluctuations in the local unemployment rate do not affect F_c, κ_c, and economic preferences[11], changes in the local unemployment rate dUR affect the expected returns to college enrollment via the following channels:

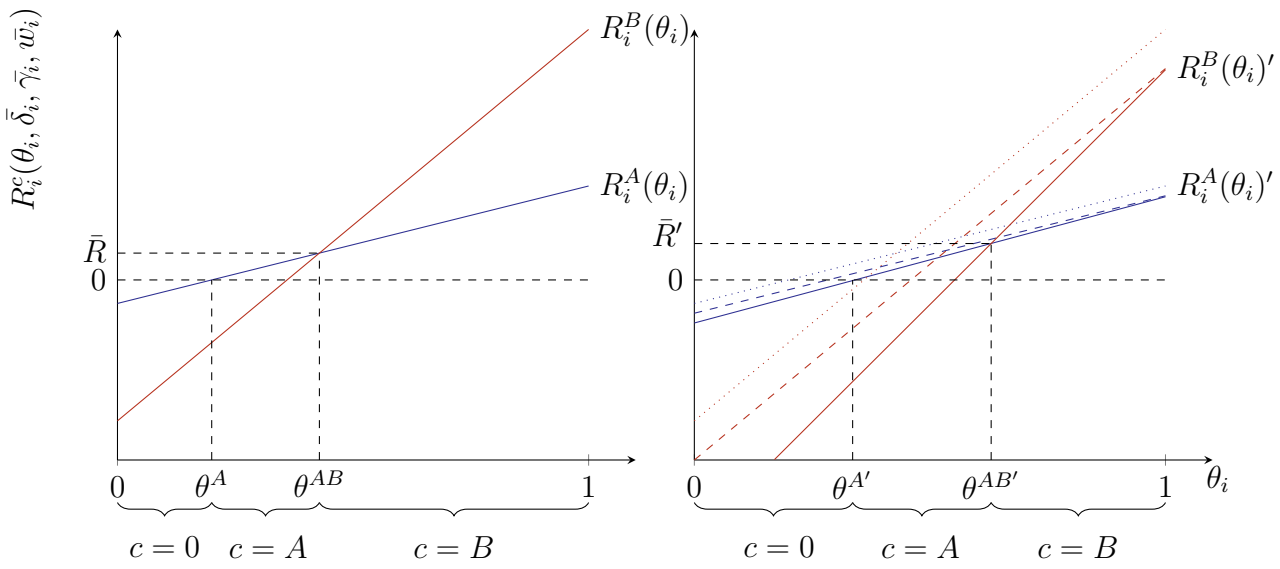
$$\frac{dR_i^c(\theta_i, \delta_i, \gamma_i, w_i)}{d\text{UR}} = (1-\delta_i) \underbrace{\frac{d\sum_{k=1}^{L-t} E_t[\pi_{t+k}^c]}{d\text{UR}}}_{(i)} - (1+\gamma_i) \underbrace{\frac{d\sum_{k=1}^{L-t} \text{Var}_t[\pi_{t+k}^c]}{d\text{UR}}}_{(ii)} + (1+\gamma_i) \underbrace{\frac{dw_i}{d\text{UR}}}_{(iii)} - \underbrace{\frac{dY_t^0}{d\text{UR}}}_{\text{(iv)}}. \tag{2.2}$$

The effect of any local labor market shock depends on how changes in the local UR affect (i) the expected average returns to college, (ii) the expected relative risk of college over apprenticeships, (iii) parental income, and (iv) outside options. Economic preferences govern the importance of single mechanisms. A necessary condition for investment in applied skills is stable outside options.

(i) Expected returns. The effect of economic shocks on the expected returns to college is ex-ante unclear. However, effects likely differ across students of different SES. As scarcity may increase reliance on routines (Mullainathan and Shafir, 2013), students without college-educated parents could perceive lower returns to education during a recession.

[11] This is a relatively strong assumption. However, as economic scarcity may increase present bias (Mullainathan and Shafir, 2013), and recessions might increase financial risk aversion (Malmendier and Nagel, 2011), changes in economic preferences might amplify the effect of economic shocks on enrollment. Later versions of this paper will show the implications for this model.

Figure 2.3: A Roy Model of Human Capital Investment



(a) Postsecondary enrollment by ability

(b) Post-shock scenario (dUR > 0)

Notes: Panel (a) shows the lifetime payoff of applied colleges (college type $c = A$) and public universities (college type $c = B$)) by ability, normalizing the lifetime payoff of apprenticeships (no college $c = 0$) to zero. Segments on the x-axis indicate enrollment shares. Panel (b) shows a new equilibrium in a scenario where the effect of an economic shock at high school graduation via channels (i) to (iii) outweighs the effect via outside options (iv).
Source: Own representation based on Charles et al. (2018).

(ii) Uncertainty. The effect of economic conditions on the relative risk of college is again ambiguous and potentially SES-dependent. Students with college-educated parents might have stronger prior beliefs about the returns to education and thus perceive stronger uncertainty increases associated with direct labor-market entry. This paper will directly test the effect of economic conditions on the expected risk and return to college, using data from the German Center for Higher Education Research's (DZHW) *Panel Study of School Leavers with a Higher Education Entrance Qualification*.

(iii) Parental income. Increases in the local UR should negatively affect parental income. Section 2.6.2 discusses the effect of local UR fluctuations on household income and the association of household income with individual college attendance.

(iv) Outside options. Local labor market shocks usually worsen outside options. However, apprenticeships as an outside option are potentially business-cycle-proof for high school graduates. Section 2.5.4 discusses the effect of labor market shocks on apprenticeships as an outside option.

Figure 2.3 shows one possible scenario where a local labor market shock reduces the overall college enrollment share while increasing the share of high school graduates that enroll at vocationally oriented type-A colleges. A necessary condition for this scenario is

stable outside options. Another factor leading to this scenario is the negative effects of recessions on the returns to education and an increase in the relative risk of education. A change in the slope of both return curves might signal a negative relationship between ability and time preferences, suggested by, e.g., Dohmen et al. (2010). Under this assumption, local labor market shocks can cause increased enrollment at college type A.

The empirical analysis in Section 2.5 estimates the overall effects of local labor market conditions on college-going and institutional choice, as well as outside options, using administrative data on the universe of students in German higher education and the universe of new apprenticeships. Section 2.6 tests ability-to-pay as a mechanism and tests the importance of economic preferences as moderators using survey data.

2.4 Data and Identification

2.4.1 Administrative Data

The *Statistik der Studenten* (student register), provided by the Federal Statistical Office, covers the universe of students enrolled in higher education in Germany (RDC, 2019). Each observation represents one individual enrollment spell and contains information on the institution, degree, field of study, final grade, entry qualification, gender, age, county, and year of high school graduation. Due to strict data protection, it does not contain individual identifiers. County-level data on the number of high school graduates, population, and economic indicators stems from the *Regionaldatenbank*; county-level unemployment rates from the Federal Employment Agency. I counted the first-year students in the student register who graduated from high school in a given county in a given year and linked this information to the county-level data described above.

To account for the importance and persistence of local labor markets (e.g., Amior and Manning, 2018) and the high share of commuting across county borders in Germany (Krebs and Pflüger, 2023), I aggregate all counties to the so-called *Raumordnungsregionen* (ROR) level. RORs are groups of counties that reflect a larger commuting zone. Throughout the analysis, I use the current 96 ROR delineations from the Federal Office for Building and Regional Planning (BBR, 2007). My final sample spans the years 1998 to 2017 and includes 5,160,522 high school graduates.[12]

[12]Of the potential 1920 region × cohort cells, I have to exclude five observations from Hesse (no information on high school graduates in 2007), as well as four observations from each Mecklenburg-

The main outcome variables are defined as follows. On the extensive margin, I use the share of high school graduates with *Abitur*, from region r and graduation cohort t that enroll within one year of graduation:

$$E_{rt} = \frac{\sum_{\tau=t}^{t+1} \sum_{i \in r,t} \text{Enrolled}_i^{y=\tau}}{\sum_{i \in r,t} \text{Graduates}_i}, \tag{2.3}$$

where y indicates the year of first-time enrollment. In the main specification, I focus on individuals i in the student register (*Enrolled*) that have obtained *Abitur* and use the number of high school graduates from the county with the same entry qualifications as the denominator. Until 2011, male high school graduates had to fulfill one year of military or civil service. Hence, my analysis focuses on enrollment within one year of high school graduation. As robustness, I alternate the specification to consider all freshmen from the student register, irrespective of their high school leaving degree, and use the young population ages 18–19 in the graduation county as the denominator.[13] Figure 2.A.1 shows the main outcome, college enrollment share of high school graduates with *Abitur* for different levels of local unemployment. All outcome variables are also defined independently by gender.

On the intensive margin, I use the share of first-time students with *Abitur* enrolling in a given degree type (general skills (full-time studies) vs. applied skills (part-time and dual studies)) and field of study as outcomes.[14]

2.4.2 Survey Data

To test the role of credit constraints and economic preferences and to estimate effects separately for students of different SES, I use survey data from the *German Socioeconomic Panel* (GSOEP, version v38). The GSOEP is a longitudinal survey of approximately 15,000 private households in Germany, and i.a. covers the educational trajectories of individuals, containing information on their state and year of high school graduation and postsecondary education. It contains information on household and parental income and education as a measure for SES. Self-assessed economic preferences in the GSOEP are experimentally validated and considered predictive of actual

Western Pomerania and Saxony-Anhalt in the years 2001 and 2000, respectively (no high school graduates due to an increase in the mandatory years of schooling).

[13] Unfortunately, data on, e.g., the number of graduates with, e.g., *Fachhochschulreife* on the county-level is only available from 2007 onward and of poor quality.

[14] Where: $E_{rt}^f = \sum_{m \in f} \sum_{i \in r,t} \text{Enrolled}_{im}^f \,/\, \sum_{i \in r,t} \text{Enrolled}_i$, gives enrollment at major m, part of the field of study, or simply degree type, f.

behavior (Dohmen et al., 2011). General willingness to take risks is surveyed yearly, and patience is every fifth year.[15] As risk attitudes are generally highly domain-specific (e.g., Weber et al., 2002; Einav et al., 2012), I rely on career-specific risk attitutdes in my analysis. I use the within-person median values to account for outliers.

2.4.3 Empirical Setup

Main Specification. To test the empirical predictions of Section 2.3, I regress the log enrollment shares E^c_{rt} in region r of graduation cohort t at college type c on the local unemployment rate UR_{rt}:

$$ln(E^c_{rt}) = \alpha_r + \zeta_t + \beta_1 \, \text{UR}_{rt} + \varepsilon_{rt}, \tag{2.4}$$

where α_r represents region fixed effects and ζ_t represents cohort fixed effect. Throughout the analysis, I adjust standard errors for clustering at the regional level of variation (Abadie et al., 2023). Under the conditional independence assumption, i.e., $E(\varepsilon_{rt} \mid \text{UR}_{rt}, \alpha_r, \zeta_t) = 0$, my estimates reflect the causal effect of a one percentage point increase in the local unemployment rate on enrollment share E_{rt}, in percent. Explicitly, I assume that conditional on region and cohort-specific fixed effects, the unemployment rate at graduation is exogenous to other changes in the relative returns to different enrollment options or cohort characteristics.

A potential threat to identification could be supply-side effects, e.g., a reduced number of study spots during economic downturns due to budget cuts (Deming and Walters, 2018b). However, public universities are funded via long-term contracts, primarily via the states, using upper-bound predictions for future student intake (European Commission, 2023). Hence, short-term fluctuations in, especially local, labor market conditions will unlikely affect the number of study spots at public universities. A downward bias would be more likely for vocationally oriented colleges financially more connected to the local private sector. Here, positive effects are thus rather likely to reflect a lower bound. Cohort fixed effects account for general trends in human capital investments, but I assume these do not vary within regions and over time. I hence test the robustness of my results toward region-specific linear trends (see Table 2.A.2). Lastly, as variation in unemployment likely reflects changes in local labor demand, reverse causality seems implausible.

[15] The questions ask: "Are you generally a person who is willing to take risks or do you try to avoid taking risks?" and: "Would you describe yourself as an impatient or a patient person in general?", respectively.

The empirical analysis relies on within-region across time variation in the local unemployment rate. Under imperfect mobility, local rather than macroeconomic shocks may be more relevant in determining their outside options and expected returns to, e.g., different occupations.[16] Also, the local unemployment rate is a stronger signal for parental employment status.[17]

Moderation. To test the role of economic preferences in moderating the effect of economic shocks on human capital investment, I estimate the interaction effects between labor market conditions at graduation, risk aversion γ_i, and time preference δ_i. Using survey data, I run the following specification on the individual level:

$$Y_i^c = \alpha_s + \zeta_t + \beta_1 \, \mathrm{UR}_{st} + \beta_2 \, (\mathrm{UR}_{st} \times \gamma_i) + \beta_3 \, (\mathrm{UR}_{st} \times \delta_i) + \theta \, \mathbf{X}_i + \varepsilon_{ist}, \tag{2.5}$$

where Y_i is a dummy variable that signals enrollment at college type c. As the GSOEP contains only the state of high school graduation, I have to rely on state-level variation. Hence, α_s denotes state-fixed effects. Individuals who assess their economic preferences differently when they enroll during a recession are a threat to identification. If high school graduates enrolled at college during a recession systematically rate themselves as more risk-loving, or more patient, the estimates would be biased upwards, in absolute terms.

2.5 Evidence from Administrative Data

2.5.1 College Enrollment and Institutional Choice

Main Effects. Table 2.1 presents the effects of local labor market conditions on college enrollment. A one pp increase in the local unemployment rate at high school graduation increases graduates' overall first-time enrollment share by 1.7 percent. This effect is driven by a negative effect on enrollment at public universities (college type B, -3.1 percent). However, local labor market shocks increase enrollment at more vocationally oriented colleges (college type A) by 2.8 percent. This effect contrasts the literature on countercyclical college enrollment and implies a shift towards applied skills. A necessary condition for the effect is stable outside options. Explanations in

[16] In Germany, only 18.6 percent of first-year students leave their state of high school graduation to study (see Table 2.A.1).

[17] However, whether local or more macroeconomic indicators signal uncertainty in the returns to different educational investments is unclear. I test the robustness of my results by using different business cycle indicators and find only little differences (see Table 2.A.2).

consistency with the Roy model are credit constraints, high levels of time preference, or decreased (increased) returns (uncertainty) of investments in general skills.

Table 2.1: Enrollment Effects of Local UR Across Institutions.

		By gender		By GDP p.c.	
	Main	Female	Male	$\geq$ median	$<$ median
Dependent variable:	(1)	(2)	(3)	(4)	(5)
Overall enrollment	-0.017***	-0.021***	-0.011***	-0.011	-0.021***
	(0.003)	(0.004)	(0.003)	(0.009)	(0.003)
	[79.95]	[76.61]	[84.12]	[82.62]	[75.32]
At university	-0.031***	-0.036***	-0.024***	-0.015	-0.036***
	(0.004)	(0.004)	(0.003)	(0.010)	(0.004)
	[59.76]	[58.89]	[60.84]	[62.14]	[55.64]
At other college	0.028***	0.035***	0.026***	-0.011	0.026***
	(0.007)	(0.007)	(0.006)	(0.012)	(0.005)
	[20.18]	[17.70]	[23.27]	[20.48]	[19.67]
No. graduates	5,160,522	2,865,289	2,295,233	3,271,572	1,888,950
No. cells	1,907	1,907	1,907	956	951
Region and year FEs	Yes	Yes	Yes	Yes	Yes

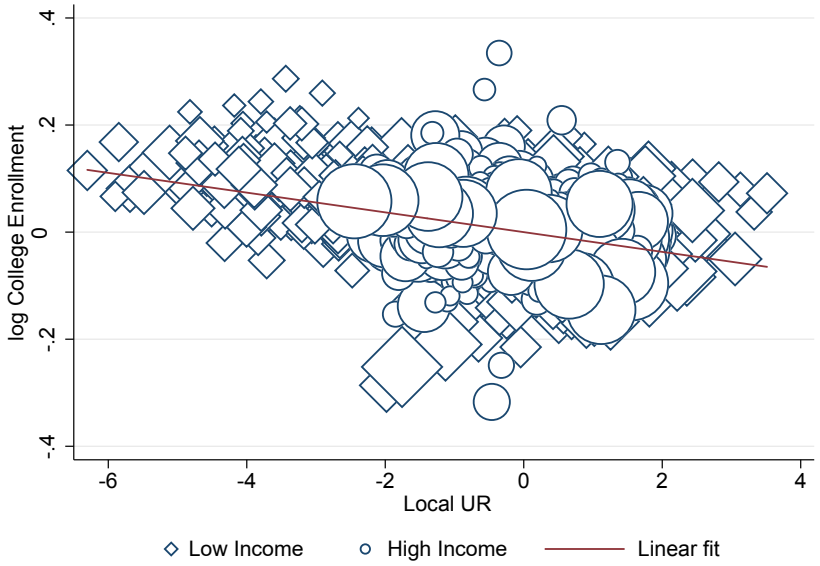
Notes: This table presents estimates from a two-way-FE regression on the regional level for the log share of high school graduates with *Abitur* enrolling at college, spanning graduation years 1998–2017. Each region is weighted by the number of high school graduates with *Abitur*. Outcome means (level) in brackets. Standard errors in parentheses allow for clustering at the regional level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: Student register, Federal Employment Agency, *Regionaldatenbank*.

Heterogeneity. Columns (2) and (3) in Table 2.1 present enrollment effects separately by gender. The effects have the same sign as the pooled coefficients and are significant across all college types. However, the average effect for women is significantly stronger than for men. A simple explanation for this could be the fact that a higher share of women obtain the Abitur. Men often start an apprenticeship after obtaining an intermediate secondary school degree and don't enter high school. Hence, the remaining men might be preselected and have stronger study intentions. This is in line with stronger associations between the expected returns to college and actual enrollment for female high school graduates in Germany (see Leibing et al., 2023).

Columns (4) and (5) report effects on college enrollment separately for regions with greater or equal and below median GDP per capita measured in 2007. Overall, enrollment effects are more pronounced for low-income regions. While effects in high-income regions are negative and insignificant, effects in low-income regions are significant and follow the same pattern as the main effects. There are different possible non-exclusive reasons for this. First, Figure 2.4 shows that low-income regions are subject to larger fluctuations in the unemployment rate, which eases inference. Second, more high school graduates may be on the margin to borrow in low-income regions. Credit constraints, in turn, could cause a substitution towards apprenticeships (and applied colleges) that

(allow for) combining paid on-the-job training and schooling. Third, individuals with higher SES might be overrepresented in higher-income regions. They typically are better informed about the returns to college, and thus, economic shocks may have a smaller impact on their enrollment behavior.

Figure 2.4: Variation in Enrollment Rates and Local UR.



Notes: This figure shows within-region across-time variation in the log share of high school graduates with *Abitur* enrolling at a university within one year of graduation (y-axis) and the local unemployment rate at high school graduation (x-axis). Circles (squares) represent a region × cohort cell of an above (below) median GDP region. The size of each circle (square) indicates the corresponding number of high school graduates. Fitted values (red) from a bivariate regression. *Source*: Student register, Federal Employment Agency, *Regionaldatenbank*, years 1998–2017

Robustness. One possible threat to identification is time-varying unobserved heterogeneity. Table 2.A.2 tests the baseline effect from Table 2.1 column one, row one, towards the inclusion of state fixed effects, interacted fixed effects, and group-specific linear trends. The effect is robust to including different group-by-year fixed effects, i.e., an interaction of year fixed effects and fixed effects indicating regions with below-median GDP p.c. and a below-median number of high school graduates, respectively. The results are more sensitive to using state fixed effects instead of region fixed effects. While the effect stays significant, using state FE reduces the estimate markedly, which suggests some unobserved heterogeneity on the state level. However, as there is more within-state and across-region variation in the unemployment rate compared to the college enrollment rate (see Table 2.A.1), including state fixed effects would absorb more variation in the outcome variable (college enrollment) than in the explanatory variable (local UR). Also, region-specific factors might be washed out when state fixed effects are included. Reassuringly, the effect increases when using the state UR.

Consequently, each row in Table 2.A.2 repeats the analysis using alternative economic indicators. Indeed, when using state-level economic indicators (state UR and state GDP per capita), the effects are robust to state fixed effects and even become larger in the case of GDP. This suggests that differences in the within-state variation of outcome and explanatory variable rather than unobserved heterogeneity explain the large impact of state fixed effects when using local economic indicators. By large, the results are robust to using the local youth unemployment rate, state unemployment rates, and local/state GDP per capita as explanatory variables. The large and positive coefficients align with my main findings as GDP is logged and signals better economic conditions. A one percent decrease in the local GDP at high school graduation reduces the college enrollment rate by 0.25 percent.

To account for the human capital investments of high school graduates with other secondary school leaving qualifications than *Abitur*, I now consider all first-year students, irrespective of their high school degree, and use the young population aged 18 to 19 years as the reference group (nominator and denominator of Equation (2.3), respectively).[18] Table 2.A.3 shows that the results are similar to the subset of high school graduates with *Abitur*. While the baseline specification in column (1) shows no significant average effect on enrollment, enrollment effects at universities (other colleges) are again significantly negative (positive). As among high school graduates without *Abitur* there is a higher share that enrolls at more applied colleges, the two extensive margins for institutional subgroups effects cancel each other out.[19] there is a shift from academic institutions (universities) towards all other, more vocationally oriented colleges. Adverse shocks in local labor market conditions induce a shift toward more applied human capital. Again, this shift is especially strong for women, but the effect on university enrollment now seems stronger for high-income regions.[20]

2.5.2 Attainment

So far, the analysis focused on first-time enrollment within one year of high school graduation. However, given the possibility to enroll in later years, the possibility to switch degrees, college, and major, and the low completion rates of university degrees

[18] Due to a lack of reliable data on the number of high school graduates with alternative high school degrees, I have to rely on the complete young population in the region.

[19] Outcome means (in levels, in brackets) of Table 2.A.3 should be interpreted carefully, as due to data availability, the base group effectively uses two birth cohorts as the denominator.

[20] One likely explanation is that among women and high-income regions, a larger share of individuals aged 18–19 graduates from high school with *Abitur* and is eligible for college enrollment (Destatis, 2020). At the same time, economic shocks might also affect the number of students that graduate from high school (e.g., Gaini et al., 2013). This is an additional reason to restrict the analysis to high school graduates.

in Germany (between 60 percent and 70 percent, see Bietenbeck et al., 2023), these effects do not necessarily need to result in changes in educational attainment. This section repeats the previous analysis using the share of high school graduates with *Abitur* that obtain any given postsecondary degree until the year 2018 as an outcome.

Table 2.2: Attainment Effects of Local UR Across Institutions.

		By gender		By GDP p.c.	
	Main	Female	Male	$\geq$ median	$<$ median
Dependent variable:	(1)	(2)	(3)	(4)	(5)
Overall attainment	-0.007**	-0.012***	0.002	0.003	-0.007**
	(0.003)	(0.004)	(0.003)	(0.007)	(0.003)
	[69.6]	[68.3]	[71.3]	[74.0]	[65.2]
University degree	-0.022***	-0.029***	-0.011**	0.009	-0.027***
	(0.005)	(0.005)	(0.004)	(0.006)	(0.005)
	[46.3]	[47.9]	[44.5]	[50.0]	[42.6]
Other college degree	0.022***	0.026***	0.022***	-0.010	0.031***
	(0.007)	(0.008)	(0.006)	(0.025)	(0.007)
	[23.3]	[20.5]	[26.8]	[24.0]	[22.6]
No. graduates	4,289,449	2,390,916	1,898,533	2,697,356	1,592,093
No. cells	1,619	1,619	1,619	812	807
Region and year FEs	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE regression on the regional level for the log share of high school graduates with *Abitur* graduating from college, spanning high school cohorts 1998–2014 graduating from college until 2018. Each region is weighted by the number of high school graduates with *Abitur*. Outcome means (level) in brackets. Standard errors in parentheses allow for clustering at the regional level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: Exams register, Federal Employment Agency, *Regionaldatenbank*.

Table 2.2 shows that effects of the local UR at high school graduation on enrollment translate to changes in later postsecondary attainment. A one pp higher local unemployment rate at high school graduation decreases overall attainment by 0.7 percent. Although this effect seems small, it is still sizable, given the pathways leading to a college degree. They are even more substantial when considering the long time horizon studied. As high school cohorts from 1998 to 2014 and degrees obtained until 2018 are considered, graduates have between four to twenty years time to obtain a college degree. After all, local labor market shocks permanently reduce educational attainment.

The previous pattern holds when comparing the effect subgroups and across degrees, and the effects are substantially stronger. A one pp increase in the local unemployment rate at high school graduation decreases the share of high school graduates obtaining a college degree at a public university by 2.2 percent and symmetrically increases the share that obtains a college degree at more vocationally oriented institutions by 2.2

percent. This substitution from general to firm-specific human capital is again stronger for women and concentrated in low-income regions.

The effects are not limited to high school graduates with *Abitur*. Table 2.A.4 shows that while the overall educational attainment of students from other school types is unaffected by local labor market shocks, there is still a considerable substitution from general to firm-specific human capital investments, especially in low-income regions. Local labor market shocks increase (decrease) the share of young individuals graduating from a vocational-oriented college (a public university) by 1.4 percent (1.2) percent. Table 2.A.5 and Table 2.A.6 show that the enrollment effects between 1998 and 2014 are almost identical to those between 1998 and 2017 for both samples.

2.5.3 Degree and Major Choice

Degree Choice. Universities of applied sciences and other more applied colleges (college type c = A) typically offer so-called dual studies, which integrate schooling and part-time work at a firm (see Section 2.2).[21] They teach applied skills by design and are offered in close cooperation with local industry. As students receive income, dual studies might also pose an attractive option to students who face credit constraints during local economic shocks. If economic shocks increase investments in applied skills, a higher local UR should also increase the share of first-year students who enroll in dual studies.

Table 2.3 shows intensive margin effects on enrollment shares of freshmen (with *Abitur*) in full-time and part-time and dual studies (i.e., applied skills). The main results in column (1) show that local economic downturns significantly increase the share enrolling in dual studies (+6.6 percent) and decrease the share of freshmen that enroll in full-time degrees (-0.6 percent). The difference in relative effect sizes is large, as most freshmen (over 94.4 percent) enroll in full-time degrees. Effects seem entirely driven by high-income regions. One potential reason is that dual studies are primarily offered in regions that fare better economically, e.g., more firms can invest in training. Hence, in contrast to full-time education at university, the supply of dual studies is somewhat cyclical. This might reduce the estimate as low-income regions face large economic fluctuations (see Figure 2.4).[22] As dual studies are almost exclusively of-

[21] Recently, public universities (college type c = B) also started to offer the option for dual studies occasionally. However, this is only for certain majors and usually in cooperation with other colleges.

[22] Table 2.A.7 extends the analysis for all freshmen, irrespective of their school leaving qualification, using the population of 18–19-year-old individuals as the denominator. The results are again significant, comparable in size, and follow the same pattern as in Table 2.3.

Table 2.3: Effects of Local UR on Degree Choice.

		By gender		By GDP p.c.	
Dependent variable:	Main (1)	Female (2)	Male (3)	$\geq$ median (4)	$<$ median (5)
Full time	-0.006***	-0.005***	-0.007***	-0.010***	-0.003
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
	[94.4]	[95.3]	[93.5]	[94.0]	[94.9]
Dual study	0.066*	0.050	0.074*	0.136***	0.012
or part time	(0.037)	(0.036)	(0.042)	(0.032)	(0.040)
	[5.6]	[4.7]	[6.5]	[6.0]	[5.1]
No. students	1,990,936	1,046,917	944,019	1,366,912	624,024
No. cells	768	768	768	384	384
Region and year FEs	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE regression on the regional level for the log share of first-time students w/ *Abitur* enrolling in full-time, part-time, and dual studies, spanning graduation years 1998–2017. All specifications include region- and year fixed effects. Each region is weighted by the number of freshmen with *Abitur*. Outcome means (level) in brackets. Standard errors in parentheses allow for clustering at the regional level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

fered at universities of applied sciences and other applied colleges, where enrollment increases, the reported results mainly represent compositional effects.

Major choice. Majors vary in occupation- rather than firm-specificity, with Computer Science, Engineering, and business being the most applied. Deming and Noray (2020) show that graduates from these majors work relatively often in occupations closely related to their field of study. Table 2.4 shows the effects of changes in the local UR on the share of first-time students who enroll in different fields of study. In line with the literature (e.g., Shu, 2016; Liu et al., 2019; Blom et al., 2021), a higher share of students enroll in STEM fields, while fewer students study to become teachers.[23] A one pp increase in the local unemployment rate increases the share of college students enrolling in STEM fields by 1.7 percent.[24]

STEM represents the largest field of study by far, with 31.9 percent of students enrolling in such majors. To disentangle the effect of local unemployment on STEM enrollment, Table 2.5 splits the effect using the shares of students pursuing degrees in Engineering, Mathematics, Computer Sciences, Physics, Chemistry, Biology, and

[23]The category *Teaching* covers all freshmen enrolling in a classic teaching degree (*Lehramt*), in a bachelor's degree with an optional teaching track, or in any degree majoring in pedagogical or educational sciences.

[24]Increased enrollment in Arts & Humanities and Political & Social Sciences contrasts the findings in Blom et al. (2021) and is hardly in line with the prediction that students enroll in more applied (or well-paying) fields during recessions. One possible explanation is that these majors are typically only available at public universities. Hence, institutional choice, or college enrollment of students in these fields, might be less elastic (*always takers*), so their relative share increases during economic shocks.

Table 2.4: Effects of Local UR on Field of Study Choice.

	STEM (1)	Arts & Humanities (2)	Political & Social Sciences (3)	Business & Economics (4)	Law & Administration (5)	Teaching (6)	Health & Medicine (7)	Other or Missing (8)
Local UR	0.023***	0.012*	0.036***	0.003	0.000	-0.062***	-0.010	0.022*
	(0.005)	(0.006)	(0.009)	(0.008)	(0.008)	(0.006)	(0.006)	(0.012)
Outcome mean	31.9	12.9	5.3	11.3	7.7	21.2	7.1	2.7
No. students	3,083,976	3,083,976	3,083,976	3,083,976	3,083,976	3,083,976	3,083,976	3,083,976
No. cells	1,907	1,907	1,907	1,907	1,907	1,907	1,907	1,907
Region and year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE regression on the regional level for the log share of freshmen with *Abitur* enrolling for different fields of study at the university, spanning high school cohorts 1998–2017. Outcome means in levels. Cells are weighted by the number of freshmen with *Abitur*. Standard errors in parentheses allow for clustering at the regional level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Geological Sciences as outcomes. Adverse economic conditions increase the share of freshmen enrolling in all STEM majors, except Physics and Chemistry, with the largest absolute changes in Engineering and the largest relative increase in Computer Sciences. This is largely in line with Liu et al. (2019) and Blom et al. (2021), where the effects are the largest for Computer Sciences and Engineering.[25] It is also in line with Hampf et al. (2020), who find positive reduced form effects on ICT and numeracy skills.

Table 2.5: Effects of Local UR on Major Choice within STEM.

	Engineering (1)	Mathematics (2)	Computer Science (3)	Physics (4)	Chemistry (5)	Biology (6)	Geological Sciences (7)	Other (8)
Local UR	0.019**	0.031***	0.052***	0.002	-0.003	0.035***	0.031***	0.084**
	(0.009)	(0.009)	(0.008)	(0.015)	(0.009)	(0.009)	(0.011)	(0.038)
Outcome mean	11.5	2.8	5.2	2.6	4.3	3.1	2.2	0.3
No. students	3,083,976	3,083,976	3,083,976	3,083,976	3,083,976	3,083,976	3,083,675	2,618,152
No. cells	1,907	1,907	1,907	1,907	1,907	1,907	1,906	1,421
Region and year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE regression on the regional level for the log share of freshmen with *Abitur* enrolling for different STEM majors at university, spanning high school cohorts 1998–2017. Outcome means in levels. Cells are weighted by the number of freshmen with *Abitur*. Standard errors in parentheses allow for clustering at the regional level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

2.5.4 Apprenticeships

What happens to high school graduates who forgo college enrollment in a recession? For high school graduates, entering the labor market instead of enrolling in college typically means starting an apprenticeship. Hence, fluctuations in the number of new apprentices can indicate how cyclical the outside options for college enrollment are. I use administrative data from the German *Berufsbildungsstatistik* on the number of

[25] They do, however, not find effects for, e.g., Physics, Mathematics, and Biology, which are majors mostly offered at public universities. As for Arts & Humanities and Political & Social Sciences, a relatively large share of always-takers could explain their relative increase.

new apprentices and their school degrees per state in each year (2008–2017) to estimate (i) the cyclicality of outside options, i.e., the absolute number of new apprentices, and (ii) the effect on alternative postsecondary education of high school graduates who do not enroll at college, i.e., the effects on the share of new apprentices that holds corresponding school degrees.

Table 2.6 presents results for the absolute number of new apprentices. A one pp increase in the state UR has a precisely estimated null effect on the number of new apprentices. However, fluctuations in the state UR have a significantly positive, but very small, effect on new apprenticeship contracts held by men and in below median GDP p.c. states. Overall, apprenticeships, as an outside option for college enrollment, are highly business-cycle-proof, which is in line with existing evidence (e.g., Brunello, 2009; Baldi et al., 2014; Lüthi and Wolter, 2020). However, labor market conditions at graduation have a large and positive effect on the number of new apprentices with an upper secondary leaving degree, e.g., the *Abitur*. A one pp increase in the state UR increases their number significantly by 968, which equals an 11.9 percent increase. These large effects suggest that instead of college enrollment, more high school graduates decide to start an apprenticeship during recessions. Given the stable overall number of new apprentices, this indicates strong displacement effects of graduates with lower school degrees.

Table 2.6: State UR and New Apprenticeship Contracts.

		By gender		By GDP p.c.	
	Main	Female	Male	$\geq$ median	$<$ median
	(1)	(2)	(3)	(4)	(5)
Panel A. All degrees					
State UR	200	-131	331***	-200	488*
	(293)	(217)	(101)	(464)	(215)
	[33,677]	[13,628]	[20,048]	[46,334]	[21,020]
Panel B. Upper secondary					
State UR	968***	358***	610**	851	862***
	(308)	(94)	(219)	(525)	(211)
	[8,128]	[4,068]	[4,060]	[11,872]	[4,384]
No. apprentices	5,388,279	2,180,523	3,207,732	3,706,695	1,681,584
No. cells	160	160	160	80	80
State and year FEs	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE regression on the state level for the number of new apprentices with different degrees, spanning apprenticeship cohorts 2008–2017. Outcome means in levels in brackets. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Consequently, Table 2.7 presents results for the share of new apprentices with different school leaving degrees. Indeed, higher state URs cause a larger share of school graduates with *Abitur* to fill new apprenticeship positions. This comes at the expense of school leavers with lower school degrees. While a one pp increase in the state UR

significantly increases the share of upper secondary degrees by 7.1 percent, it decreases the share of new apprenticeship positions filled by graduates with the lowest school leaving degree by 4.5 percent. Hence, the shift towards applied skill investment caused by economic downturns bears strong displacement effects on lower-qualified graduates.

Table 2.7: State UR and New Apprentices' Qualification.

		By gender		By GDP p.c.	
	Main	Female	Male	$\geq$ median	$<$ median
Dependent variable:	(1)	(2)	(3)	(4)	(5)
Upper secondary	0.071***	0.063***	0.078***	0.037	0.103***
	(0.014)	(0.014)	(0.016)	(0.021)	(0.014)
	[0.25]	[0.30]	[0.21]	[0.28]	[0.21]
Intermediate	-0.016	-0.021	-0.011	-0.012	-0.027***
Secondary	(0.013)	(0.013)	(0.014)	(0.022)	(0.003)
	[0.43]	[0.43]	[0.42]	[0.39]	[0.47]
Secondary	-0.045***	-0.052***	-0.041***	-0.033	-0.043**
general school	(0.011)	(0.015)	(0.010)	(0.029)	(0.013)
	[0.27]	[0.22]	[0.31]	[0.28]	[0.27]
None or other	0.089**	0.066*	0.103***	0.124	0.133*
	(0.032)	(0.037)	(0.029)	(0.069)	(0.066)
	[0.05]	[0.04]	[0.06]	[0.05]	[0.06]
No. apprentices	5,388,279	2,176,431	3,207,732	4,272,606	1,115,673
No. cells	160	160	160	80	80
State and year FEs	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE regression on the state level for the log share of new apprentices with different degrees, spanning apprenticeship cohorts 2008–2017. Outcome means in levels in brackets. Cells are weighted by the total number of new apprentices. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

2.6 Evidence from Survey Data

2.6.1 Postsecondary Education

Main effects. One limitation of the student register is that it does not allow conclusions on alternative postsecondary investment decisions of high school graduates as it exclusively covers students in higher education. Survey data from the GSOEP allows me to estimate the effects on college enrollment and vocational education explicitly. Table 2.8 shows the effect of within-state and across-year changes in labor market conditions at high school graduation on college enrollment and apprenticeships. Overall, the effects follow the same pattern as the evidence from administrative data but lack significance. One potential reason is the relatively large amount of information missing on postsecondary education (about 10 percent of high school graduates).

Robustness. Table 2.A.8 repeats the analysis using data from the National Educational Panel Study (NEPS, SC6), which has more detailed information on postsecondary education.[26] Reassuringly, the NEPS analysis reveals positive and significant effects for apprenticeships. About three percent of high school graduates neither enroll at college nor start an apprenticeship.

Table 2.8: Postsecondary Education and State UR.

		By gender		By SES	
	Main	Female	Male	High	Low
Dependent variable:	(1)	(2)	(3)	(4)	(5)
College enrollment	-0.007	-0.009	0.008	-0.018	-0.003
	(0.012)	(0.015)	(0.015)	(0.024)	(0.011)
	[0.62]	[0.60]	[0.65]	[0.76]	[0.56]
Apprenticeship	0.009	0.018	-0.007	0.014	0.009
	(0.008)	(0.016)	(0.014)	(0.014)	(0.010)
	[0.28]	[0.31]	[0.24]	[0.14]	[0.34]
Neither or missing	-0.002	-0.009	-0.001	0.005	-0.006
	(0.007)	(0.011)	(0.008)	(0.016)	(0.007)
	[0.10]	[0.09]	[0.11]	[0.10]	[0.10]
No. graduates	1,688	853	691	526	1,157
State and year FEs	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE linear probability model on the individual level for high school graduates with any high school degree, spanning graduation years 1998–2017. Baseline probabilities in brackets. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: GSOEP v38, Federal Employment Agency.

College choice. Table 2.9 presents evidence on college choice using survey data from GSOEP for college choice. In line with the evidence from administrative data, increases in the (state) unemployment rate at high school graduation cause a shift towards more applied skill investments. A one pp increase in the UR at graduation significantly decreases the enrollment probability at public universities by 1.6 percent. The effect on enrollment at other, more applied colleges is marginally significant and positive. Overall, survey data confirm the main results using administrative data.

2.6.2 Credit constraints

Main results. What is the role of credit constraints in a country with low college costs, such as Germany? Overall, the results on household income presented in Table 2.10 suggest a minor role of credit constraints. Panel A shows that a 1,000 EUR

[26] For the main analysis, I rely on data from the GSOEP for two main reasons. First, it allows to analyze graduation cohorts 1998-2017. Second, it allows to consider household income as a mechanism.

Table 2.9: College Choice and State UR.

		By gender		By SES	
Dependent variable:	Main (1)	Female (2)	Male (3)	High (4)	Low (5)
University	-0.016*	-0.014	-0.006	-0.011	-0.020
	(0.009)	(0.018)	(0.012)	(0.012)	(0.012)
	[0.58]	[0.55]	[0.61]	[0.73]	[0.51]
Other college	0.009	0.004	0.016*	-0.007	0.016**
	(0.006)	(0.008)	(0.008)	(0.012)	(0.006)
	[0.10]	[0.09]	[0.10]	[0.09]	[0.10]
No. graduates	1,430	733	578	427	1,000
State and year FEs	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE linear probability model on the individual level for high school graduates with any high school degree, spanning graduation years 1998–2017. Baseline probabilities in brackets. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: GSOEP v38, Federal Employment Agency.

increase in net income is statistically significantly associated with a 2.1 percentage point increase in the probability of attending college. This is a very small estimate given the mean net household income of around 3,400 EUR. Thus, Panel B shows that a one percent increase in income is statistically significantly associated with an increase in the probability of attending college of only 0.075 percentage points.[27]

Robustness. Even though all specifications control for gender and SES, which is positively related to both college enrollment and household income, there might be unobserved shocks on the household level that affect household income and the decision to enroll in college. Hence, the estimates do not have a causal interpretation. However, as most common potential confounding factors, such as health shocks, should similarly affect college enrollment and income, the effects are more likely to be downward biased. Panels C and D use within-household across-time changes and deviations from the predicted linear income trend in each household before the graduation year as income measures to account for potential shocks that might happen around graduation. A one percentage point higher change in income compared to the year before graduation is associated with a 0.046 percentage point increase in the probability of attending college (Panel C). Similarly, a one percentage point higher deviation in income from the pre-graduation linear prediction is associated with a 0.068 percentage point increase in the probability of attending college. Both associations are, again, small and insignificant. Overall, conditional on gender and SES, credit constraints do not play a large role in college enrollment.

[27] Table 2.A.9 shows the effect of the state UR on different income measures. A one pp increase in the state UR at graduation reduces average household income by 114 EUR (i.e., about 3.1 percent).

Table 2.10: Household Income and Postsecondary Education.

				By college type	
	Tertiary	Vocational training	Neither or missing	University	Other
	(1)	(2)	(3)	(4)	(5)
Panel A. Net income at graduation					
Y_t (in 1,000 EUR)	0.021***	-0.021***	-0.000	0.016	0.001
	(0.007)	(0.007)	(0.004)	(0.017)	(0.012)
Panel B. ln(Income)					
$\ln(Y_t)$	0.075**	-0.071**	-0.004	0.055	0.008
	(0.027)	(0.027)	(0.015)	(0.054)	(0.032)
Panel C. Immediate change					
$\ln(Y_t)$-$\ln(Y_{t-1})$	0.046	-0.041	-0.006	0.061	-0.033
	(0.060)	(0.084)	(0.048)	(0.118)	(0.093)
Panel D. Deviation from trend					
$\ln(Y_t)$-$\ln(\hat{Y}_t)$	0.068	-0.082	0.015	0.016	0.046
	(0.052)	(0.073)	(0.045)	(0.066)	(0.036)
Outcome mean	0.62	0.31	0.08	0.54	0.11
No. graduates	887	887	887	785	785
State and year FEs	Yes	Yes	Yes	Yes	Yes
Baseline controls	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE linear probability model on the individual level for high school graduates with any high school degree, spanning graduation years 1998–2017. Baseline probabilities in brackets. Standard errors in parentheses allow for clustering at the state level. Baseline controls include SES and gender. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: GSOEP v38, Federal Employment Agency.

2.6.3 The Role of Economic Preferences

Main results. Table 2.11 tests how patience and risk-taking affect the response of human capital investment to economic shocks. Conditional on economic preferences and including interaction effects with the state UR, a one pp higher state UR at graduation has no significant effect on college enrollment. However, the findings for economic preferences are statistically significant and consistent with the Roy model: a one standard deviation increase in time preference is associated with a sharp increase in the average negative effect of a one pp increase in the state UR on college enrollment (-15 pp vs. -6 pp). This highlights the mechanism of credit constraints. Economic scarcity induced by economic shocks might cause graduates with a high time preference to invest in applied skills that come with direct remuneration. For more risk-averse individuals, however, a one pp higher state UR increases the likelihood of going to college (+4 pp). The finding for risk-taking suggests that economic shocks have a larger effect on the uncertainty associated with direct apprenticeships than the uncertainty in the returns to college. Risk-averse graduates *wait out* recessions at college.[28]

[28] As risk attitudes are highly domain-specific, the main analysis uses career-related risk attitudes. Table 2.A.11 presents results for general risk-taking, where the interaction effect equals zero. Ta-

Table 2.11: Enrollment-Response and Economic Preferences.

	University		Other ollege		Apprenticeship	
	(1)	(2)	(3)	(4)	(5)	(6)
State UR	-0.006	0.003	0.002	0.000	0.004	-0.003
	(0.013)	(0.020)	(0.013)	(0.013)	(0.013)	(0.018)
... × Patience	0.009**	0.008**	-0.003	-0.003	-0.006*	-0.005*
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
... × Risk-taking	-0.010**	-0.011***	0.003	0.003	0.007***	0.008***
	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)
Patience	-0.089**	-0.079**	0.021	0.016	0.067**	0.063**
	(0.035)	(0.033)	(0.018)	(0.021)	(0.028)	(0.028)
Risk-taking	0.077*	0.102**	-0.012	-0.021	-0.065**	-0.081**
	(0.039)	(0.040)	(0.028)	(0.032)	(0.028)	(0.032)
Outcome mean	0.59	0.59	0.10	0.10	0.31	0.32
No. graduates	964	895	964	895	964	895
State and year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Ext. controls	No	Yes	Yes	No	Yes	Yes

Notes: This table presents estimates from a linear probability model on the individual level for the college enrollment probability of high school graduates. Graduation years 1998–2017. All specifications control for economic preferences. Extended controls include gender and SES. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source:* GSOEP v38, Federal Employment Agency.

Heterogeneity. Students of different socioeconomic status differ in their economic preferences (Falk et al., 2021), and low-SES students tend to sort into institutions with lower returns (Lovenheim and Smith, 2022). Table 2.12 repeats the analysis for high school graduates with low and high SES. For students with lower SES, the results follow the same pattern as the main results: Economic shocks at graduation significantly decrease the probability of enrolling at public universities by 2.8 pp and increase the probability of investing in applied skills. Effects on university enrollment are stronger for graduates with a high time preference (-4.1 pp) and weaker for risk-averse graduates (-1.7 pp), underlining the role of economic preferences.

For high-SES graduates, however, the effects of economic downturns are reversed. While interaction effects again follow the same pattern (positive for patience, negative for risk-taking), economic shocks significantly increase the probability of enrolling at university but decrease investment in applied skills. The results are robust to controlling for gender and migration background and contrast evidence from Section 2.6.1. In contrast to the unconditional model, controlling for economic preferences uncovers serious SES differences.

ble 2.A.10 and Table 2.A.12 show the effects of career-related risk attitudes and patience separately. The effects are in line with the results of the joint model presented in the main analysis.

Table 2.12: Enrollment-Response and Economic Preferences by SES.

	University		Other college		Apprenticeship	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Low SES						
State UR	-0.028*	-0.020	0.017*	0.016	0.010	0.001
	(0.016)	(0.021)	(0.009)	(0.010)	(0.014)	(0.018)
... × Patience	0.013***	0.012***	-0.003	-0.003	-0.009**	-0.008**
	(0.003)	(0.003)	(0.002)	(0.002)	(0.004)	(0.004)
... × Risk-taking	-0.011**	-0.010**	0.001	0.001	0.007*	0.006*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Outcome mean	0.51	0.51	0.10	0.10	0.37	0.37
No. graduates	663	624	663	624	701	656
Panel B. High SES						
State UR	0.040*	0.039*	-0.042*	-0.038	0.000	-0.001
	(0.019)	(0.021)	(0.021)	(0.022)	(0.018)	(0.020)
... × Patience	0.008	0.005	-0.004	-0.004	-0.004	-0.001
	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)	(0.004)
... × Risk-taking	-0.008	-0.011	0.006	0.008	0.003	0.004
	(0.007)	(0.007)	(0.004)	(0.005)	(0.003)	(0.004)
Outcome mean	0.76	0.76	0.09	0.08	0.13	0.13
No. graduates	301	271	301	271	336	305
State and year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Ext. controls	No	Yes	No	Yes	No	Yes

Notes: This table presents estimates from a linear probability model on the individual level for the enrollment probability of high school graduates with *Abitur* to enroll at university. Graduation years 1963–2006. All specifications control for economic preferences. Extended controls include gender. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source:* GSOEP v38, Federal Employment Agency.

In line with the Roy model, economic preferences of individuals, such as their risk tolerance and patience, might mediate the relationship between SES, local unemployment rates, and college attendance. For instance, risk-averse individuals of lower SES might be less inclined to invest time and money into college during times of high unemployment, fearing the uncertain returns from that investment. High-SES students might be better informed and have a stronger prior on the returns to university education (e.g. Giustinelli, 2023). If economic shocks have a smaller effect on the perceived riskiness in the returns to college, the negative effect on outside options might dominate, and university enrollment would increase.

Table 2.A.13 shows interaction effects of risk aversion separately by gender. Estimates follow a similar pattern for low- and high-SES students. Women react strongly to the local unemployment rate and are strongly affected by risk aversion. They forgo mostly university enrollment and show a higher probability of starting vocational training during economic downturns. For men, like for high-SES graduates, the changes are less pronounced, enrollment is negatively affected mostly at other colleges, and risk considerations play a smaller role. One possible explanation is that women tend to en-

roll in majors that are predominantly offered at specific college types and that women typically face different outside options to college enrollment (Chuan and Zhang, 2023). Another possible explanation is that a higher share of women graduates from high school with *Abitur* (Destatis, 2020). Hence, male graduates might be more selected and less likely to forgo university enrollment.

2.6.4 Expectations

The Roy model described in Section 2.3 presents changes in the expected risk and return to general and more firm-specific human capital as the main mechanism of how economic shocks affect postsecondary education choices. To measure the expected returns to college and apprenticeship degrees as representing general and more-firm specific human capital, respectively, I rely on the DZHW Panel Study of School Leavers with a Higher Education Entrance Qualification (Daniel et al., 2017). The data covers over 100,000 students who graduated in 2008, 2012, 2015, and 2018 in a given state. Students are surveyed half a year before and after high school graduation on their expected returns to i) a college degree and ii) an apprenticeship.[29] To avoid selective attrition, I focus on expectations as measured half a year before high school graduation. As the main outcome, I rely on standardized implicitly expected relative returns to college education vs. apprenticeships, i.e., the standardized difference between the two Likert-scale measures (i)-(ii). [30]

Main results. Table 2.13 presents the effect of the state unemployment rate one year before high school graduation in the implicitly expected relative returns to college. A one pp increase in the state UR has a non-significant effect on the expected returns to college by 0.008 standard deviations. However, the interaction effects for female high school graduates and the current high school GPA are positive and significant, pointing to significant effects across subgroups. Figure 2.5 plots the effects of a state-level labor market shock along the GPA distribution, separately by gender. While there is a positive and significant average effect of an increase in state unemployment on the expected relative returns to the college of female high school students, concentrated at the upper end of the GPA distribution, the effects on male students are mixed. At the

[29] Students are asked i): "In general, how do you value the job perspectives for graduates with a college degree?" and ii) "In general, how do you value the job perspectives for graduates with a vocational degree, without a college degree?", on a five-point Likert scale, with the option to state "Don't know".

[30] The raw measure ranges from -4 (very high returns to apprenticeships) to 4 (very high returns to college), with an average value of 0.462. I count students who are uncertain about either of the two options as having a weak preference for the other. For example, if a student values the return on a college degree as good (4) and is uncertain about apprenticeships, the difference would be equal to 1. Since there is no continuous data for the expected value of each degree, I cannot use risk as a separate outcome.

Table 2.13: State UR and Expected Relative Returns to College.

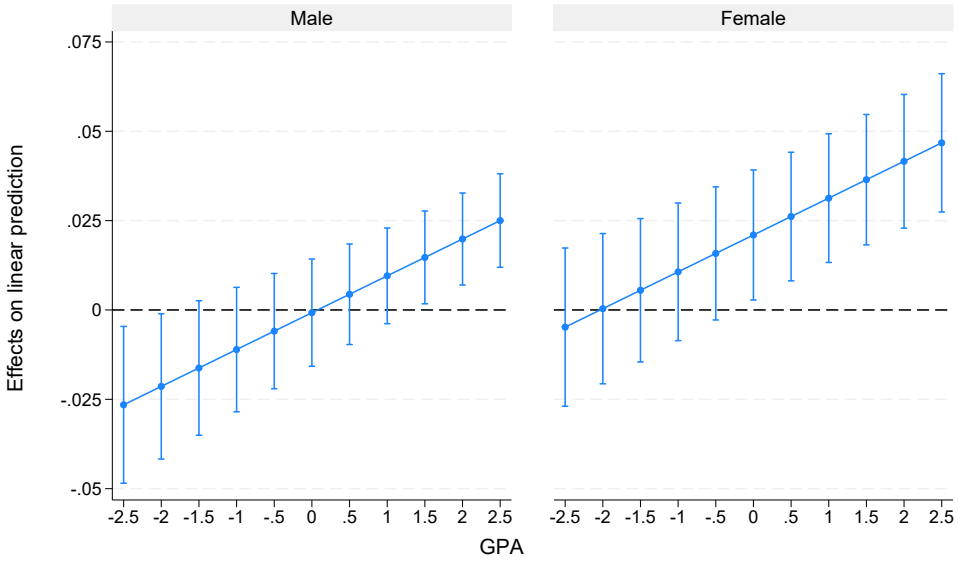
	(1)	(2)	(3)	(4)	(5)	(6)
State UR	0.008	0.009	0.009	0.000	0.008	-0.002
	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)	(0.007)
... × Low SES			-0.001			0.002
			(0.001)			(0.001)
... × Female				0.020***		0.022***
				(0.004)		(0.004)
... × GPA					0.009***	0.010***
					(0.002)	(0.002)
No. students	129,174	112,684	112,684	112,684	112,684	112,684
State and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE mode on the high school student level for the effect of the state-level unemployment rate one year before high school graduation on the standardized value of the implicitly expected relative returns to college, covering graduation years 2008, 2012, 2015, and 2018. Controls include gender, SES, and the current high school GPA (standardized). Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source:* German Centre for Higher Education Research, Federal Employment Agency.

lower end of the distribution, a one pp increase in the state UR decreases the expected relative returns to college by 2.5 percent of a standard deviation. In contrast, there is a symmetric positive effect at the upper end of the GPA distribution. While these effects appear extremely small, they are based on a broad measure of the expected returns to different degrees. Hence, even small effects in the expected relative returns measure could mean a non-trivial shift in the expectations of students that could likely affect the enrollment decision of a marginal student.

Separate results. Even though the state UR has no significant effect on the expected relative returns to college, there could still be significant effects on the separate measures of expected returns to college and apprenticeships. Table 2.A.14 and Table 2.A.15 present the effect of fluctuations in the state unemployment rate on the expected returns to college and apprenticeship, respectively. While the returns to college appear relatively business-cycle proof overall, there is a significant average negative effect on the (standardized) returns to apprenticeships. While these results seem at odds with the overall reduction in college enrollment, the marginal student might again be differently affected. State-level labor market shocks consistently reduce the expected returns to apprenticeships, but the effect on the expected returns to college varies across genders and is again moderated by the high school GPA, explaining the heterogeneous response in the relative returns to college.

Figure 2.5: Expectation-effects across GPA Distribution by Gender.



Notes: This figure plots the marginal effect of a one percentage point increase in the state unemployment rate one year before high school graduation on the implicitly expected relative return to a college degree, based on estimated in Table 2.13. *Source:* German Centre for Higher Education Research, Federal Employment Agency.

2.7 Discussion

2.7.1 What Explains Cross-country Differences?

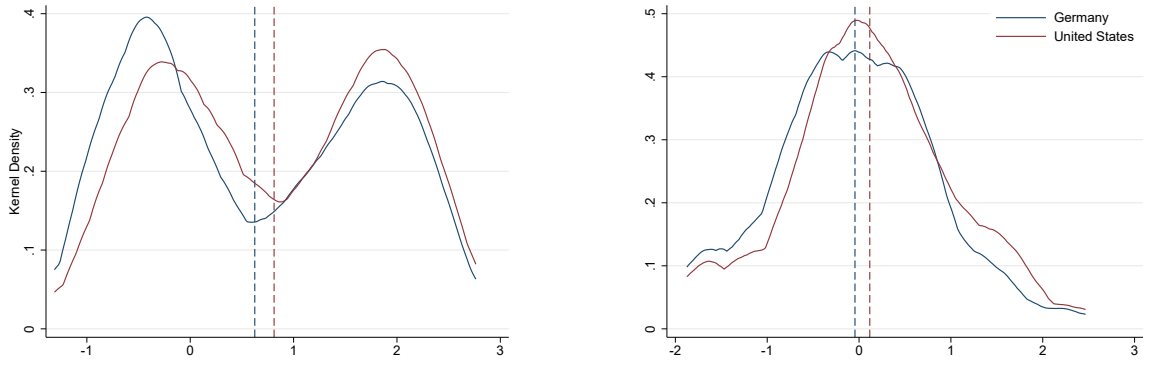
Evidence from German administrative data on procyclical college enrollment contrasts stylized facts from the U.S. Instead of enrolling at public universities, more high school graduates enroll at colleges that focus on applied skills or forgo tertiary education. Evidence from survey data suggests that individuals who would have enrolled at college in the absence of a shock now enter the labor market and start an apprenticeship.

One reason for different reactions to economic shocks may be cross-country differences in economic preferences. Indeed, data from the global preference survey reveals significant differences in the willingness to take risks and differences in patience across Germany and the U.S. Figure 2.6 shows that in Germany (the U.S.), the average willingness to take risks lies below (above) the global average (Falk et al., 2018). While both Germany and the U.S. have above-average levels of patience, individuals in the U.S. have higher average levels of patience than in Germany.[31] However, as the moderating effects of risk-taking and patience are of similar size but opposite signs, simultaneously

[31] Individuals were asked, "In general, how willing are you to take risks?" on an 11-point scale. I assume these differences are also informative about career-related risk attitudes, which my analysis focuses on.

higher levels of patience and risk-taking in the U.S. are unlikely to explain cross-country differences in the effects of economic shocks on college-going.

Figure 2.6: Patience and Risk Taking in the U.S. and Germany.



(a) Patience. (b) Risk Taking.

Notes: This figure shows the distribution of general willingness to take risks in Germany (mean = -0.044, sd = 0.893, N = 994) and the U.S. (mean = 0.117, sd = 0.919, N = 1,067). Cross-country difference in means statistically significant ($p<0.0001$). *Source*: Global Preferences Survey (Falk et al., 2018).

Another possibility is that, in the U.S., observed enrollment effects might occur at a different margin. Here, the effects are concentrated at two-year and weaker at four-year colleges (see e.g., Charles et al., 2018). Individuals who would have otherwise started or continued employment now enroll for more short-term degrees or retrain to wait out the recession. However, the German higher education system does not offer comparable associate degrees. Instead, more applied institutions offer formally equivalent bachelor's degrees. Thus, college enrollment in Germany is generally a longer-term commitment, and retraining at college is more uncommon. The de-facto study duration of a bachelor's degree in Germany is about four years, but it used to be about six years before the stepwise Bologna reform in the early 2000s (Bietenbeck et al., 2023). However, retraining alone is unlikely to explain different results. Like this study, work from the U.S. mostly focuses on first-time enrollment at college-going age (e.g., Lovenheim, 2011; Charles et al., 2018) and papers that consider retraining generally come to similar results (e.g., Betts and McFarland, 1995).

A peculiarity about the U.S. is its high college costs and highly cyclical labor markets. Germany instead has relatively low costs of college (OECD, 2011; Garritzmann, 2023) and lower degrees of labor market fluidity (Engbom, 2022, e.g.,). The biggest difference, however, is Germany's *dual education system*. Entering the labor market as an outside option to college enrollment typically means starting an apprenticeship. Unlike the labor market in the U.S., apprenticeships are relatively business cycle proof (e.g., Brunello, 2009; Baldi et al., 2014; Lüthi and Wolter, 2020), and are thus a much

more attractive outside option during economic shocks. Ultimately, this paper shows that, under stable outside options, recessions can cause an overall shift towards applied skill investments.

2.7.2 Implications for Financial Aid

Recession-induced shifts towards applied skills investments may be inefficient for several reasons. First, if high-ability individuals substitute enrollment towards more applied institutions during recessions, this could increase undermatching (e.g., Hoxby and Avery, 2012) and limit economic growth (Stuart, 2022). Second, applied skills may reduce wage risk but come at the cost of increased monopsony power (Jovanovic, 1979). Third, as the skill content of occupations is constantly changing, applied skills might become obsolete in the long run (Deming and Noray, 2020).[32] Lastly, as high school graduates displace graduates with lower school degrees from new apprenticeships, displaced individuals might become unemployed or enter unskilled jobs, causing serious externalities (e.g., Oreopoulos et al., 2012b; Liu et al., 2016).

How can policymakers ensure optimal human capital investment over the business cycle? Experimental evidence shows that information provision on the returns to college can have positive effects on study intentions (Peter and Zambre, 2017) and can increase enrollment of particularly receptive students (McGuigan et al., 2016; Kerr et al., 2020) and those with existing study intentions (Peter et al., 2021). Other studies highlight the role of loan and risk aversion as barriers to college enrollment (see Dynarski et al., 2022, for an overview on the intervention literature). Increasing the aid level and, thus, the repayment amount seems ineffective in reaching loan-averse students. In line with this, Steiner and Wrohlich (2012) find no effect of student loan increases on enrollment in Germany. However, scholarships without repayment were also ineffective in this context (Peter et al., 2017).

One reason federal aid in Germany might only imperfectly absorb the effect of economic shocks on graduates' ability to pay is the regulations on means-testing. Parental income is measured two calendar years before the first payment, i.e., two years before enrollment, and thus typically before high school graduation. Local labor market shocks in the year of high school graduation will thus have the potential to strongly impact the ability to pay for higher education when parents are laid off. Students requesting that their parents' current income be considered have to show that this would increase their monthly benefits by at least ten EUR. Aid applications are thus complex and can only

[32] Here, applied skills are defined as those acquired in majors with graduates working in a more narrow group of occupations.

be filed after enrollment, which makes them subject to uncertainty, especially during recessions. As a result, especially risk-averse students might forgo college enrollment during economic downturns.

One aspect of risk aversion is loan aversion. Low-SES students in Germany are especially loan averse: 37 percent of potentially eligible students state loan aversion as a reason for not applying for federal aid. Also, only five percent of college students take on private loans (Middendorff et al., 2017). While as described in Section 2.2, German students financially depend strongly on their parents, students in the U.S. face higher costs of college and, hence, typically finance their studies via loans, stipends, and scholarships. As student loans are much more common, loan aversion is a considerable college barrier in the U.S. (Boatman et al., 2017). Future versions of this paper will study financial risk attitudes to account for loan aversion.

Instead of simply increasing financial aid, the literature suggests that more effective measures are a reduction in the administrative burden of financial aid applications, e.g., by offering assistance (e.g., Bettinger et al., 2012b), or reducing uncertainty and complexity of the application process (Dynarski et al., 2021). For Germany, this could simply mean that aid applications can be filed before college and that parental income in the year of application is considered the standard reference for means testing.

The framing of financial aid can potentially affect institutional choice (Avery and Hoxby, 2003) and make it more appealing to loan-averse students (Field, 2009). In Germany, where student loans are interest-free and are granted for all payments exceeding 10,000 EUR, this could simply mean to phrase it as a type of scholarship or income. Related to this, a more costly measure would be to lower the abovementioned threshold or even fully grant student aid. A simple measure recurringly discussed in the German context is abolishing means testing completely. While this would potentially mitigate the effect of economic downturns on college-going, it would come at large costs. Hence, the beneficial effect on enrollment had to exceed the costs of unconditional student aid.

2.8 Conclusion

This article studies the impact of economic shocks on human capital investments and how economic preferences moderate underlying skill substitution. Using German administrative data, I show that higher local unemployment rates at graduation cause a reduction in overall first-time college-going. Simultaneously, a higher share of high school graduates enroll at more vocationally oriented institutions. Survey data reveals that high school graduates with a high time preference especially substitute firm-specific for general skill investments. Effects are stronger for low-SES students and women. As vocational education fares worse in the long run (e.g., Hanushek et al., 2017; Deming and Noray, 2020), this substitution behavior can increase existing inequalities (e.g., Lovenheim and Smith, 2022).

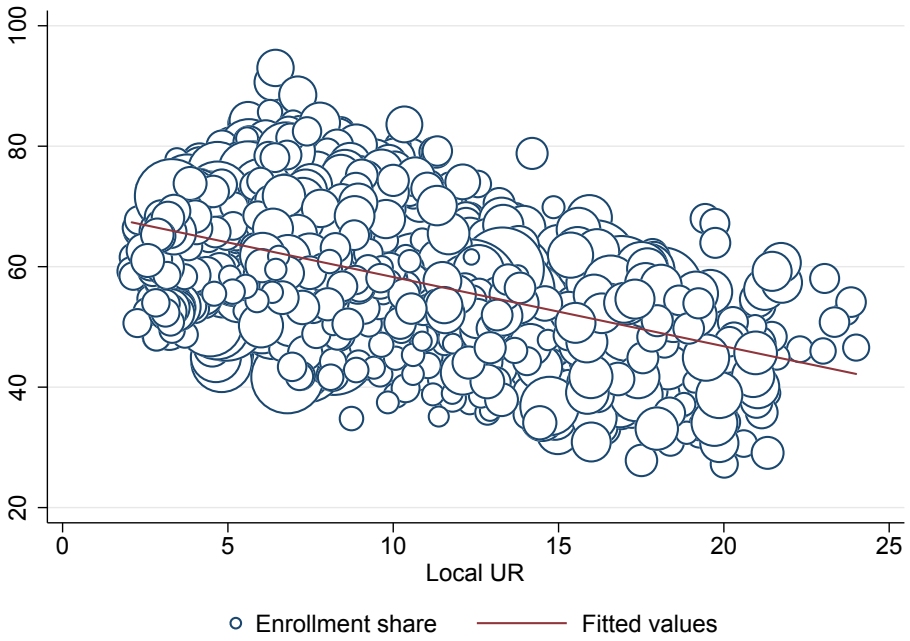
The findings of this study contrast consensus estimates from an extensive literature documenting countercyclical college-going. By accounting for the importance of economic preferences in the investment response to recessions, this study further contributes to the literature. The results suggest that cross-country differences in risk-taking can partly explain different reactions to economic shocks. The German system of higher education is representative of many countries where, at the same time, the direct costs of college are low, labor markets are moderately cyclical, and only a small share of students rely on financial aid.

A Roy model formalizes the mechanism behind skill substitution. Economic shocks affect enrollment via outside options, credit constraints, and uncertainty. Individuals choosing applied human capital investments trade in monopsony power and acquire firm-specific skills to reduce wage risk during economic downturns. However, uncertainty in apprenticeships seems to dominate uncertainty in the returns to college. Individuals with a high time preference are likelier to switch to applied skill investments, while credit constraints only play a small role. While the average student's expected relative return to college education increases during recessions, low-achieving young men increasingly favor apprenticeships over college education.

This study informs policymakers who want to ensure social mobility and an optimal investment level in human capital. Instead of increasing the level of financial aid, policymakers should provide information on the returns to college and different financing options, and especially target risk-averse students and those with a high time preference by adjusting the framing of financial aid (e.g., Avery and Hoxby, 2003; Field, 2009), offering assistance (e.g., Bettinger et al., 2012b), and reducing complexity and uncertainty (e.g., Dynarski et al., 2021) in the application process.

2.A Appendix

Figure 2.A.1: University Enrollment (in Percent) and Local UR.



Notes: This figure shows the share of high school graduates with *Abitur* from each region × cohort cell (blue circle, weighted by number of graduates) enrolling at university within one year of graduation (y-axis), and the local UR at high school graduation (x-axis). Fitted values (red) from a bivariate regression. *Source*: Student register, Federal Employment Agency, *Regionaldatenbank*, years 1998–2017

Table 2.A.1: Summary Statistics.

	Mean	SD	min	max	N
Administrative data (1998–2017, regions)					
Local UR	8.62	4.04	-	-	1,907
GDP p.c. (EUR)	31,905	9,689	-	-	1,715
High school graduates	4,311	3,404	-	-	1,907
Population (18-19)	28,039	17,674	-	-	1,907
Enrollment share (all)	59.76	9.54	-	-	1,907
Share mobile	18.66	9.37	-	-	1,907
GSOEP v18 (1998–2017, individuals)					
State UR	10.07	4.56	3.60	22.10	1,406
University	0.56	0.50	0	1	1,274
Other college	0.10	0.30	0	1	1,274
Vocational training	0.31	0.46	0	1	1,406
Female	0.55	0.50	0	1	1,406
Low SES	0.71	0.45	0	1	1,406
Risk Taking (general)	-0.07	0.96	-2.80	2.10	1,406
Risk Taking (career)	-0.06	0.97	-2.11	2.47	1,199
Risk Taking (financial)	-0.07	0.95	-1.31	3.66	1,211
Patience	-0.01	1.00	-2.84	2.00	1,406
NEPS SC6 (1963–2006, individuals)					
State UR	7.13	4.92	0.20	22.10	2,198
University	0.54	0.50	0	1	2,198
Other college	0.23	0.42	0	1	2,198
Vocational training	0.22	0.41	0	1	2,198
Female	0.50	0.50	0	1	2,198
Low SES	0.67	0.49	0	1	2,198
Risk Taking (general)	-0.01	0.98	-3.62	2.87	1,436
Risk Taking (career)	-0.03	0.94	-2.41	2.14	1,207
Risk Taking (financial)	-0.07	0.94	-1.66	2.99	1,278
Patience	-0.14	1.03	-3.46	1.95	1,102
GPA	0.09	0.94	-2.27	2.87	2,198

Notes: Minimum and maximum not available for administrative data due to data protection laws. *Source:* Student register, Federal Employment Agency, GSOEP v18, NEPS SC6, *Regionaldatenbank*.

Table 2.A.2: Robustness of Main Effect.

Outcome: College enrollment			Group-by-year FE		Linear trends	
Independent variable:	Baseline (1)	State FE (2)	By GDP (3)	By size (4)	By region (5)	By state (6)
Local UR	-0.017***	-0.010***	-0.018***	-0.018***	-0.011	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)	(0.003)
	[1,907]	[1,907]	[1,907]	[1,907]	[1,907]	[1,907]
	[5,160,522]	[5,160,522]	[5,160,522]	[5,160,522]	[5,160,522]	[5,160,522]
State UR	-0.019***	-0.020***	-0.021***	-0.020***	-0.013*	-0.016**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.007)	(0.007)
	[1,907]	[1,907]	[1,907]	[1,907]	[1,907]	[1,907]
	[5,160,522]	[5,160,522]	[5,160,522]	[5,160,522]	[5,160,522]	[5,160,522]
Youth UR	-0.017***	-0.010***	-0.018***	-0.018***	-0.004	-0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)
	[1,233]	[1,233]	[1,233]	[1,233]	[1,233]	[1,233]
	[3,574,450]	[3,574,450]	[3,574,450]	[3,574,450]	[3,574,450]	[3,574,450]
ln(local GDP p.c.)	0.246**	0.025	0.210*	0.327***	-0.180	0.009
	(0.112)	(0.028)	(0.114)	(0.118)	(0.119)	(0.027)
	[1,715]	[1,715]	[1,715]	[1,715]	[1,715]	[1,715]
	[4,718,187]	[4,718,187]	[4,718,187]	[4,718,187]	[4,718,187]	[4,718,187]
ln(state GDP p.c.)	0.119	0.224***	0.141	0.172	0.179	0.253***
	(0.205)	(0.059)	(0.204)	(0.214)	(0.442)	(0.045)
	[1,907]	[1,907]	[1,907]	[1,907]	[1,907]	[1,907]
	[5,160,522]	[5,160,522]	[5,160,522]	[5,160,522]	[5,160,522]	[5,160,522]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	No	Yes	Yes	Yes	No
State FE	No	Yes	No	No	No	Yes
Poor-by-year FE	No	No	Yes	No	No	No
Small-by-year FE	No	No	No	Yes	No	No
Region-specific trend	No	No	No	No	Yes	No
State-specific trend	No	No	No	No	No	Yes

Notes: This table tests the sensitivity of the baseline estimate in Table 2.1 towards the inclusion of different fixed effects interactions and alternative labor market indicators. Groups are below (and above) median GDP regions and regions with above (below) median number of high school graduates, respectively. Each region is weighted by the number of high school graduates with *Abitur*. Sample mean (levels) in brackets. Standard errors in parentheses allow for clustering at the regional level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table 2.A.3: Effects of Local UR on College Enrollment of 18–19 y/o.

		By gender		By GDP p.c.	
	Main	Female	Male	≥ median	< median
	(1)	(2)	(3)	(4)	(5)
Overall enrollment	-0.006	0.003	-0.015***	-0.012	-0.004
	(0.004)	(0.004)	(0.004)	(0.007)	(0.005)
	[14.08]	[14.43]	[13.75]	[15.18]	[12.32]
At university	-0.023***	-0.015***	-0.031***	-0.027***	-0.018***
	(0.004)	(0.004)	(0.004)	(0.006)	(0.005)
	[8.85]	[9.92]	[7.84]	[9.49]	[7.82]
At other college	0.025***	0.044***	0.010	0.017	0.022***
	(0.006)	(0.006)	(0.006)	(0.019)	(0.006)
	[5.23]	[4.51]	[5.91]	[5.69]	[4.50]
No. 18–19 y/o	35,944,843	17,445,535	18,499,308	22,171,790	13,773,053
No. cells	1,907	1,907	1,907	956	951
Region and year FEs	yes	yes	yes	yes	yes

Notes: This table presents estimates from a two-way-FE regression on the regional level for the log share of individuals aged 18–19 enrolling at college, spanning graduation years 1998–2017. All specifications include region- and year fixed effects. Each region is weighted by the number of 18–19-year-olds. Sample mean (levels) in brackets. Standard errors in parentheses allow for clustering at the regional level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table 2.A.4: Effects of Local UR on Attainment of 18–19 y/o.

		By gender		By GDP p.c.	
	Main	Female	Male	≥ median	< median
Dependent variable:	(1)	(2)	(3)	(4)	(5)
Overall attainment	-0.001	0.007	-0.009**	-0.004	0.002
	(0.004)	(0.005)	(0.004)	(0.009)	(0.005)
	[11.0]	[11.8]	[10.3]	[12.1]	[10.0]
University degrees	-0.012**	-0.006	-0.019***	-0.002	-0.011*
	(0.005)	(0.005)	(0.005)	(0.007)	(0.006)
	[6.1]	[7.2]	[5.1]	[6.6]	[5.6]
Other college degree	0.014**	0.029***	0.001	-0.004	0.019***
	(0.006)	(0.008)	(0.005)	(0.014)	(0.007)
	[4.9]	[4.6]	[5.3]	[5.5]	[4.4]
No. 18–19 y/o	30,734,075	14,980,191	15,753,884	18,778,683	11,955,392
No. cells	1,619	1,619	1,619	812	807
Region and year FEs	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE regression on the regional level for the log share of 18–19-year-olds in a given year between 1998 and 2014, graduating from college until 2018. Each region is weighted by the number of 18–19-year-olds. Outcome means (level) in brackets. Standard errors in parentheses allow for clustering at the regional level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: Exams register, Federal Employment Agency, *Regionaldatenbank*.

Table 2.A.5: Enrollment Effects of Local UR Across Institutions (1998-2014).

		By gender		By GDP p.c.	
	Main	Female	Male	≥ median	< median
Dependent variable:	(1)	(2)	(3)	(4)	(5)
Overall enrollment	-0.017***	-0.021***	-0.010***	-0.014	-0.020***
	(0.004)	(0.004)	(0.003)	(0.009)	(0.004)
	[79.5]	[76.4]	[83.5]	[84.1]	[74.9]
At university	-0.030***	-0.035***	-0.023***	-0.014	-0.035***
	(0.004)	(0.005)	(0.004)	(0.010)	(0.005)
	[60.9]	[60.5]	[61.6]	[65.3]	[56.5]
At other college	0.031***	0.036***	0.030***	-0.018	0.031***
	(0.007)	(0.008)	(0.007)	(0.012)	(0.006)
	[18.6]	[15.9]	[22.0]	[18.8]	[18.4]
No. graduates	4,289,449	2,390,916	1,898,533	2,697,356	1,592,093
No. cells	1,619	1,619	1,619	812	807
Region and year FEs	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE regression on the regional level for the log share of high school graduates with *Abitur* enrolling at college, spanning graduation years 1998–2014. Each region is weighted by the number of high school graduates with *Abitur*. Outcome means (level) in brackets. Standard errors in parentheses allow for clustering at the regional level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: Student register, Federal Employment Agency, *Regionaldatenbank*.

Table 2.A.6: Effects of Local UR on Enrollment of 18–19 y/o (1998-2014).

		By gender		By GDP p.c.	
	Main	Female	Male	≥ median	< median
Dependent variable:	(1)	(2)	(3)	(4)	(5)
Overall enrollment	-0.007*	0.002	-0.016***	-0.014**	-0.007
	(0.004)	(0.005)	(0.004)	(0.006)	(0.005)
	[13.1]	[13.3]	[12.8]	[14.2]	[11.9]
At university	-0.021***	-0.013**	-0.030***	-0.025***	-0.018***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
	[8.2]	[9.3]	[7.3]	[8.9]	[7.6]
At other college	0.021***	0.040***	0.007	0.015	0.014**
	(0.006)	(0.006)	(0.006)	(0.016)	(0.006)
	[4.8]	[4.0]	[5.6]	[5.3]	[4.3]
No. 18-19 y/o	30,734,075	14,980,191	15,753,884	18,778,683	11,955,392
No. cells	1,619	1,619	1,619	812	807
Region and year FEs	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE regression on the regional level for the log share of 18–19-year-olds enrolling at college, spanning 1998–2014. Each region is weighted by the number of 18–19-year-olds. Outcome means (level) in brackets. Standard errors in parentheses allow for clustering at the regional level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: Student register, Federal Employment Agency, *Regionaldatenbank*.

Table 2.A.7: Effects of Local UR on Degree Choice (all freshmen).

		By gender		By GDP p.c.	
Dependent variable:	Main (1)	Female (2)	Male (3)	≥ median (4)	< median (5)
Full time	-0.007***	-0.007***	-0.007***	-0.010***	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
	[94.2]	[94.8]	[93.5]	[93.7]	[94.7]
Dual study	0.073**	0.063*	0.076**	0.127***	0.024
or part time	(0.034)	(0.037)	(0.036)	(0.033)	(0.041)
	[5.8]	[5.2]	[6.5]	[6.3]	[5.3]
No. regions	768	768	768	384	384
No. 18–19 y/o	2,448,420	1,213,932	1,234,488	1,701,345	747,075

Notes: This table presents estimates from a two-way-FE regression on the regional level for the log share of all freshmen in full-time, part-time, and dual studies, spanning graduation years 1998–2017. All specifications include region- and year fixed effects. Each region is weighted by the number of freshmen. Sample mean (levels) in brackets. Standard errors in parentheses allow for clustering at the regional level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table 2.A.8: Postsecondary Education and State UR (NEPS).

		By gender		By SES	
Dependent variable:	Main (1)	Female (2)	Male (3)	High (4)	Low (5)
College enrollment	-0.009	-0.008	-0.011	-0.010	-0.007
	(0.006)	(0.009)	(0.007)	(0.009)	(0.007)
	[0.43]	[0.38]	[0.48]	[0.74]	[0.34]
Apprenticeship	0.013**	0.012	0.013*	0.012	0.011
	(0.005)	(0.007)	(0.007)	(0.008)	(0.007)
	[0.54]	[0.59]	[0.49]	[0.24]	[0.63]
Neither or missing	-0.003	-0.005	-0.002	-0.001	-0.004
	(0.003)	(0.005)	(0.002)	(0.002)	(0.004)
	[0.03]	[0.03]	[0.03]	[0.02]	[0.03]
No. graduates	2,198	1,099	1,099	716	1,482
State and year FEs	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE linear probability model on the individual level for high school graduates with any high school degree, spanning graduation years 1962–2007. Control variables include gender, SES, migration status, and GPA. Baseline probabilities in brackets. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: NEPS SC6, Federal Employment Agency.

Table 2.A.9: State UR and Household Income (Y_t).

	Y_t	$\ln(Y_t)$	$\ln(Y_t)$-$\ln(Y_{t-1})$	$\ln(Y_t)$-$\ln(\hat{Y}_t)$
	(1)	(2)	(3)	(4)
Panel A. All graduates				
State UR	-0.114***	-0.031***	0.000	-0.007
	(0.030)	(0.008)	(0.003)	(0.004)
	[3.76]	[8.12]	[0.02]	[-0.04]
No. graduates	1,284	1,284	1,209	966
State and year FEs	Yes	Yes	Yes	Yes
Panel B. High SES				
State UR	-0.130*	-0.024	-0.005	-0.024*
	(0.070)	(0.014)	(0.009)	(0.012)
	[4.73]	[8.36]	[0.01]	[-0.03]
No. graduates	403	403	371	277
State and year FEs	Yes	Yes	Yes	Yes
Panel A. Low SES				
State UR	-0.111**	-0.035**	0.001	-0.001
	(0.041)	(0.013)	(0.006)	(0.008)
	[3.32]	[8.00]	[0.03]	[-0.04]
No. graduates	880	880	837	689
State and year FEs	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE model for the effect of the state UR on household income (Y_t, in 1000 EUR) for high school graduates with any high school degree, spanning graduation years 1998–2017. Outcome means in brackets. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: GSOEP v38, Federal Employment Agency.

Table 2.A.10: Enrollment-Response and Risk Taking (Career).

	University		Other ollege		Apprenticeship	
	(1)	(2)	(3)	(4)	(5)	(6)
State UR	-0.003	0.005	0.004	-0.001	-0.001	-0.005
	(0.012)	(0.020)	(0.009)	(0.013)	(0.011)	(0.016)
Risk Taking	0.073*	0.104**	-0.010	-0.021	-0.059**	-0.069**
	(0.036)	(0.041)	(0.030)	(0.032)	(0.021)	(0.029)
State UR ×	-0.009**	-0.011**	0.001	0.003	0.006***	0.006**
Risk Taking	(0.004)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)
Outcome mean	0.58	0.59	0.10	0.10	0.29	0.29
No. graduates	1,166	895	1,166	895	1,285	961
State and year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Ext. controls	No	Yes	Yes	No	Yes	Yes

Notes: This table presents estimates from a linear probability model on the individual level for the college enrollment probability of high school graduates, spanning graduation years 1998–2017. All specifications include state- and year fixed effects. Extended controls include gender and SES. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source:* GSOEP v38, Federal Employment Agency.

Table 2.A.11: Enrollment-Response and Risk Taking (General).

	University		Other ollege		Apprenticeship	
	(1)	(2)	(3)	(4)	(5)	(6)
State UR	-0.017*	-0.014	0.010	0.006	0.009	0.010
	(0.009)	(0.013)	(0.006)	(0.009)	(0.009)	(0.012)
Risk Taking	-0.035	-0.045*	0.018	0.019	0.005	0.020
	(0.025)	(0.024)	(0.020)	(0.032)	(0.027)	(0.027)
State UR ×	0.000	-0.001	-0.001	-0.001	0.001	0.001
Risk Taking	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Outcome mean	0.58	0.58	0.10	0.10	0.27	0.29
No. graduates	1,386	1,037	1,386	1,037	1,626	1,167
State and year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Ext. controls	No	Yes	Yes	No	Yes	Yes

Notes: This table presents estimates from a linear probability model on the individual level for the college enrollment probability of high school graduates, spanning graduation years 1998–2017. All specifications include state- and year fixed effects. Extended controls include gender and SES. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source:* GSOEP v38, Federal Employment Agency.

Table 2.A.12: Enrollment-Response and Patience.

	University		Other ollege		Apprenticeship	
	(1)	(2)	(3)	(4)	(5)	(6)
State UR	-0.023**	-0.001	0.008	0.001	0.015	-0.000
	(0.008)	(0.019)	(0.008)	(0.013)	(0.013)	(0.018)
Patience	-0.072**	-0.083**	0.024	0.018	0.049	0.065**
	(0.034)	(0.032)	(0.017)	(0.021)	(0.028)	(0.027)
State UR ×	0.007**	0.008**	-0.003	-0.003	-0.005	-0.005*
Patience	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Outcome mean	0.58	0.59	0.10	0.10	0.32	0.32
No. graduates	1,135	895	1,135	895	1,135	895
State and year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Ext. controls	No	Yes	Yes	No	Yes	Yes

Notes: This table presents estimates from a linear probability model on the individual level for the college enrollment probability of high school graduates, spanning graduation years 1998–2017. All specifications include state- and year fixed effects. Extended controls include gender and SES. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source:* GSOEP v38, Federal Employment Agency.

Table 2.A.13: Enrollment-Response and Economic Preferences by Gender.

	University		Other college		Apprenticeship	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Female						
State UR	-0.009	-0.003	0.004	0.004	0.007	0.001
	(0.034)	(0.036)	(0.017)	(0.018)	(0.028)	(0.031)
... × Patience	0.005	0.006	-0.005	-0.005	-0.000	-0.001
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
... × Risk-taking	-0.008**	-0.008**	0.003	0.003	0.003	0.003
	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.004)
Outcome mean	0.58	0.58	0.08	0.08	0.32	0.32
No. graduates	497	497	497	497	530	530
Panel B. Male						
State UR	0.018	0.012	-0.007	-0.006	-0.012	-0.007
	(0.018)	(0.018)	(0.018)	(0.018)	(0.023)	(0.021)
... × Patience	0.010**	0.010**	-0.001	-0.001	-0.009	-0.010*
	(0.004)	(0.004)	(0.002)	(0.002)	(0.005)	(0.005)
... × Risk-taking	-0.013*	-0.013**	0.002	0.002	0.011**	0.010**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.004)	(0.004)
Outcome mean	0.60	0.60	0.12	0.12	0.26	0.26
No. graduates	398	398	398	398	431	431
State and year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Ext. controls	No	Yes	No	Yes	No	Yes

Notes: This table presents estimates from a linear probability model on the individual level for the enrollment probability of high school graduates with *Abitur* to enroll at university, spanning graduation years 1963–2006. All specifications include state- and year fixed effects and control fior risk aversion. Extended controls include GPA, migration background, and SES. Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source:* NEPS SC6, Federal Employment Agency.

Table 2.A.14: State UR and Expected Returns to College.

	(1)	(2)	(3)	(4)	(5)	(6)
State UR	-0.004	-0.000	-0.001	-0.010*	-0.001	-0.012**
	(0.007)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
... × Low SES			0.001			0.003**
			(0.001)			(0.001)
... × Female				0.023***		0.023***
				(0.006)		(0.006)
... × GPA					0.004***	0.005***
					(0.001)	(0.001)
No. students	121,645	106,593	106,593	106,593	106,593	106,593
State and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE mode on the high school student level for the effect of the state-level unemployment rate one year before high school graduation on the standardized value of the explicitly expected returns to college, covering graduation years 2008, 2012, 2015, and 2018. Controls include gender, SES, and the current high school GPA (standardized). Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source:* German Centre for Higher Education Research, Federal Employment Agency.

Table 2.A.15: State UR and Expected Returns to Apprenticeships.

	(1)	(2)	(3)	(4)	(5)	(6)
State UR	-0.018**	-0.017**	-0.017**	-0.015*	-0.016*	-0.014
	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
... × Low SES			0.001			-0.001
			(0.002)			(0.002)
... × Female				-0.004**		-0.005***
				(0.002)		(0.002)
... × GPA					-0.008***	-0.008***
					(0.002)	(0.002)
No. students	121,633	106,641	106,641	106,641	106,641	106,641
State and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes	Yes

Notes: This table presents estimates from a two-way-FE mode on the high school student level for the effect of the state-level unemployment rate one year before high school graduation on the standardized value of the explicitly expected returns to apprenticeships, covering graduation years 2008, 2012, 2015, and 2018. Controls include gender, SES, and the current high school GPA (standardized). Standard errors in parentheses allow for clustering at the state level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source:* German Centre for Higher Education Research, Federal Employment Agency.

CHAPTER 3

Lost Potential? Student Sorting in German Higher Education*

3.1 Introduction

Economic growth hinges on the optimal allocation of talent (e.g., Hsieh et al., 2019). A pivotal factor for this is high school graduates' choice of the *right* college and major that match their abilities and interests. Meritocratic higher education systems like the U.S. promise efficient matching: On the one hand, elite colleges allow highly talented students to unleash their potential and may even foster social mobility (Zimmerman, 2019). On the other hand, less selective colleges may facilitate access to higher education (Mountjoy, 2022). However, high-achieving, low-income students often do not apply at their best options and undermatch (Hoxby and Avery, 2012; Hoxby et al., 2013) and income-based segregation across colleges is high (Chetty et al., 2020).[1]

In the U.S., increasing college attendance and a shift towards selection on ability rather than socioeconomic status after WWII led to an increasing quality (MacLeod and Urquiola, 2021) and stratification (Hoxby, 2009; Hendricks et al., 2021). Figure 3.1 shows that in contrast, the German higher education landscape seems relatively egal-

*This chapter is joint work with Felix Weinhardt (European University Viadrina Frankfurt (Oder)).

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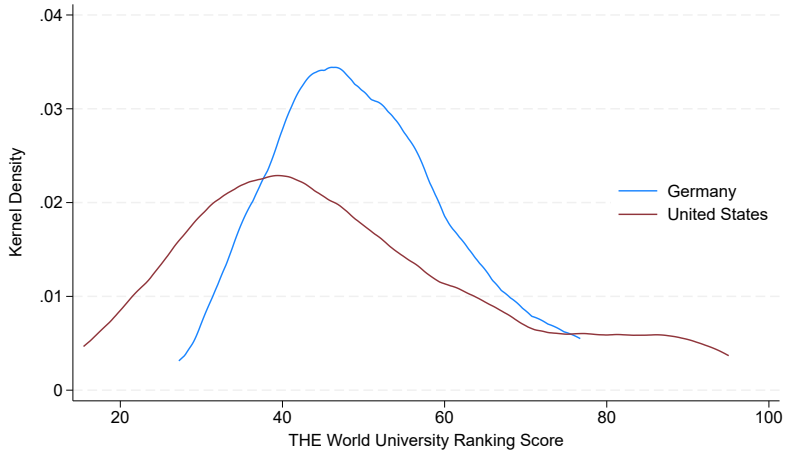
[1] Alongside misinformation about their net costs, misinformation about college quality measures such as graduation rates or peer achievement plays an important role. At the same time, misinformation about college reputation is uncommon in the U.S. (Hoxby and Turner, 2015).

Figure 3.1: University Quality in the U.S. and Germany.



Notes: University quality indicated by ranking scores across universities in Germany (N=39) and the United States (N=161). Scores represent a weighted average across teaching, research, and internationality (see Appendix Section 3.A.2 for details). *Source*: Times Higher Education Ranking, 2016.

itarian, with a lower variation in quality across German universities.[2] Historically, however, large quality differences have existed across fields (e.g., Waldinger, 2010; McClelland, 2019) and may persist today. As college and major choice is a joint decision in Germany, information on field-specific university quality is critical for a good match.

Distance to the closest university does not only co-determine who attends a university (see Spiess and Wrohlich, 2010, for Germany) but may also affect institutional (Gibbons and Vignoles, 2012) and major choice (Denzler and Wolter, 2011; Suhonen, 2014). If highly talented high school graduates prefer certain fields of study but are limited in their mobility, enrolling in the next best institution might come at high costs, as the returns to elite education are substantial (Anelli, 2020). If information on quality differences across universities is private and a result of personal experience, high-achieving first-generation students may undermatch, resulting in *lost potential*.

This paper asks how public information provision on the within-field-of-study distribution of university quality can improve the matching process of students and study programs. We use difference-in-differences approaches to study the staggered introduction and updating of the Centre for Higher Education (CHE) program-specific quality indicators via the *Die Zeit* newspaper. We combine ranking data with register data on students in German higher education and information on local rent prices from Germany's largest housing platform *ImmobilenScout24*. Conditional on rent prices, we find

[2]The reasons for this may range from financial regulations (e.g., largely tax-funded higher education and an initial ban of tuition fees by federal law (Bietenbeck et al., 2023)) to legal restrictions in the universities' freedom in the admission process (Grenet et al., 2022).

large and positive effects of quality signals on the average distance between students' country of high school graduation and their university of choice. We discuss implications for mismatch and further steps to identify effects on study and labor market outcomes.

Our results show that information provision on quality differences across universities with different fields of study has sizeable effects on student mobility. A green rating based on student satisfaction scores in the CHE rankings increases the distance traveled by freshmen within a program by over seven percent. The effects are unaffected by the local rent level around a university and are larger when using estimators that account for heterogeneity in the effects over time. Green ratings as a quality signal further increase the total number of students in a program and reduce the share of women. Ratings based on recommendations by teachers in the respective field have a lower impact than ratings based on student satisfaction. Strong effects on mobility, combined with survey data on the usage of rankings as an information source, indicate that particularly high SES students react to signals about program quality.

We contribute to the literature in the following ways: First, we complement the literature on university rankings as a factor in students' human capital investments by estimating causal effects for actual enrollment and student mobility. Using mobility measures allows us to conclude students' university choices while circumventing measurement problems that arise in oversubscribed programs. Previous studies using rankings based on student satisfaction have focused on university applications instead of studying actual enrollment (Soo, 2013; Luca and Smith, 2013; Gibbons et al., 2015).[3] Related to our study, Horstschräer (2012) combines data from the CHE ranking with administrative data on applications at German medical schools (2003–2008) and finds small positive effects of a green rating based on student satisfaction.

Second, this study contributes to the active literature on student-college matching. Prior research has focused on other factors influencing student-college matching, such as learning externalities (MacLeod and Urquiola, 2015) and the impact of college reputation on job outcomes (MacLeod et al., 2017), we extend the understanding by examining how public information on university quality, and thus reputation, affects student mobility and enrollment. Our findings align with studies highlighting the importance of information in guiding students' decisions (Dillon and Smith, 2017) and contribute to ongoing discussions on inequalities in student-program matching (Campbell et al., 2022) and what measures can improve both equity and efficiency (Black

[3]See Jacqmin and Lefebvre (2021) for an exception, studying the enrollment effects of degree accreditations in France.

et al., 2023). Moreover, we contribute to research that studies the role of the housing market for college enrollment (Charles et al., 2018; Goehausen and Thomsen, 2024).

This study informs policymakers who want to improve the student-university matching process. It highlights the importance of providing potential college students with information about quality differences. A lack of quality information may perpetuate educational inequality in a seemingly egalitarian system where many students still choose universities based on proximity. Our results suggest that students change their location decisions as a reaction to positive quality signals and thus may benefit when information about the quality distribution of colleges within the field of study is made public.

The remainder of this paper is structured as follows. We start by outlining our data and identification strategy in Section 3.2.1 and Section 3.2.2, before presenting our main results in Section 3.3. Lastly, we discuss the current limitations and corresponding agenda for future research in Section 3.4, before Section 3.5 closes.

3.2 Empirical Strategy

3.2.1 Data

We construct a novel program-level panel (1995-2018) that covers multidimensional ranking scores, the number of students enrolled, the average distance traveled between the home county and university, the average rent level in the university county, as well as other student and university characteristics, such as the institutional type, or the share of women in a program. Each program marks a specific major at a specific university. Hence, each university has different programs which can be part of a larger field of study.

Student characteristics. We use administrative data on students (1995-2018) from the German student register (RDC, 2019). The register covers all students' year, institution, and major and the year and county where students obtained their university entrance qualification. Based on the coordinates (WGS 84) of universities (College addresses from *Hochschulkompass* of German Rectors' Conference (HRK)) and the population-weighted center of counties (own calculation), we determine the distance traveled., i.e., the distance between the university of their first enrollment spell and the county of high school graduation. The student register does not cover individual student IDs for data protection reasons. We hence aggregate by program and year.

Program quality. For information on program quality, we rely on ordinal ranking data (1998–2020) from the (CHE) Centre for Higher Education (Federkeil, 2002). The *Die Zeit* newspaper since publishes the ranking online and in a special print magazine since 2005. [4] Previous CHE ranking data was published in 1998 by the *Stiftung Warentest*, a well-known German consumer organization, and from 1999 to 2004 in the *Stern* magazine. The ranking is based on self-reported general student satisfaction, according to the German grading system, on a scale of one (best) to five (worst). It covers student satisfaction with different aspects of their program, such as the number of courses offered, the teacher-to-student ratio, or the number of lab spots. To ensure comparability across fields of study, we rely on a general indicator that covers students' overall satisfaction with the study conditions of their program.

Based on their rating and the overall rating distribution in the same year and major, programs are ranked in the top, middle, and bottom tier. Programs in the top tier are indicated by a green color signal, programs in the middle tier by a yellow color signal, and programs in the bottom tier by a red (later blue) color signal. The exact cutoff criteria vary across years. Since 2005, programs from different fields of study have been covered in a three-year interval. Appendix Table 3.A.6 shows the timing of ranking publications across fields of study and the number of universities treated within each year and for each field. We use the staggered publication of ranking data across universities and fields of study to identify the causal effect of information on program quality on student mobility.

Appendix Figure 3.A.6 shows the distribution of student satisfaction across universities within different fields of study. Business and Management programs have the highest average student satisfaction and a relatively high number of outliers. Figure 3.A.7 shows the distribution of teacher recommendation share across universities within different fields of study, with similar patterns. Figure 3.A.8 and Figure 3.A.9 show equivalent distributions within different majors.

Regional characteristics. Housing data from RWI-GEO-RED V4 (2007-2018) covers the average rent level (EUR per square meter) of all properties posted online for rent on the largest housing platform *ImmobilienScout24*. Our measure does not control for housing characteristics or explicitly focus on student housing as we want to consider the extensive margin of how much adequate housing for students is supplied by the market. If certain counties only offer large renovated flats with extensive amenities, then this should be reflected in our measure.

[4] Appendix Figure 3.A.4 and Appendix Figure 3.A.5 show an exemplary ranking for the field of Economics for the print and the online editions, respectively.

3.2.2 Identification

This study uses the staggered introduction and updating of tier lists in the CHE ranking to identify the causal effect τ of a green rating, i.e., being ranked in the top group, on program-p-level outcomes Y_{pt}, such as the average distance traveled, the total number of students, the share of women, and the share of students from low-income counties in year t. We discuss the different static and dynamic effects that can be estimated and appropriate estimators from the active differences-in-differences literature (see, e.g., Borusyak et al., 2024, for an overview)

Two-Way-Fixed-Effects (TWFE) Model. In the first step, we rely on the canonical static TWFE model to estimate the effects of a green rating on program-level outcomes. In particular, we estimate:

$$Y_{pt} = \alpha_p + \beta_t + \tau D_{pt} + \gamma_u\, t + \mathbf{X}_{pt}\, \delta + \epsilon_{pt}, \tag{3.1}$$

where D_{pt} is a dummy variable that equals one if the last available rating of the respective major in year t ranks program p in the top group. α_p and β_t denote program and year fixed effects. Robustness checks include controlling for university u specific linear time-trends and different program characteristics X_{pt}, such as the local rent level. Each program cell is weighted by the number of freshmen. We adjust standard errors for clustering at the university level (Bertrand et al., 2004).

As programs can drop out of the ranking or receive an updated ranking in later years, there are different event dates E_p at which a program is treated with a green rating and dates F_p where it drops out of treatment. We define $K_{pt} = t - E_p$ as years relative to periods where the program switches from not being ranked at all or not being ranked in the top group to being ranked in the top group. To estimate effects along the event horizon and visually test for pre-trends, we estimate the following event study model:

$$Y_{pt} = \alpha_p + \beta_t + \tau_{a+} \mathbb{1}\left[K_{pt} \leqslant a\right] + \sum_{\substack{h=-a \\ h\neq -1}}^{b-1} \tau_h \mathbb{1}\left[K_{pt} = h\right] + \tau_{b+} \mathbb{1}\left[K_{pt} \geqslant b\right] + \varepsilon_{pt}, \tag{3.2}$$

where τ_h is the effect of a green rating h years relative to treatment. Conceptually, one can distinguish between instantaneous effects, i.e., the effect in the year where the treatment status D_{pt} changes, and the average effect over different years t. In addition to average effects from the standard TWFE, based on the full sample, we present effects based on a sample that excludes programs after they are ranked for the second

time in the Appendix. Identification of causal effects, i.a., relies on a common trend assumption, as well as the assumption that conditional on appearing in the ranking, the outcome of the student survey is exogenous (assumption of independent groups and strong exogeneity) and not anticipated by freshmen.

Alternative Estimators. Recent literature stresses several other threats to identification in staggered designs. As in our case, never-treated programs exist, these concerns are mostly limited to heterogeneous treatment effects and resulting negative weights. In our case, programs are ranked and updated at different times. As a consequence, already-treated programs repeatedly appear in the control group. When effects are heterogeneous across majors and across time, this might bias estimates from both the static (e.g., de Chaisemartin and D'Haultfoeuille, 2020; Goodman-Bacon, 2021) and dynamic model (e.g., Sun and Abraham, 2021).

To estimate average treatment effects, we use the DID_ℓ estimator, introduced in de Chaisemartin and D'Haultfoeuille (2024). The estimator allows the estimation of dynamic event study effects that can be aggregated to measure the average effect of the treatment. It is unbiased even if lagged treatments affect the outcome and if current and lagged treatments have heterogeneous effects across programs and over time. Additionally, we use the DID_M estimator to estimate instantaneous treatment effects, introduced in de Chaisemartin and D'Haultfoeuille (2020). Like the DID_ℓ estimator, the DID_M estimator gives a weighted sum of differences-in-differences. It is robust to dynamic effects in a staggered setting and equivalent to the first dynamic effect (h=0) of the DID_ℓ.

3.3 Main Results

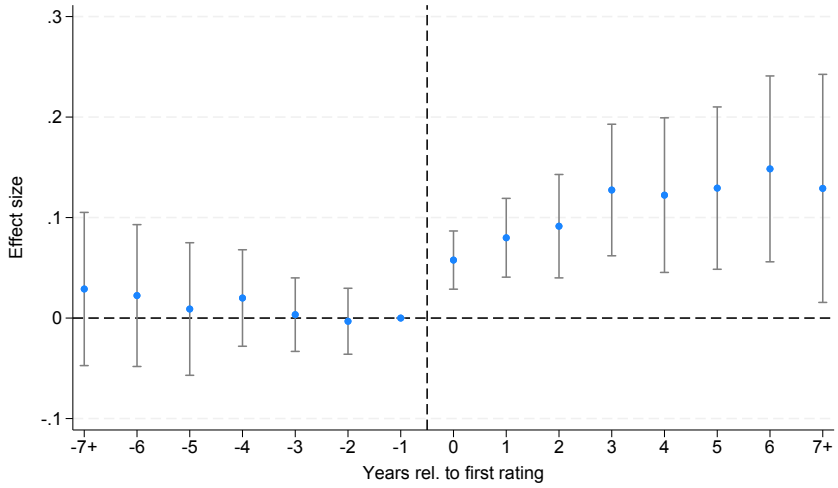
This section presents estimation results on the average effect of a green rating in the CHE ranking on program-level mobility, the number of new freshmen, and the share of women and students from low-income counties enrolling. Using survey data, we discuss SES differences in receptiveness among students. Equivalent results on the instantaneous effect of a green rating are listed in Appendix Section 3.A.1.

3.3.1 Freshmen Mobility

Event study estimates. How do university rankings affect the mobility choices of students Figure 3.2 presents event study results on the dynamic effects of a green rating in the CHE ranking on program-level mobility of freshmen students, based on Equation (3.2) and for a time horizon of seven years. Lagged coefficients appear close

to zero and insignificant, suggesting parallel trends between programs receiving a green rating in period zero and those that remain untreated, i.e., receiving a red, a yellow, or no rating. Immediate and lagged effects are positive and significant. They slightly increase over time, from around five percent in period zero to around 15 percent in period six.

Figure 3.2: Event-Study Effects of a Green Rating on Student Mobility (TWFE).



Notes: This figure shows program-level estimates on the average effect of a green rating in the student satisfaction-based CHE-Ranking on freshmen mobility, covering 1995 – 2018. Estimates based on a TWFE event study model. *Source*: German Student Register, *Centre for Higher Education (CHE).*

Appendix Figure 3.A.1 extends the effect horizon and repeats the analysis using the DID_ℓ estimator, accounting for treatment effect heterogeneity. Again, pre-trends are small and insignificant. However, the initial increase in mobility is much more pronounced and jumps from plus five percent in period zero to ten percent in period one. The effects peak in period four and decrease afterward. The visible kink suggests the absence of a linear trend as a confounding factor (Rambachan and Roth, 2023). Decreasing effects after over four years are consistent with the three-year treatment intervals of the CHE ranking (see Table 3.A.6) and indicate that standard TWFE suffers from bias arising from negative weights when including already treated programs in the control group several years after their initial treatment.

Table 3.1 presents the corresponding average effects of a green rating based on student satisfaction (Panels A and C), based on teacher recommendations (Panel B) and using a TWFE model (Panels A and B) and the DID_ℓ estimator (Panel C). Panel A, column one, indicates that a green rating in the CHE ranking increases the average distance traveled by students by 7.7 percent in a model without additional control

variables.[5] Column two shows that, as suggested by the event study in Appendix Figure 3.A.1, this effect is robust to including linear university-level trends.

Table 3.1: Average Effect of a Green Rating on Freshmen Mobility.

Dependent variable: ln(distance)	(1)	(2)	(3)	(4)
Panel A: TWFE - Student Satisfaction				
Green	0.077***	0.068***	0.078***	0.078***
	(0.016)	(0.014)	(0.012)	(0.012)
Rent (EUR/sqm)				-0.141*
				(0.084)
Panel B: TWFE - Teacher Recommendation				
Green	0.041	0.044	0.061	0.053
	(0.040)	(0.033)	(0.051)	(0.051)
Rent (EUR/sqm)				-0.141*
				(0.084)
Sample	[1995-2018]		[2007-2018]	
No. students	3,451,581	3,451,581	1,996,454	1,996,454
No. programs	52,290	52,228	26,483	26,483
Program and Time FE	yes	yes	yes	yes
University level trends	no	yes	no	no
Controls	no	no	yes	yes
Panel C: DID_ℓ - Student Satisfaction				
Green	0.133***		0.091**	0.094***
	(0.051)		(0.036)	(0.036)
Sample	[1995-2018]		[2007-2018]	
No. students	3,114,858		1,827,684	1,827,684
No. programs	44,985		23,861	23,861
Program and Time FE	yes		yes	yes
University level trends	no		no	no
Controls	no		yes	yes

Notes: This table presents program-level estimates of the average effect of a green rating on the log average distance traveled of freshmen, covering enrolment years 1995–2018. Cells weighted by number of freshmen. Standard errors in parentheses allow for clustering at the university level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: German Federal Statistical Office, *Centre for Higher Education (CHE)*, RWI-GEO-RED-V6.

Columns three and four repeat the analysis for the years 2007 to 2018. Column four additionally controls for the local rent level at a program university. Rent level information is available for years since 2007. Effects in columns 3 and 4 are identical and very similar to the effect presented in column one, signaling that the local rent level is indeed orthogonal to university quality as measured by the CHE ranking, which alleviates concerns about inequality. However, a one EUR rent increase per square meter on average decreases the average distance traveled by freshmen by around 14 percent. This large effect reflects that housing and moving costs are among the largest cost factors for German university students and is in line with Goehausen and Thomsen (2024) who find rental price booms in Germany reduced enrollment, particularly among freshmen students moving long distances.

[5]Table 3.A.1 shows that freshmen travel around 92 kilometers between their home region and the university of first-time enrollment.

Panel C shows that results based on the DID_ℓ estimator tend to be significantly larger than the traditional TWFE results. This is especially true when considering the time horizon from 1995 to 2018, with an average effect of over 13 percent. One interpretation is that the bias arising from the heterogeneous treatment effect increases when using programs already treated for a very long time in the control group. Even though, on average, programs get re-ranked every fourth year, some programs keep their green rating. As these programs are presumably of very high quality, the average distance students travel is particularly high, making them an especially problematic control group. Consequently, considering a small time horizon, the resulting difference across estimators is much smaller.

Robustness. As one manual way to circumvent such "forbidden comparisons" Borusyak et al. (2024), we perform a robustness check by focusing on the instantaneous effects of the treatment. For this, we manually restrict our sample to first-time switchers and repeat the analysis using TWFE but include treated programs only until they are ranked for a second time. Additionally, we apply the DID_M estimator for first-time switchers. Table 3.A.2 presents the estimates following the same structure as Table 3.1. Focusing on first-time switchers reveals a smaller and insignificant effect for the TWFE specification of around 2 percent. However, manually restricting comes at a large loss of power in combination with a smaller expected effect when considering the initially small effects in period zero in the TWFE event study.[6] DID_M estimates are equivalent to the period zero effects from the DID_ℓ event study (see also de Chaisemartin and D'Haultfoeuille, 2024) with an effect size of over 5 percent that is robust to linear trends, a different time frame, and the inclusion of rent level controls.[7]

3.3.2 Other outcomes

To further assess the impact of program rankings on students' university choices, we estimate the effects of a green rating on the number of students enrolling in a program. Unlike mobility measures, effects on the number of students within a program are limited by capacity constraints and don't allow conclusions about the student com-

[6] Estimates in columns three and four, Panels A and B, are substantially larger but have no straightforward interpretation as the second year of treatment is defined using the complete time frame. Future versions of this paper will use a more flexible definition of the second treatment year.

[7] Teacher recommendations in both approaches are positive but mostly insignificant and of lower magnitude than mobility effects based on student satisfaction rankings. Whether rankings based on student satisfaction or teacher recommendations are a better proxy for program quality remains an open debate. We aim to establish a more objective ranking of study programs based on administrative data to answer this question credibly (see Section 3.4).

position. For this reason, we additionally estimate the effects of green ratings on the share of women and students from low-income counties enrolling in top-tier programs.

Number of students. Table 3.2 presents effects of a green rating based on student satisfaction (Panel A) and a green rating based on teacher recommendations (Panel B) on the number of freshmen. In the TWFE model, a green rating increases the number of freshmen by around 4.5 percent.[8] This effect is robust to the inclusion of university-specific linear trends and somewhat lower (around 3 percent) for the years 2007 to 2018. It is robust to controlling for the local rent level in the university's county. Effects of a green rating in the teacher's rating have no significant effect, suggesting that average students react to student ratings. Assuming that high-ability students are more mobile, the positive effects on student mobility suggest that at least high-achieving students react to teacher ratings. Table 3.A.3 repeats the analysis for instantaneous effects (i.e., excluding programs after being ranked a second time). Effects follow the same pattern and are larger in the main specification.

Table 3.2: Average Effect of a Green Rating on Number of Freshmen.

Dependent variable: Share ln(freshmen)	(1)	(2)	(3)	(4)
Panel A: Student Satisfaction				
Green	0.045**	0.040**	0.032*	0.032*
	(0.019)	(0.017)	(0.017)	(0.017)
Rent (EUR/sqm)				-0.013
				(0.017)
Panel B: Teachers Recommendation				
Green	0.041	0.028	-0.031	-0.032
	(0.044)	(0.038)	(0.046)	(0.046)
Rent (EUR/sqm)				-0.013
				(0.017)
No. programs	55,769	55,640	27,803	27,803
No. students	3,733,636	3,733,635	2,134,560	2,134,560

Notes: This table presents program-level estimates of the average effect of a green rating on the number of freshmen, covering enrolment years 1995–2018. Cells weighted by number of freshmen. Standard errors in parentheses allow for clustering at the university level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: German Federal Statistical Office, *Centre for Higher Education (CHE)*, RWI-GEO-RED-V6.

Demographic composition. Given the increased number of students and increased average mobility of students following a positive ranking, how does being ranked in the top tier affect a program's share of female students and students from low-income counties? Table 3.3 shows that a green rating in the CHE ranking tends to decrease the share of women in the program over time by up to around 0.5 percentage points. This aligns with, e.g., Buser et al. (2014) and Saygin (2016), who find that gender differences in competitiveness and risk-taking can explain differential career choices,

[8]Table 3.A.1 shows that the average number of freshmen per program is about 68 students.

e.g., concerning applications at prestigious colleges with a more selective admission process.[9]

Table 3.3: Average Effect of a Green Rating on Female Share.

Dependent variable: Share Female	(1)	(2)	(3)	(4)
Panel A: Student Satisfaction				
Green	-0.258	-0.392	-0.479*	-0.479*
	(0.230)	(0.249)	(0.246)	(0.246)
Rent (EUR/sqm)				-0.058
				(0.195)
Panel B: Teachers Recommendation				
Green	0.810	0.405	-0.135	-0.138
	(0.515)	(0.548)	(0.574)	(0.575)
Rent (EUR/sqm)				-0.059
				(0.195)
No. programs	55,769	55,640	27,803	27,803
No. students	3,733,636	3,733,635	2,134,560	2,134,560

Notes: This table presents program-level estimates of the average effect of a green rating on the share of female freshmen, covering enrolment years 1995–2018. Cells weighted by number of freshmen. Standard errors in parentheses allow for clustering at the university level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: German Federal Statistical Office, *Centre for Higher Education (CHE)*, RWI-GEO-RED-V6.

Table 3.4 presents the estimates on the effect of a green rating on the share of freshmen from low-income counties. As university quality, as measured by the student satisfaction score, is orthogonal to the local rent level, no clear prediction arises from potential credit constraints. When interpreting high school graduation in a below-median GDP p.c. county as a broad proxy for student SES, results could indicate SES differences in the effect of rankings on mobility. However, while Table 3.A.5 suggests positive effects, the average results are inconclusive. An increase in the local rent level by one EUR per square meter reduces the share of freshmen from low-income counties by around 12 percentage points. This effect is large and again in line with Goehausen and Thomsen (2024).

Inequality. We motivate this study with a possible equity-efficiency tradeoff in education. However, our county-level measure of GDP p.c. is only a broad proxy of students' socioeconomic status. Survey data from the DZHW Panel Study of School Leavers with a Higher Education Entrance Qualification reveals that about 32.8 percent of high school graduates (N=23,676) consulted university rankings to choose the right college and that 33.9 percent of these students (N=7,762) found these rankings particularly useful. However, Table 3.5 shows that particularly students with at least one college-educated parent (high SES) use rankings and find them useful. Potential first-generation students rely significantly less often on university rankings and thus

[9]Instantaneous effects in Table 3.A.4 are inconclusive.

Table 3.4: Average Effect of a Green Rating on Share from Low-income Counties.

Dependent variable: Share Low-income	(1)	(2)	(3)	(4)
Panel A: Student Satisfaction				
Green	-0.101	0.222	0.054	0.044
	(0.312)	(0.198)	(0.284)	(0.225)
Rent (EUR/sqm)				-12.125***
				(0.826)
Panel B: Teachers Recommendation				
Green	0.748	0.147	0.927	0.154
	(0.571)	(0.487)	(0.591)	(0.526)
Rent (EUR/sqm)				-12.124***
				(0.826)
No. programs	55,769	55,640	27,803	27,803
No. students	3,733,636	3,733,635	2,134,560	2,134,560

Notes: This table presents program-level estimates of the average effect of a green rating on the share of freshmen from a below-median GDP p.c. county, covering enrolment years 1995–2018. Cells weighted by number of freshmen. Standard errors in parentheses allow for clustering at the university level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: German Federal Statistical Office, *Centre for Higher Education (CHE)*, RWI-GEO-RED-V6.

might miss out on the information provided in university rankings and sort into less prestigious colleges. These findings suggest that rating can improve the matching of especially high SES graduates. Future versions of this paper will clarify whether this still holds conditional on GPA.

Table 3.5: Information Sources across SES.

	Low SES			High SES			
	N	Mean	SD	N	Mean	SD	Diff.
Rankings used	10,445	0.287	0.452	12,284	0.365	0.482	-0.078***
Rankings helpful	2,996	0.290	0.454	4,486	0.378	0.485	-0.088***

Notes: This table presents individual-level on the usage of information sources of high school graduates. Students are classified as high SES when they have at least one parent with a college degree. Stars signal significance of group-differences: * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: DZHW Panel Study of School Leavers with a Higher Education Entrance Qualification 2008, second wave.

3.4 Discussion

This section discusses to what extent our current analysis contributes to the question of how university rankings can improve the matching process of university students. To improve matching, three conditions must be fulfilled: 1) Students react to rankings, 2) rankings measure true quality differences, and thus, 3) students benefit from selecting a higher-ranked program. So far, our paper has focused on the first point. This section

discusses steps for further analyses required to make claims about the other aspects of the matching process and further steps to extend the scope of the paper.

Students react to rankings. So far, this study shows that students do react to university ratings. A positive rating increases the number of students in a program and the average mobility of students. As students with better GPAs are typically more mobile, and high school graduates with college-educated parents are particularly receptive to the rankings, these findings suggest that rankings can improve matching and increase inequality. However, we aim to study a range of other relevant outcomes. First, we are interested in whether ratings affect not only university or program choice but also a major choice. We motivated the paper with the example of a highly talented student who prefers a certain major, is relatively immobile, and thus just chooses the next best university. However, students could be relatively mobile but have only unspecific preferences for a certain field of study. For example, some students might be undecided about math, physics, and engineering within STEM. Here, two effects are imaginable: First, a short-term effect, when, e.g., in their graduation, only one of the three majors is covered in the rating, making that particular major more attractive by reducing uncertainty in the university choice. Second, a more aggregate effect, where certain majors get, on average, higher grades and have less variance in their ratings across universities, making them relatively attractive.

Second, one large simplification this study has made so far is only looking at one specific institutional type: Traditional Universities. However, Universities of Applied Sciences (UAS) are becoming increasingly more relevant, with about 37.5 percent of higher education students enrolled in vocationally oriented colleges in winter term 2022/23 (Destatis, 2023). Consequently, the CHE lists UAS separately within a given major, and tier ratings are based on the UAS-specific quality distribution. Student satisfaction within UAS, as measured by the CHE, seems relatively high, potentially encouraging students to study at UAS instead of traditional universities. As the German student register covers all higher education institutions, we can quantify how college rankings contributed to the growing number of students in more vocationally oriented colleges.

Measuring true quality differences. To clarify whether rankings based on student satisfaction as the CHE ranking capture true quality differences, we aim to establish an alternative ranking based on data from the German student register. Top programs should attract national top-rank/GPA students, i.e., the *big fish* (Elsner and Isphording, 2017; Denning et al., 2023) and simultaneously be able to keep their top-ranked students, attract international students, and have a low distance-sensitivity. So

far, we have used faculty recommendations and interpreted them as more informative. However, further analyses must show how and in which cases both measures correlated well.

Measuring mismatch. To measure the amount of "lost potential" requires measuring mismatch, especially at the top of the distribution. Here, we are interested in how rankings affect not only study outcomes but also labor market outcomes. The German student and exams register only allows the study of student outcomes. We will use graduation rates and average grades of affected cohorts as outcomes and the degree of the university switching (as a measure of vertical-) mismatch. Another potential outcome is transfers to highly-ranked master's programs. Unfortunately, the student register does not cover the major of students' first enrollment, making it infeasible to study major-switching as a measure for horizontal mismatch.

However, when measuring the effects of mismatch, the treatment of interest is less clear than the potential outcomes. If green ratings attract more mobile and potentially more able students, then program outcomes should improve. If and to which extent this is the case, has to be estimated. If we consider the matching as an assortative process, we should also show that, e.g., yellow and red ratings attract fewer mobile students or students from the middle and lower end of the ability distribution. Overall efficiency, in the end, is a question of aggregate outcomes, looking beyond single programs. One could, e.g., measure if students who enroll when their rating is outdated (e.g., more than two years old) make *wrong* decisions more often, in a sense that they later switch universities or drop out more often. Another relevant margin is the introduction effect of rankings rather than its repeated updating. Here, we can use the staggered introduction to estimate the effects of this on graduation rates within a field of study. Lastly, this paper aims to estimate the effects on students' labor market outcomes, e.g., by using survey data from the DZHW Graduate Panel.

3.5 Conclusion

This study sheds light on the role of public information provision regarding the quality distribution of universities within fields of study in students' college choices. Using dynamic difference-in-differences approaches and combining ranking data with administrative university records, we find significant effects of quality signals on student mobility and enrollment decisions. Being ranked in the top tier increases the number of students and their average distance traveled within a program. The effects are more pronounced for ratings based on student satisfaction

We contribute to the literature on university rankings and student-college matching. By providing causal evidence of the impact of quality signals on actual enrollment and mobility patterns, we extend prior research that has primarily focused on university applications or hypothetical choices. Moreover, our study adds to the understanding of factors influencing student-college matching by highlighting the importance of public information on university quality in potentially improving students' decisions.

Our study underscores the importance of information provision in ensuring efficient and equitable student-university matching processes and providing transparent and accessible information about university quality differences, particularly within specific fields of study, to facilitate informed decision-making among prospective college students. Addressing the informational asymmetry in college choice can potentially contribute to reducing educational inequality and improving the efficiency of the matching process.

Moving forward, this study will further investigate the mechanisms underlying the effects of quality signals on student mobility and enrollment decisions. Additionally, examining the long-term impacts of quality information provision on academic and labor market outcomes will allow us to make clearer statements on matching efficiency.

3.A Appendix

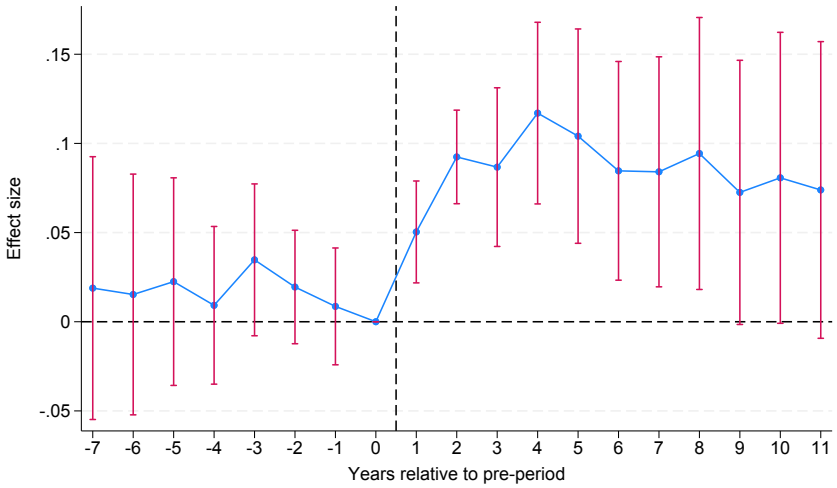
3.A.1 Additional Tables and Figures

Table 3.A.1: Summary Statistics

	N	Mean	SD	Min	Max
Program-level (1995-2013):					
Number of Students	38,277	67.87	83.98	3	n/a
Share from low-income county	38,277	35.21	19.99	0	100
Share Female	38,277	60.27	25.53	0	100
Distance Traveled (km)	38,277	91.78	51.32	n/a	n/a
County-level (2007-2018):					
Average Rent (EUR/sqm)	4,812	6.31	1.82	2.43	15.17

Notes: This table presents program and county characteristics summary statistics. Program-level descriptives represent unweighted averages. They only include programs with at least three students for data protection reasons and exclude selected minimum and maximum values. *Source*: German Federal Statistical Office, RWI-GEO-RED-V6.

Figure 3.A.1: Event-Study Effects of a Green Rating on Student Mobility (DID_ℓ).



Notes: This figure shows program-level estimates on the heterogeneity-robust average effect of a green rating in the student satisfaction-based CHE-Ranking on average freshmen mobility, covering years 1995 – 2018. Estimates based on DID_ℓ estimator (de Chaisemartin and D'Haultfoeuille, 2024). *Source*: German Student Register, *Centre for Higher Education (CHE)*.

Table 3.A.2: Instantaneous Effect of a Green Rating on Freshmen Mobility.

Dependent variable: ln(distance)	(1)	(2)	(3)	(4)
Panel A: TWFE - Student Satisfaction				
Green	0.024	0.022	0.140***	0.150***
	(0.034)	(0.032)	(0.028)	(0.030)
Rent (EUR/sqm)				-0.176**
				(0.069)
Panel B: TWFE - Teachers Recommendation				
Green	0.037	0.050**	0.170***	0.166**
	(0.029)	(0.025)	(0.061)	(0.066)
Rent (EUR/sqm)				-0.175**
				(0.069)
Sample	[1995-2018]		[2007-2018]	
No. students	1,872,023	1,872,023	674,477	674,477
No. programs	40,327	40,282	16,482	16,482
Program and Time FE	yes	yes	yes	yes
University level trends	no	yes	no	no
Controls	no	no	yes	yes
Panel C: DID_M - Student Satisfaction				
Green	0.054***	0.051***	0.058***	0.062***
	(0.011)	(0.013)	(0.016)	(0.014)
Sample	[1995-2018]		[2007-2018]	
No. students	2,541,367	2,971,705	1,825,109	1,825,109
No. programs	38,087	41,742	23,456	23,456
Program and Time FE	yes	yes	yes	yes
University level trends	no	yes	no	no
Controls	no	no	yes	yes

Notes: This table presents program-level estimates of the instantaneous effect of a green rating on the log average distance traveled of freshmen, covering enrolment years 1995–2018. Cells weighted by number of freshmen. Standard errors in parentheses allow for clustering at the university level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: German Federal Statistical Office, *Centre for Higher Education (CHE)*, RWI-GEO-RED-V6.

Table 3.A.3: Instantaneous Effect of a Green Rating on Number of Freshmen.

Dependent variable: ln(freshmen)	(1)	(2)	(3)	(4)
Panel A: Student Satisfaction				
Green	0.126***	0.066*	0.023	0.024
	(0.032)	(0.037)	(0.054)	(0.054)
Rent (EUR/sqm)				-0.023
				(0.017)
Panel B: Teachers Recommendation				
Green	0.023	-0.017	0.058	0.057
	(0.042)	(0.040)	(0.065)	(0.065)
Rent (EUR/sqm)				-0.023
				(0.017)
No. programs	43,806	43,694	17,802	17,802
No. students	2,154,078	2,154,077	812,583	812,583

Notes: This table presents program-level estimates of the instantaneous effect of a green rating on the number of freshmen, covering enrolment years 1995–2018. Cells weighted by number of freshmen. Standard errors in parentheses allow for clustering at the university level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: German Federal Statistical Office, *Centre for Higher Education (CHE)*, RWI-GEO-RED-V6.

Table 3.A.4: Instantaneous Effect of a Green Rating on Female Share.

Dependent variable: Share Female	(1)	(2)	(3)	(4)
Panel A: Student Satisfaction				
Green	0.036	0.276	0.313	0.316
	(0.442)	(0.498)	(1.247)	(1.248)
Rent (EUR/sqm)				-0.082
				(0.276)
Panel B: Teachers Recommendation				
Green	0.319	0.673*	0.560	0.558
	(0.407)	(0.403)	(1.382)	(1.378)
Rent (EUR/sqm)				-0.081
				(0.276)
No. programs	43,806	43,694	17,802	17,802
No. students	2,154,078	2,154,077	812,583	812,583

Notes: This table presents program-level estimates of the instantaneous effect of a green rating on the share of female freshmen, covering enrolment years 1995–2018. Cells weighted by number of freshmen. Standard errors in parentheses allow for clustering at the university level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: German Federal Statistical Office, *Centre for Higher Education (CHE)*, RWI-GEO-RED-V6.

Table 3.A.5: Instantaneous Effect of a Green Rating on Share from Low-income Counties.

Dependent variable: Share low-income	(1)	(2)	(3)	(4)
Panel A: Student Satisfaction				
Green	1.131**	0.538	0.081	0.457
	(0.471)	(0.512)	(0.878)	(0.790)
Rent (EUR/sqm)				-11.201***
				(1.001)
Panel B: Teachers Recommendation				
Green	-0.178	0.340	1.278	0.967
	(0.526)	(0.420)	(1.064)	(0.746)
Rent (EUR/sqm)				-11.199***
				(1.000)
No. programs	43,806	43,694	17,802	17,802
No. students	2,154,078	2,154,077	812,583	812,583

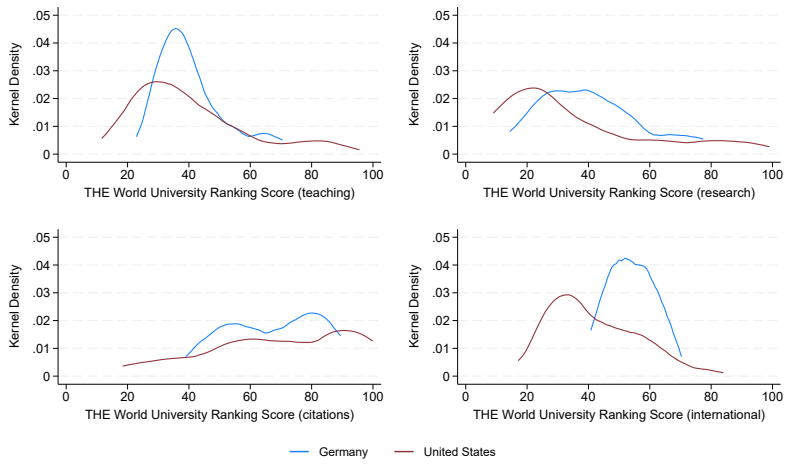
Notes: This table presents program-level estimates of the instantaneous effect of a green rating on the share of freshmen from a below-median GDP p.c. county, covering enrolment years 1995–2018. Cells weighted by number of freshmen. Standard errors in parentheses allow for clustering at the university level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. *Source*: German Federal Statistical Office, *Centre for Higher Education (CHE)*, RWI-GEO-RED-V6.

3.A.2 International Ranking Data

For the international university comparison, we rely on the 2016/17 *Times Higher Education World University Ranking* (THE) as it combines a relatively good coverage of Germany and the U.S. with a comparably low level of indicator skewness, allowing us to compare the score variance across countries (Moed, 2017). The ranking includes universities that teach undergraduates and have a research output of more than 150 articles annually and of at least 1,000 articles between 2011 and 2015. Universities can be excluded if more than 80 percent of their activity is in a single field of study (Times Higher Education, 2016). All German universities covered have at least 10,000 students.

The average THE score is a weighted average of the scores in the categories *teaching* (weight=0.295), *Research* (weight=0.290), *Citations* (weight=0.300), *Industry income* (weight=0.040), and *International outlook* (weight=0.075). In Figure 3.1, we exclude the factor *industry income* because of a relatively high share of missing data and weight the resulting score by the inverse of 0.96. Figure 3.A.2 shows that the general pattern of higher stratification in the U.S. holds across all subcategories of the average ranking score.

Figure 3.A.2: Times Higher Education World University Ranking across Categories.



Notes: University quality indicated by ranking scores across universities in Germany (N=39) and the United States (N=161). Scores separately in categories of teaching, research, citations, and internationality. *Source*: Times Higher Education Ranking, 2016.

International university rankings are the subject of a range of criticism, e.g. for their lack of objectivity and possible distortion of quality differences across countries (for an overview see, e.g., Johnes, 2018). Even though many country-specific factors, such as

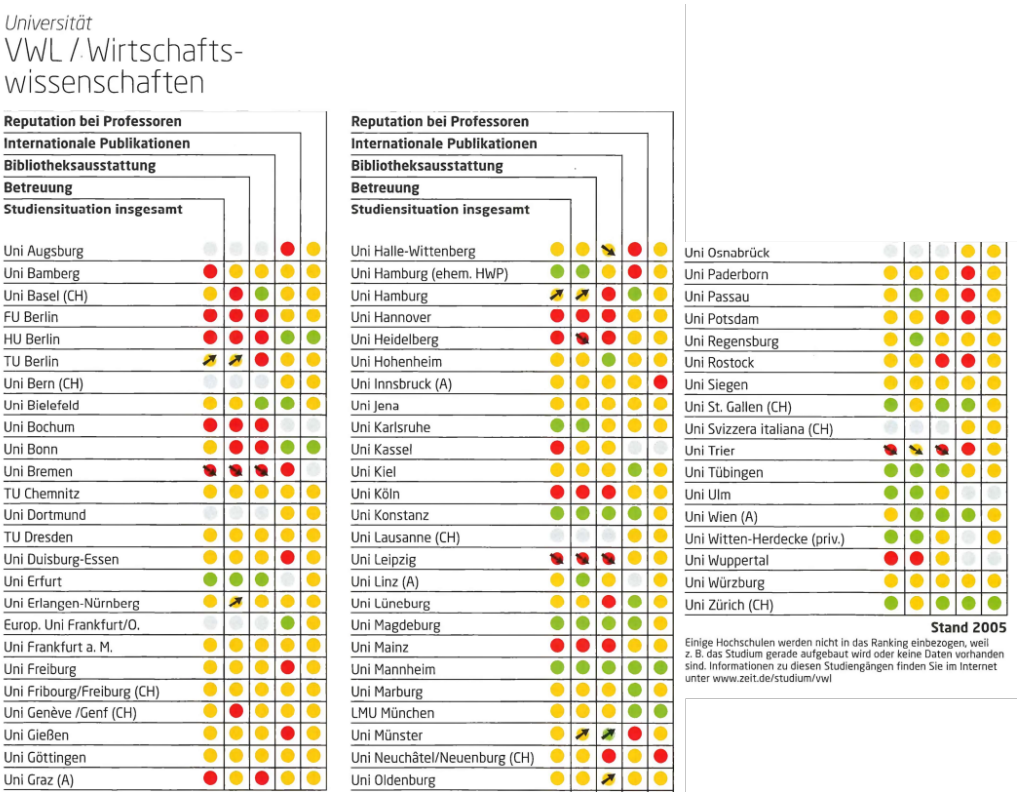
economic potential, affect a university's position in international rankings Pietrucha (2018), our goal is not to highlight differences in average university quality but the distribution of university quality within a country. Even though the THE Ranking is effectively truncated from below, "lost potential" might occur, especially at the top of the distribution.

3.A.3 CHE Ranking

Figure 3.A.3: *ZEIT Studienführer* Cover (Print Example 2023/24).

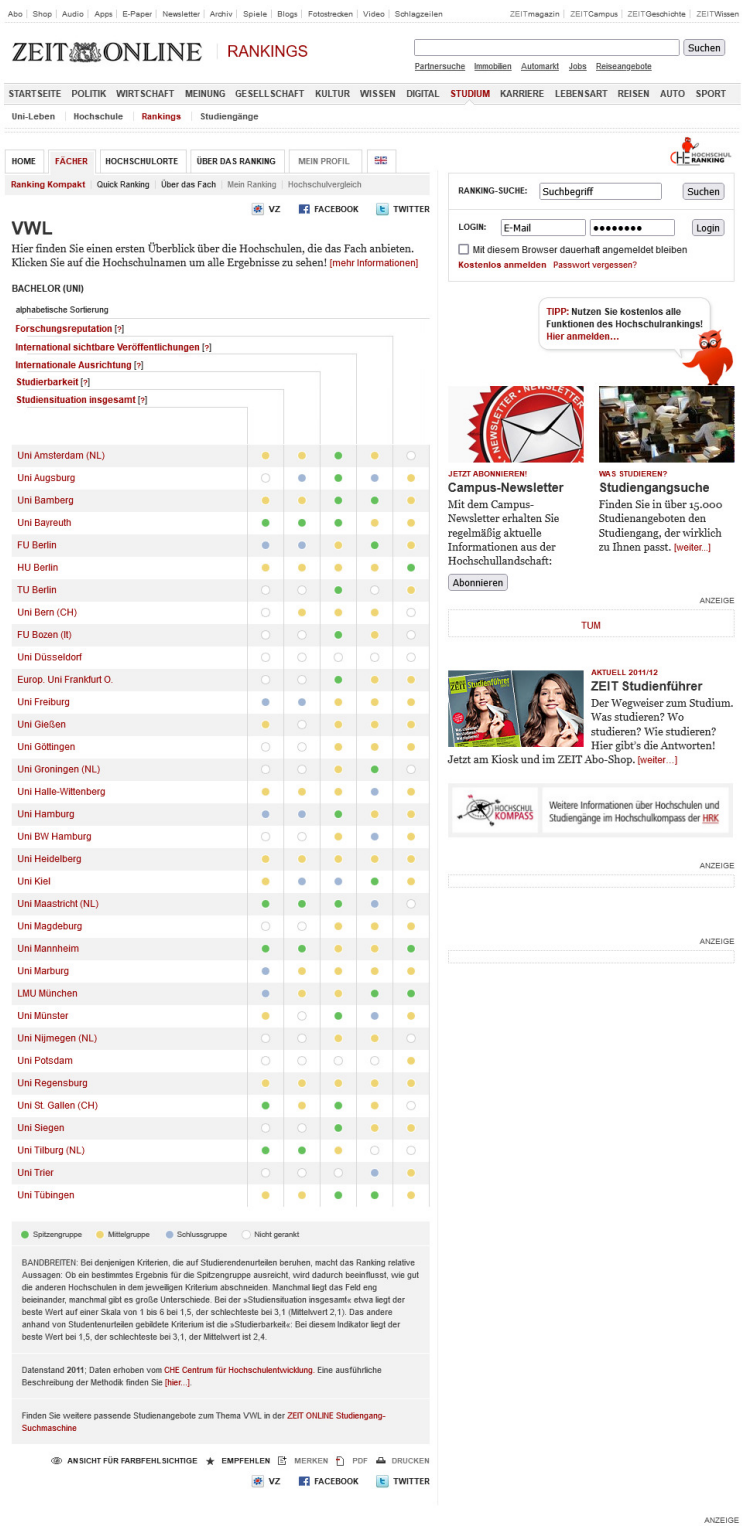
Notes: *ZEIT Studienführer*, including the CHE Ranking. *Source*: *ZEIT Studienführer* 2023/24.

Figure 3.A.4: CHE Ranking (Economics, Print Example 2007/08).



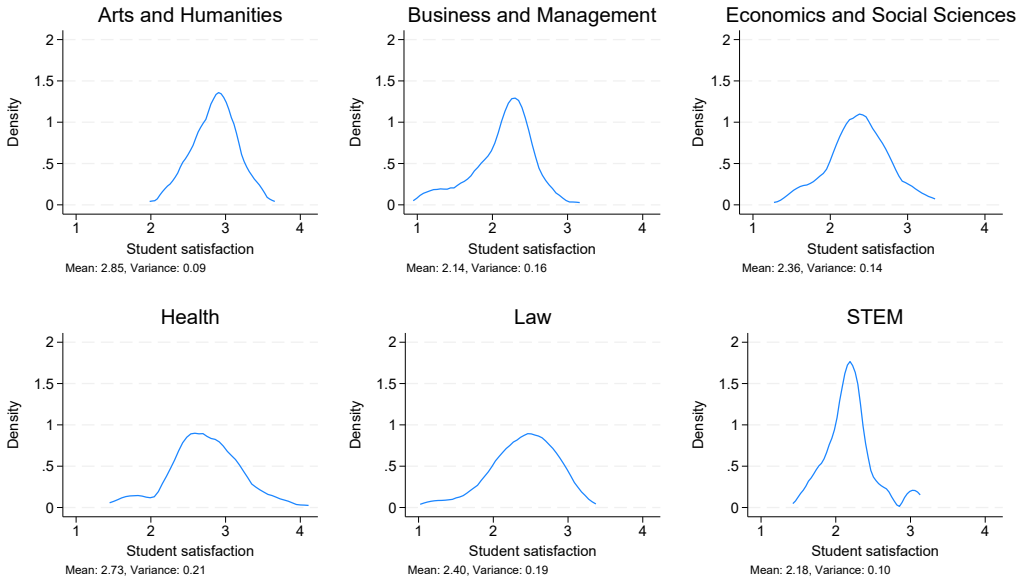
Notes: CHE Ranking for Economics programs at universities as presented in the print edition of the *ZEIT Studienführer*. Categories: overall student satisfaction ("Studiensituation insgesamt"), student-to-teacher ratio ("Betreuung"), library equipment ("Bibliotheksausstattung"), international publications ("Internationale Publikationen"), faculty recommendation ("Reputation bei Professoren"). Ranking then last updated in 2005. *Source*: *ZEIT Studienführer* 2007/08.

Figure 3.A.5: *Zeit Studienführer*: CHE Ranking (Online Example 2011/12).



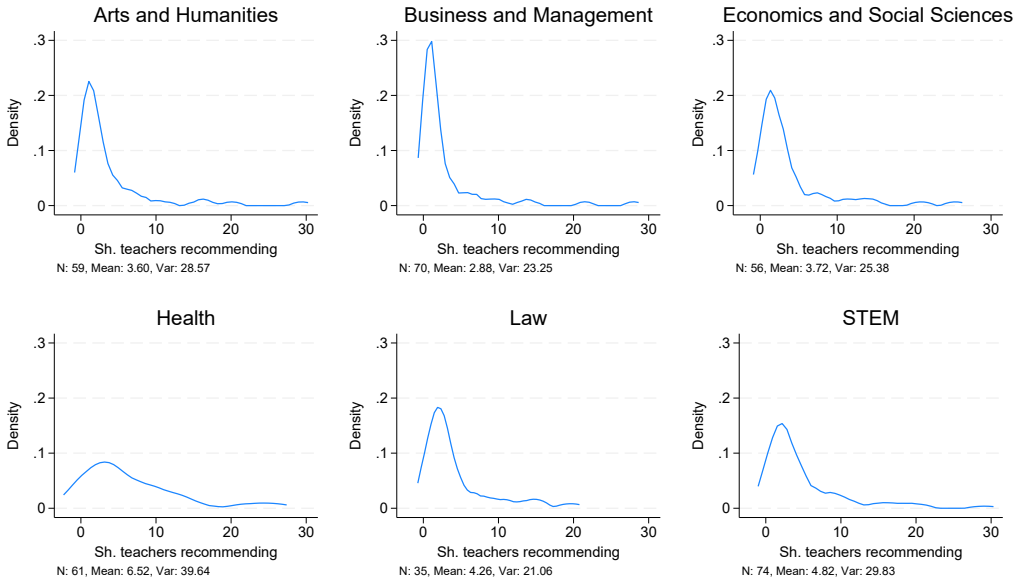
Notes: CHE Ranking for Economics programs at universities as presented in the online edition of the *ZEIT Studienführer*. Categories: overall student satisfaction ("Studiensituation insgesamt"), degrees within nominal study duration ("Studierbarkeit"), internationality ("Internationale Ausrichtung"), international publications ("International sichtbare Veröffentlichungen"), scientific reputation ("Forschungsreputation"). Ranking then last updated in 2011. *Source*: *www.zeit.de* 2007/08.

Figure 3.A.6: Average University Ranking Across Fields (Students).



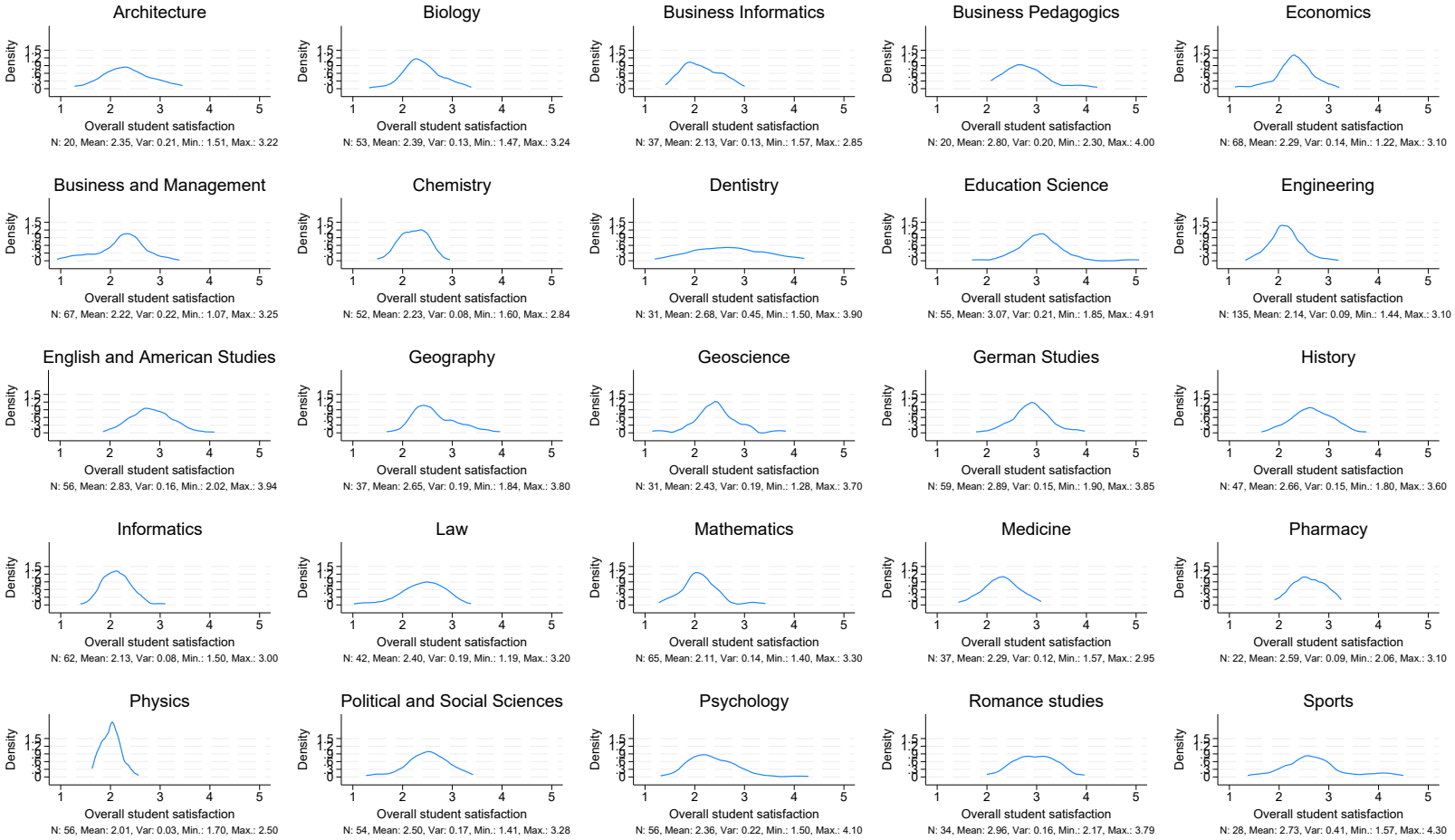
Notes: Distribution (univariate kernel density estimation) of university average continuous student satisfaction (here, 1=best, 5=worst) over different majors and years across different fields of study. *Source:* Centre for Higher Education (CHE), 1998–2020.

Figure 3.A.7: Average University Ranking Across Fields (Faculty).



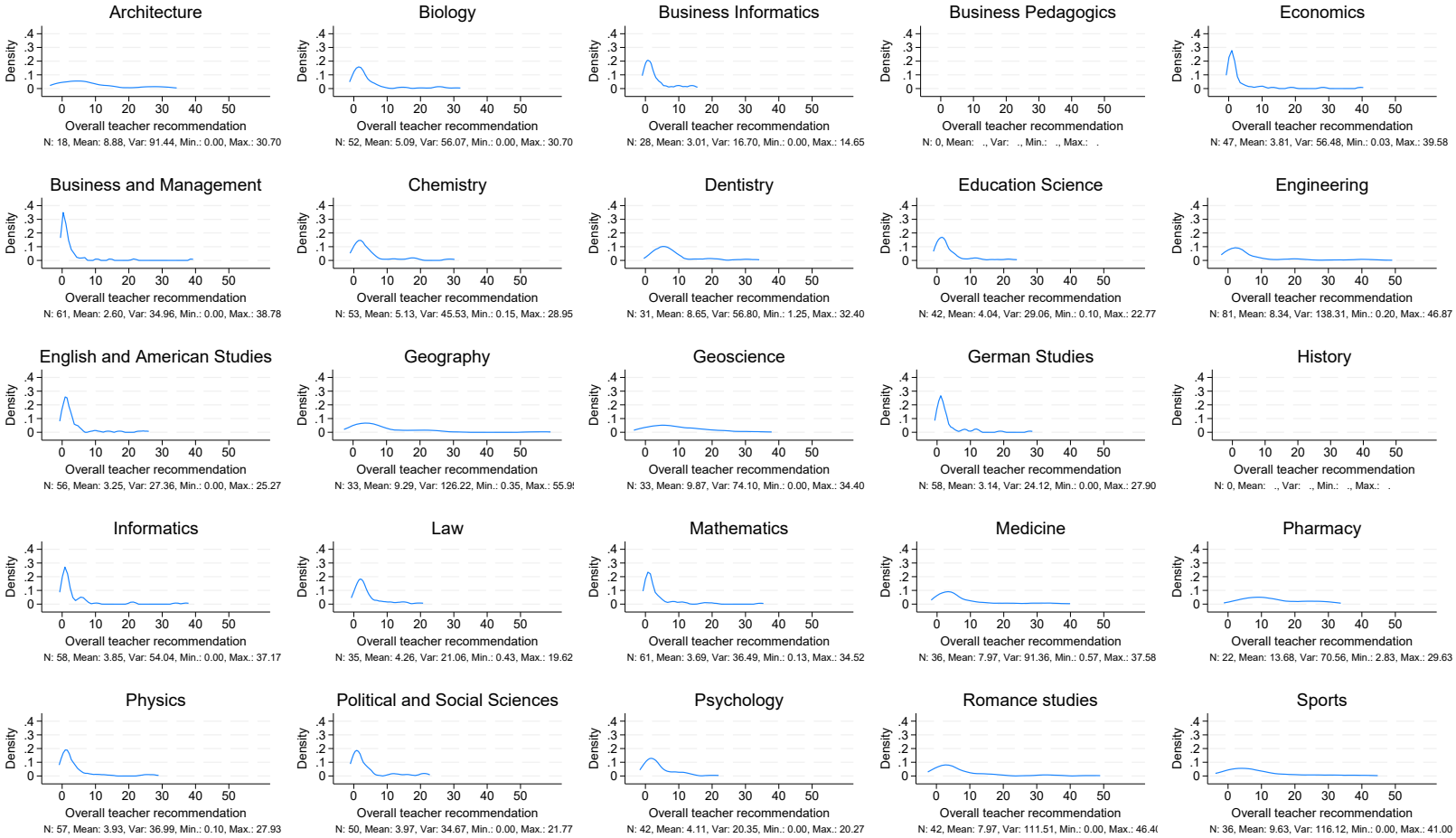
Notes: Distribution (univariate kernel density estimation) of university average teacher recommendation share over different years across fields of study. *Source:* Centre for Higher Education (CHE), 1998–2020.

Figure 3.A.8: Average University Ranking Across Majors (Students).



Notes: Distribution (univariate kernel density estimation) of university average continuous student satisfaction (here, 1=best, 5=worst) over different majors and years across majors. *Source:* Centre for Higher Education (CHE), 1998–2020.

Figure 3.A.9: Average University Ranking Across Majors (Faculty).



Notes: Distribution (univariate kernel density estimation) of university average teacher recommendation share over different years across majors.

Source: Centre for Higher Education (CHE), 1998–2020.

Table 3.A.6: Number of universities covered in CHE ranking by field of study and publication year.

Field of study:	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20
Political and Social Sciences					41			47			48			39				26			36		
Business and Management	59				69			39			40			32			35			33			35
Law		33			40			34			35			29			28			30			30
Business Informatics					16			25			24			14			17			23			26
Business and Economics								23			24			23			19			21			25
Business Engineering					12			23			22			19			24			20			20
Economics	30				30			20			21			15			17			13			10
Mathematics		49				51			57			53			42			40			33		
Physics		51				47			54			52			43						43		
Informatics		39				43			53			54			45			46			48		
Chemistry	66					61			50			49			40				27		35		
Biology						46			46			50			43				32		38		
Medicine						35			36			37			28			23			23		
Geography									35			31			23			20			21		
Dentistry						27			27			30			19			12			10		
Geoscience									22			27			21			13			15		
Pharmacy						21			22			21			20			18			17		
Sports												19			14			13			18		
German Studies				46			58			48			42			21			16			15	
English and American Studies				37			54			45			39			16			8			12	
Psychology				36			43			41			42			37			30			46	
Education Science				32			50			37			34			13			11			13	
Electrical Engineering and Information Technology			29				25			29			29			24			19			23	
Mechanical, Material, and Process Engineering			29				26			28			30			32			27			30	
Romance studies										24			27			9			10			6	
Civil and Environmental Engineering			26				17			17			19			17			7			19	
Architecture			18				15			17			17			14			14			17	

Notes: Number of universities with data on general student satisfaction across years and fields of study, published by "Stiftung Warentest" in 1998, "Stern" 1999–2004, and "Die Zeit" 2005–today.
Source: Centre for Higher Education (CHE), 1998–2020.

CHAPTER 4

Tuition Fees and Educational Attainment*

For copyright reasons, this chapter is not included in the online version of this dissertation. It is published as: *Bietenbeck, J., Leibing, A., Marcus, J., & Weinhardt, F. (2023). Tuition fees and educational attainment. European Economic Review, 154, 104431.*

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*This chapter is joint work with Jan Bietenbeck (Lund University), Jan Marcus (Freie Universität Berlin), and Felix Weinhardt (European University Viadrina Frankfurt (Oder)).

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Conclusion

This dissertation studies the dynamics of postsecondary human capital investments, with a particular focus on expectations. The transformation of the German higher education system, coupled with a well-established apprenticeship system as its outside option, makes it an ideal case to study the inherent trade-off between vocational and academic education and their respective costs and returns. To close, I repeat each chapter's main findings and discuss their limitations and how they can inform policymakers.

Chapter 1 shows that, already at high school graduation, women expect lower wages than men. Detailed data from the Berliner-Studienberechtigten-Panel (Best Up) and decomposition methods show that implicitly expected family commitments of women can account for large parts of these gaps. Women with a preference for time for family commitments have lower expected earnings than women without this preference. Men, however, don't expect to have to trade between career and family. This expected trade-off is most striking at the highest parts of the expectations distribution, suggesting that women expect to give up leadership positions to have time for their families. We further show that, for women, lower wage expectations are associated with lower college enrollment, which could be one channel of how expectations can entrench later inequalities in earnings.

In light of our findings, a natural question is to what extent the expected earnings gap and its underlying mechanisms reflect rational expectations. While the study discusses how the expected earnings gap and family penalties compare to contemporaneous gender gaps in earnings and related child penalties, it does not yet allow us to analyze whether and how gender gaps in wage expectations translated to actual gender gaps in realized earnings for our survey respondents. In the same sense, our analysis of how the expected returns to college affect later college enrollment is purely correlational. Still, the finding of a positive correlation, at least for women, aligns with economic theory. Another general shortcoming of descriptive decomposition methods, especially in small samples, is their sensitivity to including different covariates. In our case, however, the

important role of time for family commitments is robust and applies to different measures of wage expectations. Lastly, if the data allowed, another addition to the study could be the importance of role models. Information on, e.g., the labor supply and gender norms of mothers could have helped us to analyze how such factors carry over to daughters' labor market expectations.

Under certain assumptions on the abovementioned limitations, our findings help to judge two kinds of policies. First, policies that help to reconcile career and family for women can help to close gender gaps in wage expectations and associated outcomes if young individuals update their beliefs accordingly. Labor market policies might thus have unintended effects on wage expectations if these are based on rational expectations and/or affect mothers' labor supply. Second, information policies that highlight the respective strategies of how career and family can be reconciled might thus help to improve women's wage expectations within their career preferences or even change these preferences. However, policies that directly aim at wage expectations run the risk of either discouraging women or making unrealistic promises. Again, much depends on how far wage expectations reflect rational expectations.

In combination with other Best Up studies (see, e.g., Peter and Zambre, 2017; Peter et al., 2021, 2023, on the effect of information on enrollment intentions, actual enrollment, and field of study choice, respectively), **Chapter 1** thus makes a compelling case for the possibilities offered by information policies in reducing educational and labor market inequalities.

Chapter 2 shows that economic shocks at high school graduation reduce overall first-time enrollment and cause a shift towards more applied human capital investments. Instead of enrolling at traditional universities focusing on general skills, more graduates enroll at vocationally oriented colleges or start apprenticeships. Enrollment effects translate to changes in educational attainment, and high school graduates displace graduates with lower school-leaving degrees from apprenticeships. Recession-induced changes in the expected returns to college can only partly explain these shifts for low-achieving men, and conditional on economic preferences, which moderate the effect, the effects are reversed for high SES graduates. The findings suggest that investment in firm-specific human capital is used as an insurance mechanism against economic downturns and contrast conventional wisdom on the cyclicality of college-going.

This chapter's main limitation is that it finds no definitive explanation yet for why German students react the way they do. While the model offers two main explanations, credit constraints, and expectation changes, only the latter can explain observed shifts from general to applied human capital for a subpopulation. Hence, another mecha-

nism to shed light on is the role of expected non-monetary returns, such as parental approval (Boneva and Rauh, 2020). As well-known routines gain higher weight under (perceived) scarcity (Mullainathan and Shafir, 2013), recessions might contribute to the persistence of socioeconomic status. This mechanism would broadly align with the current hypothesis of applied human capital as an insurance mechanism during recessions. It is also compatible with reverse enrollment patterns in Anglo-Saxon countries, where vocational education typically has a lower standing (Chankseliani et al., 2016). A related open question is the role of firms and how apprenticeship supply changes over the business cycle (Acemoglu and Pischke, 1998).

A limitation relevant to policy implications is the question of welfare implications. Fundamentally, do economic shocks distort optimal human capital investment, or do marginal students fare better when not studying? Also, what do displaced apprentices with lower school-leaving degrees do? Do they invest in further education, or are there scarring effects? Independent of these questions, **Chapter 2** informs policymakers who want to adopt the dual education system. A business cycle-proof outside option for college enrollment, such as apprenticeships, has the potential to change educational investments over the business cycle fundamentally. Further, as risk and time preferences are important moderators in the effect of economic shocks, this study highlights the importance of reducing complexity and uncertainty in the application process for study programs and financial aid (see Dynarski et al., 2021, for an overview).

Chapter 3 investigates the effect of information provision on the within-field-of-study quality distribution of study programs via university rankings on student-to-degree matching patterns. It finds that being ranked in the top group of the ranking significantly increases the number of students and the average distance between their county of high school graduation and the eventual university of first-time enrollment. Mobility effects across different difference-in-differences estimators are large and more pronounced for ranking categories based on student satisfaction rather than recommendations by faculty. As the project is still at an early stage, its current limitations are fairly large.

This study must analyze whether students benefit from selecting a higher-ranked program to judge whether providing quality information increases the efficiency of the matching process. So far, the paper shows that students react to rankings and suggests heterogeneities across different rankings and students. We argue that increased mobility indicates that particularly high-achieving, well-informed graduates react to university rankings. However, it is unclear if and to what extent possible gains of improved matching for high-achieving students come at the cost of other students.

If less reactive students were previously overmatched, then at least the net gain of information provision (i.e., efficiency) should be positive. An inherent assumption is that rankings based on student satisfaction and teacher recommendations capture quality differences across programs. We plan to answer this question by establishing our own ranking based on postgraduate enrollment decisions. Lastly, we aim to analyze how information provision affects educational outcomes (e.g., university switching) and labor market outcomes to assess implications for efficiency.

Policy implications ultimately depend not only on efficiency effects but also on equality effects. So far, the public debate has focused primarily on the latter, which became apparent in the heated discussion on the distributional effects of tuition fees. However, the *Exzellenzinitiative* (that will also be incorporated in our analysis) has shown that there is scope for policies that aim at promoting and highlighting universities at the top of the distribution. So far, we hope that information provision on quality differences across universities has the potential to spark competition across universities. We hope to contribute further by clarifying how this competition can spark a (Pareto) improvement in matching efficiency.

Chapter 4 studies the effects of the introduction and abolition of tuition fees on educational attainment in Germany. Tuition fees substantially reduced enrollment at university but increased degree completion, depending on the total amount to be paid by incumbent students. The results suggest that this increase at the intensive margin is mainly due to a rise in study effort and potentially increased educational quality. Overall, the intensive and extensive margin effects roughly offset each other, resulting in a net-zero effect on educational attainment.

While our extensive margin results align with consensus estimates from the literature (Deming and Dynarski, 2010), intensive margin effects of the cost of higher education appear to be more context-dependent (Garibaldi et al., 2012; Barr, 2019; Denning, 2019; Murphy and Wyness, 2023). Hence, the external validity of our findings on degree completion at the zero price margin might be limited. Most importantly, however, our study lacks information on students' socioeconomic background, which we can only broadly proxy via GDP per capita in their home county. Hence, our understanding of the distributional effects of tuition fees in the German context is limited. Lastly, our study focuses on traditional universities. This raises the question of how tuition fees affect institutional choice and if the negative extensive margin effects are offset by positive enrollment effects at other colleges, such as universities of applied sciences. Depending on enrollment and completion effects at other institutions, there might still be a significant net effect on educational attainment.

Given the substantial individual and societal returns to education, who should pay for it? While upfront tuition fees have sparked protests in Germany, framing could make a difference: Most voters would support income-contingent tuition schemes, and fees framed as loan repayment in Germany (Lergetporer and Woessmann, 2022). Evidence from the U.K. suggests that deferred income-contingent fees can indeed improve enrollment for students from low-income families (Murphy et al., 2019). Additionally, information on earnings can shift public opinion in favor of fees (Lergetporer and Woessmann, 2023) and can positively affect enrollment itself (Peter and Zambre, 2017; Peter et al., 2021). Hence, adequately framed and coupled with information provision, tuition fees can be an effective means of improving the financing of universities and, at the same time, relieving the burden on the state budget.

In conclusion, this dissertation contributes to a better understanding of human capital investments and informs policymakers who want to improve the equity and efficiency of postsecondary education. The German context allows for the generation of empirical insights that can be applied to other countries under careful consideration of economic theory. In particular, the coexistence of German higher education and its dual education system can offer important insights into how labor markets can meet the rapid changes in skill demand. By synthesizing these findings, policymakers can implement strategies to foster more responsive and inclusive education.

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