ESSAYS ON POLICY EVALUATION WITH ENDOGENOUS ADOPTION

A Dissertation

Presented to

The Faculty of the Department

of Economics

University of Houston

In Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

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by

Elisabetta Gentile

December, 2011

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Abstract

Over the last decade, experimental and quasi-experimental methods have been favored by researchers in empirical economics, as they provide unbiased causal estimates. However, when implementing a program, it is often not possible to randomly assign subjects to treatment, leading to a possible endogeneity bias.

This dissertation consists of two empirical policy studies relying on large micro-level datasets to address issues of endogeneity of adoption. The first essay investigates the effect of intellectual property (IP) protection on arms-length licensing of foreign technology using a pooled cross-section of firms in 58 developing economies. While prior investigations have been mostly cross-country analyses relying on proxies for technology adoption, and with technology exporters as a target population, I analyze the determinants of foreign technology licensing for firms in developing countries, thus focusing on the implications of IP protection on economic development.

I use two different measures of IP protection: the Index of Patent Rights, based on the legal framework, and the Intellectual Property Protection index, emphasizing enforcement. I find that the relationship of IP protection and firm-level adoption of foreign technology is contingent on a country's development stage. Enacting stronger IP legislation has a positive effect only on the group of newly industrialized countries and transition economies, whereby a 1% increase in legal protection of intellectual property increases the probability

of licensing foreign technology by over 20%. When I focus on small and medium-sized firms, I find evidence that increased enforcement of existing IP rights has a negative impact on foreign technology licensing.

In the second essay, we use a unique dataset from a large urban school district in the southwest United States (LUSD-SW) to assess how uniforms affect student behavior and achievement, as well as other outcomes. While prior literature relies on cross-sectional OLS or first-difference evidence, we exploit the panel nature of our data. Since schools in LUSD are free to set their own uniform policies and most schools adopt uniforms during the time period for which we have data, we are able to produce causal estimates of uniform impacts on student outcomes through the use of school, student and principal fixed effects.

In contrast to most of the prior literature, we find that uniforms generate improvements in attendance in middle and high/school. We also find that uniforms significantly reduce teacher attrition in elementary schools. Nonetheless, uniforms have little impact otherwise. We find no statistically significant effect on disciplinary infractions, achievement, grade retention or student movements between schools.

Although we cannot completely rule out that other contemporaneous policy enactments generate the attendance and teacher attrition effects rather than uniforms, the robustness of our estimates to the inclusion of principal fixed effects, the finding that our estimates are similar when we account for adoption under new principals, and the lack of any increase in disciplinary infractions even in the short term suggest that the results are unlikely to be due to concurrent changes in enforcement policies.

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"Considerate la vostra semenza:
Fatti non foste a viver come bruti,
Ma per seguir virtute e canoscenza."

'Reflect upon the seed from which you spring:
You were not made to live the lives of brutes,
But rather to seek virtue and to learn.'

(Dante Alighieri, "La Divina Commedia", *Inferno Canto XXVI* 118-120; Trans. Thomas G. Bergin)

ESSAY 1

Intellectual Property Rights and Technology Adoption in Developing Countries: An Empirical Investigation[1]

Abstract

The adoption of foreign technology is an important driver of productivity growth in the developing world, but the role of intellectual property (IP) rights in fostering technology adoption is theoretically not clear: strong IP rights may encourage technology transfer, by increasing the rent share that goes to the inventor; or they may make it more difficult for firms in developing countries to acquire foreign technology, by consolidating the monopoly power of patent holders.

In this paper I use a pooled cross-section of firms operating in 58 developing countries to estimate the impact of stronger IP protection on foreign technology licensing, allowing me to eliminate unobserved firm-level characteristics. I find that the relationship of IP protection and firm-level adoption of foreign technology is contingent on a country's development stage: when I measure IP protection based on the legal framework, enacting stronger IP legislation has a positive effect only on the group of newly industrialized countries and transition economies, whereby a 1% increase in legal protection of intellectual property increases the probability of licensing foreign technology by over 20%. When I measure the enforcement of existing IP rights, I find that a 1% increase in enforcement decreases the probability of adopting foreign technology by roughly 10% for the pooled sample. Finally, I find that firm characteristics such as size, foreign ownership, imports, and exports are strong predictors of technology licensing status.

[1]I would like to thank Dietrich Vollrath, Scott Imberman, Sebnem Kalemli-Ozcan, Peter Hartley, Walter Park, Lewis Davis, and conference participants at the Fall Research Conference of the Association for Public Policy Analysis and Management, and the Annual Meetings of the Southern Economic Association.

1.1 INTRODUCTION

High-income economies still dominate technological innovation, with over 83% of patent applications filed worldwide in 2008 originating in OECD countries (Khan et al., 2010). In developing countries, on the other hand, productivity growth relies heavily on the successful adoption and adaptation of foreign technology.

The role of intellectual property (IP) rights in cross-country technology adoption has been the subject of vigorous debate since the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) established intellectual property standards within the context of international trade.[2] On the one hand, the theoretical literature has postulated that strong IP rights encourage innovation and technology transfer, as they increase the rent share that goes to the technology exporter (Yang and Maskus, 2001a). On the other hand, stronger IP protection may consolidate the monopoly power of patent holders, resulting in artificial scarcity, and an imitation disincentive that ultimately reduces follow-on innovation in the developing world [Helpman (1993), Glass and Saggi (2002)].

In addition, IP protection may be neither necessary, nor sufficient condition for successful technology adoption in the developing world. It may not be necessary because arms-length licensing is not the only market-mediated mechanism for technology transfer: trade in goods and services, foreign direct investment, joint ventures, and human resources – to name a few – are all conducive to knowledge spillovers. There are also important non-market channels, such as legitimate imitation, data on patent applications, employee turnover, and temporary migration (Maskus, 2004).

IP protection may not be a sufficient condition if the recipient lacks the infrastructure, technical capacity, and skills to introduce an innovation in its production process. In fact, it is uncommon for technology owners to file patents in least developed countries (LDCs), given their small market potential; therefore firms operating in LDCs, in effect, have free access to inventions (Harvey, 2008). This suggests that all in all, IP protection may just not matter to firms deciding whether to adopt foreign technology.

Finally, the fact that a country has enacted intellectual property legislation does not

[2]TRIPS came into effect on 1 January 1995.

necessarily imply that the government will enforce it aggressively. Firms in countries with very high IP standards 'on paper' may still enjoy free access due to lax enforcement (Maskus and Fink, 2005, Ch. 7).

All these considerations suggest that:

> The question: "Are tighter intellectual property rights desirable?" cannot be answered by theoretical arguments alone. The theoretical analysis is most helpful in identifying channels through which regions are affected by such policy changes and circumstances under which the answer goes one way or the other. It also helps to identify the empirical estimates that are needed in order to answer the question. (Helpman, 1993).

Existing empirical investigations of the issue, however, are not without problems: they are affected by the scarcity of data measuring technological spillovers across countries – developing countries in particular – and therefore they present the issue almost exclusively from the technology exporter's perspective. In addition, while it is possible to measure the comprehensiveness of a country's IP legislation as in Park (2008), the effort a government makes to enforce existing IP rights is not easily captured.

In this paper, I extend the literature by estimating the effect of IP protection on arms-length licensing of foreign technology using a pooled cross-section of firms in 58 developing economies.[3] Therefore, I analyze the issue from the point of view of technology *importers*, while the prior literature has focused on technology exporters – namely the US, Japan, and the EU.

I use two different measures of IP protection: the Index of Patent Rights in Park (2008), based on the legal IP framework, and the Intellectual Property Protection index in World Economic Forum (2010), which is based on a survey of executives worldwide, and emphasizes enforcement. I find that the relationship of IP protection and firm-level adoption of foreign technology is contingent on a country's level of development. Enacting stronger IP legislation has a positive effect only on the group of newly industrialized countries and transition economies, whereby a 1% increase in legal protection of intellectual property

[3]Following the World Bank classification, I refer to low-income and middle-income economies as 'developing economies'.

increases the probability of licensing foreign technology by over 20%. When I focus on small and medium-sized firms, I find evidence that increased enforcement of existing IP rights has a negative impact on foreign technology licensing: in particular, a 1% increase in enforcement decreases the probability of adopting foreign technology by roughly 10% for the pooled sample. I also find that firm characteristics are strong predictors of technology licensing status: a 1% increase in foreign ownership makes a firm 14% more likely to adopt foreign technology; a 1% increase in imports of production inputs makes a firm 7% more likely to adopt; a 1% increase in indirect exports yields a 4% increase in the probability of technology transfer.

From a policy perspective, my findings suggest that there is no one-size-fits-all solution to intellectual property standards and technology transfer. What works in fast-growing emerging economies, does not work in – and in some cases is even detrimental to – other developing countries. Therefore, a new approach to IP is needed to address the technological lag between the developed and developing world.

The fact that my results contrast with prior literature is due to fundamental differences in the data and methodology. A branch of the IP literature relies on the flow of payments for licensing contracts from one country to another as a proxy for technology transfer. Yang and Maskus (2001b) use aggregate data to look at the effects of patent strength on the flow of unaffiliated royalties and licensing fees by U.S. firms in both absolute and relative terms; Wakasugi and Ito (2007) use a survey of Japanese multinational enterprises (MNEs) to estimate the impact of the degree of IP rights enforcement on the flow of affiliated royalties to the Japanese parent company. Both studies find that these receipts rise with stronger IP rights in the recipient country, but such increase could be due to higher licensor rents per contract, rather than a larger amount of contracts.

Hu and Png (2009) exploit inter-industry variation in the importance of patent rights to estimate the impact of changes in IP rights on growth for a large sample of both developing and developed countries. They find evidence that stronger IP rights are associated with faster industrial growth measured by value added. However, these results are based on the assumption that relative patent intensity of industries is the same across all countries. In addition, Hu and Png (2009) do not find any growth-promoting effects once the sample is

split between OECD and non-OECD countries.

Using a business survey of patent applicants in the EU and Japan, Zuniga and Guellec (2009) run a multivariate analysis on the determinants of licensing to non-affiliated parties. They find that firm characteristics such as size, age, sector of activity, and country of origin are significant predictors of a firm being engaged in licensing activity.

To sum up, the role of IP in fostering technology adoption is still controversial, as theoretical predictions are often ambiguous, and affected by the assumptions underlying a specific model. Empirical work is needed to clarify the issue, but prior investigations have been mostly cross-country analyses relying on proxies for technology adoption, and with technology exporters as a target population.

In this paper, I reverse this norm by analyzing the determinants of foreign technology licensing for firms in developing countries, thus focusing on the implications of IP protection on economic development. Although structural estimation is not an option within the context of this study, my reduced-form approach includes firm-level and country-level determinants of technology adoption, thus allowing me to determine which channels are more relevant.

1.2 POLICY BACKGROUND

The term 'intellectual property' refers to the legal rights resulting from intellectual activity in the industrial, scientific, literary and artistic fields. It is divided into two categories: literary and artistic works, protected by copyright; and industrial property, which includes inventions (patents), trademarks, industrial designs, and geographic indications of source (WIPO, 2004). Arms-length licensing is a contract under which a patent holder (the *licensor*) grants a license to a *licensee*, to authorize the use of a patented invention in exchange for compensation.

In 1474 the Venetian Republic enacted the first properly developed patent law, with the explicit purpose of encouraging technological advancement. Besides granting exclusivity to the inventor of a machine or a process, it provided for destruction of infringing devices and payment of a fee to the inventor (Schaafsma, 1997). In England, the Statute of Monopolies

of 1623 was enacted to end the abuse of the royal prerogative in issuing patent monopolies, rather than protect the rights of inventors (Mossoff, 2001). In the US, the Patent Act was passed in 1790. At this stage, IP protection was based on the principle of territoriality, i.e. the rights did not extend beyond the territory of the sovereign who granted them; therefore, patent holders faced a classic free-riding problem (Braithwaite and Drahos, 2000, Ch. 7).

In the mid-nineteenth century, IP protection began to acquire an international dimension: the existence of national patent systems was a violation of the principles of free trade, as the royalties that licensors paid to licensees varied across borders. States that were affected by the free-riding problem began to negotiate bilateral treaties with other states, while those who were benefiting from the positive externality remained isolationist (*ibid.*). This phase of bilateral treaty-making was based on a strategy of reciprocity: inventors from country A would enjoy the same degree of protection in country B as inventors from country B did in country A (Johns, 2009, ch. 10).

The final incentive to serious international cooperation on intellectual property came in 1873, when the Government of the the Austro-Hungarian Empire organized an international exhibition of inventions in Vienna, but foreign inventors were reluctant to participate on account of the inadequate protection offered to their intellectual property. That same year, the Austrians hosted the first round of diplomatic negotiations, which yielded the Paris Convention for the Protection of Industrial Property in 1883 (WIPO, 2004, ch. 5).

The Paris Convention did not call for harmonization of technical rules; rather, the member states agreed to certain basic principles, but retained control over IP standard-setting. Following the principle of 'national treatment', each member country had to grant to nationals and residents of the other member countries the same IP protection as it granted to its own nationals (*ibid.*).

The original signatories to the Convention were only 14,[4] mostly Western countries. However, membership increased significantly during the first quarter of the 20th century.

After World War II, more and more developing countries joined the Convention, and began to use their political leverage to ease patent restrictions. Furthermore, as enforcing

[4]The original 14 member countries of the Paris Convention for the Protection of Industrial Property were: Belgium, Brazil, Ecuador, El Salvador, France, Great Britain, Guatemala, Italy, the Netherlands, Portugal, Serbia, Spain, Switzerland, and Tunisia.

mechanisms were virtually inexistent,[5] a lot of free-riding was tolerated (Braithwaite and Drahos, 2000). In order to protect its interests in patent-intensive sectors (e.g. pharmaceuticals, electronics, ...), the United States devised the strategy of linking intellectual property to trade, and put it in action by introducing clauses on minimum IP standards in its bilateral trade agreements.

The opportunity to give this trade-based strategy a global dimension came in 1986, with the launch of the Uruguay Round of multilateral trade negotiations. With the support of Europe, Canada, and Japan, the US introduced intellectual property in the agenda. TRIPS was negotiated at the end of the Round, and it came into effect in 1995. Its ratification was a compulsory requirement for countries that wanted to join the newborn World Trade Organization (WTO), and its enforcement was covered under the WTO dispute settlement system.

The implementation of TRIPS caused a massive wealth redistribution effect. According to McCalman (2001), the US was the major beneficiary, followed by France, Italy, Sweden and Switzerland. Developing countries were hit the hardest, but Canada, Japan, and the UK also experienced a net loss.

Developing countries were allowed a ten-year transitional period to comply with TRIPS, which expired in 2005. The transitional period was extended to 2013 for least developed countries, on condition that they provide information by 2008 on their "needs for technical and financial cooperation in order to assist them taking steps necessary to implement the TRIPS Agreement",[6] and ensure that any changes in their IP legislation made during the additional transitional period would not "result in a lesser degree of consistency with the provisions of the TRIPS Agreement".[7]

At the Doha Ministerial Conference in 2001, additional flexibilities were adopted for developing country members to protect public health.[8] They include the right to grant compulsory licenses, limits on data protection, use of broad research, and other exceptions

[5]The only available enforcement mechanism was appealing to the International Court of Justice, and most states made reservations on such clauses (Braithwaite and Drahos, 2000).

[6]Decision of the Council for TRIPS of 29 November 2005 (IP/C/40), par. 2.

[7]*Ibid.*, par. 5.

[8]Declaration on the TRIPS Agreement and Public Health (WT/MIN(01)/DEC/2) adopted on November 14, 2001, par. 4.

to patentability. However, many developing countries have not taken advantage of the flexibilities provided under TRIPS, due to both lack of legal and technical expertise, and pressure from developed countries – the US in particular – to implement tighter intellectual property standards (Musungu and Oh, 2005; Braithwaite and Drahos, 2000).

1.3 EMPIRICAL STRATEGY

A typical approach to a cross-country analysis of the determinants of technology adoption is:

$$Y_{ct} = \alpha + \beta \cdot IPindex_{ct} + X_{ct}\Gamma + \nu_{ct}, \tag{1.1}$$

where Y_{ct} represents a proxy for technology spillovers to country c at time t; $IPindex$ is a measure of IP protection, X_{ct} is a set of observable country characteristics, and ν_{ct} includes aggregate firm characteristics, such as ownership structure and sector composition. This specification is plagued by omitted variable bias because it does not take into account sector and firm differences between countries, both potential determinants of technology adoption. Therefore my preferred specification is:

$$Y_{fsct} = \alpha + \beta \cdot IPindex_{ct} + X_{ct}\Gamma + X_{ft}\Omega + \delta_s \cdot \epsilon_t + \nu_{fsct}, \tag{1.2}$$

where Y_{fsct} is the technology adoption status for firm f in sector s in country c at time t, defined as follows:

$$Y_{fsct} = \begin{cases} 1 & \text{if the firm uses technology licensed from foreign firms;} \\ 0 & \text{otherwise.} \end{cases}$$

X_{ft} is a set of observable firm characteristics: size, legal status, ownership structure, age, sales composition, access to capital, ...; $\delta_s \cdot \epsilon_t$ is sector-by-year fixed effects. I cannot use country fixed effects because intellectual property rights are a country-level policy, and firms in the sample never switch countries. Nonetheless, by controlling specifically for firms characteristics, I am able to eliminate the bias inherent in country-level work due to sector and firm composition.

Prior empirical literature has attempted to answer the question of what makes a firm more likely to license *out* its technology, thus analyzing cross-country technology transfer from the point of view of technology exporters. In this paper, I shift the focus of the investigation on what makes a firm operating in a developing country more likely to license *in* foreign technology.

1.4 DATA

I pool data from several sources to construct a cross-section of firms operating in 58 developing economies, observed between 2002 and 2010. Appendix Table 1 presents an overview of the dataset, with the sample split in three groups, according to development stage.

The firm-level information is provided by the Enterprise Surveys.[9] The sample of firms in each country is stratified by size, sector and location. Since its launch in 2001, the project has collected surveys from 15 to 20 countries a year (Dethier et al., 2008).

The outcome of interest for this paper is in the survey question:

> Does your establishment use technology licensed from a foreign owned company?

Respondents select one out of three possible answers: 'yes', 'no', or 'I don't know'. Since the 'I don't know' responses where less than 1%, they were discarded. The final sample contains over 46,000 observations. Hence, I am capturing the effect of IP protection on the actual adoption of foreign technology in developing countries, while the existing literature relies on proxies for technology transfer that are imperfect at best (e.g. inventions patented in more than one country; the flow of royalties and licensing fees into the exporting country, ...).

Table 1.1 shows significant correlations between firm characteristics and technology licensing status: foreign technology licensees tend to be larger than non-licensees; they are more likely to be publicly listed companies, or limited liability companies, and to have foreign ownership. They export more of their product, both directly and indirectly, and they are much more likely to directly import all or part of their production inputs. Conversely, the financing structure for fixed assets is not different between groups.

[9]The Enterprise Surveys are a centralized database of comparable business climate surveys from around the world, accessible at http://enterprisesurveys.org/.

Table 1.1: Firm Characteristics by Foreign Technology Licensing Status

	Yes	No	Total
Firm Size ($\frac{FTEs}{1{,}000}$)	0.29	0.11	0.13
	(0.83)	(0.40)	(0.49)
Publicly Listed Company	0.14	0.06	0.07
	(0.35)	(0.25)	(0.26)
Privately Held, LLC	0.57	0.47	0.48
	(0.49)	(0.50)	(0.50)
Sole Proprietorship	0.13	0.27	0.26
	(0.33)	(0.45)	(0.44)
Partnership/Limited Partnership	0.09	0.13	0.13
	(0.29)	(0.34)	(0.33)
Other Legal Status	0.07	0.06	0.06
	(0.75)	(0.91)	(0.89)
Ownership: Private Domestic (%)	0.75	0.91	0.89
	(0.40)	(0.27)	(0.30)
Ownership: Private Foreign (%)	0.22	0.06	0.08
	(0.39)	(0.23)	(0.26)
Ownership: Government/State (%)	0.02	0.02	0.02
	(0.11)	(0.12)	(0.12)
Ownership: Other (%)	0.01	0.01	0.01
	(0.11)	(0.09)	(0.09)
Firm Age ($\frac{years}{1{,}000}$)	0.02	0.02	0.02
	(0.02)	(0.02)	(0.02)
Observations	*6,056*	*40,248*	*46,304*
Domestic Sales (%)	0.78	0.86	0.85
	(0.33)	(0.29)	(0.30)
Indirect Exports (%)	0.06	0.03	0.04
	(0.18)	(0.15)	(0.15)
Direct Exports (%)	0.16	0.10	0.11
	(0.29)	(0.26)	(0.27)
Directly Import Inputs (%)	0.55	0.28	0.32
	(0.50)	(0.45)	(0.47)
Observations	*5,700*	*38,419*	*44,119*
Fixed Assets financed with Internal Funds / Retained Earnings (%)	0.44	0.39	0.39
	(0.45)	(0.45)	(0.45)
Fixed Assets financed with Bank Loans (%)	0.15	0.12	0.12
	(0.31)	(0.28)	(0.28)
Fixed Assets financed with Trade Credit (%)	0.04	0.03	0.03
	(0.16)	(0.15)	(0.15)
Fixed Assets financed with Owners' Contribution / New Equity Shares (%)	0.02	0.02	0.02
	(0.13)	(0.11)	(0.11)
Fixed Assets financed with Other means (%)	0.05	0.05	0.05
	(0.20)	(0.19)	(0.19)
Observations	*5,545*	*37,243*	*42,788*

Standard deviations in parentheses.

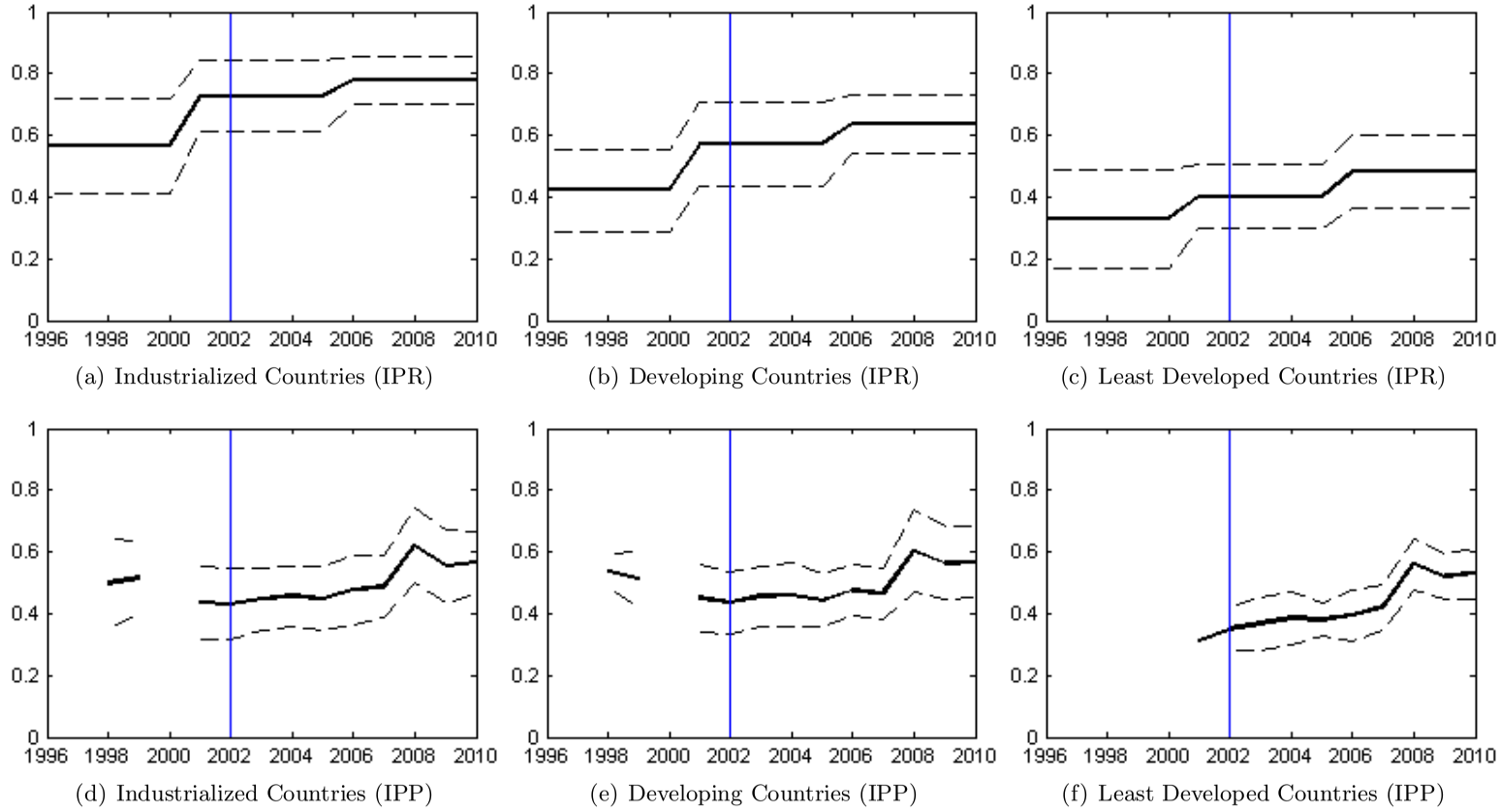
Table 1.2: Industry Sectors by Foreign Technology Licensing Status

	Means		Frequencies	
	Yes	No	Yes	No
A. Manufacturing				
Electronics	0.20	0.80	259	1,017
Chemicals and pharmaceuticals	0.19	0.81	786	3,294
Auto, auto components and other transport eq.	0.19	0.81	159	689
Paper and printing	0.16	0.84	190	1,008
Metals and machinery	0.15	0.85	925	5,432
Non-metallic and plastic materials	0.14	0.86	592	3,621
Agroindustry	0.14	0.86	54	319
Food and beverages	0.13	0.87	1,138	7,593
Textiles	0.12	0.88	459	3,378
Garments	0.10	0.90	702	6,101
Wood, furniture and crafts	0.09	0.91	321	3,242
Leather	0.07	0.93	96	1,243
Other manufacturing	0.17	0.83	207	1,009
subtotal	0.13	0.87	5,888	37,946
B. Services				
Construction	0.07	0.93	35	483
Real estate, renting and business activities	0.07	0.93	0.06	0.94
Wholesale and retail trade	0.06	0.94	52	831
Transport, storage and communications	0.01	0.99	2	192
Other services	0.11	0.89	50	404
Mining and quarrying	0.07	0.93	6	80
subtotal	0.07	0.93	168	2,302
Total	*0.13*	*0.87*	*6,056*	*40,248*

On average, 13% of the firms in the sample are foreign technology licensees. In Table 1.2, I break down adoption by sector of operation: out of 19 categories, 14 are manufacturing, representing 95% of the sample. The remaining 5% are in the services sector. Within the manufacturing sectors, those industries that are traditionally more patent-intensive have the highest licensing rates, with electronics leading at 20%, closely followed by chemicals and automotive, both at 19%. All services sectors have technology licensing below the sample average.

I use two measures of coutry-level IP protection. The first measure is the Index of Patent Rights (IPR) in Park (2008), which is the unweighted sum of five separate scores for: coverage (inventions that are patentable), membership in international treaties, duration of protection, enforcement mechanisms, and restrictions (e.g. compulsory licensing). It is updated every 5 years, and it ranges between 0 and 5.

While the IPR quantifies the extent of a country's legal framework with respect to



(a) Industrialized Countries (IPR) (b) Developing Countries (IPR) (c) Least Developed Countries (IPR)

(d) Industrialized Countries (IPP) (e) Developing Countries (IPP) (f) Least Developed Countries (IPP)

Figure 1.1: Comparing Intellectual Property Indices[a]

[a]Plotted in the top row is the Index of Patent Rights (IPR) in Park (2008); in the bottom row, the Intellectual Property Protection (IPP) Index (World Economic Forum, 2010), with a gap in the year 2000 because IPP scores were not collected. Both indices are scaled to $[0, 1]$. In each graph, the dashed lines represent the standard deviation bands, and the vertical line at the year 2002 represents the first year in my dataset. The sample is split into three groups according to development stage, as shown in Appendix Table 1.

intellectual property, it measures enforcement only indirectly, by looking at both statutory and case laws to determine the extent to which IP rights are recognized. The index does not capture such factors as the cost of going to court, how long it takes for a lawsuit to take its course, whether courts have a tendency to decide in favor of domestic firms, all of which can weaken patent rights.

In order to better capture enforcement of IP legislation, I use the raw score on 'Intellectual Property Protection' from the Executive Opinion Survey (World Economic Forum, 2010). The Survey has been at the basis of the World Competitiveness Report since 1979; in 2010, it covered 139 economies representing over 98 % of the world's gross domestic product (*ibid.*, p. 57). Survey respondents are asked the following question:

> How would you rate intellectual property protection, including anti-counterfeiting measures, in your country? [1 = very weak; 7 = very strong]

The average rating by country is the raw Intellectual Property Protection (IPP) score. This measure better reflects enforcement of IP rights, as perceived by industry executives. One limitation of the IPP is that it covers IP as a whole, not just patents. Therefore, survey respondents may have one specific type of IP in mind, depending on their country and sector of operation. For example, a Microsoft executive surveyed in China may be more concerned about copyright violations, than the enforcement of patents. In addition, as a survey-based qualitative assessment, the IPP is potentially sensitive to an 'announcement effect', i.e. respondents could be influenced by news and announcements; however, that would not necessarily generate a bias in any given direction: the announcement of a reform could lead respondents to overestimate the degree of enforcement, but a scandal could have the opposite effect.

Figure 1.1 presents a visual comparison of the two indices, both scaled to $[0, 1]$ for comparability. In each graph, the vertical line at the year 2002 represents the first year in my dataset. The 58 countries in the sample are split into three groups: a. newly industrialized countries and transition economies; b. developing countries; c. least developed countries.

The graphs in the top row of Figure 1.1 represent the mean Index of Patent Rights (IPR) within its standard deviation bands for each group of countries. It has a 'step ladder'

shape because it is updated every five years. Consistent with previous literature, the mean IPR is highest for the industrialized group, and lowest for the least-developed group.

In the bottom row, the mean Intellectual Property Protection (IPP) index is plotted for the corresponding group. There is a gap in the year 2000, because IPP scores were not collected in that year. The increase in the mean IPP score around 2008 is consistent with the end of the transitional period for developing countries in 2005.[10] Although the transitional period for least developed countries was extended to 2013, they came under a lot more scrutiny on the part of the WTO, as they were required to report about what kind of cooperation they needed to speed up the implementation of TRIPS.

Figure 1.1 suggests that while IP legislation has been steadily improving since TRIPS came into effect, the perception of enforcement hasn't changed much until recently, except for least developed countries, which show a slight upward trend throughout the time period under consideration. The fundamental difference between legal standards and enforcement is of particular relevance to analyze the effect of IP rights on cross-country technology adoption.

In addition to the IP protection measures, I include country-specific indicators to capture the differences in country performance over time: mean years of schooling of adult population from Barro and Lee (2010); survival to age 65 as a percentage of the male cohort, and GDP per capita in constant 2000 U.S. dollars, both from the World Development Indicators.

Table 1.3 presents summary statistics and correlation coefficients for all country-specific variables. On average, firms using licensed foreign technology operate in countries with slightly higher GDP per capita and mean years of schooling, but the difference is statistically insignificant. The correlogram shows that the correlation between IPR and IPP is a low 0.24; the IPR is highly correlated with GDP and mean years of schooling of the adult population, whereas the IPP has low correlation with all the other country-specific variables.

Figure 1.2(a) represents average technology licensing by world region, where the hor-

[10] Between 2007 and 2008 there was a slight change in the question formulation. Until 2007 the question read: *Intellectual property protection in your country: (1 = is weak and not enforced, 7 = is strong and enforced)*; whereas in 2008 it became: *How would you rate the protection of property rights, including financial assets, in your country? 1 = Very weak, 7 = Very strong.* It is unlikely for the change in formulation to have caused the spike in the average scores, since the effect seems to go away in the years following 2008.

Table 1.3: Country-Level Characteristics

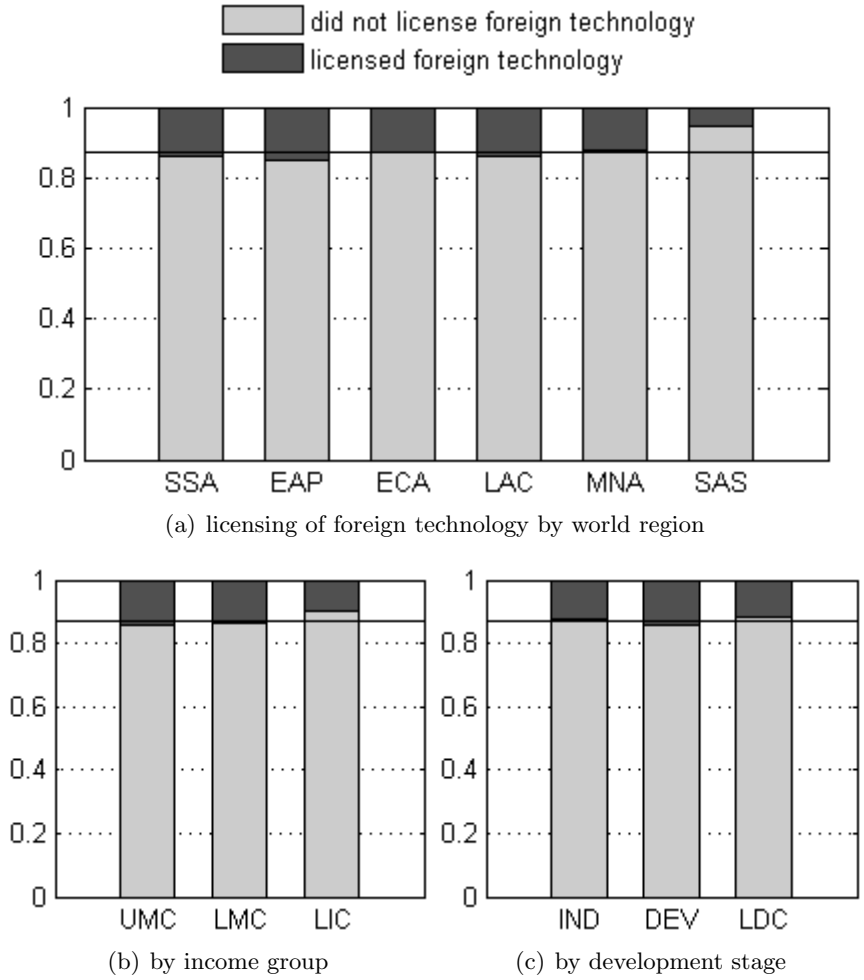
A. Summary Statistics by Foreign Technology Licensing Status

	Yes	No	Total
Index of Patent Rights (IPR)	0.66	0.64	0.64
	(0.15)	(0.15)	(0.15)
Intellectual Property Protection	0.50	0.49	0.49
Index (IPP)	(0.10)	(0.10)	(0.10)
GDP per Capita	0.28	0.25	0.26
	(0.24)	(0.23)	(0.23)
Mean Years of Schooling	6.65	6.43	6.46
of Adults	(2.14)	(2.23)	(2.22)
Survival to Age 65, male	0.64	0.64	0.64
(% of cohort)	(0.15)	(0.14)	(0.14)
Observations	6,056	40,248	46,304

B. Correlation Coefficients

	ipr	ipp	gdp	meanyrsch	to65ma
ipr	1.00				
ipp	0.24	1.00			
gdp	0.57	0.29	1.00		
meanyrsch	0.68	0.12	0.57	1.00	
to65ma	0.24	0.20	0.46	0.34	1.00

Standard deviations in parentheses. IPR and IPP indices scaled to [0,1] for comparability.



(a) licensing of foreign technology by world region

(b) by income group

(c) by development stage

Figure 1.2: Average Technology Adoption by Region and Development Stage[a]

[a]Panel (a) shows average adoption for the six world regions: Sub-Saharan Africa (SSA), East Asia and the Pacific (EAP), Europe and Central Asia (ECA), Latin America and the Caribbean (LAC), Middle East and North Africa (MNA), and South Asia (SAS). Panel (b) splits the sample by income group: Upper Middle Income (UMC), Lower Middle Income (LMC), and Low Income (LIC). Finally, Panel (c) groups the countries based on development stage: Newly Industrialized Countries and Transition Economies (IND), Developing Countries (DEV), and Least Developed Countries (LDC). In each graph, the horizontal line at 0.87 represents the sample average technology licensing.

izontal line at 0.87 is the sample average. All regional averages are close to the sample average, except for South Asia, with a 5% technology licensing rate significantly lower than the sample average. Figure 1.2(b) groups firms based on their country of operation's income level: upper middle income, lower middle income, and low income. Only low-income countries, with a 10% licensing rate, are slightly below the sample average. Finally, figure 1.2(c) groups firms based on the development stage of their country of operation, as detailed in the Appendix. The 'Industrialized' (IND) group includes newly industrialized countries and transition economies; the 'Least-developed' (LDC) group is defined by the UN-OHRLLS,[11] and the 'Developing' (DEV) group includes those countries that do not belong in either one of the other categories. The group averages in figure 1.2(c) are, again, very close to the sample average.

1.5 THE RELATIONSHIP OF IP AND TECHNOLOGY ADOPTION

Table 1.4 provides estimates for the pooled sample. Column (1) is the baseline specification in equation 1.1, with only country-level covariates, whereas columns (2) through (4) are the preferred specification in equation 1.2, with an increasing number of firm characteristics, as well as sector-by-year and legal status fixed effects. The baseline approach yields positive and statistically significant coefficients for both IPR and IPP. In particular, a 1% increase in legal protection of intellectual property would increase the probability of licensing foreign technology by 4%, whereas a 1% increase in enforcement of existing IP rights would increase it by 7%.

These results are consistent with previous cross-country analyses, which found positive effects of strong IP rights on technology adoption and growth. However, they are likely to suffer from omitted variable bias. In fact, once I add the firm characteristics and fixed effects, the estimates for both IPR and IPP become small and statistically insignificant, whereas firm size, ownership structure, exports, and imports are strong predictors of technology licensing status. For example, a 1% increase in foreign ownership makes a firm more likely to be a foreign technology licensee by 18 pp, whereas a 1% increase in government ownership

[11] The UN Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS) is accessible at http://www.unohrlls.org/.

Table 1.4: Effect of IP Protection on Foreign Technology Licensing

	Legal Framework				Enforcement			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Index of Patent Rights (IPR)	0.040**	-0.015	0.000	0.001				
	(0.016)	(0.017)	(0.017)	(0.017)				
IP Protection Index (IPP)					0.069***	-0.011	0.010	0.006
					(0.016)	(0.018)	(0.018)	(0.019)
GDP per capita	0.054***	0.046***	0.049***	0.049***	0.053***	0.044***	0.048***	0.049***
	(0.010)	(0.011)	(0.011)	(0.011)	(0.009)	(0.011)	(0.011)	(0.011)
Mean Years of Schooling of Adults	0.001	-0.001	-0.002	-0.002	0.002***	-0.002*	-0.002*	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Survival to Age 65, male (% of cohort)	-0.032**	-0.120***	-0.151***	-0.158***	-0.040***	-0.119***	-0.150***	-0.158***
	(0.013)	(0.015)	(0.015)	(0.016)	(0.013)	(0.015)	(0.015)	(0.015)
Firm Size ($\frac{FTEs}{1{,}000}$)		0.115***	0.092***	0.089***		0.115***	0.092***	0.089***
		(0.007)	(0.008)	(0.008)		(0.007)	(0.008)	(0.008)
Size Squared		-0.006***	-0.005***	-0.005***		-0.006***	-0.005***	-0.005***
		(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
Ownership: Private Foreign (%)		0.211***	0.182***	0.182***		0.211***	0.182***	0.182***
		(0.008)	(0.009)	(0.009)		(0.008)	(0.009)	(0.009)
Ownership: Gov't/State (%)		-0.063***	-0.059***	-0.061***		-0.063***	-0.058***	-0.061***
		(0.014)	(0.015)	(0.016)		(0.014)	(0.015)	(0.016)
Ownership: Other (%)		0.071***	0.076***	0.082***		0.072***	0.076***	0.082***
		(0.018)	(0.019)	(0.020)		(0.018)	(0.019)	(0.020)
Firm Age ($\frac{years}{1{,}000}$)		0.047*	0.036	0.033		0.047**	0.036	0.033
		(0.024)	(0.023)	(0.023)		(0.024)	(0.023)	(0.023)
Age Squared		-0.005	0.001	0.004		-0.005	0.001	0.004
		(0.029)	(0.027)	(0.027)		(0.029)	(0.027)	(0.027)
Sales: Indirect Exports (%)			0.045***	0.048***			0.045***	0.048***
			(0.012)	(0.012)			(0.012)	(0.012)
Sales: Direct Exports (%)			-0.003	-0.002			-0.003	-0.002
			(0.007)	(0.007)			(0.007)	(0.007)
Directly Import Inputs			0.087***	0.086***			0.087***	0.086***
			(0.004)	(0.004)			(0.004)	(0.004)
Fixed Assets financed with Bank Loans (%)				0.015**				0.015**
				(0.006)				(0.006)
Fixed Assets financed with Trade Credit (%)				0.026**				0.026**
				(0.011)				(0.011)
Fixed Assets financed with Owners' Contr. (%)				-0.003				-0.003
				(0.015)				(0.015)
Fixed Assets financed with Other Means (%)				0.015*				0.015*
				(0.008)				(0.008)
Observations	*46,304*	*46,304*	*44,119*	*42,788*	*46,304*	*46,304*	*44,119*	*42,788*
Sector-by-Year FEs		X	X	X		X	X	X
Legal Status FEs		X	X	X		X	X	X

Standard errors in parentheses. Columns (2) through (4) include sector, year, and sector-by-year fixed effects, along with a firm's legal status of publicly listed company, privately held / limited liability company, and partnership / limited partnership, with sole proprietorship being the excluded category. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

decreases the likelihood of being a licensee by 6 pp; a 1% increase in direct imports increases the probability of licensing by 5%. The effect of firm size is positive and statistically significant at the 1% level. However, since firm size is expressed as $\frac{FTEs}{1{,}000}$,[12] it is quite small: increasing firm size by one FTE would increase the probability of licensing foreign technology by roughly $\frac{1}{100}$ pp. Finally, increasing the share of fixed assets financed with bank loans or the share financed with trade credit by 1% increases the probability of a firm being a licensee by 2 and 3 pp respectively, albeit the coefficients in this case are only significant at the 5% level.

One potential explanation for the small and insignificant coefficients for IPR and IPP in Table 1.4 may be that firms operating in countries at different stages of development are affected differently, and in the pooled regression the effects are canceling each other out. Therefore I split the sample in three groups according to development stage as in Appendix Table 1: newly industrialized countries and transition economies; developing countries; and least developed countries. Table 1.5 presents the results whereby the specifications in columns (1) through (4) match the corresponding columns in Table 1.4, but only a small group of regressors is displayed for sake of simplicity. For the 'industrialized' group the IPR has a positive and significant effect, suggesting that a 1% increase in legal protection of intellectual property would yield an increase in the probability of licensing foreign technology between 26 and 30%. The estimates are positive for LDCs as well, albeit only significant at the 10% level, whereas they are still small and insignificant for developing countries. As far as the IPP is concerned, it is statistically insignificant across the board, but negative for both the 'industrialized' and the 'developing' groups, and positive for the LDC group.

Moving on to firm characteristics, the results by groups are quite consistent with the results for the pooled sample in Table 1.4. For example, a 1% increase in foreign ownership makes a firm 19% more likely to license foreign technology in 'industrialized' and 'developing' countries, and 16% more likely in LDCs. A 1% increase in direct imports makes a firm 9% more likely to adopt in 'industrialized' and 'developing' countries, 6% in LDCs. However,

[12]Full-time equivalent (FTE) is the ratio of the total number of paid hours during a period (e.g. a week) by the total number of working hours per week. The ratio units are FTE units or equivalent employees working full-time. An FTE of 1.0 is equivalent to one employee working full-time. This measure is more precise than headcount because employees may work a different number of hours per week.

Table 1.5: Effect of IP Protection on Foreign Technology Licensing by Development Stage

	Industrialized Countries				Developing Countries				Least Developed Countries			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
						A. Legal Framework						
Index of Patent Rights (IPR)	0.340***	0.302***	0.264***	0.284***	-0.052**	0.009	0.012	0.005	0.083*	0.094*	0.106*	0.109**
	(0.034)	(0.048)	(0.049)	(0.052)	(0.025)	(0.028)	(0.028)	(0.028)	(0.049)	(0.054)	(0.054)	(0.054)
Firm Size ($\frac{FTEs}{1{,}000}$)		0.118***	0.097***	0.095***		0.137***	0.108***	0.103***		0.148***	0.134***	0.137***
		(0.010)	(0.011)	(0.012)		(0.015)	(0.015)	(0.015)		(0.025)	(0.027)	(0.028)
Ownership: Private Foreign (%)		0.218***	0.187***	0.187***		0.213***	0.187***	0.188***		0.168***	0.159***	0.159***
		(0.014)	(0.015)	(0.015)		(0.012)	(0.013)	(0.013)		(0.020)	(0.020)	(0.020)
Sales: Indirect Exports (%)			0.044**	0.046**			0.035**	0.041**			0.066**	0.068**
			(0.020)	(0.021)			(0.017)	(0.018)			(0.030)	(0.031)
Directly Import Inputs			0.086***	0.087***			0.085***	0.084***			0.056***	0.055***
			(0.007)	(0.008)			(0.006)	(0.006)			(0.011)	(0.012)
Fixed Assets financed with Bank Loans (%)				0.021**				0.018**				-0.005
				(0.010)				(0.008)				(0.020)
Fixed Assets financed with Trade Credit (%)				0.033**				0.025				-0.008
				(0.017)				(0.016)				(0.062)
						B. Enforcement						
IP Protection Index (IPP)	0.282***	-0.078	-0.047	-0.070	-0.042*	-0.023	-0.020	-0.022	0.159***	0.053	0.061	0.077
	(0.031)	(0.049)	(0.053)	(0.056)	(0.025)	(0.030)	(0.030)	(0.030)	(0.058)	(0.073)	(0.074)	(0.075)
Firm Size ($\frac{FTEs}{1{,}000}$)		0.119***	0.097***	0.096***		0.137***	0.108***	0.102***		0.146***	0.133***	0.136***
		(0.010)	(0.011)	(0.012)		(0.015)	(0.015)	(0.015)		(0.025)	(0.027)	(0.028)
Ownership: Private Foreign (%)		0.223***	0.190***	0.190***		0.213***	0.187***	0.189***		0.168***	0.159***	0.159***
		(0.014)	(0.015)	(0.015)		(0.012)	(0.013)	(0.013)		(0.020)	(0.020)	(0.020)
Sales: Indirect Exports (%)			0.053***	0.056***			0.035**	0.041**			0.067**	0.069**
			(0.020)	(0.021)			(0.017)	(0.018)			(0.030)	(0.031)
Directly Import Inputs			0.087***	0.088***			0.085***	0.084***			0.055***	0.054***
			(0.007)	(0.008)			(0.006)	(0.006)			(0.011)	(0.012)
Fixed Assets financed with Bank Loans (%)				0.020**				0.018**				-0.006
				(0.010)				(0.008)				(0.020)
Fixed Assets financed with Trade Credit (%)				0.027				0.024				-0.008
				(0.017)				(0.016)				(0.062)
Observations	*17,051*	*17,051*	*15,533*	*14,536*	*23,597*	*23,597*	*23,078*	*22,823*	*5,656*	*5,656*	*5,508*	*5,429*

Standard errors in parentheses. Columns (2) through (4) include sector, year, and sector-by-year fixed effects, along with a firm's legal status of publicly listed company, privately held / limited liability company, and partnership / limited partnership, with sole proprietorship being the excluded category. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

the effect of firm size has now doubled in magnitude to approximately $\frac{2}{100}$ pp across the board.

1.6 SPECIFICATION CHECKS

As Maskus (2000) and others have demonstrated in an aggregate setting, there is a U-shaped (or, at the very least, positive) relationship between IP standards and GDP per capita, suggesting endogeneity of patent rights. In a firm-level cross-sectional setting, there may still be reverse causality if firms have sufficient influence on policymakers to set IP protection at their desired level.

In order to address this issue, I need to consider what kind of firms are more likely to be able to influence their governments to set their desired level of IP protection. For example, large firms may have more resources than small and medium-sized firms to lobby their central governments. The Enterprise Surveys define large firms as having 100 or more employees; therefore, I restrict the models in Tables 1.4 and 1.5 to firms with less than 100 employees. Table 1.6 provides estimates for the pooled sample of small and medium-sized firms. The coefficients for both IPR and IPP are now negative and statistically significant. In particular, a 1% increase in the IPR yields a 3% decrease in a firm's probability to license foreign technology, though only significant at the 10% level. A 1% increase in the IPP makes a firm 10% less likely to adopt foreign technology. Moving on to firm characteristics, firm size is still positive and significant with a magnitude of roughly $\frac{1}{10}$ pp; a 1% increase in foreign ownership makes a firm 14% more likely to adopt foreign technology; a 1% increase in imports of production inputs makes a firm 7% more likely to adopt; a 1% increase in indirect exports makes a firm 4% more likely to adopt. As far as financing of fixed assets is concerned, increasing the share financed with trade credit, or the share financed with other means by 1% makes a firm 2% more likely to license foreign technology, whereas financing with bank loans has now gone to zero.

Table 1.7 presents estimates with the sample split in three groups according to development stage. The IPR is still positive and significant for the 'industrialized' group as in Table 1.5, and it is insignificant for the other two. However, the IPP is now negative across

Table 1.6: Effect of IP Protection on Foreign Technology Licensing, Excluding Large Firms

	Legal Framework				Enforcement			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Index of Patent Rights (IPR)	0.026	-0.045**	-0.031*	-0.031*				
	(0.017)	(0.018)	(0.018)	(0.018)				
IP Protection Index (IPP)					-0.025	-0.107***	-0.096***	-0.097***
					(0.016)	(0.019)	(0.019)	(0.020)
GDP per capita	0.042***	0.031***	0.033***	0.030***	0.050***	0.039***	0.042***	0.040***
	(0.010)	(0.011)	(0.011)	(0.011)	(0.010)	(0.011)	(0.011)	(0.011)
Mean Years of Schooling of Adults	-0.000	-0.001	-0.002	-0.001	0.001	-0.002**	-0.002**	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Survival to Age 65, male (% of cohort)	-0.059***	-0.090***	-0.107***	-0.112***	-0.059***	-0.087***	-0.106***	-0.111***
	(0.014)	(0.016)	(0.016)	(0.016)	(0.014)	(0.016)	(0.016)	(0.016)
Firm Size (FTEs/1,000)		1.691***	1.147***	1.170***		1.699***	1.165***	1.190***
		(0.265)	(0.272)	(0.279)		(0.265)	(0.272)	(0.279)
Size Squared		-5.041	-2.012	-2.138		-5.058	-2.095	-2.238
		(3.260)	(3.343)	(3.414)		(3.261)	(3.345)	(3.416)
Ownership: Private Foreign (%)		0.159***	0.136***	0.135***		0.159***	0.137***	0.135***
		(0.011)	(0.011)	(0.011)		(0.011)	(0.011)	(0.011)
Ownership: Gov't/State (%)		-0.036**	-0.034*	-0.037**		-0.039**	-0.037**	-0.040**
		(0.016)	(0.018)	(0.019)		(0.016)	(0.018)	(0.019)
Ownership: Other (%)		0.066***	0.069***	0.073***		0.071***	0.072***	0.076***
		(0.018)	(0.019)	(0.020)		(0.018)	(0.019)	(0.020)
Firm Age ($\frac{years}{1,000}$)		-0.042*	-0.035	-0.037		-0.040	-0.033	-0.035
		(0.024)	(0.025)	(0.025)		(0.024)	(0.025)	(0.025)
Age Squared		0.049	0.040	0.044		0.048	0.039	0.043
		(0.032)	(0.033)	(0.033)		(0.032)	(0.033)	(0.033)
Sales: Indirect Exports (%)			0.040***	0.041***			0.039***	0.040***
			(0.014)	(0.014)			(0.014)	(0.014)
Sales: Direct Exports (%)			0.003	0.004			0.003	0.004
			(0.009)	(0.010)			(0.009)	(0.010)
Directly Import Inputs			0.072***	0.073***			0.071***	0.072***
			(0.005)	(0.005)			(0.005)	(0.005)
Fixed Assets financed with Bank Loans (%)				-0.001				0.000
				(0.007)				(0.007)
Fixed Assets financed with Trade Credit (%)				0.024**				0.023*
				(0.012)				(0.012)
Fixed Assets financed with Owners' Contr. (%)				-0.009				-0.012
				(0.017)				(0.017)
Fixed Assets financed with Other means (%)				0.020**				0.020**
				(0.009)				(0.009)
Observations	*35,039*	*35,039*	*33,667*	*32,740*	*35,039*	*35,039*	*33,667*	*32,740*
Sector-by-Year FEs		X	X	X		X	X	X
Legal Status FEs		X	X	X		X	X	X

Standard errors in parentheses. Columns (2) through (4) include sector, year, and sector-by-year fixed effects, along with a firm's legal status of publicly listed company, privately held / limited liability company, and partnership / limited partnership, with sole proprietorship being the excluded category. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 1.7: Effect of IP Protection on Foreign Technology Licensing by Development Stage, Excluding Large Firms

	Industrialized Countries				Developing Countries				Least Developed Countries			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
						A. Legal Framework						
Index of Patent Rights (IPR)	0.254***	0.229***	0.203***	0.224***	-0.018	-0.002	0.003	0.000	0.082*	0.063	0.062	0.062
	(0.034)	(0.050)	(0.052)	(0.055)	(0.025)	(0.028)	(0.029)	(0.029)	(0.048)	(0.054)	(0.054)	(0.054)
Firm Size (FTEs/1,000)		0.765*	0.477	0.504		3.127***	2.531***	2.530***		1.345	0.675	0.709
		(0.410)	(0.423)	(0.447)		(0.387)	(0.395)	(0.398)		(0.833)	(0.851)	(0.861)
Ownership: Private Foreign (%)		0.160***	0.141***	0.141***		0.167***	0.149***	0.147***		0.116***	0.103***	0.104***
		(0.019)	(0.020)	(0.021)		(0.016)	(0.017)	(0.017)		(0.022)	(0.023)	(0.023)
Sales: Indirect Exports (%)			0.051**	0.051**			0.028	0.031*			0.040	0.037
			(0.024)	(0.025)			(0.019)	(0.019)			(0.035)	(0.035)
Directly Import Inputs			0.073***	0.073***			0.063***	0.064***			0.051***	0.052***
			(0.009)	(0.010)			(0.007)	(0.007)			(0.014)	(0.014)
Fixed Assets financed with Bank Loans (%)				0.010				-0.001				-0.032
				(0.011)				(0.009)				(0.024)
Fixed Assets financed with Trade Credit (%)				0.043**				0.012				-0.033
				(0.018)				(0.016)				(0.064)
						B. Enforcement						
IP Protection Index (IPP)	0.174***	-0.094*	-0.086	-0.096	-0.096***	-0.098***	-0.089***	-0.084***	0.065	-0.045	-0.057	-0.051
	(0.033)	(0.053)	(0.058)	(0.063)	(0.025)	(0.031)	(0.031)	(0.031)	(0.057)	(0.074)	(0.075)	(0.075)
Firm Size		0.774*	0.466	0.486		3.148***	2.551***	2.548***		1.254	0.568	0.606
		(0.412)	(0.425)	(0.449)		(0.387)	(0.395)	(0.398)		(0.833)	(0.851)	(0.862)
Ownership: Private Foreign (%)		0.164***	0.144***	0.144***		0.167***	0.150***	0.147***		0.115***	0.102***	0.104***
		(0.019)	(0.020)	(0.021)		(0.016)	(0.017)	(0.017)		(0.022)	(0.023)	(0.023)
Sales: Indirect Exports (%)			0.056**	0.057**			0.029	0.032*			0.042	0.040
			(0.024)	(0.025)			(0.019)	(0.019)			(0.035)	(0.035)
Directly Import Inputs			0.073***	0.074***			0.063***	0.064***			0.052***	0.053***
			(0.009)	(0.010)			(0.007)	(0.007)			(0.014)	(0.014)
Fixed Assets financed with Bank Loans (%)				0.009				-0.000				-0.032
				(0.011)				(0.009)				(0.024)
Fixed Assets financed with Trade Credit (%)				0.037**				0.011				-0.033
				(0.018)				(0.016)				(0.064)
Observations	*11,936*	*11,936*	*11,078*	*10,384*	*18,654*	*18,654*	*18,251*	*18,074*	*4,449*	*4,449*	*4,338*	*4,282*

Standard errors in parentheses. Columns (2) through (4) include sector, year, and sector-by-year fixed effects, along with a firm's legal status of publicly listed company, privately held / limited liability company, and partnership / limited partnership, with sole proprietorship being the excluded category. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

the board, although it is statistically significant only for the 'developing' group. While the effects for firm size, exports, and financing status vary across groups in both magnitude and statistical significance, the effect of foreign ownership is consistently positive and significant. This raises the concern that the results might be driven by intra-firm technology transfer from parent companies to subsidiaries of multinational corporations.

In order to address this concern, I drop firms with foreign ownership, which are 11% of the whole sample, but just under 7% of small and medium-sized firms. The corresponding results for the pooled sample are presented in Table 1.8, and they are remarkably consistent with Table 1.6. In Table 1.9 I split the sample by development stage and, again, I find that legal IP protection has a positive and significant effect only on the 'Industrialized' group. Instead the estimates for enforcement are still negative across the board, still significant for the 'developing' group, and now significant at the 10% level for the 'industrialized' group.

1.7 CONCLUSION

The effect of intellectual property protection on cross-country technology transfer has been a widely debated issue since IP rights made their debut in international trade with the TRIPS agreement. Theoretical predictions are ambiguous, and sensitive to the assumptions underlying a specific model; empirical investigations are plagued by the scarcity of data measuring cross-country technology spillovers.

In this paper I assess whether stronger IP protection affects licensing of foreign technology in developing countries, thus moving the focus from technology exporters to technology importers. While the previous literature relied on proxies for technology transfer, I have a pooled cross-section of firms operating in 58 developing countries with information on licensing status, sector of activity, size, ownership and other characteristics. I use two alternative measures of IP protection: the Index of Patent Rights, representing the completeness of a country's legal framework for intellectual property; and the Intellectual Property Protection Index, reflecting a qualitative assessment of enforcement.

While prior work has found strong IP protection to have a positive impact on technology transfer (growth), I find that the relationship of IP protection and firm-level technology

Table 1.8: Effect of IP Protection on Foreign Technology Licensing, Excluding Large Firms and Firms with Foreign Ownership

	Legal Framework				Enforcement			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Index of Patent Rights (IPR)	0.023	-0.046***	-0.033*	-0.032*				
	(0.016)	(0.018)	(0.018)	(0.018)				
IP Protection Index (IPP)					-0.036**	-0.107***	-0.100***	-0.105***
					(0.016)	(0.019)	(0.019)	(0.019)
GDP per capita	0.041***	0.025**	0.027**	0.023**	0.050***	0.032***	0.035***	0.032***
	(0.010)	(0.011)	(0.011)	(0.011)	(0.009)	(0.011)	(0.011)	(0.011)
Mean Years of Schooling of Adults	0.000	0.000	-0.001	0.000	0.000	-0.002	-0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Survival to Age 65, male (% of cohort)	-0.052***	-0.094***	-0.109***	-0.115***	-0.052***	-0.089***	-0.107***	-0.113***
	(0.014)	(0.016)	(0.016)	(0.016)	(0.014)	(0.015)	(0.016)	(0.016)
Firm Size ($\frac{FTEs}{1{,}000}$)		1.669***	1.223***	1.236***		1.677***	1.241***	1.258***
		(0.265)	(0.273)	(0.280)	(0.265)	(0.273)	(0.280)	
Size Squared		-6.043*	-3.963	-4.074		-6.067*	-4.044	-4.193
		(3.286)	(3.371)	(3.442)		(3.287)	(3.373)	(3.445)
Ownership: Gov't/State (%)		-0.036**	-0.032*	-0.033*		-0.039**	-0.036**	-0.036*
		(0.016)	(0.018)	(0.019)		(0.016)	(0.018)	(0.019)
Ownership: Other (%)		0.063***	0.066***	0.070***		0.067***	0.070***	0.074***
		(0.018)	(0.019)	(0.020)		(0.018)	(0.019)	(0.020)
Firm Age ($\frac{years}{1{,}000}$)		-0.020	-0.017	-0.018		-0.018	-0.015	-0.017
		(0.024)	(0.024)	(0.025)		(0.024)	(0.025)	(0.025)
Age Squared		0.025	0.019	0.023		0.024	0.018	0.022
		(0.031)	(0.032)	(0.033)		(0.031)	(0.032)	(0.033)
Sales: Indirect Exports (%)			0.034**	0.037***			0.034**	0.036***
			(0.014)	(0.014)			(0.014)	(0.014)
Sales: Direct Exports (%)			0.010	0.012			0.010	0.012
			(0.010)	(0.010)		(0.010)	(0.010)	
Directly Import Inputs			0.067***	0.067***			0.066***	0.066***
			(0.005)	(0.005)			(0.005)	(0.005)
Fixed Assets financed with Bank Loans (%)				0.007				0.008
				(0.007)				(0.007)
Fixed Assets financed with Trade Credit (%)				0.024**				0.023*
				(0.012)				(0.012)
Fixed Assets financed with Owners' Contr. (%)				-0.017				-0.021
				(0.016)				(0.016)
Fixed Assets financed with other means (%)				0.023**				0.023**
				(0.009)				(0.009)
Observations	*32,666*	*32,666*	*31,459*	*30,594*	*32,666*	*32,666*	*31,459*	*30,594*
Sector-by-Year FEs		X	X	X		X	X	X
Legal Status FEs		X	X	X		X	X	X

Standard errors in parentheses. Columns (2) through (4) include sector, year, and sector-by-year fixed effects, along with a firm's legal status of publicly listed company, privately held / limited liability company, and partnership / limited partnership, with sole proprietorship being the excluded category. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 1.9: Effect of IP Protection on Foreign Technology Licensing by Development Stage, Excluding Large Firms and Firms with Foreign Ownership

	Industrialized Countries				Developing Countries				Least Developed Countries			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
						A. Legal Framework						
Index of Patent Rights (IPR)	0.200***	0.210***	0.194***	0.225***	-0.023	0.002	0.005	0.003	0.084*	0.036	0.021	0.021
	(0.033)	(0.050)	(0.051)	(0.054)	(0.025)	(0.028)	(0.029)	(0.029)	(0.046)	(0.054)	(0.054)	(0.054)
Firm Size ($\frac{FTEs}{1{,}000}$)		0.750*	0.637	0.673		2.900***	2.319***	2.327***		2.139***	1.665**	1.604*
		(0.410)	(0.423)	(0.447)		(0.388)	(0.397)	(0.400)		(0.820)	(0.842)	(0.852)
Sales: Indirect Exports (%)			0.046*	0.050*			0.018	0.021			0.042	0.040
			(0.024)	(0.026)			(0.018)	(0.019)			(0.033)	(0.033)
Directly Import Inputs			0.061***	0.061***			0.060***	0.060***			0.045***	0.044***
			(0.009)	(0.010)			(0.007)	(0.007)			(0.015)	(0.015)
Fixed Assets financed with Bank Loans (%)				0.011				0.010				-0.014
				(0.011)				(0.009)				(0.026)
Fixed Assets financed with Trade Credit (%)				0.043**				0.011				0.013
				(0.018)				(0.016)				(0.074)
						B. Enforcement						
IP Protection Index (IPP)	0.084***	-0.109**	-0.101*	-0.119*	-0.094***	-0.084***	-0.074**	-0.072**	0.060	-0.003	-0.050	-0.041
	(0.032)	(0.054)	(0.059)	(0.064)	(0.024)	(0.031)	(0.031)	(0.031)	(0.057)	(0.073)	(0.075)	(0.076)
Firm Size ($\frac{FTEs}{1{,}000}$)		0.764*	0.634	0.664		2.917***	2.335***	2.342***		2.100**	1.612*	1.556*
		(0.411)	(0.424)	(0.448)		(0.388)	(0.397)	(0.400)		(0.820)	(0.841)	(0.851)
Sales: Indirect Exports (%)			-0.019	0.056**			0.019	0.022			0.043	0.041
			(0.030)	(0.026)			(0.018)	(0.019)			(0.033)	(0.033)
Directly Import			0.061***	0.062***			0.059***	0.059***			0.045***	0.045***
Inputs			(0.009)	(0.010)			(0.007)	(0.007)			(0.015)	(0.015)
Fixed Assets financed with Bank Loans (%)				0.010				0.011				-0.014
				(0.011)				(0.009)				(0.026)
Fixed Assets financed with Trade Credit (%)				0.037**				0.010				0.013
				(0.018)				(0.016)				(0.074)
Observations	*11,195*	*11,195*	*10,443*	*9,795*	*17,571*	*17,571*	*17,201*	*17,034*	*3,900*	*3,900*	*3,815*	*3,765*

Standard errors in parentheses. Columns (2) through (4) include sector, year, and sector-by-year fixed effects, along with a firm's legal status of publicly listed company, privately held / limited liability company, and partnership / limited partnership, with sole proprietorship being the excluded category. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

adoption is contingent on a country's development stage. In particular, enacting stronger IP legislation has a positive effect only on the group of newly industrialized countries and transition economies, whereby a 1% increase in legal protection of intellectual property increases the probability of licensing foreign technology by over 20%.

When I focus on small and medium-sized firms, I find evidence that increased enforcement of existing IP rights has a negative impact on foreign technology licensing: in particular, a 1% increase in enforcement decreases the probability of adopting foreign technology by roughly 10%. I also find that firm characteristics are strong predictors of technology licensing status: a 1% increase in foreign ownership makes a firm 14% more likely to adopt foreign technology; a 1% increase in imports of production inputs makes a firm 7% more likely to adopt; a 1% increase in indirect exports yields a 4% increase in the probability of technology transfer.

It is perhaps not surprising that there are no clear predictions of the effect of IP protection on technology transfer in the theoretical literature: my results suggest that there are several different mechanisms at work in the data, and each may dominate in one group of countries with certain characteristics, but not in another.

The policy implications of my findings are evident: there is no one-size-fits-all solution to intellectual property standards and technology transfer. What works in fast-growing emerging economies, does not work in – and in some cases is even detrimental to – other developing countries. Therefore, a new approach to IP is needed to address the technological lag between the developed and developing world.

An interesting area to explore for future research is the potential indirect effects of tighter IP protection on cross-country technology adoption. Since arms-length licensing is not the only channel for technology transfer, firms may react to the policy change by seeking alternative channels to acquire foreign technology. Unfortunately, I cannot disentangle direct and indirect effects with this particular dataset.

Furthermore, the Enterprise Surveys only record whether firms have successfully entered into a licensing agreement with a foreign entity. We don't know how many firms tried, and why they were unsuccessful; or how many did not even try, although they could benefit from it. If future business surveys could collect this kind of information, it would draw a

more detailed picture of the barriers to technology adoption faced by firms in the developing world.

Bibliography

Robert J. Barro and Jong-Wha Lee. A New Data Set of Educational Attainment in the World, 19502010. Working Paper 15902, National Bureau of Economic Research, April 2010.

John Braithwaite and Peter Drahos. *Global Business Regulation*. Cambridge University Press, 2000.

Jean-Jacques Dethier, Maximilian Hirn, and Stephane Straub. Explaining Enterprise Performance in Developing Countries with Business Climate Survey Data. Policy Research Working Paper Series, The World Bank, Dec 2008.

Amy J. Glass and Kamal Saggi. Intellectual Property Rights and Foreign Direct Investment. *Journal of International Economics*, 56:387–410, 2002.

Ian Harvey. Intellectual Property Rights: The Catalyst to Deliver Low Carbon Technologies. Breaking the Climate Deadlock Briefing Paper, The Climate Group, 2008.

Elhanan Helpman. Innovation, Imitation, and Intellectual Property Rights. *Econometrica*, 61(6):1247–1280, 1993.

Albert G. Z. Hu and Ivan P. L. Png. Patent Rights and Economic Growth: Evidence from Cross-Country Panels of Manufacturing Firms. Working Paper, 2009.

Adrian Johns. *Piracy: The Intellectual Property Wars from Gutenberg to Gates*. University of Chicago Press, 2009.

Mosahid Khan, Ryan Lamb, Bruno Le Feuvre, Sacha Wunsch-Vincent, et al. World intellectual property indicators. Wipo publication, World Intellectual Property Organization, 2010.

Keith E. Maskus. *Intellectual Property Rights in the Global Economy*. Institute for International Economics, 2000.

Keith E. Maskus. Encouraging International Technology Transfer. ICTSD-UNCTAD Issue Paper 7, United Nations Conference on Trade and Development (UNCTAD), 2004.

Keith E. Maskus and Carsten Fink, editors. *Intellectual Property and Development: Lessons from Recent Economic Research*. World Bank Publications, 2005.

Phillip McCalman. Reaping What You Sow: An Empirical Analysis of International Patent Harmonization. *Journal of International Economics*, 55:161–186, 2001.

Adam Mossoff. Rethinking the Development of Patents: An Intellectual History, 1550-1800. *Hastings Law Journal*, 52:1255–1322, 2001.

Sisule F. Musungu and Cecilia Oh. The Use of Flexibilities in TRIPS by Developing Countries: Can They Promote Access to Medicines? Technical Report 4C, World Health Organization, August 2005.

Walter G. Park. International Patent Protection: 1960-2005. *Research Policy*, 37(4):761–766, 2008.

Xavier Sala-i-Martin, Jennifer Blanke, Margareta Drzeniek Hanouz, et al. *The Global Competitiveness Report 2010-2011*. World Economic Forum, 2010.

Paul E. Schaafsma. An Economic Overview of Patents. *Journal of the Patent and Trademark Office Society*, 79, 1997.

Ryuhei Wakasugi and Banri Ito. Protection of Intellectual Property Rights and International Technology Transfer: Empirical Evidence. In *2007 APEA Conference*, 2007.

WIPO. WIPO Intellectual Property Handbook: Policy, Law and Use. WIPO publication, Wold Intellectual Property Organization, 2004.

Guifang Yang and Keith E. Maskus. Intellectual Property Rights, Licensing and Innovation in an Endogenous Product-Cycle Model. *Journal of International Economics*, 53:169–187, 2001a.

Guifang Yang and Keith E. Maskus. Intellectual Property Rights and Licensing: An Econometric Investigation. *Weltwirtschafliches Archiv*, 137, 2001b.

Pluvia M. Zuniga and Dominique Guellec. Who Licenses out Patents and Why? Lessons from a Business Survey. OECD Science, Technology and Industry Working Papers 2009/05, Organisation for Economic Co-operation and Development, Mar 2009.

APPENDIX

Overview of the Dataset

Table 1.10: Newly Industrialized Countries and Transition Economies

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	*Total*
Brazil	0	1,634	0	0	0	0	0	876	0	*2,510*
Bulgaria	0	0	0	275	0	525	0	90	0	*890*
China	696	0	0	0	0	0	0	0	0	*696*
India	0	0	0	1,999	0	0	0	0	0	*1,999*
Lithuania	0	0	0	179	0	0	0	93	0	*272*
Mexico	0	0	0	0	1,042	0	0	0	1,140	*2,182*
Philippines	0	0	0	0	0	0	0	919	0	*919*
Romania	0	0	0	578	0	0	0	173	0	*751*
Russian Federation	0	0	0	578	0	0	0	580	0	*1,158*
South Africa	0	589	0	0	0	680	0	0	0	*1,269*
Turkey	0	0	0	1,289	0	0	838	0	0	*2,127*
Ukraine	0	0	0	553	0	0	445	0	0	*998*
Viet Nam	0	0	0	513	0	0	0	767	0	*1,280*
Total	*696*	*2,223*	*0*	*5,964*	*1,042*	*1,205*	*1,283*	*3,498*	*1,140*	*17,051*

Table 1.11: Developing Countries

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	*Total*
Algeria	0	0	0	0	0	405	0	0	0	*405*
Argentina	0	0	0	0	647	0	0	0	778	*1,425*
Bolivia	0	0	0	0	362	0	0	0	116	*478*
Botswana	0	0	0	0	114	0	0	0	87	*201*
Cameroon	0	0	0	0	118	0	0	113	0	*231*
Chile	0	0	0	0	633	0	0	0	775	*1,408*
Colombia	0	0	0	0	631	0	0	0	702	*1,333*
CostaRica	0	0	0	340	0	0	0	0	318	*658*
CotedIvoire	0	0	0	0	0	0	0	164	0	*164*
DominicanRep	0	0	0	111	0	0	0	0	0	*111*
Ecuador	0	431	0	0	523	0	0	0	118	*1,072*
Egypt	0	0	958	0	0	992	0	0	0	*1,950*
ElSalvador	0	465	0	0	437	0	0	0	0	*902*
Ghana	0	0	0	0	0	291	0	0	0	*291*
Guatemala	0	455	0	0	313	0	0	0	352	*1,120*
Guyana	0	0	0	0	0	0	0	0	71	*71*
Honduras	0	449	0	0	260	0	0	0	0	*709*
Indonesia	0	0	0	0	0	0	0	1,134	0	*1,134*
Jamaica	0	0	0	75	0	0	0	0	113	*188*
Jordan	0	0	0	0	479	0	0	0	0	*479*
Kenya	0	188	0	0	0	396	0	0	0	*584*
Mauritius	0	0	0	178	0	0	0	139	0	*317*
Morocco	0	0	843	0	0	455	0	0	0	*1,298*
Nicaragua	0	452	0	0	351	0	0	0	0	*803*
Nigeria	0	0	0	0	0	947	0	0	1,549	*2,496*
Pakistan	0	0	0	0	0	764	0	0	0	*764*
Panama	0	0	0	0	236	0	0	0	110	*346*
Paraguay	0	0	0	0	371	0	0	0	117	*488*
Peru	0	0	0	0	360	0	0	0	759	*1,119*
Syria	0	0	0	0	0	0	0	335	0	*335*
Uruguay	0	0	0	0	361	0	0	0	356	*717*
Total	*0*	*2,440*	*1,801*	*704*	*6,196*	*4,250*	*0*	*1,885*	*6,321*	*23,597*

Table 1.12: Least Developed Countries

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	*Total*
Angola	0	0	0	0	213	0	0	0	130	*343*
Bangladesh	0	0	0	0	0	1,199	0	0	0	*1,199*
BurkinaFaso	0	0	0	0	51	0	0	92	0	*143*
Burundi	0	0	0	0	102	0	0	0	0	*102*
Ethiopia	0	0	0	0	359	0	0	0	0	*359*
Madagascar	0	0	0	277	0	0	0	203	0	*480*
Malawi	0	0	0	151	0	0	0	75	0	*226*
Mali	0	150	0	0	0	301	0	0	112	*563*
Mauritania	0	0	0	0	79	0	0	0	0	*79*
Mozambique	0	0	0	0	0	340	0	0	0	*340*
Senegal	0	237	0	0	0	259	0	0	0	*496*
Tanzania	0	250	0	0	270	0	0	0	0	*520*
Uganda	0	0	0	0	307	0	0	0	0	*307*
Zambia	195	0	0	0	0	304	0	0	0	*499*
Total	*195*	*637*	*0*	*428*	*1,381*	*2,403*	*0*	*370*	*242*	*5,656*

ESSAY 2

Dressed for Success? The Effect of School Uniforms on Student Achievement and Behavior (with Scott Imberman)[1]

Abstract

Uniform use in public schools is rising, but we know little about how they affect students. Using a unique dataset from a large urban school district in the southwest United States, we assess how uniforms affect behavior, achievement and other outcomes. Each school in the district determines adoption independently, providing variation over schools and time. By including student and school fixed effects we find evidence that uniform adoption improves attendance in secondary grades, while in elementary schools they generate large increases in teacher retention.

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2.1 INTRODUCTION

In 1996, the US Department of Education found that only 3% of public schools required uniforms. As a result of this and in the belief that uniforms make "schoolrooms more orderly [and] more disciplined," President Clinton and the Department of Education encouraged schools to adopt uniforms (Mitchell, 1996). This led to substantial growth in the use of uniforms in public schools. By 2005 uniform adoption had more than quadrupled as it spread to 14% of public schools.[2] Today, many large school districts have some schools that require students to wear uniforms. Most notably Philadelphia public schools require all students to wear uniforms while New York City, Long Beach, and Dallas require uniforms in pre-secondary grades. Other large school districts, including Miami-Dade, Houston, Chicago, and Boston, permit individual schools to adopt uniforms.

Despite their widespread use and even though politicians and administrators specifically cite improvements in discipline and achievement as justifications for uniform adoption (Archibold, 1998; Los Angeles Daily News, 2009; Steinberg, 1998), the effects of uniforms on students remain unclear. In addition, proponents of uniforms suggest that the largest impacts may be on non-cognitive skills such as self-esteem and discipline. Recently researchers have established that non-cognitive skill formation is an important part of education and may be just as important a determinant of students' future social and employment success as academic ability (Heckman and Rubinstein, 2001; Heckman et al., 2006; Imberman, 2011; Jacob, 2002; Segal, 2009).

In this paper, we identify the impact of uniforms on student achievement, attendance and behavior using student-level panel data from a large urban school district in the southwest United States (LUSD-SW). Since schools in LUSD are free to set their own uniform policies and most schools adopt uniforms during the time period for which we have data, we are able to produce causal estimates of uniform impacts on student outcomes through the use of school, student and principal fixed effects.

Theoretically it is unclear how uniforms might affect students' achievement and behavior. Uniforms could improve student outcomes through a few mechanisms. First, they

[2]US Department of Education, National Center for Education Statistics

potentially provide direct improvements in safety by making it easy to identify unauthorized visitors to a school, preventing the use of gang colors and insignia, and reducing theft since students no longer bring expensive clothing items to school (Stanley, 1996). For example, the Los Angeles Times argues that "in gang-plagued areas where wearing a certain color is enough to set off a fight, [uniforms] create a more neutral atmosphere on campus" (Los Angeles Times, 2009). Second,uniforms may instill respect for authority in students which, in turn, could improve behavior and reduce classroom disruptions. Third, a concern for adolescents, particularly girls, is that there may be substantial peer pressure to dress well which could, in turn, lead to low self-esteem if a child is unable to dress "properly" due to low income or parental preferences. Uniforms negate much of this peer pressure by requiring students to wear the same clothing.

Uniforms also make the process of dressing for school faster, particularly for adolescent girls, potentially providing extra time for sleeping or studying. For example, at a high school near Boston a senior remarks that "for some people it takes hours to get dressed. If we had a uniform it would take three minutes" (Alspach, 2007). Finally, uniforms provide an additional tool that administrators and teachers can use for discipline by providing students with rewards of "uniform-free" days for good behavior.

Nonetheless, uniforms could negatively affect student outcomes. One possibility is that the restrictiveness of uniforms induces students to become disruptive as a way to rebel against authority or increased conformity could make school boring. Another possibility is that improvements generated by uniforms could induce students with behavioral problems who would otherwise have attended alternative education environments such as charter schools or dropped out of school to remain in the public schools. This could ultimately reverse improvements from uniforms via negative peer effects (Carrell and Hoekstra, 2010; Gaviria and Raphel, 2001; Figlio, 2007; Imberman et al., forthcoming). On the other hand, such an impetus to remain in the public schools could also occur for high quality students, and thus uniforms could generate a positive peer effect in the long run. Finally, some research has suggested that uniforms may actually reduce self-esteem as it restricts the ability of students to express themselves (Wade and Stafford, 2003).

There are also considerations beyond student behavior and achievement when schools

decide whether to adopt uniforms. In particular, opponents argue that uniforms restrict students' rights and impose financial hardships (Brunsma and Rockquemore, 1998). For example, a recent report in Britain found that uniform costs varied by a factor of 10 and climbed as high as £200 (BBC, 2003). While most schools with uniform policies in the US provide subsidies to low-income families, the remaining share of costs may still be substantial.

Despite the large growth in the use of uniforms in public schools over the past decade, there is very little empirical research that assesses their impacts on student outcomes. Brunsma and Rockquemore (1998) compare students who attend schools with and without uniforms in a nationally representative sample of high-school students. They find little difference in absenteeism, behavior problems, and substance abuse while uniforms correlate negatively with test scores.[3] Brunsma (2004) and Yeung (2009) conduct further analyses using similar data and find no significant impact on behavior or achievement. Stanley (1996) finds, on the other hand, that behavior improved after the Long Beach Unified School District instituted uniforms.[4]

A potential drawback with these studies is that they rely on cross-sectional variation in uniform status.[5] The exception is Stanley (1996), who compares results before and after adoption, but in this case she is limited to a district-wide change which might be contemporaneous with general trends in behavior. Hence, the estimates are subject to bias as schools and districts that choose to adopt uniforms may be inherently different from those that do not. Of particular concern is that schools and districts that adopt uniforms are likely to have lower achievement and more behavioral problems than those that choose not to adopt uniforms. In addition, students and parents may choose schools in part based on whether or not they have uniforms. Alternatively, if uniforms have an impact on student

[3]Bodine (2003) notes that their sample of schools that require uniforms are almost all private schools and hence the results may not apply to public schools.

[4]A related paper is Evans et al. (2008) who evaluate a random lottery that gave uniforms to students in Kenya. They find improvements in attendance and, preliminarily, test scores for students who receive uniforms. However, while this suggests that uniforms can be effective tools at improving student outcomes, the context is very different from the United States. In this case the authors do not evaluate a policy change of imposing uniforms, rather they measure the impact of providing uniforms for free to students in schools where they are already required. This reduces the cost of education for those students, who would have had to purchase the uniforms otherwise. Thus, they are not able to evaluate the effect of a change in uniform policy.

[5]Yeung improves on the regression models by focusing on value-added scores rather than test score levels.

outcomes parents may respond to this by changing schools. For example, parents may treat uniforms as a signal by administrators that they are working to improve a school. In this case, parents who are more concerned about their children's education would be inclined to switch to schools with uniforms. Since parental concern is correlated with student outcomes, estimates that do not account for this would be biased. While controlling for school and student characteristics helps address these biases, they are very likely to be insufficient as there are many aspects of a school's decision to adopt uniforms, such as principals' preferences for discipline and the quality of teachers, and parents' decisions to send their children to uniformed schools that affect student outcomes and are inherently unobservable.

The sparseness and identification difficulties of the prior literature provide an unclear picture of how uniforms affect student outcomes. To fill this gap in the literature, we address the selection problem by exploiting the panel nature of our data. As such, we include student and school fixed effects in our models. These account for unobservable characteristics of students and schools themselves that are correlated with uniform status and fixed over time. We also provide models that further control for principal fixed effects. These help account for uniform adoption that is correlated with the disciplinary preferences of school leaders. Using this strategy we are able to provide, to our knowledge, the first causal estimates of the impact of uniforms on achievement, attendance, behavior, retention and school switching. We also investigate whether uniforms affect teacher attrition, which has become increasingly problematic in urban schools.[6]

In contrast to most of the prior literature, we find that uniforms generate improvements in attendance in middle and high/school. The attendance results are particularly strong for girls. We also find that uniforms significantly reduce teacher attrition in elementary schools. This is an intriguing result as it suggests that uniforms can potentially serve as a tool to help keep experienced teachers in low-income urban schools. Nonetheless, uniforms have little impact otherwise. We find no statistically significant effect on disciplinary infractions, achievement, grade retention or student movements between schools. Hence, overall we conclude that the effects of uniforms are minimal with the exceptions of attendance for middle

[6]See e.g. Boyd et al. (2010); Clotfelter et al. (2008); Feng (2010); Rivkin et al. (2005); and Watlington et al. (2010).

and high-school students and teacher attrition in elementary schools. Although we cannot completely rule out that other contemporaneous policy enactments generate the attendance and teacher attrition effects rather than uniforms, the robustness of our estimates to the inclusion of principal fixed effects, the finding that our estimates are similar when we account for adoption under new principals, and the lack of any increase in disciplinary infractions even in the short term suggest that the results are unlikely to be due to concurrent changes in enforcement policies.

2.2 UNIFORMS IN LUSD-SW

LUSD is an urban school district with more than 200,000 students and close to 300 schools, making it one of the largest in the country. The district has substantial poverty - 59% of students qualified for free or reduced-price lunch in 2006-07. Like other urban school districts it is also heavily minority - 59% of students are Hispanic and 29% are African-American. Parents of students in LUSD have a number of choice options which could allow students to move in response to uniform policies. First, LUSD itself has a large magnet program. Second, the LUSD area has a substantial number of charter schools and private schools. In 2004-05 state charter schools near to or within LUSD's boundaries had a population equal to 9% of LUSD's enrollment. LUSD is also surrounded by many suburban school districts.[7] Given these characteristics of the district, we will consider how uniforms affect student movements in addition to test scores, attendance, retention and behavior.

LUSD has permitted its schools to require students to wear uniforms since at least 1992.[8] Initially, only a handful of schools required uniforms. However, uniform adoption grew substantially over the following 13 years. Of schools that responded to our survey of uniform policies, which we describe in more detail below, only 10% required uniforms in 1993. By 2006, 82% of these schools required uniforms. In addition, no schools abandoned uniforms after adoption. These characteristics suggest that parents and school administrators in LUSD generally believe that uniforms are helpful.

[7] Eleven districts directly border LUSD.

[8] The earliest any school required uniforms was in 1968, but this was a school operating under contract with LUSD rather than being directly run by LUSD. Of LUSD's own schools, the earliest date provided in our survey of uniform policies was 1992.

Schools are given wide latitude by LUSD in designing their uniform policies. Nonetheless, while certain characteristics of school uniforms vary across schools, such as color choices and whether a specific shirt purchased from the school is required, the policies are very similar. As of the 2007-08 school year, all schools that require uniforms mandate specific colors and styles for both shirts and pants. Almost all of these schools specify between 1 and 3 colors for shirts, and casual or denim pants in khaki or navy colors. Some schools specifically limit students to wearing polo style shirts. Only a handful of schools require students to purchase specific shirts with a school logo. Some middle and high schools also require different grades to wear assigned colors. The most common uniform includes a polo style shirt in one of the school's colors combined with khaki, denim, or navy pants. Girls are generally given the option of wearing pants or skirts.[9]

2.3 EMPIRICAL STRATEGY

The primary concern with an analysis of the effects of school uniforms on student outcomes is that schools and districts choose whether or not to adopt uniforms. As a result uniform adoption is likely correlated with unobservable characteristics of the school that could affect student performance, such as neighborhood characteristics or parental involvement in the school. If this is the case, then *naïve* OLS estimates will be biased. The selection process is further complicated by the possibility that schools adopt uniforms in response to existing achievement and behavior levels or even trends in student outcomes. For example, schools may decide to adopt uniforms in response to increasing discipline problems. In addition, parents and students may respond to uniform policies by changing schools.

We can model this framework as

$$Y_{ijt} = \alpha + \beta \cdot Uniform_{jt} + X_{ijt}\Omega + \gamma_i + \delta_j + \epsilon_{ijt}, \tag{2.1}$$

[9]Disobeying a mandatory uniform policy is considered a "level II" disciplinary infraction, which requires intervention by a school administrator. Such a violation can result in a variety of punishments depending on the severity of the infraction and the student's prior behavior. These can range from a call to the student's parent to in-school suspension, although the administrator is given discretion to increase or reduce the punishment beyond this range if necessary. Repeated violations can result in out-of-school suspension or placement in a disciplinary alternative education center.

where Y_{ijt} is an outcome for student i in school j and academic year t, $Uniform$ is an indicator for whether or not the student has to wear a uniform, X is a set of student characteristics and grade-by-year fixed effects. While we use this model to measure behavioral impacts such as attendance and discipline as well as grade retention and school switching, as is standard in education production models we look at the impact on changes in achievement via a restricted value-added model. Hence for achievement models the dependent variable is $Y_{ijt} - Y_{ij,t-1}$. γ, δ and ϵ are error terms where γ varies over students but not schools or time, δ varies over schools but not students or time, and ϵ varies over schools, students and time. Ideally we would want $Uniform$ to be uncorrelated with γ, δ, and ϵ, but due to the reasons described above this is unlikely. Table 2.1 provides some evidence for this. Using the first year of our data, 1993, we provide characteristics of schools by whether they never adopt uniforms, are early adopters, or are late adopters of uniforms. While schools that adopt late are generally similar to those that adopt early, schools that never adopt uniforms have statistically significantly higher achievement, lower free lunch eligibility rates, and smaller minority populations.

Thus, a simple regression that compares schools with uniforms to those without uniforms will likely be biased. The availability of panel data where schools adopt uniforms at different times and students move between schools with and without uniforms allows us to use student and school fixed effects to address this concern. This procedure accounts for any unobserved characteristics of students and schools that may affect the school's decision to adopt uniforms, the parents' decision to move their child to a school with uniforms, and student outcomes, as long as these characteristics do not vary over time. Thus, we correct for omitted variables such as parents' preferences for discipline, students' innate tendencies to misbehave, student ability, and schools' long-term problems with discipline and test scores.

Hence, in our model bias remains only if students select into uniformed schools or schools adopt uniforms based on time-varying characteristics. To test the validity of this strategy, we will provide event-study analyses that track student outcomes in each year before and after uniform adoption, so that we might identify if there is any evidence of additional trending after controlling for the fixed effects. Since uniforms may have different impacts

Table 2.1: School Characteristics in 1993

	Elementary			Middle/High		
	Early Adopter	Late Adopter	Never Adopter	Early Adopter	Late Adopter	Never Adopter
Female	0.49	0.49	0.49	0.49	0.49	0.48
	(0.02)	(0.03)	(0.03)	(0.10)	(0.03)	(0.05)
African-American	0.31	0.46**	0.25	0.40	0.46	0.43
	(0.33)	(0.31)	(0.30)	(0.30)	(0.36)	(0.34)
Hispanic	0.53	0.42	0.41	0.44	0.44	0.31
	(0.33)	(0.29)	(0.33)	(0.27)	(0.34)	(0.26)
White	0.14	0.09	0.30**	0.14	0.08	0.21
	(0.19)	(0.14)	(0.14)	(0.14)	(0.11)	(0.21)
Free Lunch	0.68	0.69	0.46**	0.46	0.40	0.21***
	(0.22)	(0.18)	(0.29)	(0.16)	(0.17)	(0.11)
Reduced-Price Lunch	0.04	0.04	0.04	0.02	0.01	0.01***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Limited English	0.32	0.28	0.24	0.15	0.15	0.10
Proficiency	(0.21)	(0.21)	(0.24)	(0.12)	(0.13)	(0.13)
At-Risk Status	0.56	0.55	0.44*	0.59	0.68*	0.56
	(0.17)	(0.16)	(0.23)	(0.18)	(0.14)	(0.29)
Special Education	0.10	0.10	0.10	0.16	0.12	0.20
	(0.03)	(0.04)	(0.04)	(0.19)	(0.05)	(0.25)
Gifted and Talented	0.08	0.06	0.21	0.11	0.04*	0.22
	(0.12)	(0.10)	(0.27)	(0.17)	(0.08)	(0.36)
TAAS Math	0.37	0.38	0.51**	0.33	0.27	0.46
Pass Rate	(0.15)	(0.17)	(0.19)	(0.19)	(0.11)	(0.20)
TAAS Reading	0.50	0.49	0.62**	0.44	0.38	0.49
Pass Rate	(0.15)	(0.16)	(0.18)	(0.20)	(0.09)	(0.19)
Disciplinary Infractions	0.04	0.03	0.02	0.54	0.44	0.17***
	(0.06)	(0.02)	(0.03)	(0.36)	(0.39)	(0.12)
Attendance Rate	95.9	95.6	96.3	92.1	92.1	93.4
	(0.9)	(1.1)	(0.8)	(6.4)	(3.1)	(2.3)
Observations	*72*	*30*	*14*	*21*	*22*	*9*

'Early adopters' adopt uniforms prior to 2001; 'late adopters' adopt from 2001 to 2007. Standard deviations in parentheses. Means shown in table are unweighted averages over school-level means. *, **, *** denote that mean is significantly different from early adopters at the 10%, 5%, and 1% levels, respectively.

by gender and grade level, we conduct all of our analyses separately for males and females and for elementary (grades 1-5) and middle/high school (6-12) grades as well as providing pooled estimates. Further, we estimate variations on the model in equation (2.1) to look at different effects by student race, economic status and achievement. In addition, we test whether uniform effects vary by student characteristics given the student is in a school with other students like him or her – i.e. does the effect on African-American students in a heavily African-American school differ from African-American students in a heavily white and Hispanic school?

A second concern is that uniform adoption by a school may be part of a wider policy change. Of particular concern is that uniforms may be implemented concurrently with changes in discipline enforcement. To the extent that this is true, then our estimates represent the reduced-form impact of such a policy combined with uniform adoption. Unfortunately there is no way to test for this directly, since enforcement enhancements – as well as other policy changes – are unobservable.

While we cannot fully rule out that our estimates pick up the effects of other policies that are adopted contemporaneously with uniforms, we nonetheless provide some analyses that assess the extent to which changes in policy may be affecting our estimates. First, we conduct regressions that include principal fixed effects. This addresses the possibility that principals who are strict disciplinarians may be more inclined to adopt uniforms or when certain principals consistently institute a set of policies combined with uniforms in different schools. Results using this model are similar to our baseline estimates. Our second test is to interact uniform status with whether a school's uniform is adopted during the first two years of a principal's term. This addresses the possibility that some schools respond to worsening behavior by bringing in a new principal who includes uniforms as part of a package of reforms. In addition, new principals may be more willing to experiment with different strategies, including uniforms. If these phenomena were driving our estimates we would expect to see statistically significantly different impacts for uniforms adopted early in a principal's term relative to later. While we do find that new principals who adopt uniforms have higher infraction rates than old principals, there is no statistically significant difference in achievement gains or attendance. Finally, and perhaps most importantly, when we break

down infractions into those resulting in an in-school suspension and those resulting in an out-of-school suspension, we find no significant impact on either type of punishment. Nor do we find statistically significant changes in the rates of in-school suspensions relative to more severe infractions in school-level regressions. If administrators increased enforcement concurrent with uniform adoption, we would expect to see more incidences of disciplinary infractions, at least temporarily. Hence, while we cannot rule out the possibility that enforcement plays a role in our results, these tests suggest that such a story is unlikely.

2.4 DATA

In this paper we utilize two sources of data from a large urban school district in the south-west United States (LUSD-SW). The first is a set of administrative records for students in LUSD from 1993 through 2006.[10] This data includes student demographics, test scores, disciplinary records and attendance records for every student in LUSD. Testing data include students's scaled scores on the Stanford Achievement Test (9^{th} & 10^{th} editions) which we standardize within grade and year.[11] The Stanford Achievement Test is a nationally normed standardized exam that LUSD administers annually in grades 1 through 11. The exams are "low stakes" in the sense that they do not count towards state accountability requirements or requirements of the Federal "No Child Left Behind" Act. However, students do need to achieve minimum scores on the reading and math portions to advance to the next grade. Discipline data includes any infraction that results in an in-school suspension or more severe punishment. Attendance records include the attendance rate for each student. Test score data is only available starting in 1998-99, hence while we use all years for estimates of the impacts on attendance, discipline, grade retention, school switching and the likelihood of leaving LUSD, we must restrict our analysis to 1998-99 and later for test score analyses.

Unfortunately, LUSD does not keep centralized records of when schools adopted uni-

[10]Since the data used in this study are confidential, researchers interested in replication studies or access to the data for other reasons should contact the authors to be informed of the district identity. In order to access the data the researchers will be required to submit a research proposal to LUSD's research office. Upon receiving written approval from LUSD we will provide the data directly to the requestors.

[11]In 2005-06 and 2006-07 LUSD received some evacuees from Hurricanes Katrina and Rita. While we keep these students in the data, they do not contribute to the standardization. Results dropping evacuees are nearly identical.

forms. Thus, we emailed and mailed a survey to the principal of each school in LUSD with the following questions in the fall of 2007:

- *Does your school currently require students to wear uniforms? Note that we define a uniform as any outfit where a particular style of shirt (i.e. polo) and bottom (i.e. khaki, skirt, etc.) and a specified color are required.*
- *If your school currently requires uniforms, what school year did you first require them? Were there any years since then when the requirement was suspended?*
- *If your school currently does not require uniforms, did you ever require them in the past, and if so, could you please provide the years during which students were required to wear uniforms?*

We then followed up via telephone with any school that did not respond to the initial survey or to clarify their answers. If the principal did not know the date we requested that he or she ask his or her staff members. Data collection was completed in October, 2008.[12] For the 292 schools that were in operation in the 2007-08 school year, 79% were able to provide dates of uniform adoption, while the date could not be determined for 14% and 7% of the schools refused to participate in the survey.[13] Figure 2.1 shows the number of schools in LUSD that require uniforms, do not require uniforms, or for which the uniform requirements could not be determined. Since our survey was based off of schools existing in 2007-08, earlier years have higher rates of unknown uniform status than later years. Nonetheless, it is clear that the number of schools requiring uniforms increased substantially over the course of the sample. Since we use school fixed effects to help identify the uniform impact it is also important to know how many schools switch to requiring uniforms over the course of the sample. From 1993-04 to 2006-07 166 schools adopt uniforms. From 1999-00 through 2006-

[12] In some cases we were provided a range of years or a statement that uniforms had been required since a certain date. In these cases if the dates provided were after the start of our sample period we followed up and requested that the principal ask other staff and faculty to identify specific dates of adoption. If an exact date still could not be determined we dropped that school from our sample.

[13] Some schools responded that the uniform policy was adopted before a certain date. In these cases, unless that date was prior to the start of our data in 1993, we considered the uniform adoption date for those schools to be unknown. This occurs for 13 schools. In addition three schools stated that they recommended but did not require uniforms. These schools are considered to not have a uniform for the purposes of this study since there would be no punishment for the student if they choose not to wear the uniform.

07, the period after the first year of testing data, 84 schools adopt uniforms. Hence there is substantial variation in policies during the period for which we have data.[14]

Table 2.2 provides summary statistics for students by their school's uniform status split by grade level. In general, uniform and non-uniform schools have similar demographics, the exceptions being that students in middle/high grades who attend uniform schools are poorer, students in uniformed elementary schools are more likely to be at-risk, and students in both elementary and middle/high schools with uniforms are more likely to be Hispanic.[15] In terms of outcomes, test scores are higher in elementary non-uniform schools than in uniform schools, albeit generally not significantly so, while for both grade levels uniform schools have more disciplinary infractions and higher attendance rates.

In general, the schools for which we could not determine uniform policies are demographically similar to the rest of the schools in LUSD, although elementary schools have more minority and low-income students. On the other hand, the schools with unknown uniform status have consistently lower test scores than schools where uniform status is known. This leads to a concern that our results may be biased due to survey non-response. The school fixed effects mitigate this concern as they limit the bias to non-response based on time-varying characteristics of schools. Nonetheless, some bias may remain. To address this, we conduct inverse-probability weighted regressions where observations are weighted by the inverse of the predicted values from a propensity score of the likelihood of a school being included in the sample.[16] Estimates using this procedure are very similar to our main estimates.[17] Hence, it appears unlikely that our results are affected by non-response bias.

[14]The LUSD data also includes 39 charter schools directly authorized by LUSD. However, while large in numbers, they make up a small portion of the observations (2.4%) and only 8 changed uniform policies during the time span of our data. Hence, due to the school fixed effects, very few charters contribute to the identification. Indeed, results that exclude charter schools are very similar to our main results.

[15]A student is considered at-risk if he or she is low-achieving, has previously been retained, is pregnant or a parent, is LEP, has been placed in alternative education or juvenile detention, is on parole or probation, is homeless, or has previously dropped out of school.

[16]We estimate a probit of being in the sample from the universe of schools in LUSD from 1993 through 2006. Data is from the state education agency. We include year dummies; per-student total and instructional expenditures; enrollment shares by race, economic disadvantage, limited-English proficiency, vocational program, special education, bilingual education, gifted, grade level, and mobility; teacher experience, baseline salaries, tenure, and specialization; and student-teacher ratios in the regressions. See Wooldridge (2002, pg. 587-590) for a technical treatment.

[17]Results provided in Appendix Table 2.13.

Figure 2.1: Uniform Adoption in LUSD-SW

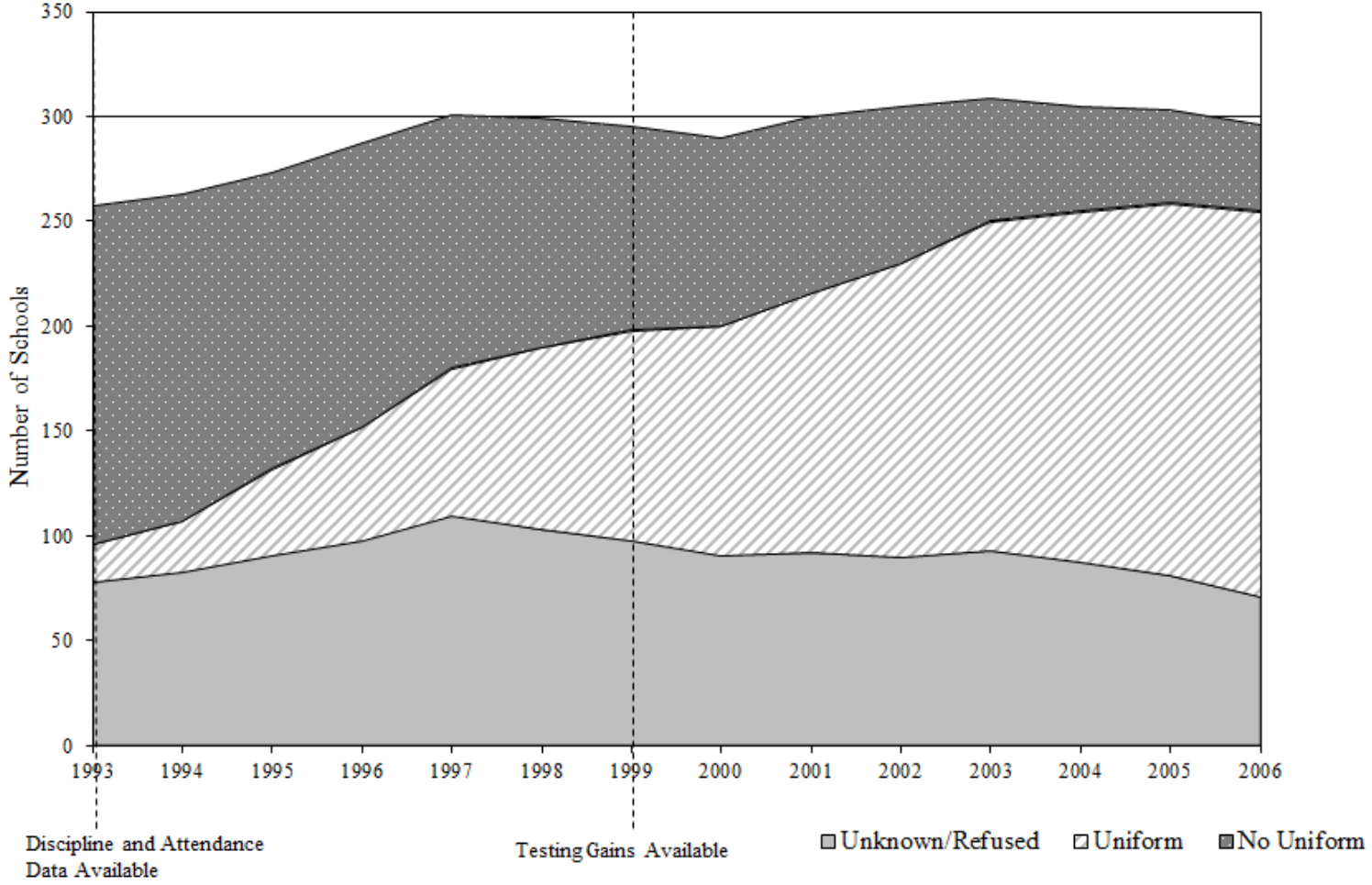


Table 2.2: Student-Level Descriptive Statistics

	Elementary			Middle/High		
	Uniform not Req.	Uniform Req.	Unknown	Uniform not Req.	Uniform Req.	Unknown
			A. Demographics			
Female	0.49	0.49	0.49	0.49	0.51*	0.48
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
African-American	0.30	0.27	0.41*	0.36	0.30	0.33
	(0.46)	(0.44)	(0.49)	(0.48)	(0.46)	(0.47)
Hispanic	0.52	0.60**	0.53	0.48	0.58**	0.53
	(0.50)	(0.49)	(0.50)	(0.50)	(0.49)	(0.50)
White	0.15	0.10*	0.04**	0.12	0.09**	0.11
	(0.35)	(0.30)	(0.19)	(0.33)	(0.28)	(0.31)
Free Lunch	0.65	0.67	0.77***	0.43	0.58***	0.54*
	(0.48)	(0.47)	(0.42)	(0.50)	(0.49)	(0.50)
Reduced Price Lunch	0.07	0.09***	0.08**	0.04	0.09***	0.06***
	(0.25)	(0.29)	(0.26)	(0.20)	(0.29)	(0.24)
Limited English Proficiency	0.34	0.37	0.35	0.15	0.13	0.16
	(0.47)	(0.48)	(0.48)	(0.36)	(0.34)	(0.37)
At Risk Status	0.52	0.59***	0.58*	0.58	0.59	0.58
	(0.50)	(0.49)	(0.50)	(0.49)	(0.49)	(0.49)
Special Education	0.10	0.09*	0.10	0.12	0.13	0.13
	(0.30)	(0.29)	(0.29)	(0.33)	(0.33)	(0.34)
Gifted and Talented	0.12	0.11	0.05***	0.12	0.12	0.10
	(0.32)	(0.31)	(0.22)	(0.33)	(0.32)	(0.30)
Observations	*402,728*	*490,802*	*323,302*	*704,605*	*368,928*	*204,752*
			B. Outcomes			
Stanford Math	0.15	0.00	-0.13***	0.01	0.01	-0.03
	(1.07)	(0.98)	(0.93)	(1.03)	(0.99)	(0.96)
Observations	*117,571*	*288,711*	*140,731*	*259,019*	*280,540*	*106,024*
Stanford Reading	0.19	0.00*	-0.16***	0.00	0.01	-0.03
	(1.09)	(0.98)	(0.93)	(1.03)	(0.99)	(0.96)
Observations	*117,522*	*288,343*	*140,792*	*258,077*	*280,291*	*105,879*
Stanford Language	0.17	0.00	-0.15***	0.01	0.02	-0.07
	(1.08)	(0.98)	(0.94)	(1.03)	(0.99)	(0.96)
Observations	*117,604*	*288,718*	*140,792*	*258,077*	*280,291*	*105,879*
Disciplinary Infractions	0.06	0.09***	0.10***	0.64	0.92***	0.82*
	(0.40)	(0.50)	(0.55)	(1.60)	(2.00)	(1.85)
Observations	*402,728*	*490,802*	*323,302*	*704,605*	*368,928*	*204,752*
Attendance Rate	96.1	96.7***	96.1	92.2	93.7***	92.2
	(6.4)	(4.1)	(5.0)	(11.1)	(9.5)	(12.0)
Observations	*389,968*	*488,163*	*317,929*	*687,822*	*367,906*	*200,375*

Standard deviations in parentheses. All test scores are measured in standard deviations from the grade-year mean scale score. Elementary includes students in grades 1 through 5. Middle/high includes grades 6 through 12. *, **, *** denote that estimates from a regression of the outcome on "uniform required" or "unknown" relative to "uniform not required" is significantly different from early adopters at the 10%, 5%, and 1% levels, respectively. Standard errors in these regressions are clustered by school.

2.5 RESULTS

2.5.1 Determinants of Uniform Adoption

Before analyzing the impacts of uniforms, it is useful to understand why schools in LUSD choose to adopt uniforms. In Table 2.3 we provide estimates from probit regressions of the likelihood of adopting uniforms on mean student characteristics in a school the prior year. In addition to the variables listed in the table, the regressions include year indicators and controls for the share of the students in each grade level. To avoid contaminating these estimates with changes induced by uniforms we exclude all school-years after uniform adoption. These results paint a nuanced picture of the determinants of adoption depending on whether the school is elementary or secondary. First, elementary schools appear to adopt when they are gaining more students but with less spending per student. One possible explanation is these schools use uniforms as a way to maintain control in the school when there are fewer resources available for behavior monitoring. Peculiarly, however, schools also adopt when student teacher ratios fall. Schools also appear to adopt when the share of students who have special needs falls. These conflicting factors make it difficult to assess whether elementary schools adopt uniforms for specific reasons.

For secondary schools, on the other hand, the estimates in Table 2.3 provide a clearer picture. The schools adopt uniforms when they have high rates of low-income non-minority, at-risk, and special education students. Hence, uniform adoption in secondary schools is associated with having higher special needs populations. A potential explanation for this is that when schools gain large special needs populations, discipline becomes harder to control and so schools adopt uniforms in an attempt to compensate. While the estimate on disciplinary infractions is not statistically significant, it is positive with a t-statistic greater than one. Unfortunately, if schools behave in this fashion, it potentially generates identification problems. First, it highlights the possibility that schools adopt uniforms in response to increases in discipline problems. Second, it indicates that uniforms may be part of a larger package of reforms with the goal of improving discipline. Below, we provide evidence that the former concern does not appear to play a major role in our results. We will also provide some evidence consistent with our results deriving from uniforms themselves

Table 2.3: Probit Estimates of Uniform Adoption on Prior-Year School Characteristics

	All Schools (1)	Elementary (2)	Middle/High (3)
Enrollment (in thousands)	0.278*	0.449**	-0.470
	(0.146)	(0.188)	(0.319)
	[0.045]	[0.083]	[-0.084]
Female Share	1.452	1.149	4.449**
	(1.415)	(1.838)	(1.779)
	[0.237]	[0.205]	[0.637]
Economic Disadvantage Share	0.497	-0.555	2.388***
	(0.539)	(0.836)	(0.779)
	[0.081]	[-0.099]	[0.342]
African-American Share	-1.614**	-0.484	-3.997***
	(0.791)	(0.998)	(1.380)
	[-0.263]	[-0.086]	[-0.573]
Hispanic Share	-1.396	-0.235	-3.280**
	(0.876)	(1.135)	(1.399)
	[-0.228]	[-0.042]	[-0.470]
Other Non-White Share	-5.657**	-4.472	-9.759**
	(2.819)	(3.259)	(3.841)
	[-0.923]	[-0.798]	[-1.398]
At-Risk Share	0.808	1.085	2.105**
	(0.648)	(0.950)	(0.930)
	[0.132]	[0.194]	[0.302]
Special Education Share	0.216	-2.782**	2.636**
	(0.785)	(1.319)	(1.170)
	[0.035]	[-0.497]	[0.378]
Gifted Share	-1.285**	-1.569**	0.621
	(0.646)	(0.797)	(0.613)
	[-0.210]	[-0.280]	[0.089]
Limited English Proficiency Share	-0.682	-0.701	-2.503**
	(0.657)	(0.980)	(1.001)
	[-0.111]	[-0.125]	[-0.359]
Per-Pupil Total Operating Expenditures (in USD thousands)	-0.041	-0.171***	-0.014
	(0.029)	(0.047)	(0.041)
	[-0.007]	[-0.031]	[-0.002]
Mean Teacher Experience	0.083	0.002	0.137
	(0.062)	(0.069)	(0.100)
	[0.014]	[0.000]	[0.020]
Mean Teacher Tenure	-0.077	0.002	-0.135
	(0.066)	(0.072)	(0.101)
	[-0.013]	[0.000]	[-0.019]
Student-Teacher Ratio	-0.074***	-0.087**	-0.014
	(0.029)	(0.036)	(0.047)
	[-0.012]	[-0.015]	[-0.002]
Mean Attendance Rate	0.002	0.100	-0.014
	(0.027)	(0.078)	(0.034)
	[0.000]	[0.018]	[-0.002]
Mean Disciplinary Infraction Rate	0.238	0.589	0.196
	(0.148)	(0.547)	(0.157)
	[0.039]	[0.105]	[0.028]
Observations	*1,281*	*795*	*646*

Standard errors clustered by school in parentheses. Average marginal effects in brackets. Regressions also include year indicators and controls for student share in each grade. Some schools are categorized as elementary if they have any students in grades KG-5 and middle/high if there are any students in grades 6-12. Schools with students in both grade ranges are included in both elemenatary and middle/high samples. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

and not from other policy changes. Nonetheless, we acknowledge that we will not be able to fully rule out such a scenario.

2.5.2 Impacts on Discipline and Attendance

Since uniform proponents often cite behavioral improvements as the main benefit of uniforms, we start by considering the impact of uniforms on disciplinary infractions and attendance. Table 2.4 provides our primary estimates of these outcomes for elementary and secondary students, respectively.[18] Columns (1) and (3) include school and student fixed effects, along with controls for students' economic status, and grade-year fixed effects. Columns (2) and (4) provide estimates where we add principal fixed effects.[19]

For elementary school students we find little evidence of uniforms having impacts on attendance or disciplinary infractions. On the other hand, for middle and high school students, we find significant improvements in attendance rates, particularly for females. School fixed effects estimates in column (3) indicate that female attendance increases by a statistically significant 0.3 percentage points after uniform adoption. This is equivalent to an additional $\frac{1}{2}$ day of school per year in a 180 day school-year. For males the point estimate is 0.2 pp but it is not statistically significant. However, in column (4), when we add the principal fixed effects, the estimates get larger, with female and male impact estimates rising to 0.5 and 0.4 pp, respectively. These estimates are statistically significant for both genders. For disciplinary infractions, estimates for middle/high school students are similar to those for elementary students.[20]

As mentioned above, a concern with these estimates is that they may be due to uniforms being adopted concurrently with an increase in discipline enforcement and other policy changes. If this is the case then we may be misidentifying the uniform impact as a more general impact of school reform. In addition to the robustness of our results to principal

[18] Appendix Table 2.14 provides counts for each of the fixed effects in these models.

[19] LUSD principals undergo a substantial amount of churn as 14% of schools in LUSD get a new principal each year. This common movement of principals between schools is useful for this analysis as it ensures a substantial amount of variation remains even after controlling for both principal and school fixed effects. We also found that results were similar to baseline if instead of principal fixed effects we used principal-school spell fixed effects in place of school fixed effects.

[20] Estimates for discipline and attendance using gains models are qualitatively similar with the exception of a significant negative effect for elementary male attendance. These results are provided in Appendix Table 2.15.

Table 2.4: Effect of Uniforms on Discipline and Attendance

		Elementary		Middle/High	
		(1)	(2)	(3)	(4)
		A. Attendance Rate			
All	Uniform Required	-0.018	-0.015	0.261*	0.422***
		(0.040)	(0.044)	(0.143)	(0.150)
	Observations	*878,131*	*862,248*	*1,055,728*	*1,027,308*
Females	Uniform Required	0.037	0.045	0.318**	0.463***
		(0.042)	(0.047)	(0.141)	(0.166)
	Observations	*429,626*	*421,916*	*525,447*	*511,404*
Males	Uniform Required	-0.064	-0.069	0.195	0.377**
		(0.044)	(0.050)	(0.155)	(0.146)
	Observations	*448,505*	*440,332*	*530,281*	*515,904*
		B. Disciplinary Infractions			
All	Uniform Required	0.013	-0.003	0.021	0.018
		(0.012)	(0.008)	(0.056)	(0.059)
	Observations	*893,530*	*877,342*	*1,073,533*	*1,044,250*
Females	Uniform Required	0.002	-0.003	-0.013	0.016
		(0.006)	(0.004)	(0.042)	(0.046)
	Observations	*436,940*	*429,092*	*534,135*	*519,690*
Males	Uniform Required	0.023	-0.004	0.053	0.020
		(0.019)	(0.012)	(0.073)	(0.074)
	Observations	*456,590*	*448,250*	*539,398*	*524,560*
Student fixed effects		X	X	X	X
School fixed effects		X	X	X	X
Principal fixed effects			X		X

Standard errors clustered by school in parentheses. Elementary covers grades 1-5 and middle high covers grades 6-12. Each regression includes grade-by-year indicators, and the student's free lunch, reduced-price lunch, or other economic disadvantage status. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Counts for the number of student, school and principal fixed effects in each regression are provided in Appendix Table 2.14.

Table 2.5: Effect of Uniforms on In-School and Out-of-School Suspensions

		Elementary		Middle/High	
		(1)	(2)	(3)	(4)
		A. In-School Suspensions			
All	Uniform Required	0.005	-0.000	0.057	0.047
		(0.006)	(0.004)	(0.051)	(0.062)
	Observations	*768,016*	*753,495*	*919,504*	*894,079*
Females	Uniform Required	0.001	-0.000	0.021	0.041
		(0.002)	(0.002)	(0.041)	(0.049)
	Observations	*375,500*	*368,460*	*457,541*	*445,068*
Males	Uniform Required	0.007	-0.000	0.093	0.054
		(0.010)	(0.006)	(0.064)	(0.075)
	Observations	*392,516*	*385,035*	*461,963*	*449,011*
		B. Out-of-School Suspensions			
All	Uniform Required	0.011	-0.002	-0.031	-0.018
		(0.012)	(0.006)	(0.023)	(0.018)
	Observations	*768,016*	*753,495*	*919,504*	*894,079*
Females	Uniform Required	0.002	-0.004	-0.031*	-0.017
		(0.006)	(0.003)	(0.016)	(0.014)
	Observations	*375,500*	*368,460*	*457,541*	*445,068*
Males	Uniform Required	0.019	-0.002	-0.033	-0.020
		(0.018)	(0.010)	(0.032)	(0.023)
	Observations	*392,516*	*385,035*	*461,963*	*449,011*
Student fixed effects		X	X	X	X
School fixed effects		X	X	X	X
Principal fixed effects			X		X

Standard errors clustered by school in parentheses. Elementary covers grades 1-5 and middle high covers grades 6-12. Each regression includes grade-by-year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Counts for the number of student, school and principal fixed effects in each regression are provided in Appendix Table 2.14.

fixed effects, another piece of evidence against this concern is the lack of significant impacts on disciplinary infractions. If uniforms are adopted along with an enhanced enforcement policy we would expect to see an increase in infractions. However, a null finding for overall discipline may hide shifts in the types of punishment. In particular, we might expect enhanced enforcement to lead to a shift towards more severe punishments. To test this, in Table 2.5 we provide impact estimates of the number of in-school suspensions, the lowest level of infraction in our data, or out-of-school suspensions a student receives.[21] If there is an increase in enforcement we would expect to see a shift from less severe to more severe punishments. The results in Table 2.5 provide little evidence for a shift in punishments as only one estimate is statistically significant at the 10% level and this becomes insignificant when principal fixed effects are added. Further, in Appendix Table 2.16 we estimates school-level regressions of uniform status on infraction, in-school suspension, out-of-school suspension and other infraction rates. We also estimate the impact of uniforms on the percent of infractions in a school resulting in an in-school suspension. Only one estimate – in-school suspension rates in middle/high schools – is statistically significant, and only at the 10% level. Finally, in the first row of Tables 2.6 and 2.7 we conduct another test where we interact uniform status with whether the school adopts uniforms during the first two years of a principal's term. New principals in particular may be more likely to adopt uniforms as a part of a broader package of school reform, hence we need to see whether our results hold while accounting for these principals.[22] While we find that when uniforms are adopted under new principals there is a significant increase in infractions, this appears to have little impact on the overall estimates, as the main effects (i.e. the uniform impact for existing principals) are similar to the baseline estimates for both attendance and discipline.

Another potential concern is that schools may adopt uniforms when experiencing trends in attendance and discipline. The latter is of particular concern since schools might be inclined to adopt uniforms in response to changes in discipline. To address this, we estimate a variation of equation 2.1 where, instead of using an indicator variable for whether a school

[21] Infractions broken down by type was not collected in 1995-96 and 1996-97. In-school and out-of-school suspensions account for 96% of recorded infractions. The rest are expulsions and referrals to alternative disciplinary schools.

[22] These models have school and student fixed effects but no principal fixed effects.

Table 2.6: Robustness Checks and Heterogenous Impacts for Attendance and Discipline - Elementary

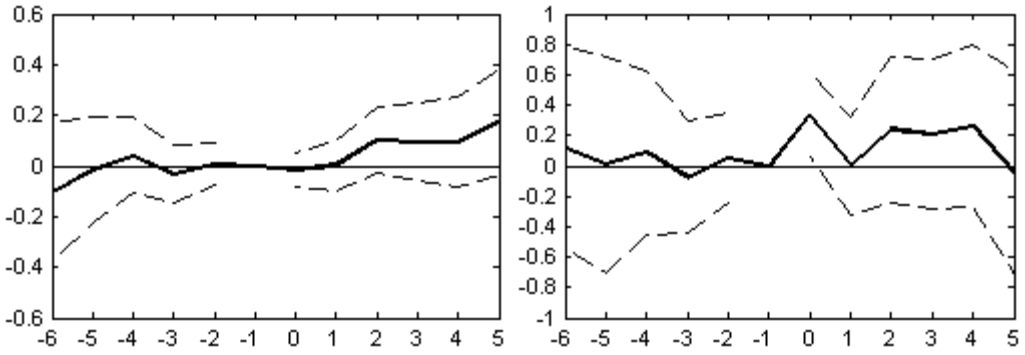
	Female		Males	
	Attendance	Discipline	Attendance	Discipline
	(1)	(2)	(3)	(4)
(1) Separate estimates for schools that adopt under new principals				
Uniform Required	0.029	-0.003	-0.072	-0.002
	(0.045)	(0.004)	(0.048)	(0.013)
Uniform*New Principal	0.027	0.017	0.031	0.091*
	(0.082)	(0.017)	(0.074)	(0.054)
Observations	*429,626*	*436,940*	*448,505*	*456,590*
(2) Exclude early (pre-1997) and late (post-2004) adopters				
Uniform Required	0.012	0.001	-0.117***	0.011
	(0.041)	(0.006)	(0.044)	(0.021)
Observations	*286,183*	*291,007*	*298,455*	*303,853*
(3) Exclude all students who are enrolled but do not take Stanford Math, Reading, & Language exams				
Uniform Required	0.093	0.017	-0.053	0.079*
	(0.069)	(0.017)	(0.055)	(0.046)
Observations	*165,939*	*165,963*	*168,863*	*168,893*
(4) Separate estimates by grade level				
Uniform Required*Grades 1-3	0.026	0.005	-0.082*	0.029
	(0.046)	(0.006)	(0.048)	(0.019)
Uniform Required*Grades 4-5	0.054	-0.003	-0.034	0.014
	(0.055)	(0.006)	(0.058)	(0.021)
Observations	*429,626*	*436,940*	*448,505*	*456,590*
(5) Uniform status interacted with economic disadvantage				
Uniform Required	-0.139*	-0.005	-0.137*	-0.027*
	(0.077)	(0.005)	(0.082)	(0.016)
Uniform Required*Disadvantaged	0.222***	0.003	0.140**	0.024**
	(0.063)	(0.004)	(0.063)	(0.011)
Uniform Required*Disadvantaged	0.023	-0.001	-0.030	-0.005
*Above-Median Disadvantaged	(0.089)	(0.005)	(0.068)	(0.011)
Uniform Required*Above-Median Disadvantaged	-0.033	0.007	-0.034	0.050**
	(0.104)	(0.007)	(0.094)	(0.022)
Above-Median Disadvantaged	0.051	-0.001	0.065	-0.033*
	(0.084)	(0.007)	(0.084)	(0.019)
Observations	*429,626*	*436,940*	*448,505*	*456,590*

Standard errors clustered by school in parentheses. Each regression includes student and school fixed effects along with grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. Elementary includes students in grades 1-5, while middle/high includes grades 6-12. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.7: Robustness Checks and Heterogenous Impacts for Attendance and Discipline - Middle/High

	Female		Males	
	Attendance	Discipline	Attendance	Discipline
	(1)	(2)	(3)	(4)
(1) Separate estimates for schools that adopt under new principals				
Uniform Required	0.344*	-0.056	0.292	-0.031
	(0.186)	(0.047)	(0.188)	(0.088)
Uniform*New Principal	-0.093	0.154**	-0.345	0.296**
	(0.230)	(0.075)	(0.251)	(0.137)
Observations	*525,447*	*534,135*	*530,281*	*539,398*
(2) Exclude early (pre-1997) and late (post-2004) adopters				
Uniform Required	0.277	-0.018	0.112	0.048
	(0.198)	(0.054)	(0.157)	(0.085)
Observations	*302,410*	*306,975*	*308,946*	*313,760*
(3) Exclude all students who are enrolled but do not take Stanford Math, Reading, & Language exams				
Uniform Required	0.178**	0.037	0.165*	0.122*
	(0.088)	(0.039)	(0.087)	(0.069)
Observations	*219,238*	*219,250*	*202,385*	*202,413*
(4) Separate estimates by grade level				
Uniform Required*Grades 6-8	0.393***	-0.016	0.303**	0.007
	(0.143)	(0.052)	(0.135)	(0.085)
Uniform Required*Grades 9-12	0.242	-0.010	0.120	-0.024
	(0.272)	(0.052)	(0.224)	(0.087)
Observations	*525,447*	*534,135*	*749,979*	*760,728*
(5) Uniform status interacted with economic disadvantage				
Uniform Required	0.256	-0.001	0.046	0.051
	(0.216)	(0.039)	(0.225)	(0.057)
Uniform Required*Disadvantaged	0.087	0.014	0.216*	0.029
	(0.126)	(0.017)	(0.111)	(0.032)
Uniform Required*Disadvantaged	0.275	-0.089*	0.621***	-0.131**
*Above-Median Disadvantaged	(0.176)	(0.046)	(0.197)	(0.051)
Uniform Required*Above-Median Disadvantaged	-0.222	-0.052	-0.586*	-0.015
	(0.234)	(0.081)	(0.344)	(0.155)
Above-Median Disadvantaged	0.116	-0.006	0.157	-0.078
	(0.174)	(0.048)	(0.226)	(0.086)
Observations	*525,447*	*534,135*	*530,281*	*539,398*
(6) Uniform status interacted with 5th grade achievement quartiles				
Uniform Required	0.405	0.079	0.481*	0.316***
	(0.288)	(0.065)	(0.251)	(0.079)
Uniform Required*2nd Quartile	-0.092	0.077	-0.152	-0.161***
	(0.169)	(0.050)	(0.197)	(0.053)
Uniform Required*3rd Quartile	-0.426**	0.052	-0.213	-0.121**
	(0.201)	(0.060)	(0.183)	(0.053)
Uniform Required*4th Quartile	-0.300	0.078	-0.305	-0.086
	(0.223)	(0.067)	(0.214)	(0.068)
Observations	*134,068*	*134,139*	*133,139*	*133,200*

Standard errors clustered by school in parentheses. Each regression includes student and school fixed effects along with grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. Elementary includes students in grades 1-5, while middle/high includes grades 6-12. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.



(a) Attendance (elementary) (b) Attendance (middle/high0

Figure 2.2: Attendance Before and After Uniform Adoption.[a]

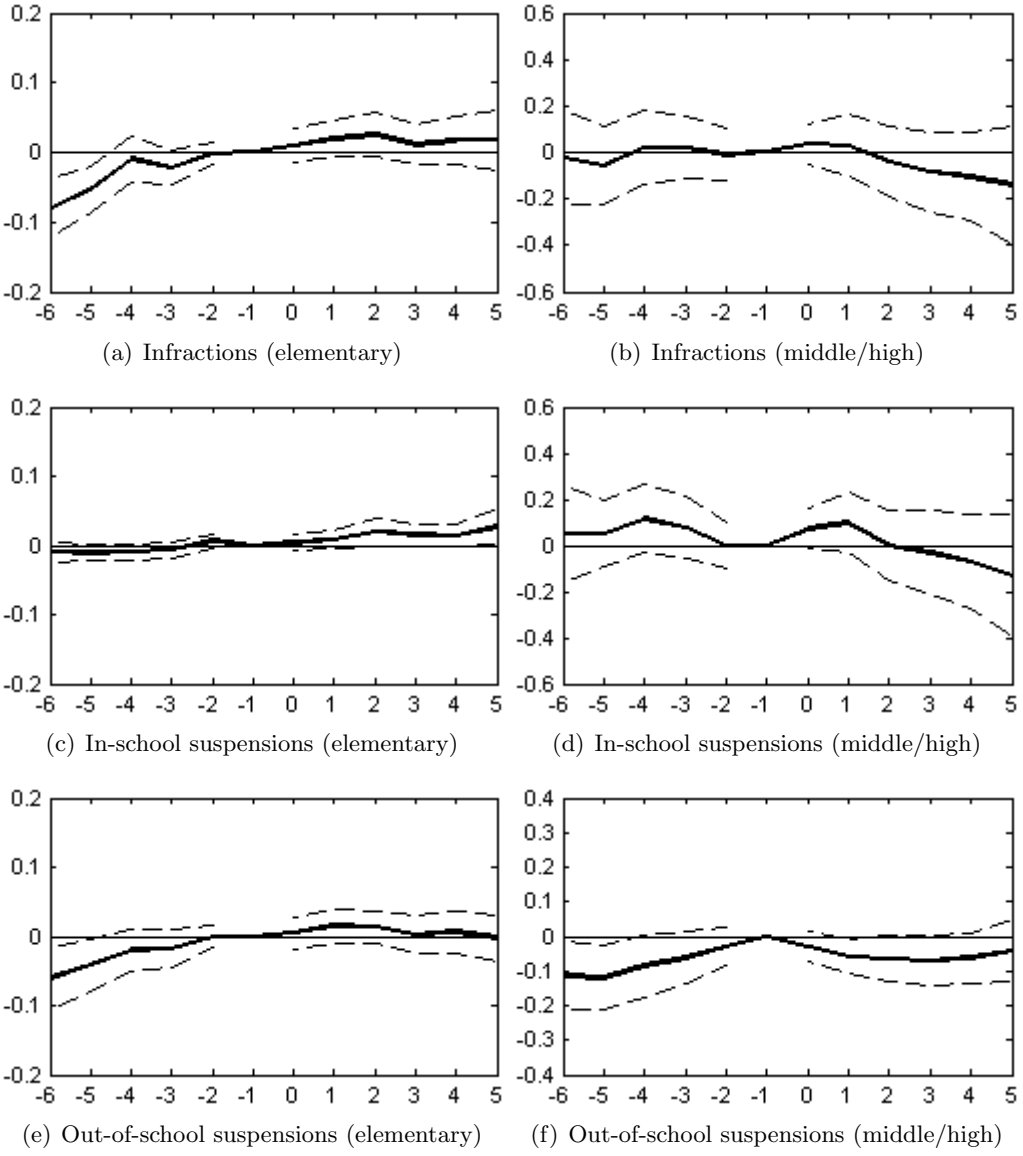
[a]Graphs show point estimates and 95% confidence intervals for estimates from regressions of the outcome on indicators for each year prior to and after uniform adoption (year $t = -1$ is omitted), grade-by-year indicators, student economic status, student fixed effects and school fixed effects. Numerical values are provided in Appendix Table 2.17.

requires a uniform, we use indicators for a school being in a period 6 or more, 5, 4, 3, or 2 years prior to uniform adoption. In addition, so that we might track the evolution of uniform effects after adoption, we include indicators for the school being in the year of adoption, and 1, 2, 3, 4 and 5 or more years after. Note that we omit one year prior to adoption so that trends can be detected as significant deviations from that year's estimate. The overall impact of being a school that adopts uniforms at some time in the data is captured by the school fixed effects. These models do not include principal fixed effects. The results from these event study analyses are provided in Figures 2.2 and 2.3 where the solid line shows the coefficient estimates and the dotted lines show 95% confidence intervals.[23]

Figure 2.2 provides the event studies for attendance rates. The graphs show little evidence of pre-adoption trending for both elementary and middle/high schools. Further, we see clear increases in attendance rates after adoption for middle/high students, although for each given year they are not statistically significant. Nonetheless, the graph suggests that the the significant pooled estimates provided in Table 2.4 are a level shift in attendance rates, rather than a trend shift.

For disciplinary infractions, we see in Figure 2.3 that, while there is an increase up to four years prior to adoption for elementary schools, this flattens out afterwards, indicating

[23]Coefficients and standard errors are provided in Appendix Table 2.17.



(a) Infractions (elementary)

(b) Infractions (middle/high)

(c) In-school suspensions (elementary)

(d) In-school suspensions (middle/high)

(e) Out-of-school suspensions (elementary)

(f) Out-of-school suspensions (middle/high)

Figure 2.3: Discipline Before and After Uniform Adoption.[a]

[a]Graphs show point estimates (solid line) and 95% confidence intervals (dotted lines) for estimates from regressions of the outcome on indicators for each year prior to and after uniform adoption (year $t = -1$ is omitted), grade-by-year indicators, student economic status, student fixed effects and school fixed effects. Numerical values are provided in Appendix Table 2.17.

no significant trending in the four years before adoption. For middle and high schools, the infraction rates are flat throughout the period prior to adoption. After adoption, the figures show no significant impact on infractions at any time for both grade levels. We also provide event study figures for in-school and out-of-school suspensions. For elementary school students, the pattern for out-of-school suspensions is similar to the overall pattern, while for in-school suspensions there is no evidence of pre-trends, and a slight but only marginally significant uptick in later years. For middle and high school students, both in-school and out-of school suspensions show similar patterns to overall infractions in the years after adoption, but out-of-school suspensions experience a small increasing trend prior to adoption. This suggests that our baseline estimates may slightly understate the reduction in out-of-school suspensions from uniforms.

In Table 2.8 we investigate whether the impacts (or lack thereof) on attendance and discipline vary by a student's race or racial composition of a school and find mixed results.[24] For elementary schools, African-Americans and Hispanics respond most positively in terms of attendance, particularly African-American students in schools with African-American population higher than the district average. Nonetheless, when added to the main effects, these do not differ on net from zero and in fact, the estimates suggest that students from other races are negatively impacted by uniforms. On the other hand, African-American students experience increases in disciplinary infractions not experienced by other races.

For middle/high students, while there are no significant differences in discipline effects, the attendance results differ sharply from those for elementary students. The results suggest that most of the improvements in attendance accrue to students in schools that are below median in their African-American or Hispanic populations, regardless of race. Hence uniforms appear to be more effective in mixed-race or primarily Caucasian and Asian (the other two major racial populations in LUSD) schools. The exception to this pattern is that African-American students in schools with high African-American populations also experience improvements in attendance.

Returning to Tables 2.6 and 2.7, we provide a number of additional specification and

[24]The left-out category includes Caucasians, Asians, and Native Americans. Although we would normally consider the latter two categories to be separate minorities, their sample sizes are too small to get precise estimates at 2.9% and 0.1%, respectively. Whites account for 10.2% of the sample.

Table 2.8: Effect of Uniforms Interacted with Student and School Ethnicity on Attendance and Discipline

	Attendance			Discipline		
	All	Females	Males	All	Females	Males
	(1)	(2)	(3)	(4)	(5)	(6)
	i. Elementary					
Uniform Required	-0.376***	-0.405***	-0.354***	-0.027	-0.016*	-0.036
	(0.092)	(0.110)	(0.101)	(0.018)	(0.008)	(0.027)
Uniform Required*Above-Median	0.243***	0.140	0.345***	0.047**	0.009	0.082**
African-American*African-American	(0.085)	(0.112)	(0.128)	(0.021)	(0.013)	(0.033)
Uniform Required*Above-Median	0.037	0.039	0.023	-0.017	-0.011	-0.022
Hispanic*Hispanic	(0.076)	(0.083)	(0.101)	(0.019)	(0.012)	(0.028)
Uniform Required*Above-Median	-0.090	-0.116	-0.062	-0.010	-0.001	-0.019
African-American	(0.095)	(0.102)	(0.105)	(0.021)	(0.010)	(0.033)
Uniform Required*Above-Median	0.150	0.176	0.127	0.024	0.007	0.038
Hispanic	(0.093)	(0.111)	(0.109)	(0.026)	(0.014)	(0.040)
Uniform Required*African-American	0.203**	0.432***	-0.010	0.046***	0.034***	0.060**
	(0.102)	(0.126)	(0.143)	(0.017)	(0.010)	(0.027)
Uniform Required*Hispanic	0.281***	0.347***	0.242**	0.023	0.011	0.033
	(0.088)	(0.106)	(0.108)	(0.015)	(0.008)	(0.024)
Above-Median African-American	-0.098	-0.005	-0.188**	0.031	0.010	0.053
	(0.080)	(0.106)	(0.082)	(0.023)	(0.011)	(0.036)
Above-Median Hispanic	0.012	0.012	0.017	-0.028	-0.009	-0.044
	(0.058)	(0.093)	(0.060)	(0.044)	(0.022)	(0.065)
Observations	*878,131*	*429,626*	*448,505*	*893,530*	*436,940*	*456,590*
	ii. Middle/High					
Uniform Required	0.538**	0.472*	0.624**	-0.066	-0.067	-0.071
	(0.244)	(0.244)	(0.267)	(0.095)	(0.070)	(0.125)
Uniform Required*Above-Median	0.595***	0.638***	0.565***	-0.047	-0.007	-0.081
African-American*African-American	(0.167)	(0.198)	(0.186)	(0.048)	(0.043)	(0.063)
Uniform Required*Above-Median	0.103	0.180	0.046	-0.014	-0.014	-0.020
Hispanic*Hispanic	(0.171)	(0.202)	(0.180)	(0.045)	(0.035)	(0.071)
Uniform Required*Above-Median	-0.426**	-0.374*	-0.512**	0.112	0.077	0.142
African-American	(0.212)	(0.205)	(0.250)	(0.087)	(0.062)	(0.119)
Uniform Required*Above-Median	-0.479**	-0.518**	-0.506*	0.144	0.116	0.176
Hispanic	(0.241)	(0.250)	(0.266)	(0.098)	(0.071)	(0.132)
Uniform Required*African-American	-0.131	-0.122	-0.129	-0.029	-0.053	0.004
	(0.154)	(0.155)	(0.189)	(0.073)	(0.063)	(0.086)
Uniform Required*Hispanic	0.029	0.151	-0.082	-0.028	-0.034	-0.017
	(0.189)	(0.203)	(0.207)	(0.047)	(0.038)	(0.061)
Above-Median African-American	0.883***	0.891***	0.876***	-0.087	-0.069	-0.103
	(0.210)	(0.216)	(0.224)	(0.093)	(0.071)	(0.117)
Above-Median Hispanic	0.150	0.270	0.051	-0.112	-0.075	-0.149
	(0.177)	(0.163)	(0.209)	(0.121)	(0.083)	(0.159)
Observations	*1,055,728*	*525,447*	*530,281*	*1,073,533*	*534,135*	*539,398*

Standard errors clustered by school in parentheses. Each regression includes student and school fixed effects along with grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. Elementary includes students in grades 1-5, while middle/high includes grades 6-12. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

heterogeneity tests. Row (2) provides results when we drop schools that adopt uniforms early (before 1994) or late (after 2004) and find qualitatively similar results. Results are also similar to baseline in row (3) where we limit the sample to students who take math, reading and language achievement exams, although in this case we get a marginally significant increase in middle/high discipline infractions. In row (4) we split the elementary estimates by grades 1 - 3 and grades 4 - 5 while middle/high estimates are split by grades 6 - 8 and 9 - 12. The results are similar to baseline. In row (5) we provide models for heterogeneity by economic disadvantaged status similar to those provided in Table 2.8 for race. The results suggest that the attendance improvements mainly accrue to students who are economically disadvantaged, particularly those who are in high-poverty schools. Finally, the last row of Table 2.7 provides estimates for middle/high students that test whether the uniform impacts vary by fifth grade achievement, where we identify achievement quartiles based on district-wide performance. The results suggest that the attendance improvements from uniforms are most prominent in low-achieving students. In Appendix Table 2.18 we provide results for the same analysis using within-high-school quartiles. Results are similar.

2.5.3 Impacts on Achievement

It is intriguing to see whether the improvements found in attendance rates spill over into achievement. Additionally, as mentioned in the introduction, there are a number of other reasons why uniforms may affect achievement directly. Hence, in this section we consider the impact of uniform adoption on students' test score outcomes. All test scores are standardized across LUSD within year and grade, therefore estimates are provided in standard deviation units. We also use annual changes (gains) in achievement as our outcome measures, so that we can better account for value-added of schools to the student's performance.[25]

Table 2.9 provides our main achievement results for elementary and middle/high respectively.[26] The table is structured as Table 2.4.[27] While the estimates are generally negative, in only one instance – elementary female reading – is the effect statistically significant. The

[25] Appendix Table 2.19 provides levels models for comparison.

[26] Appendix Table 2.20 provides counts for each of the fixed effects in these models.

[27] We also estimated basic OLS models that control only for observable characteristics of students. These results showed slightly negative, but insignificant correlations of uniform status with achievement gains of up to 0.03 standard deviations. This is consistent with the findings of Yeung (2009).

Table 2.9: Effect of Uniforms on Achievement Gains

		Elementary		Middle/High	
		(1)	(2)	(3)	(4)
		A. Math			
All	Uniform Required	-0.020	-0.008	-0.024	-0.015
		(0.029)	(0.028)	(0.023)	(0.025)
	Observations	*239,272*	*233,891*	*420,165*	*412,259*
Females	Uniform Required	-0.042	-0.027	-0.015	-0.004
		(0.032)	(0.035)	(0.025)	(0.028)
	Observations	*117,551*	*114,878*	*211,909*	*207,919*
Males	Uniform Required	-0.002	0.005	-0.033	-0.027
		(0.031)	(0.029)	(0.021)	(0.024)
	Observations	*121,721*	*119,013*	*208,256*	*204,340*
		B. Reading			
All	Uniform Required	-0.015	-0.024	-0.014	-0.015
		(0.022)	(0.029)	(0.011)	(0.020)
	Observations	*238,759*	*233,413*	*420,058*	*412,114*
Females	Uniform Required	-0.045*	-0.061**	-0.008	-0.007
		(0.024)	(0.029)	(0.012)	(0.021)
	Observations	*117,338*	*114,682*	*211,967*	*207,975*
Males	Uniform Required	0.017	0.012	-0.020	-0.025
		(0.025)	(0.035)	(0.013)	(0.022)
	Observations	*121,421*	*118,731*	*208,091*	*204,139*
		C. Language			
All	Uniform Required	0.006	0.020	0.005	0.018
		(0.027)	(0.032)	(0.013)	(0.018)
	Observations	*239,348*	*233,975*	*419,229*	*411,322*
Females	Uniform Required	0.029	0.044	0.003	0.015
		(0.028)	(0.030)	(0.013)	(0.018)
	Observations	*117,619*	*114,943*	*211,552*	*207,550*
Males	Uniform Required	-0.011	-0.000	0.006	0.021
		(0.031)	(0.037)	(0.015)	(0.021)
	Observations	*121,729*	*119,032*	*207,677*	*203,772*
Student fixed effects		X	X	X	X
School fixed effects		X	X	X	X
Principal fixed effects			X		X

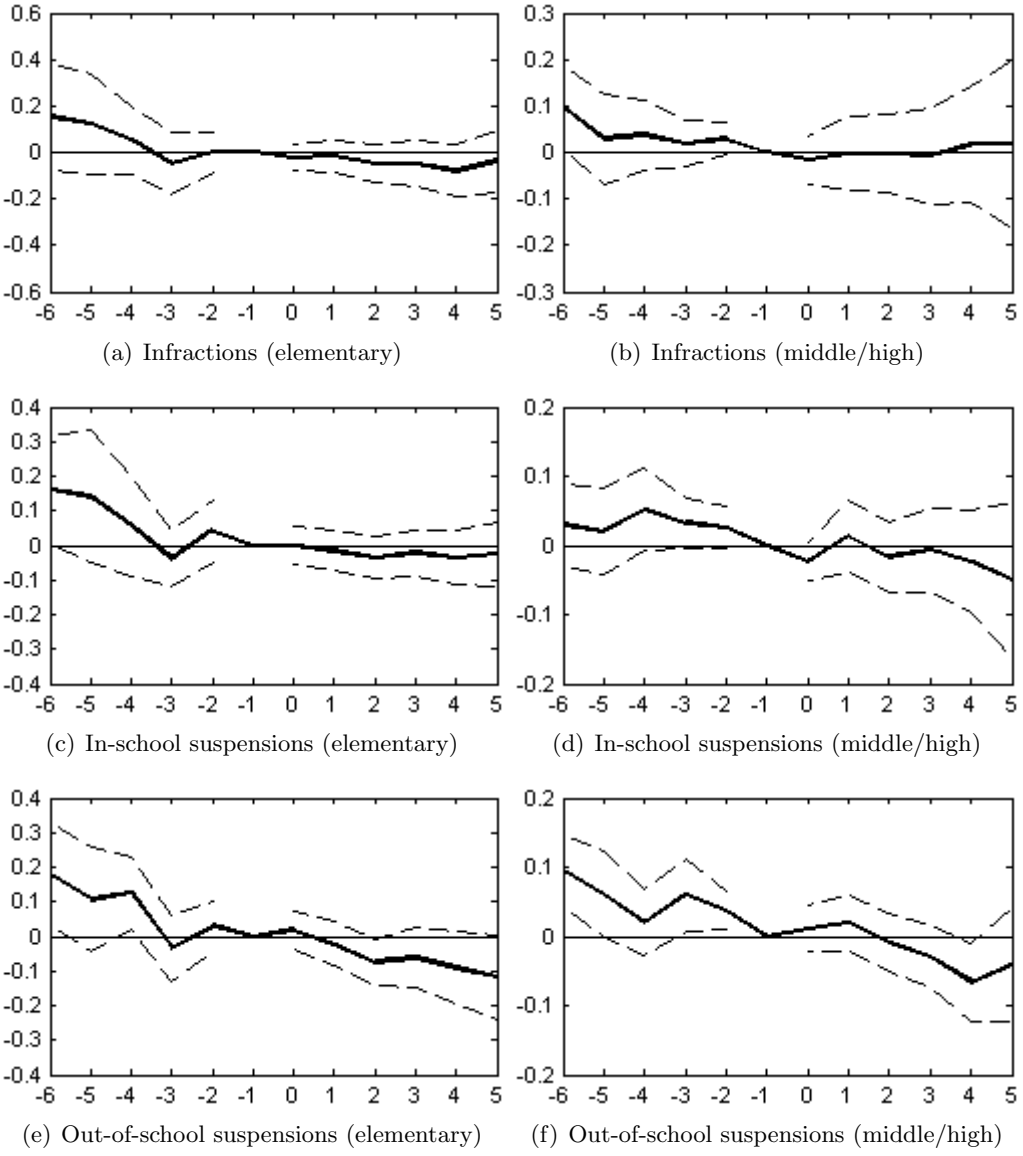
Standard errors clustered by school in parentheses. Elementary covers grades 1-5 and middle high covers grades 6-12. Each regression includes grade-by-year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Counts for the number of student, school and principal fixed effects in each regression are provided in Appendix Table 2.20.

results are similar when we add principal fixed effects. Hence, these results indicate that uniforms have little impact on achievement gains.

In Figure 2.4 we provide event-study graphs of the impact estimates for achievement gains similar to those provided for attendance and discipline in Figures 2.2 and 2.3.[28] One potential complication highlighted in this figure is that there appears to be some evidence of pre-adoption trends. In particular, the figures suggest that schools adopt uniforms after achievement gains fall. However, upon closer examination these trends are not as problematic as they initially seem. First, for elementary schools while there is a drop up to 3 years prior to adoption in all three exams, achievement growth flattens and remains roughly constant afterwards until uniform adoption. Hence, we can check whether this trending affects the results by estimating models that drop all observations more than three years prior to uniform adoption. These results are provided in the first row of Tables 2.10 and 2.11 and are similar to the results in Table 2.9, indicating that the trending in those years have little effect on our estimates. For middle schools there appears to be little evidence of trending in math or reading. Nonetheless, language achievement does seem to fall consistently throughout the graph. However, the drop-off prior to adoption is relatively small and the post-adoption estimates suggest that uniforms did little to either counteract or exacerbate this trend. Post-adoption achievement is relatively flat in all other cases, consistent with the results in Table 2.9.

Tables 2.10 and 2.11 also provide some robustness and heterogeneity analyses for achievement similar to those provided in Tables 2.6 and 2.7 for discipline and attendance. First, we estimate models that interact uniform status with whether uniforms are adopted under new principals. These show no significant difference by principal experience. Further, we provide estimates that drop early and late adopters, limit to students who take all three exams, estimate heterogeneous effects by grade level within elementary and middle/high grades, and interact uniform status with the student's fifth grade achievement quartile (middle/high only). In general the estimates differ little from baseline. The key exception is that math achievement effects are significantly higher for students in the bottom quartile of their own school's distribution. Finally, in Appendix Tables 2.22 and 2.23 we analyze heterogeneity

[28] Coefficients and standard errors are provided in Appendix Table 2.21.



(a) Infractions (elementary)

(b) Infractions (middle/high)

(c) In-school suspensions (elementary)

(d) In-school suspensions (middle/high)

(e) Out-of-school suspensions (elementary)

(f) Out-of-school suspensions (middle/high)

Figure 2.4: Student Test Scores Before and After Uniform Adoption.[a]

[a]Graphs show point estimates and 95% confidence intervals for estimates from regressions of the outcome on indicators for each year prior to and after uniform adoption (year $t = -1$ is omitted), grade-by-year indicators, student economic status, student fixed effects and school fixed effects. Numerical values are provided in Appendix Table 2.21.

Table 2.10: Robustness Checks and Heterogenous Impacts for Achievement - Elementary

	Female			Males		
	Math	Reading	Language	Math	Reading	Language
	(1)	(2)	(3)	(1)	(2)	(3)
(1) Drop observations more than three years prior to adoption						
Uniform Required	-0.058*	0.006	0.005	-0.022	-0.023	0.029
	(0.029)	(0.027)	(0.006)	(0.029)	(0.029)	(0.019)
Observations	*125,908*	*122,835*	*362,185*	*129,799*	*126,570*	*377,807*
(2) Separate estimates for schools that adopt under new principals						
Uniform Required	-0.042	-0.068**	0.025	-0.012	-0.003	-0.018
	(0.032)	(0.027)	(0.030)	(0.025)	(0.030)	(0.037)
Uniform*New Principal	0.001	0.072	-0.015	-0.033	0.057	0.026
	(0.074)	(0.048)	(0.058)	(0.074)	(0.044)	(0.056)
Observations	*117,244*	*117,036*	*117,311*	*121,261*	*120,964*	*121,266*
(3) Exclude early (pre-1997) and late (post-2004) adopters						
Uniform Required	-0.047	-0.060**	0.059*	0.001	0.020	0.021
	(0.038)	(0.027)	(0.032)	(0.034)	(0.028)	(0.033)
Observations	*71,590*	*71,454*	*71,659*	*73,797*	*73,559*	*73,768*
(4) Exclude all students who are enrolled but do not take Stanford Math, Reading, & Language exams						
Uniform Required	-0.046	-0.041	0.031	-0.015	0.012	-0.019
	(0.031)	(0.025)	(0.028)	(0.030)	(0.025)	(0.032)
Observations	*104,054*	*104,054*	*104,054*	*105,785*	*105,785*	*105,785*
(5) Separate estimates by grade level						
Uniform Required*Grades 1-3	-0.023	-0.047*	0.043	0.027	0.025	0.013
	(0.035)	(0.025)	(0.028)	(0.034)	(0.026)	(0.032)
Uniform Required*Grades 4-5	-0.077*	-0.040	0.003	-0.055	0.002	-0.055
	(0.043)	(0.030)	(0.040)	(0.042)	(0.030)	(0.039)
Observations	*117,551*	*117,338*	*117,619*	*121,720*	*121,420*	*121,728*

Standard errors clustered by school in parentheses. Each regression includes student and school fixed effects along with grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. Elementary includes students in grades 1-5, while middle/high includes grades 6-12. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.11: Robustness Checks and Heterogenous Impacts for Achievement - Middle/High

	Female			Males		
	Math	Reading	Language	Math	Reading	Language
	(1)	(2)	(3)	(1)	(2)	(3)
(1) Drop observations more than three years prior to adoption						
Uniform Required	-0.011	0.020	0.023	-0.023	0.019	0.074
	(0.024)	(0.013)	(0.039)	(0.019)	(0.015)	(0.066)
Observations	*205,955*	*205,536*	*375,085*	*201,070*	*200,530*	*374,087*
(2) Separate estimates for schools that adopt under new principals						
Uniform Required	0.002	-0.008	0.012	-0.022	-0.017	0.016
	(0.024)	(0.012)	(0.014)	(0.018)	(0.018)	(0.021)
Uniform*New Principal	-0.080	-0.039	0.003	-0.018	-0.039	-0.010
	(0.087)	(0.037)	(0.028)	(0.075)	(0.029)	(0.026)
Observations	*177,220*	*177,252*	*176,858*	*173,582*	*173,323*	*172,972*
(3) Exclude early (pre-1997) and late (post-2004) adopters						
Uniform Required	-0.048	-0.021	0.017	-0.050*	-0.024	0.014
	(0.035)	(0.017)	(0.018)	(0.026)	(0.022)	(0.024)
Observations	*91,542*	*91,688*	*91,516*	*90,738*	*90,759*	*90,565*
(4) Exclude all students who are enrolled but do not take Stanford Math, Reading, & Language exams						
Uniform Required	-0.016	-0.021*	0.003	-0.014	-0.021	0.022
	(0.029)	(0.011)	(0.013)	(0.024)	(0.015)	(0.018)
Observations	*147,029*	*147,029*	*147,029*	*134,908*	*134,908*	*134,908*
(5) Separate estimates by grade level						
Uniform Required*Grades 6-8	-0.019	-0.013	0.024	-0.040*	-0.027	0.030
	(0.028)	(0.013)	(0.020)	(0.021)	(0.024)	(0.027)
Uniform Required*Grades 9-12	-0.019	-0.024	0.004	-0.015	-0.028	-0.002
	(0.055)	(0.021)	(0.018)	(0.043)	(0.021)	(0.023)
Observations	*177,584*	*177,612*	*177,218*	*174,043*	*173,782*	*173,430*
(6) Uniform status interacted with 5th grade achievement quartiles						
Uniform Required	0.004	-0.002	0.010	-0.018	-0.008	0.015
	(0.029)	(0.017)	(0.018)	(0.034)	(0.019)	(0.022)
Uniform Required*2nd Quartile	0.024	0.029**	0.001	-0.007	-0.000	-0.001
	(0.021)	(0.014)	(0.015)	(0.026)	(0.017)	(0.018)
Uniform Required*3rd Quartile	0.015	0.013	0.002	0.011	0.023	-0.011
	(0.024)	(0.017)	(0.018)	(0.031)	(0.015)	(0.017)
Uniform Required*4th Quartile	0.044*	0.018	-0.004	0.017	-0.002	-0.034
	(0.026)	(0.016)	(0.018)	(0.035)	(0.019)	(0.021)
Observations	*115,846*	*115,860*	*115,698*	*112,925*	*112,960*	*112,720*

Standard errors clustered by school in parentheses. Each regression includes student and school fixed effects along with grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. Elementary includes students in grades 1-5, while middle/high includes grades 6-12. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

by student race and school racial composition; whereas in Appendix Table 2.24 we analyze heterogeneity by disadvantaged status. For race the results are mixed, with little evidence of consistent patterns across exams. On the other hand, we find some evidence that students who are not economically disadvantaged experience improvements in language scores.

2.5.4 Impacts on Student Movements, Grade Retention, and Teacher Attrition

In Table 2.12 we provide impact estimates for some alternative outcomes of interest.[29] A possible explanation for the results in Table 2.4 is that certain types of students are more or less likely to change schools as a result of uniforms. If this is the case, then we may have attrition bias. However, such behavior would also be interesting in its own right, as student movements could provide insight into whether parents see uniforms as beneficial. If students are less likely to leave a school after uniforms are adopted, this potentially shows a revealed preference by parents for uniforms and their behavioral benefits. Hence, in panels A and B we estimate linear probability models of whether uniforms affect the likelihood of students to switch schools within LUSD or leave the district.[30] We drop students who are in the highest grades of their school, since a school's uniform policy would no longer apply for students who are graduating or leaving to attend another school due to normal grade progression. Hence, including these students may lead to biased estimates.[31] We find no statistically significant impacts of uniforms on either school switching or district leaving, with the exception of a marginally significant reduction in leaving for middle/high females when we include principal fixed effects. Nonetheless, this potential effect is economically small and hence overall the results indicate that our estimates for other outcomes are unlikely to be biased due to attrition.

In panel C we investigate whether uniforms have any impact on grade retention. Unfortunately, our data does not provide us with direct measures of retention. Instead we identify a student as having been retained if his or her grade level is less than or equal to their grade level the prior year. Note that this limits the analysis to students who are

[29] Counts of fixed effects are provided in Appendix Table 2.25.

[30] Leavers in middle/high also include dropouts. While it would be interesting to look at dropouts separately, our data on dropouts is unreliable due to misreporting of some dropouts as leaving for other reasons.

[31] Results are similar if we do not make this restriction.

Table 2.12: Effect of Uniforms on Leaving the District, Switching Schools, Grade Retention and Teacher Attrition

		Elementary		Middle/High		Elementary		Middle/High	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		A. Switches Schools in LUSD				B. Leaves LUSD			
All	Uniform Required	-0.002	-0.001	0.012	0.021	-0.004	0.002	-0.007	-0.011*
		(0.007)	(0.008)	(0.010)	(0.016)	(0.003)	(0.003)	(0.006)	(0.006)
	Observations	*700,988*	*688,578*	*757,637*	*738,315*	*700,988*	*688,578*	*757,637*	*738,315*
Females	Uniform Required	-0.006	-0.004	0.010	0.020	-0.004	0.003	-0.010	-0.013*
		(0.007)	(0.008)	(0.009)	(0.015)	(0.003)	(0.004)	(0.006)	(0.007)
	Observations	*342,332*	*336,253*	*373,256*	*363,854*	*342,332*	*336,253*	*373,256*	*363,854*
Males	Uniform Required	0.002	0.002	0.014	0.022	-0.003	0.003	-0.004	-0.010
		(0.007)	(0.008)	(0.010)	(0.017)	(0.004)	(0.004)	(0.007)	(0.006)
	Observations	*358,656*	*352,325*	*384,381*	*374,461*	*358,656*	*352,325*	*384,381*	*374,461*
		C. Grade Retention				D. Teacher Attrition			
All	Uniform Required	-0.006*	0.001	-0.007*	-0.004	-0.046***	-0.036*	-0.019	-0.014
		(0.003)	(0.004)	(0.004)	(0.005)	(0.014)	(0.020)	(0.015)	(0.020)
	Observations	*594,032*	*583,832*	*885,866*	*864,795*	*1,213*	*1,176*	*811*	*737*
Females	Uniform Required	-0.004	0.000	-0.006	-0.003	-	-	-	-
		(0.003)	(0.004)	(0.004)	(0.004)	-	-	-	-
	Observations	*290,486*	*285,535*	*442,560*	*432,087*	-	-	-	-
Males	Uniform Required	-0.007*	0.001	-0.008*	-0.005	-	-	-	-
		(0.004)	(0.004)	(0.004)	(0.005)	-	-	-	-
	Observations	*303,546*	*298,297*	*443,306*	*432,708*	-	-	-	-

Standard errors clustered by school in parentheses. Switching, leaving, and grade retention: Elementary covers grades 1-5 and middle high covers grades 6-12. A student is identified as being retained if their grade in year t is less than or equal to their grade in year $t-1$. Each regression includes grade-by-year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Teacher attrition regressions: Elementary includes any school with enrollment in grades KG-5. Middle/High includes any school with enrollment in grades 6-12. Some schools fall into both categories and hence there is overlap. Each regression includes year indicators and school-level share enrolled in each grade, female, free lunch, reduced-price lunch, other economic disadvantage, African-American, Hispanic, and Caucasian. Data on teacher attrition covers 1996-07 through 2004-05. Attrition is calculated by matching teacher names within a school across years. Counts for the number of student, school and principal fixed effects in each regression are provided in Appendix Table 2.25.

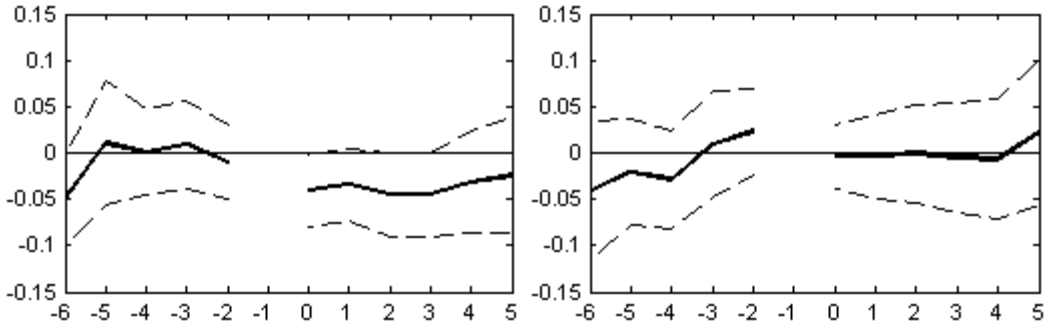
enrolled in LUSD both in the current and prior year. In models with school and student fixed effects, we find a marginally significant reduction in grade retention for males in both elementary and middle/high schools. However, when we add principal fixed effects, the estimates drop to statistical insignificance. Hence, the results do not provide compelling evidence of an impact of uniforms on grade retention.

In panel D we estimate the impact of uniforms on teacher attrition using school-year level observations. To calculate attrition rates, we identify teachers using their first and last names. If a name does not appear in the same school the following year, we count that as an attrition. Note that this will likely lead us calculate attrition rates that are too large as we will count a name change as an attrition. This should only be a problem, however, if the likelihood of a teacher changing his or her name is correlated with uniform adoption, which we believe to be highly unlikely. In addition to school fixed effects, the model controls for year indicators and the share of students in the school enrolled in each grade, female, free lunch, reduced-price lunch, other economic disadvantage, African-American, Hispanic, and Caucasian. The results show a significant reduction in teacher attrition after the adoption of uniforms in elementary schools of 5 percentage points. This is a large effect relative to the mean attrition rate of 25%. When we add principal fixed effects the estimate reduces to 4 percentage points but remains significant at the 10% level. For middle school the point estimates are also negative, but smaller and statistically insignificant. In order to investigate this result further, we provide event study graphs in Figure 2.5.[32] The figure shows a notable drop in attrition for elementary schools during the year of uniform adoption that remains at the new level thereafter. There is also little indication of trending prior to adoption.

2.6 CONCLUSION

Concerns about school safety and the desire by administrators to try different strategies to improve test scores and behavior has led many schools to adopt student uniforms. However, the current evidence on uniforms is sparse and the existing research relies on cross-sectional

[32]Coefficient estimates provided in Appendix Table 2.26.



(a) Teacher Attrition (elementary) (b) Teacher Attrition (middle/high

Figure 2.5: Teacher Attrition Before and After Uniform Adoption.[a]

[a]Graphs show point estimates and 95% confidence intervals for estimates from regressions of the outcome on indicators for each year prior to and after uniform adoption (year $t = -1$ is omitted), year indicators, share of school eligible for free-lunch, eligible for reduced-price lunch, otherwise economically disadvantaged, African-American, Hispanic, Caucasian, female, in each grade and and school fixed effects. Numerical values are provided in Appendix Table 2.26.

variation. Since schools likely adopt uniforms in response to poor behavior or achievement, the results from this research may suffer from substantial bias.

In this paper we assess whether requiring uniforms in schools affects student outcomes using administrative data from a large urban school district in the southwest United States. Since schools in this district independently decide whether or not to adopt uniforms over the time period for which we have data, we are able to incorporate school fixed effects and student fixed effects into our regressions. This allows us to account for schools endogenously deciding to adopt uniforms off of their fixed characteristics as well as students' selection into uniform schools provided that such selection is based on students' fixed characteristics. These corrections are very important as evidenced by the fact that, while most prior work has found uniforms to have insignificant to negative impacts, we find that uniforms have a positive influence on student attendance in secondary grades. Attendance rates in grades 6 through 12 increase by 0.3 to 0.4 percentage points after a school adopts uniforms. On the other hand, we find little evidence that uniforms have lasting impacts on achievement, grade retention, or the likelihood of students switching schools or leaving the district for all genders and grade levels.

In terms of discipline we also find little evidence of uniform effects. We note that these results are inconsistent with an alternative theory of concurrent strengthening of

enforcement policies, since if this were the case we would expect to see at least a temporary increase. We also provide evidence from models that include principal fixed effects to account for the disciplinary philosophy and quality of school leadership, and from models that consider whether uniform impacts vary by whether uniforms are adopted by a principal who is new to a school. New principals are likely to be more inclined to adopt changes in many parts of a school besides uniform adoption and sometimes may be brought in to "shake up" a school. Our results are robust to both of these specifications. Nor do we find significant changes in the severity of punishments. Hence, we believe that our estimates isolate the impacts of uniforms from potential changes in enforcement, although we cannot rule out the possibility that uniforms are adopted concurrently with other policies.

Finally, we find that uniforms generate significant reductions in teacher attrition in elementary schools on the order of 5 percentage points. This is a large effect relative to the mean of 25% annual attrition. Hence, even if uniforms' impacts on student outcomes are limited, they are a potentially useful tool for reducing teacher turnover.

Bibliography

Kyle Alspach. Measured Look at Uniforms: Alternative to Dress Code. *Boston Globe*, May 17 2007.

Anonymous. School Uniform Costs Vary Widely. *BBC.com*, May 9 2003.

Anonymous. Council Recommends Uniforms at All City Schools. *Los Angeles Daily News*, November 4 2009a.

Anonymous. School uniforms – yes, but. *Los Angeles Times*, December 9 2009b.

Randal C. Archibold. Advocates of School Uniform Plan Enlist Children to Help Make Their Case. *New York Times*, February 26 1998.

Ann Bodine. School Uniforms, Academic Achievement, and Uses of Research. *The Journal of Educational Research*, 97(2):67–73, 2003.

Don Boyd, Hamp Lankford, Susanna Loeb, Mathhew Ronfeldt, and Jim Wyckoff. The Role of Teacher Quality in Retention and Hiring: Using Applications to Transfer to Uncovere Preferences of Teachers and Schools. *Journal of Policy Analysis and Management*, 30(1): 88–110, 2010.

David L. Brunsma. *The School Uniform Movement and What it Tells Us about American Education*. Scarecrow Education, 2004.

David L. Brunsma and Kerry A. Rockquemore. Effects of Student Uniforms on Attendance, Behavior Problems, Substance Abuse, and Academic Achievements. *The Journal of Educational Research*, 92(1), 1998.

Scott Carrell and Mark Hoekstra. Externalities in the Classroom: How Children Exposed to Domestic Violence Affect Everyone's Kids. *American Economic Journal: Applied Economics*, 2(1):211–228, January 2010.

Charles T. Clotfelter, Elizabeth J. Glennie, Helen F. Ladd, and Jacob L. Vigdor. Teacher Bonuses and Teacher Retention in Low Performing Schools: Evidence from the North Carolina $1800 Teacher Bonus Program. *Public Finance Review*, 36(1):63–87, 2008.

David Evans, Michael Kremer, and Muthoni Ngatia. The Impact of Distributing School Uniforms on Children's Education in Kenya. *World Bank, mimeo*, 2008.

Li Feng. Hire Today, Gone Tomorrow: New Teacher Classroom Assignments and Teacher Mobility. *Education Finance and Policy*, 5(3):278–316, 2010.

David Figlio. Boys Named Sue; Disruptive Children and Their Peers. *Education Finance and Policy*, 2(4):376–394, Fall 2007.

Alejandro Gaviria and Steven Raphel. School-Based Peer Effects and Juvenile Behavior. *Review of Economics and Statistics*, 83:257–268, 2001.

James J. Heckman and Yona Rubinstein. The Importance of Noncognitive Skills: Lessons from the GED Testing Program. *The American Economic Review - Papers and Proceedings*, 91(2):145–149, 2001.

James J. Heckman, Jora Stixrud, and Sergio Urzua. The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behavior. *Journal of Labor Economics*, 24(3):411–482, 2006.

Scott A. Imberman. Achievement and Behavior of Charter Students: Drawing a More Complete Picture. *Review of Economics and Statistics*, 93(2):416–435, 2011.

Scott A. Imberman, Adriana D. Kugler, and Bruce I. Sacerdote. Katrina's Children: Evidence on The Structure of Peer Effects from Hurricane Evacuees. *American Economic Review*, forthcoming.

Brian A. Jacob. Where the Boys Aren't: Non-Cognitive Skills, Returns to School, and the Gender Gap in Higher Education. *Economics of Education Review*, 21(6):589–598, 2002.

Alison Mitchell. Clinton Will Advise Schools on Uniforms. *New York Times*, February 1996.

Steven G. Rivkin, Eric A. Hanushek, and John F. Kain. Teachers, Schools and Academic Achievement. *Econometrica*, 73(2):417–458, 2005.

Carmit Segal. Classroom Behavior. *Journal of Human Resources*, 43(4):783–814, Fall 2009.

M.Sue Stanley. School Uniforms and Safety. *Education and Urban Society*, 28(4):424, 1996.

Jacques Steinberg. Guilianai Says He Supports Plan for Requiring School Uniforms. *New York Times*, February 12 1998.

Kathleen K. Wade and Mary E. Stafford. Public School Uniforms: Effect on Perceptions of Gang Presence, School Climate, and Student Self-Perceptions. *Education and Urban Society*, 35(4):399, 2003.

Eliah Watlington, Robert Shockley, Paul Guglielmino, and Rivka Felsher. The High Cost of Leaving: An Analysis of the Cost of Teacher Turnover. *Journal of Education Finance*, 36(1):22–37, 2010.

Jeffrey M. Wooldridge. *Econometric Analysis of Cross Section and Panel Data*. MIT Press, 2002.

Ryan Yeung. Are Uniforms a Good Fit? Results from the ECLS-K and the NELS. *Educational Policy*, 23(6):847–874, 2009.

APPENDIX

Table 2.13: Main Regressions Weighted by Inverse Probability of School Being Included in Sample

	Females		Males	
	Elementary	Middle/High	Elementary	Middle/High
	(1)	(2)	(3)	(4)
		A. Attendance		
Uniform Required	0.033	0.353**	-0.091	0.233
	(0.051)	(0.148)	(0.058)	(0.165)
Observations	*418,569*	*517,640*	*437,191*	*522,073*
		B. Discipline		
Uniform Required	0.004	-0.009	0.030	0.048
	(0.008)	(0.052)	(0.027)	(0.091)
Observations	*425,820*	*526,301*	*445,197*	*531,164*
		C. Math		
Uniform Required	-0.061	-0.013	-0.013	-0.022
	(0.054)	(0.037)	(0.051)	(0.030)
Observations	*112,930*	*173,996*	*116,952*	*170,346*
		D. Reading		
Uniform Required	-0.038	-0.017	0.010	-0.025
	(0.031)	(0.016)	(0.031)	(0.020)
Observations	*112,740*	*174,026*	*116,676*	*170,084*
		E. Language		
Uniform Required	0.032	0.014	-0.006	0.014
	(0.039)	(0.016)	(0.041)	(0.023)
Observations	*113,001*	*173,664*	*116,962*	*169,772*

Standard errors clustered by school in parentheses. Regressions are weighted by the inverse of predicted values from a probit regression conducted at the school level. See text for list of variables included. Each regression includes student and school fixed effects, a lagged dependent variable, grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. Elementary includes students in grades 1-5, while middle/high includes grades 6-12. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.14: Number of Fixed Effects in Regressions of Uniform Effect on Discipline and Attendance (Tables 1.4 and 1.5)

		A. Attendance		B. Disciplinary Infractions		C. In-School Suspensions		D. Out-of-School Suspensions	
		(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
					i. Elementary				
All	*School F.E.s*	154	106	155	108	154	105	154	105
	Grade F.E.s	4	4	4	4	4	4	4	4
	Year F.E.s	13	13	13	13	11	11	11	11
	Grade-by-Year F.E.s	52	52	52	52	44	44	44	44
	Student F.E.s	304,644	300,162	310,871	306,227	299,077	294,606	299,077	294,606
	Principal F.E.s	-	279	-	277	-	273	-	273
Females	*School F.E.s*	155	104	154	103	155	110	155	110
	Grade F.E.s	4	4	4	4	4	4	4	4
	Year F.E.s	13	13	13	13	11	11	11	11
	Grade-by-Year F.E.s	52	52	52	52	44	44	44	44
	Student F.E.s	149,891	147,625	152,817	150,479	146,954	144,707	146,954	144,707
	Principal F.E.s	-	281	-	282	-	268	-	268
Males	*School F.E.s*	152	102	152	108	153	105	153	105
	Grade F.E.s	4	4	4	4	4	4	4	4
	Year F.E.s	13	13	13	13	11	11	11	11
	Grade-by-Year F.E.s	52	52	52	52	44	44	44	44
	Student F.E.s	156,510	154,238	159,856	157,492	153,647	151,375	153,647	151,375
	Principal F.E.s	-	280	-	275	-	271	-	271
					ii. Middle/High				
All	*School F.E.s*	136	103	136	104	136	99	136	99
	Grade F.E.s	6	6	6	6	6	6	6	6
	Year F.E.s	12	13	12	12	11	11	11	11
	Grade-by-Year F.E.s	79	78	79	79	66	66	66	66
	Student F.E.s	326,527	320,047	333,581	326,608	322,669	315,965	322,669	315,965
	Principal F.E.s	-	199	-	198	-	194	-	194
Females	*School F.E.s*	132	97	132	94	132	96	132	96
	Grade F.E.s	6	6	6	6	6	6	6	6
	Year F.E.s	12	13	13	12	11	11	11	11
	Grade-by-Year F.E.s	79	78	78	79	66	66	66	66
	Student F.E.s	161,936	158,742	165,381	161,964	159,943	156,636	159,943	156,636
	Principal F.E.s	-	197	-	200	-	187	-	187
Males	*School F.E.s*	132	86	132	94	132	95	132	95
	Grade F.E.s	6	6	6	6	6	6	6	6
	Year F.E.s	12	13	13	13	11	10	11	10
	Grade-by-Year F.E.s	79	78	78	78	66	67	66	67
	Student F.E.s	166,620	163,284	170,290	166,682	164,408	160,971	164,408	160,971
	Principal F.E.s	-	211	-	203	-	193	-	193

Table 2.15: Gains Models

	Females		Males	
	Elementary	Middle/High	Elementary	Middle/High
	(1)	(2)	(3)	(4)
	A. Attendance			
Uniform Required	-0.026	0.271*	-0.126**	0.120
	(0.063)	(0.160)	(0.059)	(0.143)
Observations	*284,986*	*374,033*	*297,571*	*373,362*
	B. Discipline			
Uniform Required	0.002	-0.025	0.004	-0.002
	(0.006)	(0.048)	(0.019)	(0.078)
Observations	*289,434*	*379,259*	*302,393*	*378,821*

Standard errors clustered by school in parentheses. Each regression includes student and school fixed effects, grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status and an indicator for whether the current principal is a new principal. Elementary includes students in grades 1-5, while middle/high includes grades 6-12. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.16: School-Level Estimates Effect of Uniforms on Disciplinary Infraction Rates

	Elementary	Middle/High
	(1)	(2)
A. Infractions Per-Pupil		
Uniform Required	0.019	0.089
	(0.017)	(0.058)
Observations	*1,903*	*1,299*
B. In-School Suspensions Per-Pupil		
Uniform Required	0.006	0.093*
	(0.005)	(0.051)
Observations	*1,647*	*1,114*
C. Out-of-School Suspensions Per-Pupil		
Uniform Required	0.012	0.006
	(0.016)	(0.033)
Observations	*1,647*	*1,114*
D. Other Infractions Per-Pupil		
Uniform Required	0.001	0.008
	(0.002)	(0.005)
Observations	*1,647*	*1,114*
E. Infractions Resulting in In-School Suspensions (%)		
Uniform Required	0.000	0.052
	(0.029)	(0.037)
Observations	*1,552*	*1,085*

Standard errors clustered by school in parentheses. Data only includes infractions that result in a suspension or more severe punishment. Less severe infractions such as those that result in detention are not observed. Each regression includes school fixed effects along with shares of the school in each grade, female, African-American, Hispanic, Asian, White, Native American, eligible for free lunch, reduced-price lunch, otherwise economically disadvantaged, and year indicators. Elementary include anys chool with students in grades 1-5, while middle/high includes any school with grades 6-12. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.17: Event Study on Discipline and Attendance

	Disciplinary Infractions		In-School Suspensions		Out-of-School Suspensions		Attendance	
	Elementary	Middle/High	Elementary	Middle/High	Elementary	Middle/High	Elementary	Middle/High
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
6 or More Years Prior	-0.080***	-0.023	-0.010	0.048	-0.060***	-0.115**	-0.107	0.125
	(0.021)	(0.104)	(0.007)	(0.106)	(0.023)	(0.050)	(0.139)	(0.338)
5 Years Prior	-0.053***	-0.056	-0.011*	0.052	-0.042**	-0.120**	-0.016	0.008
	(0.017)	(0.086)	(0.006)	(0.074)	(0.019)	(0.047)	(0.106)	(0.361)
4 Years Prior	-0.010	0.019	-0.010*	0.116	-0.020	-0.086*	0.042	0.091
	(0.017)	(0.081)	(0.006)	(0.075)	(0.016)	(0.046)	(0.076)	(0.275)
3 Years Prior	-0.022*	0.020	-0.007	0.078	-0.018	-0.061	-0.034	-0.074
	(0.012)	(0.067)	(0.006)	(0.068)	(0.014)	(0.038)	(0.059)	(0.189)
2 Years Prior	-0.002	-0.010	0.006	-0.000	-0.001	-0.029	0.005	0.051
	(0.008)	(0.058)	(0.005)	(0.053)	(0.008)	(0.028)	(0.042)	(0.150)
Year of Adoption	0.010	0.035	0.004	0.071	0.005	-0.030	-0.016	0.335**
	(0.012)	(0.046)	(0.006)	(0.045)	(0.012)	(0.023)	(0.036)	(0.138)
1 Year After Adoption	0.020	0.030	0.008	0.097	0.015	-0.058**	0.003	0.002
	(0.013)	(0.067)	(0.007)	(0.067)	(0.013)	(0.026)	(0.050)	(0.166)
2 Years After Adoption	0.025	-0.039	0.019*	0.000	0.014	-0.065*	0.102	0.239
	(0.016)	(0.075)	(0.011)	(0.079)	(0.012)	(0.034)	(0.065)	(0.247)
3 Years After Adoption	0.011	-0.086	0.015*	-0.032	0.002	-0.070*	0.094	0.209
	(0.015)	(0.089)	(0.008)	(0.094)	(0.014)	(0.037)	(0.079)	(0.250)
4 Years After Adoption	0.017	-0.104	0.014*	-0.070	0.006	-0.063	0.094	0.259
	(0.018)	(0.096)	(0.008)	(0.105)	(0.016)	(0.038)	(0.091)	(0.271)
5 or More Years After Adoption	0.017	-0.140	0.027**	-0.131	-0.002	-0.043	0.174	-0.044
	(0.022)	(0.129)	(0.013)	(0.134)	(0.017)	(0.046)	(0.108)	(0.342)
Observations	*893,530*	*1,073,533*	*768,016*	*919,504*	*768,016*	*919,504*	*878,131*	*1,055,728*
Student fixed effects	X	X	X	X	X	X	X	X
School fixed effects	X	X	X	X	X	X	X	X

Standard errors clustered by school in parentheses. Covers grades 1-5. Each regression includes grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.18: Interactions of Uniform Status in Middle/High with Within-School 5th Grade Math Quartile on Achievment Gains, Attendance and Discipline

	Attendance	Discipline	Math	Reading	Language
	(1)	(2)	(3)	(4)	(5)
			i. All		
Uniform Required	0.298***	0.096	0.022	-0.016	0.015
	(0.113)	(0.075)	(0.027)	(0.015)	(0.014)
Uniform*2nd Quartile	-0.067	-0.027	-0.040**	0.011	0.011
	(0.071)	(0.020)	(0.016)	(0.010)	(0.011)
Uniform*3rd Quartile	-0.108	-0.047	-0.038	0.008	0.011
	(0.086)	(0.029)	(0.023)	(0.013)	(0.013)
Uniform*4th Quartile	-0.191	-0.065	-0.069**	-0.008	0.003
	(0.125)	(0.040)	(0.034)	(0.014)	(0.014)
Observations	*562,230*	*562,286*	*435,162*	*430,703*	*429,964*
			ii. Females		
Uniform Required	0.240**	0.024	0.025	-0.024	0.013
	(0.116)	(0.056)	(0.031)	(0.015)	(0.013)
Uniform*2nd Quartile	-0.070	-0.003	-0.037**	0.009	0.005
	(0.069)	(0.021)	(0.015)	(0.012)	(0.012)
Uniform*3rd Quartile	-0.066	-0.006	-0.035	0.011	0.020
	(0.090)	(0.024)	(0.024)	(0.014)	(0.015)
Uniform*4th Quartile	-0.156	-0.018	-0.057	0.005	0.015
	(0.124)	(0.031)	(0.037)	(0.015)	(0.015)
Observations	*282,915*	*282,937*	*219,737*	*217,883*	*217,510*
			iii. Males		
Uniform Required	0.338***	0.161	0.019	-0.009	0.018
	(0.129)	(0.099)	(0.026)	(0.018)	(0.018)
Uniform*2nd Quartile	-0.052	-0.047*	-0.042**	0.015	0.019
	(0.095)	(0.027)	(0.019)	(0.013)	(0.014)
Uniform*3rd Quartile	-0.139	-0.085**	-0.042*	0.006	0.001
	(0.100)	(0.041)	(0.025)	(0.015)	(0.016)
Uniform*4th Quartile	-0.215	-0.110**	-0.080**	-0.019	-0.009
	(0.143)	(0.053)	(0.034)	(0.015)	(0.017)
Observations	*279,315*	*279,349*	*215,425*	*212,820*	*212,454*

Standard errors clustered by school in parentheses. Covers grades 1-5. Each regression includes grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.19: Levels Models

	Females		Males	
	Elementary	Middle/High	Elementary	Middle/High
	(1)	(2)	(3)	(4)
		A. Math		
Uniform Required	-0.067**	-0.025**	-0.046*	-0.033***
	(0.026)	(0.012)	(0.027)	(0.011)
Observations	*199,569*	*271,401*	*206,713*	*268,158*
		B. Reading		
Uniform Required	-0.043**	-0.022**	-0.038*	-0.021**
	(0.018)	(0.010)	(0.020)	(0.010)
Observations	*199,382*	*271,429*	*206,483*	*267,942*
		C. Language		
Uniform Required	-0.013	0.001	-0.015	0.005
	(0.018)	(0.010)	(0.023)	(0.011)
Observations	*199,601*	*271,009*	*206,721*	*267,359*

Standard errors clustered by school in parentheses. Each regression includes student and school fixed effects, grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status and an indicator for whether the current principal is a new principal. Elementary includes students in grades 1-5, while middle/high includes grades 6-12. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.20: Number of Fixed Effects in Regressions of Uniform Effect on Achievement Gains (Table 1.9)

		A. Math		B. Reading		C. Language	
		(1)	(2)	(1)	(2)	(1)	(2)
		i. Elementary					
All	*School F.E.s*	148	71	147	74	148	67
	Grade F.E.s	4	4	4	4	4	4
	Year F.E.s	7	7	7	7	7	7
	Grade-by-Year F.E.s	28	28	28	28	28	28
	Student F.E.s	106,765	104,682	106,708	104,635	106,798	104,715
	Principal F.E.s	-	211	-	208	-	215
Females	*School F.E.s*	148	80	147	82	147	78
	Grade F.E.s	4	4	4	4	4	4
	Year F.E.s	7	7	7	7	7	7
	Grade-by-Year F.E.s	28	28	28	28	28	28
	Student F.E.s	52,666	51,605	52,630	51,569	52,668	51,605
	Principal F.E.s	-	202	-	200	-	204
Males	*School F.E.s*	147	74	147	75	148	72
	Grade F.E.s	4	4	4	4	4	4
	Year F.E.s	7	7	7	7	7	7
	Grade-by-Year F.E.s	28	28	28	28	28	28
	Student F.E.s	54,454	53,420	54,429	53,405	54,487	53,455
	Principal F.E.s	-	208	-	207	-	210
		ii. Middle/High					
All	*School F.E.s*	109	76	109	72	108	71
	Grade F.E.s	5	5	5	5	5	5
	Year F.E.s	7	6	7	7	7	7
	Grade-by-Year F.E.s	36	37	36	36	36	36
	Student F.E.s	158,310	156,453	158,266	156,406	158,064	156,185
	Principal F.E.s	-	120	-	124	-	125
Females	*School F.E.s*	107	75	106	66	107	69
	Grade F.E.s	5	5	5	5	5	5
	Year F.E.s	7	7	6	7	7	7
	Grade-by-Year F.E.s	36	36	37	36	36	35
	Student F.E.s	79,627	78,666	79,648	78,694	79,563	78,588
	Principal F.E.s	-	118	-	127	-	126
Males	*School F.E.s*	108	72	108	71	107	77
	Grade F.E.s	5	5	5	5	5	5
	Year F.E.s	7	7	7	7	7	7
	Grade-by-Year F.E.s	36	36	36	35	36	36
	Student F.E.s	79,158	78,253	79,086	78,171	78,970	78,056
	Principal F.E.s	-	123	-	124	-	117

Table 2.21: Event Study on Achievement Gains

	A. Math		B. Reading		C. Language	
	Elementary	Middle/High	Elementary	Middle/High	Elementary	Middle/High
	(1)	(2)	(3)	(4)	(5)	(6)
6 or More Years Prior	0.155	0.097**	0.160**	0.030	0.180**	0.095***
	(0.117)	(0.046)	(0.079)	(0.030)	(0.075)	(0.027)
5 Years Prior	0.124	0.029	0.141	0.020	0.107	0.061*
	(0.110)	(0.049)	(0.098)	(0.032)	(0.078)	(0.032)
4 Years Prior	0.053	0.037	0.055	0.052*	0.126**	0.020
	(0.075)	(0.039)	(0.074)	(0.030)	(0.054)	(0.024)
3 Years Prior	-0.048	0.019	-0.039	0.032*	-0.034	0.060**
	(0.069)	(0.026)	(0.042)	(0.019)	(0.048)	(0.027)
2 Years Prior	0.002	0.030*	0.043	0.026	0.031	0.038**
	(0.045)	(0.017)	(0.046)	(0.016)	(0.037)	(0.014)
Year of Adoption	-0.022	-0.016	-0.000	-0.023	0.020	0.011
	(0.028)	(0.026)	(0.027)	(0.014)	(0.028)	(0.017)
1 Year After Adoption	-0.016	-0.003	-0.016	0.013	-0.022	0.019
	(0.034)	(0.041)	(0.029)	(0.027)	(0.033)	(0.021)
2 Years After Adoption	-0.049	-0.004	-0.037	-0.017	-0.075**	-0.009
	(0.043)	(0.043)	(0.031)	(0.026)	(0.035)	(0.021)
3 Years After Adoption	-0.051	-0.007	-0.023	-0.007	-0.062	-0.029
	(0.051)	(0.053)	(0.034)	(0.031)	(0.045)	(0.023)
4 Years After Adoption	-0.078	0.017	-0.036	-0.024	-0.091*	-0.066**
	(0.057)	(0.063)	(0.040)	(0.038)	(0.053)	(0.029)
5 or More Years After Adoption	-0.037	0.017	-0.025	-0.050	-0.118*	-0.041
	(0.068)	(0.092)	(0.048)	(0.058)	(0.063)	(0.042)
Observations	239,272	420,165	238,759	420,058	239,348	419,229
Student fixed effects	X	X	X	X	X	X
School fixed effects	X	X	X	X	X	X

Standard errors clustered by school in parentheses. Covers grades 1-5. Each regression includes grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.22: Effect of Uniforms Interacted with Student and School Ethnicity on Test Score Gains - Elementary

	A. Math			B. Reading			C. Language		
	All	Females	Males	All	Females	Males	All	Females	Males
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Uniform Required	-0.108	-0.094	-0.115	-0.070	-0.137***	-0.004	0.029	0.032	0.032
	(0.081)	(0.099)	(0.073)	(0.043)	(0.043)	(0.051)	(0.055)	(0.061)	(0.062)
Uniform Required*Above-Median	0.075**	0.131***	0.029	0.040*	0.057*	0.024	0.074**	0.131***	0.017
African-American*African-American	(0.031)	(0.036)	(0.042)	(0.023)	(0.031)	(0.030)	(0.029)	(0.046)	(0.034)
Uniform Required*Above-Median	-0.082**	-0.042	-0.120**	-0.053	-0.012	-0.089**	-0.029	0.007	-0.055
Hispanic*Hispanic	(0.040)	(0.043)	(0.047)	(0.035)	(0.036)	(0.045)	(0.032)	(0.042)	(0.044)
Uniform Required*Above-Median	0.041	0.026	0.053	-0.004	0.004	-0.011	0.012	0.028	-0.001
African-American	(0.064)	(0.075)	(0.061)	(0.048)	(0.047)	(0.057)	(0.059)	(0.066)	(0.061)
Uniform Required*Above-Median	0.124**	0.109*	0.134**	0.027	0.059	-0.002	0.010	0.055	-0.029
Hispanic	(0.058)	(0.061)	(0.060)	(0.044)	(0.040)	(0.053)	(0.049)	(0.051)	(0.057)
Uniform Required*African-American	-0.053	-0.123**	-0.000	0.012	0.024	0.001	-0.109***	-0.167***	-0.057
	(0.045)	(0.060)	(0.047)	(0.030)	(0.037)	(0.042)	(0.037)	(0.044)	(0.056)
Uniform Required*Hispanic	0.017	-0.026	0.054	0.054	0.046	0.059	-0.045	-0.101**	-0.006
	(0.054)	(0.068)	(0.053)	(0.036)	(0.044)	(0.040)	(0.044)	(0.051)	(0.058)
Above-Median African-American	-0.024	-0.025	-0.023	0.003	0.001	0.000	-0.028	-0.074	0.011
	(0.062)	(0.078)	(0.059)	(0.049)	(0.050)	(0.057)	(0.055)	(0.067)	(0.056)
Above-Median Hispanic	-0.135**	-0.147***	-0.121**	-0.014	-0.028	-0.006	0.003	-0.050	0.049
	(0.056)	(0.056)	(0.060)	(0.046)	(0.039)	(0.055)	(0.047)	(0.051)	(0.052)
Observations	*270,257*	*133,007*	*137,250*	*269,483*	*132,670*	*136,813*	*262,662*	*129,281*	*133,381*

Standard errors clustered by school in parentheses. Each regression includes student and school fixed effects along with grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. Elementary includes students in grades 1-5, while middle/high includes grades 6-12. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.23: Effect of Uniforms Interacted with Student and School Ethnicity on Test Score Gains - Middle/High

	A. Math			B. Reading			C. Language		
	All	Females	Males	All	Females	Males	All	Females	Males
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Uniform Required	0.036	0.047	0.026	-0.016	-0.017	-0.017	0.072**	0.087***	0.056
	(0.036)	(0.034)	(0.042)	(0.025)	(0.039)	(0.023)	(0.030)	(0.027)	(0.043)
Uniform Required*Above-Median	0.004	-0.008	0.018	0.007	0.032**	-0.025*	0.023*	0.040**	0.006
African-American*African-American	(0.014)	(0.014)	(0.021)	(0.011)	(0.015)	(0.014)	(0.012)	(0.018)	(0.016)
Uniform Required*Above-Median	0.006	0.007	-0.000	-0.020	-0.027*	-0.014	-0.009	-0.014	-0.010
Hispanic*Hispanic	(0.015)	(0.015)	(0.020)	(0.013)	(0.015)	(0.019)	(0.013)	(0.017)	(0.018)
Uniform Required*Above-Median	0.003	0.007	-0.005	-0.008	-0.008	-0.008	-0.033	-0.048*	-0.021
African-American	(0.029)	(0.031)	(0.032)	(0.022)	(0.028)	(0.026)	(0.027)	(0.027)	(0.036)
Uniform Required*Above-Median	-0.080**	-0.091***	-0.071*	-0.021	-0.013	-0.028	-0.064**	-0.086***	-0.040
Hispanic	(0.033)	(0.034)	(0.036)	(0.021)	(0.028)	(0.025)	(0.026)	(0.030)	(0.033)
Uniform Required*African-American	-0.005	0.005	-0.014	0.030*	0.014	0.051***	-0.026*	-0.039**	-0.013
	(0.018)	(0.020)	(0.022)	(0.015)	(0.021)	(0.015)	(0.014)	(0.016)	(0.017)
Uniform Required*Hispanic	-0.011	-0.010	-0.007	0.032**	0.028*	0.036**	0.007	0.014	0.003
	(0.021)	(0.022)	(0.023)	(0.015)	(0.017)	(0.016)	(0.012)	(0.012)	(0.018)
Above-Median African-American	-0.012	-0.013	-0.010	0.005	-0.010	0.021	0.050*	0.061**	0.041
	(0.022)	(0.028)	(0.022)	(0.017)	(0.025)	(0.014)	(0.029)	(0.024)	(0.037)
Above-Median Hispanic	0.010	0.020	0.007	-0.002	0.014	-0.019	-0.015	-0.003	-0.025
	(0.029)	(0.027)	(0.034)	(0.019)	(0.020)	(0.025)	(0.025)	(0.026)	(0.029)
Observations	*469,503*	*237,012*	*232,491*	*469,248*	*237,076*	*232,172*	*468,510*	*236,660*	*231,850*

Standard errors clustered by school in parentheses. Each regression includes student and school fixed effects along with grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. Elementary includes students in grades 1-5, while middle/high includes grades 6-12. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.24: Effect of Uniforms Interacted with Student and School Economic Disadvantage Status

	Females		Males	
	Elementary	Middle/High	Elementary	Middle/High
	(1)	(2)	(3)	(4)
		A. Math		
Uniform Required	-0.032	-0.000	0.027	-0.017
	(0.048)	(0.021)	(0.039)	(0.021)
Uniform Required*Disadvantaged	-0.006	-0.012	-0.004	0.003
	(0.032)	(0.010)	(0.031)	(0.010)
Uniform Required*Disadvantaged*	-0.042	0.036*	-0.018	-0.000
*Above-Median Disadvantaged	(0.034)	(0.019)	(0.027)	(0.033)
Uniform Required*Above-Median	0.006	-0.036	-0.058	-0.044
Disadvantaged	(0.057)	(0.039)	(0.060)	(0.051)
Above-Median Disadvantaged	0.031	-0.040	0.091	-0.015
	(0.051)	(0.037)	(0.061)	(0.033)
Observations	133,007	237,012	137,250	232,491
		B. Reading		
Uniform Required	-0.096***	-0.019	0.036	-0.021*
	(0.028)	(0.016)	(0.030)	(0.011)
Uniform Required*Disadvantaged	0.053**	0.005	-0.005	0.014
	(0.025)	(0.010)	(0.027)	(0.010)
Uniform Required*Disadvantaged*	-0.042	-0.013	-0.002	-0.017
*Above-Median Disadvantaged	(0.028)	(0.023)	(0.023)	(0.024)
Uniform Required*Above-Median	0.028	0.020	-0.057	0.006
Disadvantaged	(0.049)	(0.028)	(0.045)	(0.036)
Above-Median Disadvantaged	0.026	0.001	0.064	0.001
	(0.045)	(0.024)	(0.041)	(0.020)
Observations	132,670	237,076	136,813	232,172
		C. Language		
Uniform Required	0.087**	0.037**	0.066*	0.031*
	(0.037)	(0.016)	(0.039)	(0.017)
Uniform Required*Disadvantaged	-0.062*	-0.020*	-0.021	-0.009
	(0.037)	(0.010)	(0.028)	(0.014)
Uniform Required*Disadvantaged*	0.025	-0.028	-0.034	-0.027
*Above-Median Disadvantaged	(0.027)	(0.022)	(0.032)	(0.020)
Uniform Required*Above-Median	-0.069*	0.017	-0.088*	0.004
Disadvantaged	(0.035)	(0.034)	(0.050)	(0.036)
Above-Median Disadvantaged	0.064***	-0.014	0.141***	-0.002
	(0.023)	(0.010)	(0.042)	(0.014)
Observations	129,281	236,660	133,381	231,850

Standard errors clustered by school in parentheses. Covers grades 1-5. Each regression includes grade indicators, year indicators, interactions of grade and year indicators, and the student's free-lunch, reduced-price lunch, or other economic disadvantage status. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 2.25: Number of Fixed Effects in Regressions of Uniform Effect on Student Movements, Grade Retention, and Teacher Attrition (Table 1.12)

		A. Switches Schools in LUSD		B. Leaves LUSD		C. Grade Retention		D. Teacher Attrition	
		(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
					i. Elementary				
All	School F.E.s	154	100	154	100	153	106	144	140
	Grade F.E.s	4	4	4	4	4	4	-	-
	Year F.E.s	12	12	12	12	12	12	8	8
	Grade-by-Year F.E.s	48	48	48	48	48	48	-	-
	Student F.E.s	270,916	266,810	270,916	266,810	224,720	221,632	-	-
	Principal F.E.s	-	259	-	259	-	265	-	141
Females	School F.E.s	152	103	152	103	154	104		
	Grade F.E.s	4	4	4	4	4	4		
	Year F.E.s	12	12	12	12	12	12		
	Grade-by-Year F.E.s	48	48	48	48	48	48		
	Student F.E.s	133,218	131,167	133,218	131,167	110,849	109,270		
	Principal F.E.s	-	254	-	254	-	267		
Males	School F.E.s	150	110	150	110	151	104		
	Grade F.E.s	4	4	4	4	4	4		
	Year F.E.s	12	12	12	12	12	12		
	Grade-by-Year F.E.s	48	48	48	48	48	48		
	Student F.E.s	139,084	136,976	139,084	136,976	115,018	113,472		
	Principal F.E.s	-	246	-	246	-	264		
					ii. Middle/High				
All	School F.E.s	79	55	79	55	129	87	114	103
	Grade F.E.s	5	5	5	5	6	6	-	-
	Year F.E.s	12	12	12	12	11	11	8	8
	Grade-by-Year F.E.s	60	60	60	60	74	74	-	-
	Student F.E.s	293,650	287,915	293,650	287,915	270,108	266,364	-	-
	Principal F.E.s	-	142	-	142	-	197	-	103
Females	School F.E.s	77	57	77	57	124	97		
	Grade F.E.s	5	5	5	5	6	6		
	Year F.E.s	12	12	12	12	11	12		
	Grade-by-Year F.E.s	60	60	60	60	74	73		
	Student F.E.s	145,061	142,306	145,061	142,306	134,912	132,962		
	Principal F.E.s -	138	-	138	-	178			
Males	School F.E.s	79	54	79	54	126	87		
	Grade F.E.s	5	5	5	5	6	6		
	Year F.E.s	12	12	12	12	11	11		
	Grade-by-Year F.E.s	60	60	60	60	74	73		
	Student F.E.s	150,046	147,027	150,046	147,027	136,848	135,016		
	Principal F.E.s	-	142	-	142	-	194		

Table 2.26: Event Study on Teacher Attrition

	Elementary	Middle/High
	(1)	(2)
6 or More Years Prior	-0.051**	-0.040
	(0.025)	(0.038)
5 Years Prior	0.010	-0.021
	(0.034)	(0.029)
4 Years Prior	0.001	-0.029
	(0.024)	(0.027)
3 Years Prior	0.009	0.009
	(0.024)	(0.029)
2 Years Prior	-0.010	0.023
	(0.020)	(0.024)
Year of Adoption	-0.041**	-0.004
	(0.020)	(0.018)
1 Year After Adoption	-0.034*	-0.004
	(0.020)	(0.023)
2 Years After Adoption	-0.045*	-0.001
	(0.023)	(0.027)
3 Years After Adoption	-0.045*	-0.005
	(0.023)	(0.030)
4 Years After Adoption	-0.032	-0.007
	(0.028)	(0.033)
5 or More Years After Adoption	-0.024	0.022
	(0.032)	(0.040)
Observations	1,213	811

Standard errors clustered by school in parentheses. Elementary includes any school that has students in grades 1-5 and middle high covers grades 6-12. Data on teacher attrition covers 1996-07 through 2004-05. Attrition is calculated by matching teacher names within a school across years. Counts for the number of student, school and principal fixed effects in each regression are provided in Online Appendix Table 2.