PhD THESIS DECLARATION

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PhD in *Economics and Finance*

Cycle *XXVI*

Candidate's tutor *Maristella Botticini*

Year of thesis defence *2016*

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Acknowledgements

Many people have contributed, directly or indirectly, to this thesis. Their guidance, advises and encouragement have been crucial to prod me into becoming a researcher, greatly improved the quality of my work and made the PhD experience an incredible and enriching adventure.

I am greatly indebted to Maristella Botticini and Francesco Giavazzi for their constant ad excellent supervision. Massimo Morelli provided continuous advice an fruitful discussion. I am very grateful to Alberto Alesina and Guido Tabellini whose suggestions and careful assistance have been precious. Giampaolo Lecce as a friend and a coauthor contributed to make the PhD years a stimulating and enjoyable journey. Rosario Crinò has been my steady source of tireless support, unceasing encouragement and never-ending inspiration.

Lastly this thesis benefited from the comments of my friends and colleagues, especially Elisa Borghi, Italo Colanone, Michela Carlana, Volker Lindenthal, Tommaso Orlando, and Santiago Vincent Perez. All remaining errors are my own resposibility.

Abstract

This Thesis is an effort to provide answers to two important questions in the debate on the link between institutions and economic performance. Why do good institutions, when exported to a different context, sometimes fail to boost growth? Through which mechanisms, and with what implications, do institutions act on economics outcomes? After a brief introduction in Chapter 1, Chapter 2 addresses the first question exploiting an historical example of an institutional transplant. The Chapter argues that cultural proximity is a fundamental element for good institutions to have a positive effect on economic outcomes. Chapter 3 focuses on financial institutions and provides a new mechanism through which good institutions affect economic performance. In particular, the chapter shows that easier access to credit allows firms to produce goods of superior quality, which in turn improves countries' export capacity. Finally, Chapter 4 studies the impact that good institutions have on the returns to capital, and argues that richer countries –which have better institutions – display a higher productivity of capital. The chapter further shows that this relation has become stronger over the last two decades.

Chapter 1

Introduction

A rapidly-growing literature emphasizes the key role of institutions in determining countries' economic performances. Using both historical and contemporaneous data previous studies find that better institutions are usually associated with better economic outcomes. Despite the richness of this literature two crucial questions are not yet satisfactorily answered. First, why do good institutions, when exported to a different context, sometimes fail to boost growth? Second, through which mechanisms, and with what implications, do institutions act on economics outcomes? This thesis makes a step toward answering this two questions.

Chapter 2 investigates the reason why institutional transplant may fail. The Chapter argues that culture acts as a mediator of the imported institutions and that the institutional transfer essentially hinges on the "cultural compatibility" between the originating and the receiving country. In order to test this hypothesis we focus on the transplant of Napoleonic Institution in Germany after the French Revolution. This historical example fits well our purpose as it allows us to exploit both the exogeneity of the institutional transplant and the rich heterogeneity in the cultural environment of late-modern Germany. Our novel finding is that the transplant of the Napoleonic Code, a good legal institution, had heterogeneous effects on economic performance across German areas characterized by different cultural traits. In particular, the transplant was more effective in areas with stronger cultural commonality with France, where it increased the measures of economic performance by 12-20% while having virtually no effect in other regions.

Chapter 3 highlights a new mechanism through which better institutions translate into better economic outcomes. Focusing on financial institutions, the chapter shows, both theoretically and empirically, that easier access to credit raises countries' economic performance by allowing them to produce goods of superior quality. The

Chapter also shows that the production of high-quality goods is an important mechanism through which good financial institutions affect the level of countries' economic activity, in particular their export capacity. To make these points the Chapter develops a simple multi-country and multi-industry trade model with financial frictions, heterogeneous firms and endogenous product quality. The model is then estimated using a unique dataset that contains estimates of product quality and measures of financial imperfections for all countries and manufacturing industries over the last three decades.

Finally, Chapter 4 studies the impact that good institutions have on the productivity of capital. In particular, using a methodology recently developed by Caselli and Feyrer (2007), I show that rich countries –characterized by better institutions– display on average higher marginal product of capital. The chapter also shows that this relation has become stronger over time. This result is important as it may help to explain one of the most famous puzzles in international economics, namely the Lucas puzzle. Richer countries, that according to standard theories should export capital, may attract larger capital flows precisely because their productivity of capital is higher.

Chapter 2

Institutional Transplant and Cultural Proximity: Evidence from Nineteenth-Century Prussia

Introduction[1]

Economists have long argued the importance of good institutions for economic growth. Rule of law, better enforcement of contracts, security of property rights are usually associated with better economic outcomes, such as higher investment in physical and human capital, and technological progress. Some countries lacking good legal institutions have attempted to import them from abroad with the goal of boosting economic growth (e.g. Chinese antitrust law, Japanese national Civil Code). However, the adoption of good foreign institutions not always led to positive economic outcomes (e.g. in British African colonies).

Why does institutional transplant fail? Is culture responsible for it? When institutions are perceived as "foreign" or "in conflict" with local culture and social norms they may not be assimilated and, thus, not fully enforced. If this is the case, the effectiveness of a transplanted formal institution will crucially hinge on the reception by local communities and elites. This paper focuses on the differential long term economic effect of an institutional transplant. Specifically, we argue that the growth effect of transferring a well functioning institution from its original setting depends on the cultural compatibility with the receiving country.

[1]This Chapter is joint work with Giampaolo Lecce and has been circulated as CESifo Working Paper No. 5652

In order to test our hypothesis we focus on a particular historical natural experiment: the Napoleonic invasion of German territories and the consequent imposition of French institutions. Our novel finding is that the transplant of the Napoleonic Code, a good legal institution, had heterogeneous effects on economic performance across German areas characterized by different cultural traits. In particular, the transplant was more effective in areas with stronger cultural commonality with France. The imposition of the Napoleonic Code increases our measure of economic performance by 12-20% in areas culturally similar to France while it has virtually no effect in culturally distant ones.

A potential mechanism through which culture affects the adoption of the new formal institutions is local enforcement. In his quest to build a pan-European empire, Napoleon sought to assimilate the conquered territories and forge a class of loyal new *Frenchmen* to support him in the administration of the empire. Historical evidence shows how, in some areas, local elites willingly fit themselves into the Napoleonic society because they shared the same values, thus facilitating the implementation of new institutions (it is the case of Piedmont and Rhineland). In other areas, instead, the amalgamation policy pursued by Napoleon imposed French culture on a reluctant population and the Napoleonic Code was simply too alien to be enforced by local communities.[2]

In our empirical analysis we construct several measures to capture different dimensions of cultural distance with the French invader. Our first proxy of similarity is the Protestant share of the population. Given that France was predominantly Catholic at that time, this measure serves as an inverse proxy for cultural proximity. Religious affiliation has several advantages: it is available for all 451 Prussian counties, it is well measured and varies substantially across different areas. The Protestant share, however, may not capture all aspects of cultural commonality that maybe relevant for an institutional transplant, hence we also construct alternative proxies based on hand-collected data. These measures are intended to capture cultural linkages and the exposure to French Culture before the French revolution, namely: (i) presence of Huguenots colonies, (ii) ties between each German reign and the Kingdom of France, (iii) the attitudes of each ruler both towards the French enlightened ideals and French customs.

We perform several robustness checks to ensure that our results are not spuriously driven by observable and unobservable characteristics of Prussian counties. First, we map Prussian counties to pre-Napoleonic reigns. This allows us to condition the es-

[2] For a thorough and insightful discussion see Parsons (2010).

timation on a full set of reign fixed effects, thereby controlling for any difference in pre-existing social norms, historical facts and economic characteristics. Second, we explore a wide range of alternative specifications using a large set of controls and different proxies for economic performance and institutions. Third, we show that our finding is not contaminated by past implementation of liberal reforms in some Prussian areas. Finally, we explore a number of competing explanations such as: (i) human capital accumulation, (ii) religious fractionalization within county and (iii) religious diversity with neighboring counties. We find none of these to fully explain our results.

Our paper contributes to an emerging literature on the interplay between cultural traits and institutions. Guiso et al. (2015) argue that social norms are crucial to sustain legal institutions. Acemoglu and Jackson (2015), in a seminal paper, model the interaction between law enforcement and social norms.[3] An interesting prediction of their model is that laws in conflict with prevailing social norms may backfire as they do not spur the private cooperation of citizens necessary for an effective enforcement. We are the first to address a similar question from an empirical perspective. In the context of Napoleonic invasions, their prediction implies that the reception of French institutions can be different depending on the underlying cultural environment of the several states receiving the Code, consistently with our results.

We also connect to three strands of research. First we relate to the literature on transplant of legal systems.[4] While these studies mainly focus on the effectiveness of imported legal institutions and attribute differences in adoption to the process of lawmaking and to the demand for law, we test the channel of cultural similarity as a mediating factor in the reception of transplanted institution and analyze the long term economic effect of the interplay between new legal institutions and the local culture. The second important stream of literature we connect to is the one investigating the importance of good institutions for economic growth. Starting with the seminal work of Douglass North, many scholars have emphasized that institutions "matter".[5] In an influential paper, Acemoglu et al. (2011) exploited the variation in institutional reforms during Napoleonic campaigns across 18^{th} and 19^{th} century to show that these radical reforms had a positive and significant effects on long-term economic performance.[6] In contrast to the existing contributions, our analysis does not focus on the positive effect

[3]Bisin and Verdier (2012) also have a theoretical model on the interaction of culture and institutions.

[4]See, for example, Berkowitz et al. (2003).

[5]See, for example, North (1990) and Acemoglu et al. (2001, 2002). For the relation between institution and the legal origin of countries see Glaeser and Shleifer (2002) and Shleifer et al. (2008).

[6]See also Acemoglu et al. (2012) and Buggle (2013).

of adopting a good institution but on the heterogeneous reception and the different economic effect in areas characterized by variegated cultural traits.

Finally, we touch upon the literature analyzing the link between culture and economic performance.[7] In particular, related to our paper are the works by Becker and Woessmann (2009) and Cantoni (2014). They test the Weberian hypothesis[8] using data on early modern Germany – the same historical environment that we exploit – and provide controversial results. Cantoni (2014) analyzes the impact of Protestantism on urbanization, starting from the 17^{th} century. He finds no significant effect of Protestant ethic on economic development. Becker and Woessmann (2009) use an argument similar to the one proposed by Botticini and Eckstein (2005, 2012) stressing the importance of human capital to explain economic prosperity. Using cross-county variation in Prussia during the 19^{th} century, they find evidence of higher level of human capital in Protestant areas, thus providing an alternative channel to explain the higher prosperity of Protestant regions. We provide the first empirical evidence of the mediating effect of culture in a law transplant, thereby marrying the literatures on culture and that on institutions.

The rest of the paper is organized as follows. Section 2 reviews the historical background, discussing the political situation of German territories before French invasion, French military campaigns, and the introduction of the Civil Code. Section 3 describes our data and provides some descriptive statistics. Section 4 presents our main results and discusses their robustness. Section 5 explores some alternative potential explanations for our findings. Section 6 investigates the effects of the other cultural measures, different from religious affiliation, that affect the reception of the Napoleonic code. Finally, Section 7 concludes.

2.1 Historical Overview

2.1.1 The Holy Roman Empire before 1800

The territories of the Holy Roman Empire had always been characterized by a considerable degree of heterogeneity. Since its foundation in 962 AD the Holy Roman Em-

[7]See Alesina and Giuliano (2010, 2015), Algan and Cahuc (2010), Bisin and Verdier (2000), Doepke and Zilibotti (2008), Fernàndez et al. (2004), Galor and Moav (2002), Giavazzi et al. (2014), Greif (1993), Guiso et al. (2008), Nannicini et al. (2013), Nunn and Wantchekon (2011) and Tabellini (2008, 2010). Fernàndez (2011) provides a detailed review on this literature.

[8]See the seminal work by Max Weber (1930) "The Protestant Ethic and the Spirit of Capitalism".

pire was a multi-ethnic, multi-cultural, and multi-lingual ensemble of several entities – eventually hundreds – governed by kings, dukes, counts and bishops, collectively known as princes. These different layers of political power became gradually more autonomous as the Holy Roman emperors shifted their attention to their local kingdoms.

Pivotal in the progressive disintegration of the Empire was Protestant Reformation. Starting as a protest against the corruption of the Roman Catholic Church, the Reformation quickly spread out throughout central Germany gaining the support of several princes who wanted to stress their political and religious independence. In 1555, after several years of war, the Emperor and the Protestant German princes signed a peace treaty in Augsburg. The principle of *cuius regio eius religio* ("whose realm, his religion") was affirmed making Lutheranism an official religion of the Empire. The ambition of the emperor to centralize power and rule over a unified empire was thus permanently shattered. Religious and political wars continued to afflict the Holy Roman Empire until a stable resolution was reached with the Peace of Westphalia. By 1648 the Empire was just a confederation of German princes who, in their own lands, had the right to legislate, impose taxes, organize an army, mint and engage in foreign policy.

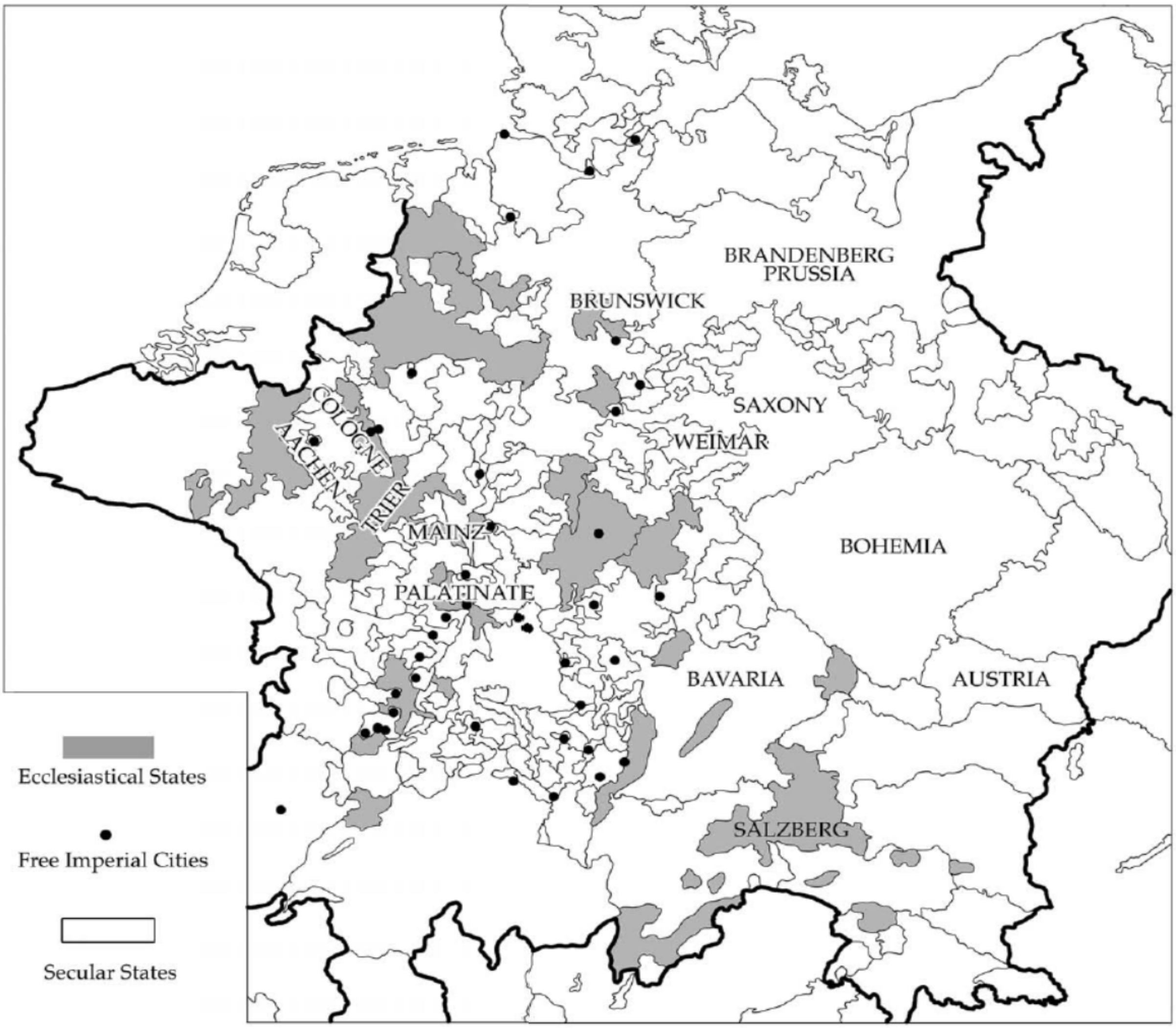
The political fragmentation of the Empire (see Figure 2.1) gave rise to persistent institutional and cultural heterogeneity. This diversity was also reinforced by the internal migration of religious minorities, most notably Jews and French Protestants, which imported their own values and customs. All these elements contribute to create an extremely variegated picture where each territory displays its own identity. Religious affiliation, albeit just facet, is the first evident aspect of these cultural differences.

2.1.2 The French Revolution and the Napoleonic Military Campaigns

The emergence of revolutionary France as an aggressive and strong military power at the end of the 18^{th} century marked the end of the Holy Roman Empire. The first crushing victories by the French army created a power vacuum in the German territories which Napoleon exploited to create a "cordon sanitaire" between France and its traditional Eastern enemies, Austria and Russia. By 1795 Napoleon was in control of the left bank of the Rhine which was formally annexed to the French Empire with the treaty of Luneville (1801).[9] When the Habsburg ceded part of their German estates to Napoleon's allies, in 1805, the end of the Holy Roman Empire was essentially de-

[9] According to Fisher (1903), this treaty has also been called the "First Revolution of Germany" given that a "territory of 150,000 square miles, peopled by 3,500,000 inhabitants, and amounting to about a seventh part of the population and territory of the whole Empire" was transferred to the French Empire.

Figure 2.1: Holy Roman Empire in 1789



Source: Eric D. Brose. *German History 1789-1871: From the Holy Roman Empire to the Bismarckian Reich.* Berghahn Books, 1997.

termined. The following year, central Germany was unified in the *Confederation of the Rhine*, a formally independent confederation of sixteen states whose protector and unofficial ruler was Napoleon.[10] French expansion continued until Napoleon's downfall after the Russian campaign in 1812. By that time French sphere of influence extended to Poland (with the creation of the Duchy of Warsaw in 1807) and to Northern Germany (with the annexation of the Hanseatic cities of Hamburg, Lubeck, and Bremen in 1810). By the first decade of 19th century Napoleon had taken over the majority of German reigns. Figure 2.2 shows the counties in territories controlled by Napoleon differentiating between annexed areas and satellite states.

In his expansion of the French Empire, Napoleon was mainly driven by ideological and geo-political concerns, rather than by the economic outlook of the region. Besides the security concern of having influence over a buffer region that separated France from the two main Eastern powers, the Revolutionary rhetoric of *France natural borders* was driving his military campaigns.[11] Therefore, following Acemoglu et al. (2010), we can consider Napoleonic invasions as a quasi-natural shock in our empirical analysis.

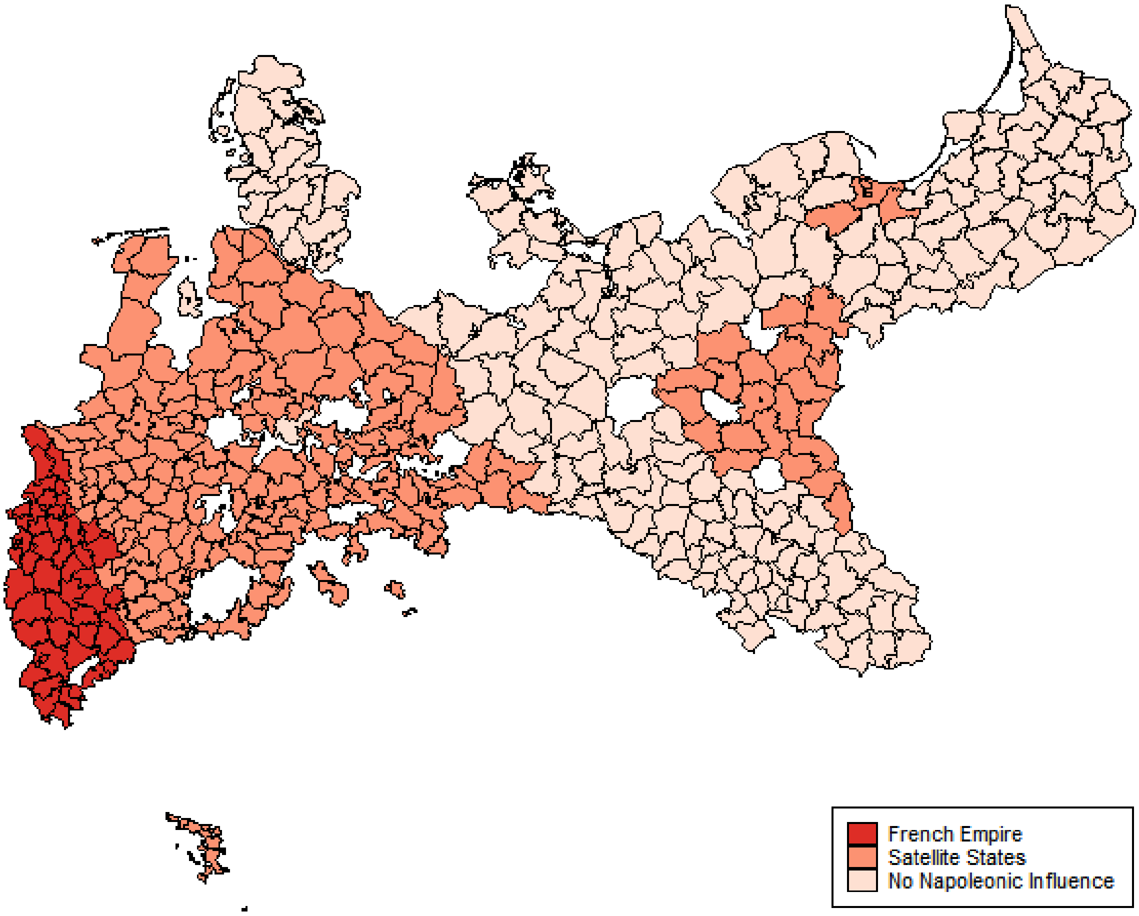
2.1.3 The Imposition of the French Institutions

Despite the marked institutional heterogeneity of the Holy Roman Empire resulting from the high territorial fragmentation, some useful general features can be identified. At the dawn of 19^{th} century the institutions of the *ancien regime* still pervaded the German territories and feudal privileges were the norm. In rural areas, even where serfdom had been abolished, peasants were subject to several restrictions and burdened by a list of duties and services they had to provide to their lords. In the cities, guilds regulated the access to different trades, often limiting the development and the growth of

[10] The members of the Confederation promised to "supply their protector with a military contingent" (Lefebvre, 1969) and, in return for their support, they were given higher statuses or additional territories. For example the free cities of Augsburg and Nuremberg were annexed by Bavaria and Frankfurt to Dalberg, Nassau became a duchy and Dalberg became the prince primate of the Confederation of the Rhine.

[11] Discussion on the Rhine question began well before the outbreak of the hostilities in 1792. The idea of French natural borders became prominent among the jacobian revolutionaries. Georges Jacques Danton on January 21, 1793 during the national convention was arguing in favor of the annexation of Belgium saying that "the limits of France are marked by nature, we will reach reach the four corners of the horizon, to the edge of the Rhine, to the edge of the ocean, to the edge of the Pyrenees, to the edge of the Alps. The boundaries of our Republic must be there". For more details see Smets (1998).

Figure 2.2: Counties Under Napoleonic Influence



the industry they controlled.[12] Equality before the law was still far from being contemplated: aristocrats, clergy, military benefited from particular exemptions, while other groups were discriminated (e.g. Jews).

The arrival of Napoleon was a disruptive force. His rule over central Europe meant the imposition of a series of institutional reforms. The most important was arguably the introduction of the Civil Code. Emblem of the values promoted during the French Revolution, the *Code Napoleon* (1804) introduced equality before the law to all men regardless of their social and economic status. Moreover, it consecrated absolute property rights to which the code dedicated a total of 1776 articles.[13] Finally, the Code provided a modern legal framework that regulated all aspects of social interaction, from family matters to economic contracts. The process of codification continued with

[12]In the Rhenish area, for example, guilds were imposing strict limitations on the adoption of new technologies (Kisch, 1989).

[13]A huge amount when compared to 515, the number of articles regulating person. See Woolf (2002).

the promulgation of the Code of Civil Procedure (1806), the Commercial Code (1807), the Criminal Code and the Code of Criminal Procedure (1808) and the Penal Code (1810). All these codes were imposed on the satellites states under Napoleon's control. Interestingly, some states decided to retain the codes even after Napoleon's fall, and even in those reigns that formally abandon the *Code Napoleon*, the institutions were permanently affected.[14] Beyond the judicial innovations, French rule also implied a more efficient model of administration and the implementation of fiscal reforms that introduced budgeting and rationalization of public expenditures.

The introduction of judicial and bureaucratic reforms occasionally generated hostility among the indigenous population: the new norms were often perceived as extraneous and incompatible with local culture and customs.[15] Historical evidence shows that in some areas the code met the opposition not only of the aristocracy, deprived of its privileges, but even of the very social classes the revolution meant to emancipate. This suggests that the transition from the *ancien regime* to the modern era evolved at different speeds across territories and, in some states, the transplant of French institutions failed.

2.2 Data and Variables

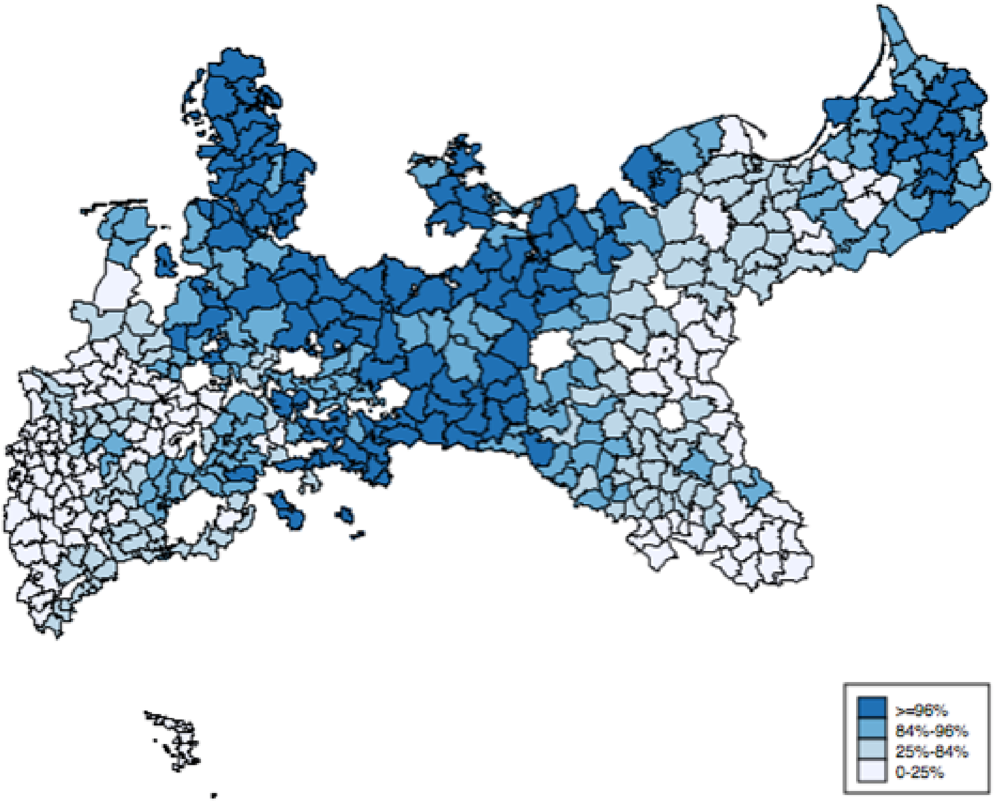
We build a novel dataset containing cross-sectional information on 447 Prussian counties immediately after the German unification (1871).[16] We combine census data from the Ifo Prussian Economic History Database (iPEHD) with pre-Napoleonic information compiled using historical sources. In particular, we map all the counties into 48 18^{th} century reigns: this allows us to build pre-Napoleonic variables at kingdom level based on historical rulers, their relations with France and the implementation of liberal reforms. We complement the resulting dataset with information on the historical

[14] In the Rhineland territories annexed to Prussia after the Congress of Vienna, a commission was set up to decide whether to extend Prussian law or keep the French one. The Commission ended its work in 1818 and recommended the preservation of the French judicial system. French law remained in force in Rhineland until 1900. But also local population and business community where at the forefront to retain the code. See Rowe (2000) and Diefendorf (1975) for more details. Another notable example is the Duchy of Baden that decided to retain the Napoleonic code even after 1815.

[15] For anecdotal evidence on Rhineland and the Duchy of Warsaw, see Rowe (2003) p. 130 and Fisher (1903) p.151.

[16] We choose this period because it guarantees the widest geographical coverage (including information on the former members of the Confederation of the Rhine) and also a sufficient time lag for the new institutions to affect economic performance.

Figure 2.3: Share of Protestant 1871



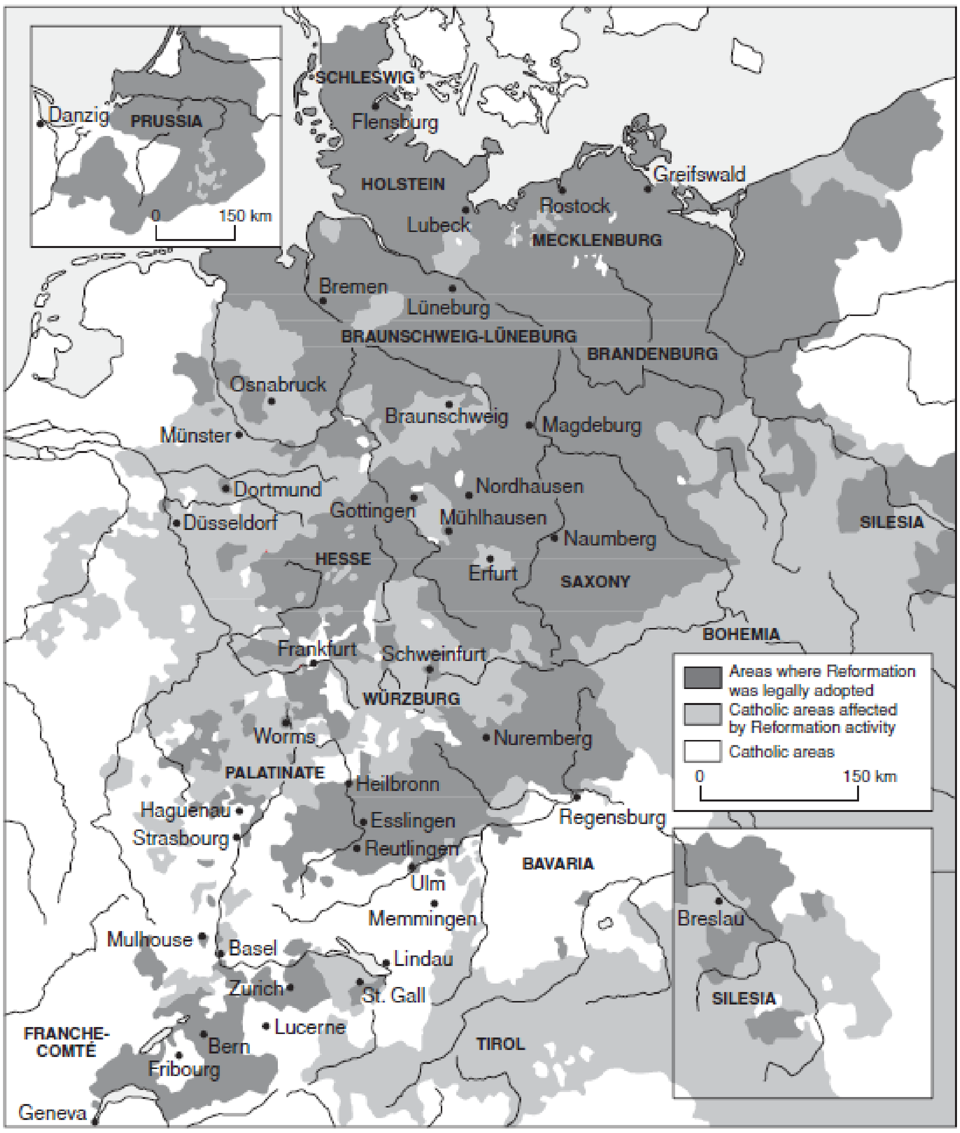
religious affiliation by Cantoni (2012) and Spenkuch (2010).

Following an established strand of literature (Allen, 2001; Galloway et al., 1994; Becker and Woessmann, 2009), we use wages to proxy for economic performance. Our main measure of county-level income is the average annual wage of male elementary school teachers from the 1886 Education Census. This is the only direct measure of income available for all counties at that time. Teacher's salary, albeit representative of a simple occupational group, reflects the development of the county as its main determinants were local contributions. One drawback of this proxy is that it may be influenced both by the value the local community attaches to education and by other benefits provided to the teachers (e.g. free housing). In our empirical analysis we address these issues controlling for factors that affect both the demand for teachers (e.g. number of pupils, demographic structure, etc) and supply of teacher (free housing, total number of teachers). Exploiting other waves of the Prussian Census, we assess the robustness of our results using the wage of a daily laborer in 1892 and other two income proxies first proposed by Becker and Woessmann (2009): income tax revenue per capita and the size of the non agricultural sector. Cultural traits are notably difficult to measure. We use religious affiliation as our favorite measure of cultural diversity. Besides being easily measurable, religious beliefs are suitable to capture cultural commonality, in particular "*[we] expect that two countries with the same religion tend to have similar cultures*" (Guiso et al., 2009). Moreover, as already mentioned above, religion has been of paramount importance in shaping the politics of the Holy Roman Empire, determining alliances, wars and lineages. Hence, we expect religious affiliation to synthesize various cultural aspects beyond the mere spiritual dimension and to play a fundamental role in the transplant of French institutions. In particular, we expect Protestant territories to be less receptive to the new institutions which embedded centuries of French Catholic culture. The persistence of religious affiliation across centuries has been well documented (Cantoni 2012). We then use the share of Protestants in the county from the 1871 Census as an inverse measure of cultural similarity before the Napoleonic invasion. Figure 2.3 shows the geographical distribution of this measure, Protestant are mainly concentrated in the central part of modern Germany. To test the robustness of the results we construct a dummy variable containing information on the religious affiliation at the beginning of the 17^{th} century taken from Cantoni (2012) and Spenkuch (2010).

A possible concern is that religious affiliation does not capture all the relevant cultural aspects that contribute to a successful institutional transplant. We thus construct two alternative measures of cultural similarity with France: *French Ties* and *Pro French*. The former variable is based on the ties between each reign and the Kingdom of France in 17^{th} and 18^{th} century. First, we expect that early interaction with French courts and customs should facilitate the assimilation of French institutions. We investigate whether, during the 18^{th} century, one of the rulers had a direct French relative (mother, father, spouse) and so an explicit link with the French aristocracy. Second, we investigate whether the reigns received Huguenots migrants during the 17^{th} century, exploiting county level data by Hornung (2014).[17] Many Huguenots left France after Louis XIV revoked the Edict of Nantes in 1685 and the majority of them migrated to the Protestant neighboring countries. Some sovereigns even competed to attract these skilled French immigrants offering them special privileges: a prominent example is the Electorate of Brandenburg which, with the Edict of Potsdam, granted the Huguenots a tax-free status for ten years and allowed them to hold church services in their native language. Often, these French migrants built their own communities in the towns in

[17] We complement these data by Poole (1880).

Figure 2.4: The expansion of Protestantism in Germany to 1570



Source: C. Scott Dixon. *The Reformation in Germany.* Oxford: Blackwell Publishers, 2002.

which they settled preserving their own traditions and identity. We construct a dummy variable, *French Ties*, that equals one either if the ruler had a direct French relative, or if the reign registered the presence of Huguenots' colonies. We expect the transplant to be more effective if the reign in 17^{th} and 18^{th} century had ties with France since people were previously exposed to French culture.

The second variable we construct, *Pro-French*, should capture, using historical sources (Essays, Bibliography, etc.), the inclination of the local ruler toward either the French enlightened ideals or French habits and customs . The *Pro-French ruler* dummy equals 1 if the 18^{th} century rulers (i) displayed a positive disposition toward customs and tradition of the French court (e.g. the Landgrave of Hesse-Darmstadt, Ernest Louis, was so fascinated with the grandeur of the Louis XIV court that he dissipated the finance of his reign in the effort of emulating it), or (ii) embraced the French Enlightenment ideals (e.g. the Elector of Palatinate Charles Theodore had an assiduous correspondence with Voltaire), or (iii) had a long standing relation with the French Royal House (e.g. William Henry, Prince of Nassau-Saarbrucken, often traveled to Paris where he even received military honors). We construct a *Pro-French index* based on the fraction of years the *Pro-French ruler* was in power. For example, Charles Theodore held power for 48 years, hence he contributes to the his reign's index by 0.53.3 (i.e. 48 over 90 years). Albeit highly subjective, this variable nicely summarizes the attitudes towards the foreign culture and we expect those rulers with a more favorable stance toward France to better accept and implement the transplanted institutions.

Our results might be induced by institutional rather than cultural proximity. In fact, during the 18^{th} century, some rulers, inspired by the Enlightenment principles, enacted reforms in their states promoting literacy, simplifying justice and the administration.[18] It is possible that these early reforms were implemented in places culturally closer to France, making it easier to enforce the institutions brought by Napoleon. In order to control for this potential confounding factor, we construct a measure of historical institutional proximity. In particular, we collect data on progressive reforms in the educational, judicial or administrative system implemented in each reign between 1700 and 1790. We classify as *Reformists* those rulers who implemented at least one modernizing reform. Given that this index captures similarity between the Napoleonic institutions and the pre-existing ones, we conjecture that *institutional-proximity* positively affects the success of the transplant.

Our main measure of institutional transplant is a binary variable, which takes value

[18] For more details, see Arvind and Stirton (2010).

Table 2.1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Napoleon	0.555	0.498	0	1	447
French Empire	0.121	0.326	0	1	447
Satellite States	0.434	0.496	0	1	447
Years of French Invasion	4.749	6.072	0	19	447
Income of male elem. school teachers (1886)	983.123	201.322	711.961	1954.194	447
Protestant Share	0.644	0.377	0.003	0.999	447
French Ties	0.11	0.313	0	1	447
Pro-French	0.801	0.399	0	1	423
Huguenots	0.075	0.264	0	1	346
Institutional Proximity	0.469	0.361	0	1	447
% of county population in urban areas	0.276	0.22	0	1	447
% females	0.51	0.015	0.44	0.546	447
% age below 10	0.247	0.025	0.153	0.299	447
Total Population (log)	10.804	0.416	9.359	13.625	447
County Area (log)	10.798	1.152	5.313	12.955	447
Universities Holy Roman Empire	0.06	0.238	0	1	447
Hanseatic or Imperial City	0.098	0.298	0	1	447

1 if the county is either in the provinces annexed to the French Empire (e.g. Rhineland) or in a satellite state (e.g. Kingdom of Westphalia). This variable reflects the presence of French Institutions since, in our sample, all the territories under direct or indirect control of Napoleon were imposed the Civil Code and, at least partially, the set of modernizing reforms. Employing a dummy variable is the simplest way to account for the introduction of the Napoleonic institutions. Certainly, the exposure to the new institutions was not homogeneous across reigns as it varied according to the fortune of the military campaigns. Therefore, in some specifications, we employ alternative proxies that take into account the different intensity of French presence.[19] Consistently with the existing literature, the expected linear effect of the transplant of good institutions on economic performance is positive on average.

Finally, in our analysis, we use a rich set of controls including historical, geographic and contemporaneous controls. *Historical controls* are meant to capture pre-existing differences across counties. We construct a dummy variable for the presence of Hanseatic or free imperial cities in 16^{th}-century, since they benefited from particular economic

[19] In one specification we differentiate territories annexed to the French empire, which faithfully imported all French institutions, from satellite kingdoms. In another one, we use years of French presence, which ranges from 5 to 20 years, as a proxy of institutions.

Table 2.2: Comparison of Means

	Napoleon=0	Napoleon=1	Diff
Catholic	855.64	1016.05	-160.41
	(15.22)	(21.62)	(38.76)
Protestant	941.31	972.34	-31.04
	(15.54)	(16.85)	(24.01)
Diff	-85.67	43.7	-129.37
	(26.57)	(32.99)	

Notes: Comparison of Average income of male elementary school teachers 1886
Standard errors in parenthesis.

and diplomatic privileges. We also control for pre-Napoleonic economic development using urban population in 1500 taken from Becker and Woessmann (2009).[20] *Geographic controls* include the distance from the district capital to control for peripheral areas, the latitude (in radiants) and a dummy variable for polish-speaking provinces (mainly located in the East and mainly underdeveloped).[21] Using information from the 1871 and 1886 Censuses, we control for demographic and social characteristics of the population and industrial features in the county (e.g. share of people employed in mining), and other aspects that may affect the wage of teachers (*contemporaneous controls*). Table 2.1 reports summary statistics for our main variables. Table 2.2 compares the means of our main dependent variable between invaded and not invaded territories across different religious affiliation.

2.3 Institutional Transplant and Religious Beliefs

2.3.1 Identification strategy

This section presents the empirical model we shall use to test our central hypothesis, namely the dependence of the reception of the Napoleonic Code on the pre-existing cultural traits of the county. We test whether the institutional transfer was more effec-

[20]See also De Long and Shleifer (1993) De Long and Shleifer (1993).

[21]We do not include longitude in our specifications because it is strongly correlated with institutional variable. Indeed, Napoleonic invasion followed the West-East trajectory starting from the neighboring territories toward Russia, hence longitude captures the intensity of the French presence.

tive in kingdoms culturally more similar to the French Empire, thus inducing a better economic performance.

Our baseline model is as follows:

$$\begin{aligned} y_i = \alpha + \beta_1 Culture_i + \beta_2 Napoleon_i + \beta_3 Culture_i \times Napoleon_i \\ + \mathbf{H}_i\beta_4 + \mathbf{H}_i \times Napoleon_i\beta_5 + \mathbf{G}_i\beta_6 + \mathbf{G}_i \times Napoleon_i\beta_7 + \mathbf{E}_i\beta_8 + \mathbf{X}_i\beta_9 + \varepsilon_i \end{aligned} \quad (2.1)$$

where y_i is the average income of male elementary school teachers in county i, $Culture_i$ is measured by religious affiliation (i.e. Protestant share measured at county level), $Napoleon_i$is a binary variable for the adoption of the Napoleonic code. H_i, G_i, E_i and X_i are, respectively, vectors of historical, geographical, educational and economic controls; ε_i is a standard error term. We also include the interaction of $Napoleon_i$ with pre-Napoleonic and geographic variables to control for potential non-linear confounding factors.

The key coefficient β_3 is the interaction between the transplanted French institution and the measure of local culture. We expect β_3 to be significantly different from zero and, in particular, that cultural similarity and institutions positively interact. Hence our prior is $\beta_3 < 0$ when Protestant share is used (i.e. Napoleonic institutions had a weaker impact in Protestant areas). Our identification strategy relies on two main assumptions. First, the areas invaded by Napoleon were not chosen because they were more prosperous, i.e. French occupation is exogenous. As extensively argued by Acemoglu et al. (2011), French military invasions were not driven by economic reasons but mainly by geographic and historical ones, as discussed above. Second, religious affiliation is persistent across centuries and thus the share of Protestants in 1871 captures cultural traits that already existed before the arrival of Napoleon. Previous empirical evidence supports this assumption, persistence in religious distribution is observed when comparing religious affiliation data after the Peace of Augsburg (1555) with the more recent one. (see Figure 2.4).[22]

2.3.2 Results

In this section we test our main specification. Table 2.3 reports the results. The most striking result is the negative and significant coefficient of the interaction term across

[22]Spenkuch (2010) provides detailed data and figures of Protestant and Catholic distributions in Germany after the Peace of Augsburg.

the different specifications. Column 1 provides evidence that Napoleonic institution had no impact on economic performance in strongly Protestant areas. In particular this is true in most of our counties given that in half of them the Protestant share exceeds 75%. The different specifications also show a significant positive effect of Protestantism and of the French institution on teachers' wage, in line with previous work. Column 1 refers to the most parsimonious specification, which includes only geographic controls, however our estimates prove to be robust to the inclusion of several control variables. In column 2, we control for a set of historical variables to take into account pre-existing differences. In columns 3-4 we add economic and education controls. These variable capture the economic and social outlook of the county after the Congress of Vienna. We find that some of these variables have an effect significantly different from zero but the significance of the interaction term coefficient is barely affected. Column 5 includes the interaction between Napoleonic institutions and historical and geographic controls in order to rule out potential concerns about possible alternative interactions driving the results. Column 6 adds to the baseline specification pre-napoleonic reign fixed effects to control for existing differences across reigns and exploit within reign variation. The estimated coefficient of the interaction term does not change (it slightly decreases) and does not lose statistical significance.

2.3.3 Robustness Checks

This section presents a battery of alternative specifications in order to investigate the robustness of the baseline estimates. The results are reported in Table 2.4.

Clustered Standard Errors Panel a) clusters standard errors at the pre-Napoleon reign (row 1) and 1871 Prussian political district level (row 2) to allow for an arbitrary variance-covariance matrix capturing potential serial correlation in the residual error term. The coefficients of interest are always statistically significant as in the baseline estimates.

Fixed Effects In Panel b) we include additional pre-Napoleonic fixed effects. This is crucial to capture pre-existing differences across counties. We include rulers' fixed effects, these are a smaller number with respect to reigns'ones since several kingdoms had the same ruler. Our results are robust to the inclusion of this control.

Additional Controls In panel c), we show that our evidence is preserved when adding supplementary controls addressing potential issues. A possible concern could be that our result is induced by differences in purchasing power across regions or by

Table 2.3: Institution and Religious Affiliation

Log average wage male elementary teacher 1886	(1)	(2)	(3)	(4)	(5)	(6)
Napoleon	0.0969***	0.0910***	0.109***	0.0881***	0.220	1.838*
	(0.0220)	(0.0218)	(0.0276)	(0.0202)	(0.659)	(1.066)
Protestant Share	0.168***	0.186***	0.206***	0.201***	0.270***	0.164***
	(0.0238)	(0.0242)	(0.0296)	(0.0242)	(0.0248)	(0.0232)
Napoleon × Protestant Share	-0.0936***	-0.109***	-0.182***	-0.155***	-0.269***	-0.107**
	(0.0338)	(0.0335)	(0.0331)	(0.0284)	(0.0335)	(0.0447)
Constant	8.526***	8.696***	6.801***	6.105***	6.420***	5.109***
	(0.322)	(0.362)	(0.335)	(0.409)	(0.451)	(0.653)
Geographic Controls	yes	yes	yes	yes	yes	yes
Historical Controls	no	yes	yes	yes	yes	yes
Economic Controls	no	no	yes	yes	yes	yes
Education controls	no	no	no	yes	yes	yes
Hist & Geo Interactions	no	no	no	no	yes	yes
Reign FE	no	no	no	no	no	yes
R^2	0.377	0.403	0.637	0.648	0.718	0.808
Obs.	447	447	447	447	447	447

Notes: Geographic Controls: latitude, area of the county (log), distance from the district capital and polish speaking area. *Historical controls*: year of annexation to Prussia, population in 1500 and Hanseatic or Imperial cities. *Economic controls*: total population size (log), percentage of county population in urban areas 1871, percentage of labor force in mining 1882 and number of farms 1882 (log). *Education controls*: percentage of pupils with distance to school over 3 km, total number of pupils 1886 (log), total number of teachers 1886 (log) and number of free apartments for male teachers 1886.
Robust standard errors in parenthesis.
*** p<0.01, ** p<0.05, * p<0.1

other drivers that influence the demand for teachers, and hence their wages. Hence, we first include a price measure to capture potential differences in purchasing power across the different counties. This proxy is constructed as the ratio between total expenditures in new school buildings in 1886 over the total number of new school buildings. This measure should capture variation in housing prices, a relevant component of CPI.[23] Albeit not perfect, this is the only available measure of historical unit values at county level. We then add a group of demographic variables in 1871 – including household size, share of population born in the county, share of population of Prussian origin, share of females and share of the population under 16, that might influence the demand of teachers. We also include literacy rate in an additional specification. The results always confirm the baseline estimates. Another important concern is that our results could be biased by the presence of printing presses in the county. Johannes Gutenberg established the first printing press in Mainz around 1450. The diffusion of printing presses is strongly correlated with distance from Mainz.[24] The presence of a printing press has facilitated the diffusion of French books and manuscripts. We collect data from the Universal Short Title Catalogue that is "a collective database of all books published in Europe between the invention of printing and the end of the sixteenth century". We focus our attention on all cities in which a book in French language was printed. We create a dummy variable at county level equal to one if a book in French language was printed in that county. Results are robust when we add a dummy controlling for French books (row 7). Finally we want our results not to be determined by hostility or francophobia generated by previous military invasions. Bonaparte might have been seen as the legitimate heir of Louis XIV, hence the "hereditary enemy". We verify if the reign was occupied by the French Army for a period longer than one year before the Napoleonic invasion. In alternative, previous invasions might also be interpreted as a higher exposure to French culture, hence as a catalyst for the adoption of the new institution. We thus construct a dummy variable that equals one if the reign had been occupied by French troops after the Peace of Westphalia. Our main result is not affected by the introduction of this control (row 8).

Outliers In panel d), we show that our evidence is not driven by influential observations. First, we trim (row 9) and winsorize (row 10) the extreme 1% of observations of our dependent variable. We then compute a measure of influence (row 11), specifically

[23]See Moretti (2013).

[24]See Dittmar (2011) for more information on the diffusion of printing presses and the economic impact in European Cities in sixteenth-century.

how much an observation has affected the estimate of a regression coefficient.

In particular we computed the difference between the regression coefficient of the interaction term (Protestant × Napoleonic Code) calculated for the entire dataset and the regression coefficient calculated with the observation deleted, scaled by the standard error calculated with the observation deleted.[25]

Alternative Institutional Variables In panel e), we show that the results hold when using different proxies for the French institution. Specifically we reduce our treatment group depending on the exposure to Napoleonic code. We start by using a more conservative definition of institutional variable, namely we define as invaded only those territories formally annexed to the French Empire (row 12). In this subsample the effect of the treatment might be reinforced since, not only the code was imposed, but also the administrative structure and local governors were replaced by the French ones. We then exclude the territories under the direct control of the French Empire and we consider only those territories in the Confederation of the Rhine (i.e. Satellite States) which adopted the code (row 13). Finally, we use years of French domination as a proxy for intensity-to-treatment (row 14). Reassuringly, all measures yield the same message as the preferred Napoleonic-invasion dummy.

Alternative Protestant Variables In panel f), we show that the results are robust to using alternative measures of religious affiliation. First (row 15), we use a dummy that equals one if the county has an absolute Protestant majority (share of Protestant >50%). Crucial for our identification is the persistence of the religious affiliation, hence using a binary variable attenuates the potential concern that Protestant share may have changed over time. We then construct a historical measure of the Protestant majority in seventeenth century using data from Cantoni (2012). The advantage of this measure is that it is defined two centuries before the arrival of Napoleon. It has however two limitations: the historical religious affiliation is defined at reign level - not county level- in 1600 (row 16) and it is not available for the entire sample. Finally, in order to address endogeneity concerns, we follow the literature instrumenting Protestant share with the distance from Wittenberg. We identify the exogenous variation in Protestantism using the concentric diffusion of Protestantism in Prussia around Luther's city (row 17). Note that the coefficients maintain the same sign as in the baseline specification, and remain significant at conventional levels.

[25]The cut-off value we use for highly influential observation is : 2/sqrt(n). Even though, our results are robust to different cut-off values.

Table 2.4: Robustness checks on the baseline model

	Institutions × Protestant			
	Coeff.	Std.Err.	Obs.	R^2
a)Clustered Std.Err.				
1) At Pre-Napoleonic-Reign	-0.236***	(0.0605)	447	0.667
2) At 1871 District	-0.236***	(0.0686)	447	0.667
b)Fixed Effects				
3) Pre-Napoleonic Ruler FE	-0.160***	(0.0396)	447	0.796
c)Additional Controls				
4) Price (Real estate unit values)	-0.230***	(0.0366)	441	0.666
5) Price and Demo Controls	-0.154***	(0.0382)	441	0.696
6) Price, Literacy and Demo Controls	-0.0725*	(0.0373)	441	0.716
7) French Books	-0.247***	(0.0365)	447	0.670
8) French Occupation	-0.257***	(0.0368)	429	0.665
d)Outliers				
9) Trimming	-0.258***	(0.0319)	439	0.671
10) Winsorising	-0.236***	(0.0341)	447	0.672
11) Df Beta	-0.312***	(0.0286)	426	0.723
e)Alternative Instit. Var.				
12) French Empire	-2.125*	(1.239)	253	0.784
13) Satellite States	-0.222***	(0.0404)	393	0.663
14) Year of French Domination	-0.00773*	(0.00468)	447	0.665
f)Alternative Protestant Var.				
15) Prot. Maj. 1871	-0.175***	(0.0265)	447	0.658
16) Cantoni Prot. Maj. 1600	-0.0498**	(0.0236)	438	0.638
17) IV (Distance Wittemberg)	-0.328***	(0.0485)	446	0.660
g)Alternative Dependent Var.				
18) Wage Urban Male Lab. 1892	-0.256***	(0.0484)	430	0.716
19) Income Tax Revenue p.c.	-0.803***	(0.178)	421	0.329
20) % Pop in Manuf./Services	-0.0973***	(0.0267)	447	0.769

Notes: Dependent variable: Log average wage, male elementary school teacher 1886 unless differently specified in the table.

Robust standard errors in parenthesis unless differently specified in the table.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Alternative Outcomes Variables Panel g) shows that the baseline results hold for alternative proxies of economic prosperity. In row (18) we use the only other direct measure of income available, that is wage of daily laborer in 1892.[26]Following Becker and Woessmann (2009) we use income tax revenue per capita (row 19) and the size of the non agricultural sector (row 20). The coefficient of the interaction term remains consistently negative and statistically significant across the different specifications.

2.3.4 Diff-in-Diff Specification

Our main specification allows us to exploit a rich variation across counties and to investigate several dimensions of institutions and culture. However, a possible concern is that historical controls and reign fixed effects do not fully account for pre-Napoleonic trends. We then test our hypothesis using a different dataset that allows us to implement a Diff-in-Diff specification.

We exploit the dataset compiled by Acemoglu et al. (2011). The dataset has information on urbanization levels and religious affiliation for a panel of 19 independent German states (or provinces of larger states) for the period 1750-1900. Unfortunately these data have a higher level aggregation (19 states vs more than 400 counties) and are not fit for a deeper investigation of potential channels that may drive our results.

In this case our baseline specification is

$$\begin{aligned} u_{it} = \delta_t + \mu_i + \alpha_1 Post_t + \alpha_2 Post_t \times Napoleon_i + \alpha_3 Post_t \times Prot_i \\ + \alpha_4 Post_t \times Napoleon_i \times Prot_i + \varepsilon_{it} \end{aligned} \tag{2.2}$$

where u_{it} is urbanization rate, *Post* is a dummy variable that equals one if we consider a time period after the Napoleonic invasion (i.e. second half of nineteenth century), *Napoleon* is a dummy that captures French presence in the state and *Prot* is the share of Protestants around 1800. Column 1 in Table 2.5 shows that after the Napoleonic invasion, there is a negative interaction between French institutions and Protestant share, consistent with our previous results. These findings are robust also in columns 2-3, where respectively we implement a weighted regression (weighted by total population in 1750) and an unweighted one but controlling for the level of population in 1750. Columns 4 provides similar results but using a different measure of French institutions, i.e. the number of years of French presence, while column 5 shows consistent

[26]Table 2.4 displays the results for the male laborers in urban areas. The coefficients are virtually the same when using wage of rural male daily laborer or wage of female daily laborer. Results are available upon request.

results using year dummies. The evidence suggests that this "moderating effect" due to the negative interaction between culture and the civil code is significantly affecting the urbanization rate since 1875, i.e. 60 years after the Congress of Vienna.

2.4 Possible Alternative Explanations

This section investigates alternative channels proposed in the literature that might explain our findings. We investigate three possible alternative channels: human capital accumulation, religious fractionalization and diversity from neighborhood. Human capital accumulation is a significant driver of economic growth but it is also closely related to the diffusion of Protestantism, as already stressed in the existing literature.[27]

A potential concern is that some of the institutions brought by Napoleon had a negative impact on the human capital accumulation of the regions. Narrative evidence suggests that Napoleon's educational policies were not aimed to boost literacy but targeted higher education in order to breed well-prepared military and administrative elites. Hence, technical schools were promoted (Polytechnic, Conservatory of art and trades, etc.) and lycees introduced. Napoleon, in fact, paid very little attention to primary education – and even less to the education of girls – which was mainly managed at local level and left to religious institutions. These policies could have led to a relevant role of Catholic parishes in the invaded areas weakening Protestant human capital accumulation. We use pre-Napoleonic measures of education, the presence of schools and monasteries – relevant educational centers – in 1517 and the presence of universities before Napoleonic invasion, and their interaction with Napoleonic Code in order to test the validity of this potential channel. In column 1 of Table 2.6 we show that including these controls does not affect the significance of the interaction term. Hence, human capital cannot alternatively explain our result.

Most of the counties invaded by French troops were mainly Catholic. An alternative explanation of the negative interaction between Protestantism and institutions may be that those counties with a higher share of Protestants were also highly fractionalized. A potential concern is that the interaction term reflects the effects of religious diversity. Several papers have investigated the cost and the benefits of diversity, whether racial, ethnic, religious, or linguistic.[28] Fragmented societies are often more prone to poor policy management and pose more politico-economic challenges than

[27]For the effect of human capital on economic growth see, for example, Barro (2001) and Gennaioli et al. (2014).

[28]For example Alesina and La Ferrara (2005)

Table 2.5: Difference in Difference Estimation

Dep. Var.: Urbanization Rate	(1) Baseline	(2) Weighted	(3) Initial Urbanization	(4) Years of French	(5) Napoleon × Years
Post 1850	9.925***	10.38***	8.734***	11.64***	
	(2.442)	(2.325)	(2.861)	(2.949)	
Napoleon × Post 1850	21.78***	21.23***	23.29***		
	(7.467)	(4.889)	(6.842)		
Post 1850 × Nap. × Prot. Share	-28.13***	-29.18***	-30.45***		
	(8.458)	(6.563)	(8.340)		
Years of French × Post 1850				1.454***	
				(0.272)	
Post 1850 × French Yrs. × Prot. Share				-2.233***	
				(0.751)	
Napoleon × 1750					10.49
					(12.01)
Napoleon × 1800					20.68
					(14.45)
Napoleon × 1850					19.38
					(12.50)
Napoleon × 1875					37.67**
					(16.93)
Napoleon × 1900					50.93**
					(20.67)
Prot. Share × Nap. × 1750					-12.46
					(14.67)
Prot. Share × Nap. × 1800					-24.65
					(16.57)
Prot. Share × Nap. × 1850					-24.65
					(15.06)
Prot. Share × Nap. × 1875					-47.80**
					(18.84)
Prot. Share × Nap. × 1900					-62.55**
					(21.95)
Constant	8.526***	9.012***	8.505***	8.524***	5.531***
	(0.832)	(0.712)	(0.826)	(0.851)	(1.611)
Number of id	19	19	19	19	19
R^2	0.506	0.530	0.509	0.503	0.878
Obs.	109	109	109	109	109

*Notes: A*ll regressions have territory and year fixed effects. Weighted regressions are weighted by territories total population in 1750. Robust standard errors clustered by territory.
*** p<0.01, ** p<0.05, * p<0.1

homogenous ones; however, a diverse cultural or ethnic mix also brings variety in abilities and experiences that may be productive and lead to innovation and creativity. A highly fractionalized area can be a better recipient of French institutions if the diversity fosters open-mindedness and ability to adapt to changes. Furthermore if religious heterogeneity is correlated with political instability, French domination might have both a sharper or a weaker effect in those counties that are more heterogeneous. We construct a Herfindal Index using the shares of three biggest religious groups (Protestants, Catholics and Jews) and we use this measure and its interaction with the Napoleonic dummy to test this alternative explanation. Column 2 shows that our results are robust even when we include a measure of religious fragmentation.

Another concern may be that counties that display internal religious homogeneity might be very diverse from their neighboring counties and thus economically and politically disadvantaged. Since Protestant counties in the western part of the sample are a minority among a Catholic majority, this issue could drive our main results. We create a measure of religious distance with neighboring counties as the difference between Protestant share of the county and the average Protestant share of the neighbouring counties. Column 3 confirms that the negative interaction term is not determined by religious distance from the Catholic neighborhood. Finally, column 4 includes all the alternative explanations, we implement a horserace, and findings support our hypothesis that cultural incompatibility drives the negative coefficient between Protestant share and institutions. Our results are robust across the different alternative explanations and these confirm the fact that culture plays a relevant role in law transplants.

Table 2.6: Alternative Channels

Log average wage male elementary school teacher 1886	(1) Education	(2) Rel. Frag.	(3) Rel. Distance	(4) Horserace
Napoleon	-0.420	-0.524	-0.290	-0.311
	(0.833)	(0.853)	(0.860)	(0.848)
Protestant Share	0.279***	0.239***	0.250***	0.227***
	(0.0252)	(0.0243)	(0.0274)	(0.0266)
Napoleon × Protestant Share	-0.245***	-0.209***	-0.214***	-0.187***
	(0.0362)	(0.0352)	(0.0381)	(0.0378)
Universities Holy Roman Empire	-0.0439			-0.0401
	(0.0425)			(0.0444)
Napoleon × Universities HRE	0.0735			0.0778
	(0.0599)			(0.0604)
Monasteries or Schools in HRE	0.116			0.0866
	(0.0722)			(0.0702)
Napoleon × Monasteries or Schools in HRE	-0.0396			-0.0109
	(0.0809)			(0.0790)
Religious Fragmentation		0.203***		0.169***
		(0.0418)		(0.0438)
Napoleon × Religious Fragmentation		-0.350***		-0.316***
		(0.0820)		(0.0859)
Rel. Dist. from Neighbours			-0.163***	-0.110**
			(0.0463)	(0.0463)
Napoleon × Rel. Dist. from Neighbours			0.223***	0.117
			(0.0801)	(0.0816)
Constant	9.279***	9.171***	9.055***	9.129***
	(0.402)	(0.395)	(0.424)	(0.419)
Geographic Controls	yes	yes	yes	yes
Historical Controls	yes	yes	yes	yes
Economic Controls	yes	yes	yes	yes
Education controls	yes	yes	yes	yes
Hist & Geo Interactions	yes	yes	yes	yes
R^2	0.523	0.532	0.521	0.546
Obs.	447	447	431	431

Notes: Geographic Controls: latitude, area of the county (log), distance from the district capital and polish speaking area. *Historical controls*: year of annexation to Prussia, population in 1500 and Hanseatic or Imperial cities. *Economic controls*: total population size (log), percentage of county population in urban areas 1871, percentage of labor force in mining 1882 and number of farms 1882 (log). *Education controls*: percentage of pupils with distance to school over 3 km, total number of pupils 1886 (log), total number of teachers 1886 (log) and number of free apartments for male teachers 1886. Robust standard errors in parenthesis. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

2.5 The relevance of Cultural Commonality

Summing up: our results are robust to possible measurement issues, we devote this section to investigate whether Protestant areas are characterized by other cultural features and different institutional qualities that can explain the negative interaction in our findings. In particular, we want to stress that the weaker impact of French institution on Prussian economy is mainly driven by the clash with local culture. We construct alternative measures of cultural commonality (see Section 3) and use then in our specifications in the place of the share of Protestants. First we introduce our proxies of alternative cultural dimensions since French institutions might be better received in those areas with historical higher exposure to French culture, through protracted huguenots' presence or family connections. Then we control whether territories characterized by more liberal rulers who enacted progressive reforms in the eighteenth century, might have been more willing to accept Napoleonic institutions. Hence, we want to disentangle the effect of institutional proximity from the one of cultural commonality on the growth effect of the institutional transplant. To this purpose, as we discussed above, we construct a measure of institutional reforms based on judicial, administrative and educational progressive reforms implemented in the eighteenth century (see Section 3). Table 2.7 presents our results. In columns 1-4 we show that other dimensions of culture have a positive and significant effect on the transplant. We obtain similar results when we use French Ties or the Pro-French dummy. Columns 5-6 show that the pre-existing liberal institutions amplify the effect of Napoleonic Code but they do not delete the effect of cultural similarity. This suggests that the cultural environment is important for the effectiveness of French institutions and that Catholic territories might have had a more favorable attitude towards French culture. When running our different cultural and institutional measures against each other (columns 7-8) we find that the effect is explained by both dimensions. This appears to support the hypothesis that a reign that was historically more exposed to liberal and enlightened ideas was more prone to accept and implement Napoleonic institutions, but also that culture commonality played a relevant role. Earlier connections and links with the exporter have a positive impact on the reception and the effectiveness of the transferred institutions. Finally, the interaction term between Napoleonic Code and Protestant share has a lower magnitude, supporting the fact that religious beliefs are not the only cultural dimension important for economic transplant.

Table 2.7: The Effect of Cultural Commonality

Log average wage male	French Ties		Pro-French		Institutional Proximity		Horserace	
elementary school teacher 1886	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Napoleon	0.0777**	-2.463***	-0.246***	-3.052***	-0.198***	-2.254***	-2.590***	-2.752***
	(0.0378)	(0.880)	(0.0576)	(0.515)	(0.0617)	(0.567)	(0.564)	(0.460)
Protestant Share	0.206***	0.243***	0.147***	0.191***	0.147***	0.178***	0.190***	0.191***
	(0.0448)	(0.0458)	(0.0445)	(0.0415)	(0.0479)	(0.0479)	(0.0454)	(0.0400)
Napoleon × Protestant Share	-0.148**	-0.248***	-0.0634	-0.184***	-0.0758	-0.160***	-0.169***	-0.187***
	(0.0616)	(0.0657)	(0.0463)	(0.0459)	(0.0464)	(0.0522)	(0.0521)	(0.0437)
French Ties	-0.0164	-0.0188					-0.00675	
	(0.0354)	(0.0266)					(0.0197)	
Napoleon × French Ties	0.0719*	0.0685*					0.0712*	
	(0.0390)	(0.0386)					(0.0379)	
Pro-French			-0.495***	-0.529***				-1.971***
			(0.0632)	(0.0645)				(0.127)
Napoleon × Pro-French			0.666***	0.755***				2.193***
			(0.0738)	(0.0631)				(0.134)
Institutional Proximity					-0.312***	-0.338***	-0.327***	0.880***
					(0.0584)	(0.0673)	(0.0643)	(0.0753)
Napoleon × Inst. Proximity					0.354***	0.386***	0.391***	-0.877***
					(0.0614)	(0.0669)	(0.0619)	(0.0803)
Constant	6.093***	7.207***	7.214***	8.141***	7.246***	8.105***	8.108***	7.853***
	(0.648)	(0.631)	(0.463)	(0.390)	(0.470)	(0.423)	(0.390)	(0.393)
Historical Controls	yes	yes	yes	yes	yes	yes	yes	yes
Geographic Controls	yes	yes	yes	yes	yes	yes	yes	yes
Economic Controls	yes	yes	yes	yes	yes	yes	yes	yes
Education controls	yes	yes	yes	yes	yes	yes	yes	yes
Hist & Geo Interactions	no	yes	no	yes	no	yes	yes	yes
R^2	0.650	0.677	0.710	0.756	0.706	0.733	0.739	0.764
Obs.	430	430	426	426	447	447	430	426

Notes: Standard errors, clustered at the pre-Napoleon-reign level, in parenthesis.
*** p<0.01, ** p<0.05, * p<0.1

2.6 Concluding Remarks

This paper is the first attempt to investigate whether culture and institutions interact. Specifically, we ask if “cultural proximity” may facilitate the assimilation of good foreign institutions thus enhancing their positive effect on economic outcomes.

Nineteenth-century Prussia provides a very suitable context to test this hypothesis as it allows us to exploit a quasi-natural experiment, the Napoleonic military campaign, in an environment characterized by a rich variety of cultural traits. All our evidence points to the importance of culture as a mediating factor in the reception of foreign institutions. Indeed, the positive effect of radical institutional reforms brought by the French empire in territories which either shared religious beliefs or had experienced previous contact with France culture is almost double compared to the one in “culturally distant” areas. Our results survive even when controlling for a measure of institutional proximity between pre-existing institutions and the new imported ones.

Although we analyze a very specific historical environment and extrapolation to other contexts might be hazardous, our findings call for extreme care when deciding to export seemingly good institutions, for the transplant may fail when it conflicts with local culture and pre-existing institutions.

Chapter 3

Financial Imperfections, Product Quality, and International Trade

Introduction[1]

Product quality plays a central role in economics. The production of high-quality goods influences key aspects of countries' economic performance, including growth, development, export success, and labor market outcomes.[2] Yet, not all countries are able to produce high-quality goods: according to an influential literature, product quality varies markedly both across countries and across industries; see Schott (2004), Khandelwal (2010), Hallak and Schott (2011), and Feenstra and Romalis (2014).

This variation partly reflects large differences in economic development and factor endowments across countries (e.g., Schott, 2004, Hummels and Klenow, 2005, and Hallak, 2006, 2010). However, a substantial share of it remains unexplained after accounting for these factors, suggesting that other forces must be at play.[3] An interesting hypothesis is that this variation could also reflect the interplay between economic distortions at the country level and technological characteristics of industries (Nunn and Trefler, 2014). Intuitively, countries have different types and degrees of economic distortions, which could influence domestic producers when choosing the quality of their products. In turn, these distortions could be felt asymmetrically across industries, due to different technological features of their production process.

[1] This paper is coauthored with Rosario Crinò and it has been circulated as a CEPR DP 10555

[2] See, e.g., Gancia and Zilibotti (2005) on growth, Hidalgo et al. (2007) on development, Verhoogen (2008) on export success, and Verhoogen (2008) and Khandelwal (2010) on employment and wages.

[3] For instance, Khandelwal (2010, Table 4) regresses product-level quality estimates on countries' GDP and factor endowments, controlling for product fixed effects. He obtains an R-squared of 0.2.

In this paper, we study the empirical relevance and implications of this argument, focusing on credit market imperfections. Recent evidence based on firm-product level data for China shows that, when credit is scarcer, Chinese firms lower the quality of their products in destination markets where they regularly export (Fan et al., 2015). Little is known, instead, about how financial imperfections shape the aggregate variation in product quality across countries and industries, and with what macroeconomic implications.[4] The aim of this paper is to take a first step towards filling these gaps. To this purpose, we address three new research questions. First, what is the contribution of financial imperfections to the geographical and sectoral variation in average quality observed in the data? Second, what are the mechanisms through which financial imperfections work? And finally, what are the implications for macroeconomic outcomes such as aggregate trade flows and prices?

To answer these questions we assemble a unique data set, which contains quality estimates for all products exported by each country in the world over the last three decades. Our analysis makes three contributions. First, we show that the interplay between cross-country differences in financial frictions and cross-industry differences in financial vulnerability is a major determinant of the geographical and sectoral variation in average product quality. Second, we unveil two margins through which this effect takes place: an 'extensive margin', which reflects the selection of products sold by a country in a given destination market, and an 'intensive margin', which reflects changes in the quality of those products. Empirically, we find adjustments along the intensive margin to explain the bulk of the overall effect of financial imperfections, suggesting that the latter severely distort firms' decisions to adopt better technologies. Finally, we find product quality to be important for understanding the effects of financial development on aggregate trade flows. As is well known, financially more developed countries export relatively more in financially more vulnerable industries, but the mechanisms are little understood (Beck, 2002; Manova, 2013). Our results show that a key reason why financial development raises the relative exports of financially more vulnerable industries is that it boosts average quality disproportionately more in such sectors. Our findings also point to a key role of quality for understanding the response of export prices to financial development and, thus, for interpreting their aggregate variation across countries and industries.

While our main contributions are empirical, we discipline the analysis using a simple theoretical framework. In a standard multi-country and multi-industry model of

[4]In this paper, whenever we speak of financial imperfections, we refer to the interplay between financial frictions at the country level and financial vulnerability at the industry level.

trade and finance with heterogeneous firms (Manova, 2013), we allow for endogenous output quality, following a well-established literature that introduces quality differentiation in heterogeneous-firms models à la Melitz (2003); see, in particular, Verhoogen (2008) and Kugler and Verhoogen (2012). Specifically, we assume that firms choose the quality of their products to optimize a trade-off between the higher revenue generated by higher-quality goods and the fixed cost required to increase product quality (Sutton, 2001, 2007).[5]

The novel prediction of the model is that the average quality of products sold by a country in a given destination and industry responds to financial development along two margins. First, financial development raises the quality of goods sold by incumbent firms, as better credit conditions loosen their liquidity constraint and allow them to finance higher fixed costs of quality upgrading (intensive margin). This effect is more pronounced in financially more vulnerable industries, where firms rely more on external financing (Rajan and Zingales, 1998) and have fewer tangible assets to pledge as collateral (Claessens and Laeven, 2003). Second, financial development induces new firms to enter the market. This reduces the average quality of products sold therein by the country, because the new entrants are less productive than the incumbents and thus produce lower-quality goods (extensive margin). Also this effect is generally stronger in financially more vulnerable industries.

After presenting the model, we illustrate our strategy for testing these implications and quantifying the importance of financial imperfections. The model delivers an equation that links the average quality of goods sold by a country in a given destination and industry to the financial variables. By parametrizing bilateral trade frictions and production costs, we derive a structural equation that can be brought to the data. Importantly, the model implies a specification that includes full sets of origin country-time effects and destination country-industry-time effects. The coefficients are thus identified from the combination of cross-country variation in financial development and cross-industry variation in financial vulnerability, while controlling for all (observable and unobservable) time-varying factors that could affect product quality uniformly across industries, exporting countries, and destination markets. To untangle the two margins and quantify their contributions, we then generalize a two-step estimation procedure proposed by Helpman et al. (2008) and Manova (2013). We ex-

[5]See Choi et al. (2009), Baldwin and Harrigan (2011), Crinò and Epifani (2012), Crozet et al. (2012), Johnson (2012), Hallak and Sivadasan (2013), Feenstra and Romalis (2014), Fan et al. (2014), Alcalá (2015), Antoniades (2015), and Fan et al. (2015) for other recent contributions including quality differentiation in heterogeneous-firms models along similar lines.

tend the procedure to deal with circumstances in which the outcome variable is not bilateral trade, but an average quantity such as average product quality in our case. This estimation procedure also corrects for sample selection bias, which may arise because the quality equation is estimated on the (possibly) non-random sub-sample of observations with positive trade flows.

To perform the empirical analysis we put together an unusually large and rich data set. We merge numerous indicators of financial development for 171 countries over 1988-2011, with measures of financial vulnerability for 273 manufacturing industries. We combine these data with time-varying estimates of the average quality of goods exported by each of these countries to each of the members of the European Union (EU) within each industry. To construct these estimates, we use highly detailed data at the product level and a methodology introduced by Khandelwal (2010), which assigns higher quality to products displaying larger market shares in a given market, conditional on prices. These quality estimates are the empirical counterpart of the average quality derived in the model and serve as the dependent variable in our empirical specification.

We find financial imperfections to be an important predictor of quality variation across countries and industries. Specifically, financial development raises average product quality relatively more in industries where firms rely more on external financing and have fewer collateralizable assets. This result is robust across alternative samples and many alternative ways of proxying for product quality, financial development, and financial vulnerability. We also consider various competing explanations, and show that controlling for factor endowments, economic development, and many other forces of change does not overturn this result. Moreover, we extensively discuss remaining concerns with endogeneity. In this respect, we argue that the specific pattern of our coefficients cannot be easily generated by alternative stories based on reverse causality. To further substantiate this argument, we show that our evidence is unchanged when exploiting two sources of exogenous variation in the ability of the environment to provide credit: equity market liberalizations (Manova, 2008) and systemic banking crises (Kroszner et al., 2007).

We use different exercises to quantify the contribution of financial imperfections to the observed variation in average quality across countries and industries. We find our estimates to be not only statistically significant but also quantitatively large. In fact, the financial variables seem quantitatively no less relevant than other determinants of product quality considered in the existing literature.

Next, we explore the mechanisms that underlie the effect of financial imperfections.

We find robust evidence that quality adjustments within incumbent firms (the intensive margin) explain 70-80% of the overall effect. The combination of firm selection (the extensive margin) and sample selection bias explains the remaining 20-30%. While we are the first to point out these two mechanisms, untangle them, and quantify their contribution, it is reassuring that our results are consistent with evidence from studies on different effects of financial imperfections. For instance, Midrigan and Xu (2014) find that, in a sample of Korean firms, most of the TFP effect of financial imperfections occurs within firms. Our results support the authors' explanation that financial imperfections induce severe within-firm distortions in the decision to upgrade technology.

Finally, we study the implications of these results for aggregate trade flows. To this purpose we re-consider, through the lens of our findings, the effects of financial development on specialization and trade, which have been the object of a vast and important empirical literature. Our results imply that financially more developed countries should export relatively more in financially more vulnerable industries, because financial development gives a stronger boost to average product quality in those sectors, thereby increasing their relative exports. Consistently, we find quality adjustments to explain the bulk of the overall impact of financial development on export flows across industries. Moreover, we find that the cross-industry response of export prices to financial development is difficult to reconcile with models that treat quality as exogenous and homogeneous. Export prices respond instead to financial development consistently with the predictions of models in which quality is endogenous. The implication of these results is that recognizing the role of product quality is key for understanding the mechanisms through which financial development affects aggregate trade flows and prices.

In addition to the works cited above, we make contact with three strands of research. First, we brush against the empirical firm-level literature on credit constraints and exports.[6] While this literature shows how individual firms engage in export activities when credit is scarce, our main contribution is to dissect the aggregate relation between finance, quality, and trade, which is still little understood. Second, we connect with the important literature on the real effects of financial frictions.[7] By showing how financial imperfections affect product quality and, through this channel, aggre-

[6]See, e.g., Amiti and Weinstein (2011), Behrens et al. (2013), Chaney (2013), Feenstra et al. (2014), and Paravisini et al. (2015).

[7]See, among others, Rajan and Zingales (1998) and Claessens and Laeven (2003) for early contributions; Bonfiglioli (2008) and Erosa and Cabrillana (2008) for more recent work; and Matsuyama (2008) for a survey.

gate trade flows and prices, we unveil new types of real effects beyond those traditionally considered in this literature. Finally, we relate to the influential literature on the determinants of comparative advantage.[8] Our results suggest an alternative mechanism through which financial institutions may affect the pattern of trade.

The remainder of the paper is organized as follows. Section 3.1 sketches the model and provides the key theoretical insights. Section 3.2 introduces the estimation strategy. Section 3.3 presents the data and illustrates the procedure to estimate product quality. Section 3.4 discusses the empirical results. Section 3.5 finally concludes.

3.1 Theoretical Framework

In this section we briefly illustrate a simple model that will guide our empirical analysis. The model allows for endogenous output quality in a standard theory of trade and finance with heterogeneous firms (i.e., Manova, 2013). Our interest is in studying how financial imperfections affect the average quality of goods sold by countries in different destinations and industries. Accordingly, we consider a set-up with multiple countries and sectors, heterogeneous in financial frictions and financial vulnerability, respectively. We analyze how the interplay between these country and industry characteristics affect average quality, by influencing both the quality choices of incumbent exporters in a given market and export market entry.[9] In the next sections, we summarize the main ingredients of the model and discuss its aggregate implications. Additional details and derivations are reported in Appendix A.1.

3.1.1 Set-Up

We consider a static, partial equilibrium, model of a world economy composed of J countries, indexed by $i, j = 1, .., J$, with i and j denoting importing and exporting countries, respectively. In each country there are S industries, indexed by $s = 1, .., S$, each of

[8] See Romalis (2004), Nunn (2007), and Levchenko (2007) for early work; Chor (2010), Bombardini et al. (2012), Chor and Manova (2012), Broner et al. (2012), and Manova (2013) for more recent studies; and Nunn and Trefler (2014) for an updated survey.

[9] Fan et al. (2015), and ongoing work by Ciani and Bartoli (2015), focus instead on the quality choices of individual firms that export continuously to a given destination. Accordingly, they use one-sector models and different formalizations of credit constraints, thereby abstracting from cross-industry differences in financial vulnerability and from cross-country differences in financial frictions, and do not derive aggregate predictions on average quality at the country-industry level.

which consists of a continuum of differentiated products, labeled by l. The representative consumer in country i has the following preferences:

$$U_i = \prod_s C_{is}^{\vartheta_s}, \qquad \vartheta_s \in (0,1), \sum_s \vartheta_s = 1, \tag{3.1}$$

$$C_{is} = \left[\int_{l \in B_{is}} (q_{is}(l)\, x_{is}(l))^{\alpha}\, dl\right]^{1/\alpha}, \quad \alpha \in (0,1), \tag{3.2}$$

where B_{is} is the set of industry-s products available for consumption in country i, $x_{is}(l)$ is consumption of product l, $q_{is}(l) \geq 1$ is its quality, and $\varepsilon = (1-\alpha)^{-1} > 1$ is the elasticity of substitution between any two products. Product quality can be interpreted as any attribute of the good that is valued by the consumer and chosen by firms.

Consumer maximization yields the following demand for good l in country i:

$$x_{is}(l) = \frac{q_{is}(l)^{\varepsilon-1}\, p_{is}(l)^{-\varepsilon}\, Y_{is}}{P_{is}^{1-\varepsilon}}, \tag{3.3}$$

where $p_{is}(l)$ is the price of the good, $Y_{is} \equiv \vartheta_s R_i$ is the share of total spending R_i devoted to industry-s products, and $P_{is} = \left[\int_{l \in B_{is}} (p_{is}(l)/q_{is}(l))^{1-\varepsilon}\, dl\right]^{1/(1-\varepsilon)}$ is the ideal, quality-adjusted, price index associated with eq. (3.2). Note that demand is decreasing in the price and increasing in the quality of the good.

In any country j and industry s, there are N_{js} active firms, which produce differentiated products under monopolistic competition. To enter the industry, each firm bears a sunk entry cost $c_{js} f_{Ej}$, where f_{Ej} is the number of bundles of country j's inputs and c_{js} is the cost of each bundle. An entrant then draws an input-per-unit-output coefficient a, whose inverse $1/a$ represents productivity. The distribution of a's across active firms is described by a cumulative distribution function $G(a)$, with probability density function $g(a)$ and support $[a_L, a_H]$, where $0 < a_L < a_H$. This distribution function is the same across countries and industries.[10]

To produce a good for destination i, a country-j firm active in industry-s incurs a marginal cost equal to:

$$MC_{ijs}(a) = \omega_{ijs}(a)\, q_{ijs}^{\delta}, \quad \omega_{ijs}(a) \equiv \tau_{ij} c_{js} a, \tag{3.4}$$

where $\tau_{ij} > 1$ is an iceberg trade cost that needs to be paid for shipping goods from country j to country i, $\delta \in [0,1)$ is the quality elasticity of marginal cost, and $\omega_{ijs}(a)$

[10]The a's capture productivity differences across active firms in the same country and industry. Aggregate differences across countries and industries in terms of factor prices are subsumed in the unit input costs c_{js}'s.

can be interpreted as a measure of the marginal cost per unit of quality.[11] Producing higher-quality products also entails higher fixed costs. This captures the fact that quality upgrading typically involves investments in R&D, innovation, and marketing, which are mostly fixed outlays (Sutton, 2001, 2007). In particular, the fixed cost is equal to:

$$FQ_{ijs} = c_{js} q_{ijs}^{\gamma}, \tag{3.5}$$

where $\gamma > 0$ is the elasticity of the fixed cost to product quality.[12] In (3.4) and (3.5), q is indexed by i as, in this baseline model, we maintain the standard assumption that firms can differentiate quality across destination markets (see, e.g., Verhoogen, 2008, Feenstra and Romalis, 2014, Crinò and Epifani, 2012, and Fan et al., 2015).[13] By comparing (3.3) and (3.5), note that quality upgrading involves a trade-off between higher demand (hence revenue) and higher fixed costs. Finally, we assume that selling in destination i involves a fixed export cost (as in Melitz, 2003) equal to:[14]

$$EX_{ijs} = c_{js} f_{Xij}. \tag{3.6}$$

We model financial frictions and financial vulnerability as in Manova (2013). We assume that, in any given industry, a fraction $d_s \in (0, 1)$ of the fixed costs must be borne up-front, before revenue is realized. Hence, a country-j firm producing in industry s

[11]Marginal cost may be increasing in quality if, for instance, higher-quality products require better inputs (e.g., Verhoogen, 2008, Kugler and Verhoogen, 2012, Johnson, 2012, Crinò and Epifani, 2012, Fan et al., 2014, and Fan et al., 2015). All our results hold if the marginal cost is independent of quality, as can immediately be seen by setting $\delta = 0$ throughout. As discussed in Appendix A.1, $\delta \in [0, 1)$ implies that firm revenue is increasing in quality, while quality-adjusted prices (p_{ijs}/q_{ijs}) are decreasing in it consistent with empirical evidence (e.g., Baldwin and Harrigan, 2011).

[12]See Kugler and Verhoogen (2012), Crinò and Epifani (2012), Hallak and Sivadasan (2013), and Fan et al. (2015) for a similar formulation.

[13]Case studies show that firms do differentiate quality across destinations, by tailoring R&D, innovation, marketing, and advertising expenditure to the characteristics of each market (Verhoogen, 2008). Furthermore, micro-econometric evidence suggests that quality variation for the same firm and product across destinations must be large, in order to make sense of the observed pattern of export unit values across importing countries (Bastos and Silva, 2010; Manova and Zhang, 2012; Bastos et al., 2014). In Appendix A.1 we show, however, that the key insights of the baseline model generalize to the alternative case in which firms choose a single quality across all destinations.

[14]Assuming that this cost depends as well on quality (similarly to the production cost in eq. 3.5), does not change the main insights of the model. Since this cost reflects activities that involve products along the entire quality spectrum (e.g., the creation of distribution networks abroad or the adaptation of the good to foreign regulatory standards and customs shipping rules), we focus here on the case where EX_{ijs} is constant, as in the original model by Manova (2013).

needs to borrow $d_s\left(FQ_{ijs}+EX_{ijs}\right)$ from external investors to service destination i.[15,16] To be able to borrow, the firm must pledge collateral. We assume that a fraction $t_s \in (0,1)$ of the sunk entry cost is invested in tangible assets, which can be collateralized. Hence, the collateral is equal to:

$$CO_{js} = t_s c_{js} f_{Ej}. \tag{3.7}$$

The parameters d_s and t_s describe the financial vulnerability of industry s: the higher is d_s and the lower is t_s, the financially more vulnerable is the industry. As customary, we assume that d_s and t_s vary across industries due to innate technological factors (e.g., the nature of the production process or the cash harvest period), which are exogenous from the perspective of each firm.[17]

Countries differ in their level of financial development, and thus in the strength of financial frictions facing domestic firms. To parsimoniously capture all factors that could influence the ability of the environment to facilitate transactions between investors and firms, we assume that each country has a different degree of financial contractibility. This means that an investor in country j can expect to be repaid with probability $\lambda_j \in (0,1)$. Instead, with probability $1-\lambda_j$ the contract is not enforced, and the investor seizes the collateral. In this case, the firm needs to replace the collateral to be able to borrow again in the future.

At the beginning of the period, each firm signs a contract with an investor. The contract specifies: (*a*) how much the firm needs to borrow, (*b*) the amount F_{ijs} that will be paid to the investor if the contract is enforced, and (*c*) the value of the collateral

[15] As discussed in Manova (2013), the underlying assumption is that firms cannot use the profits earned in previous periods to finance the fixed costs, for instance, because they have to distribute all profits to their shareholders. Alternatively, and equivalently, d_s can be interpreted as the fraction of the fixed costs that remains to be financed externally after having used all the past profits.

[16] The assumption that only fixed costs are financed externally is consistent with the evidence discussed in Sutton (2001, ch. 4) and Sutton (2007, ch. 5). Indeed, the investment made by firms for upgrading quality mostly consists of fixed outlays, and part of this investment is faced before the project pays off. Accordingly, most of the outside capital used by firms for producing higher-quality goods covers fixed rather than variable costs. In Appendix A.1 we show, however, that the key insights of the model hold if firms finance as well a fraction of their marginal cost with external capital.

[17] As shown in Appendix A.3, the model could be simplified by assuming that firms borrow against their cash flow instead of pledging collateral. This alternative version would not require assumptions about the nature of the collateral, and would yield the same predictions about the role of external finance dependence. Our data show, however, that cross-industry differences in asset tangibility have as well strong power for predicting variation in average quality, a finding that can only be explained by the more general model presented here.

that will be seized by the investor if the contract is not enforced. After that, revenue is realized and the investor is paid at the end of the period.

3.1.2 Firms' Decisions

A country-j firm active in industry s chooses a price p_{ijs}, quality q_{ijs}, and payment F_{ijs} to maximize profits in destination market i, subject to two constraints: (*1*) a liquidity constraint, which states that in case of repayment the firm can promise the investor at most the cash flow; and (*2*) the participation constraint of the investor, which states that the value of the loan cannot exceed the expected return from the investment. The model is fully derived in Appendix A.1. Here, we briefly discuss the decisions of firms regarding entry in destination i and the quality of goods sold therein.

For convenience, we illustrate these decisions graphically in Figure 3.1. Absent financial frictions, all firms with $a \in \left[a_L, a^*_{ijs}\right]$ would enter market i with the optimal quality, denoted by $q^o_{ijs}(a)$ and equal to:

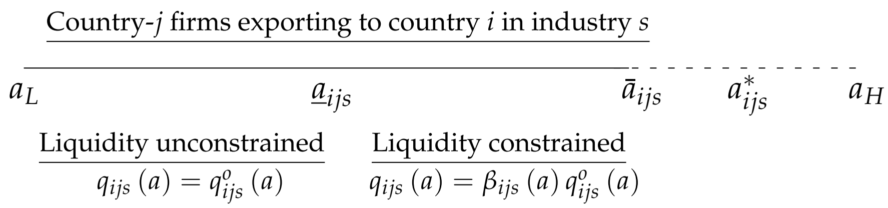
$$q^o_{ijs}(a) = \left[\left(\frac{\tau_{ij} c_{js} a}{\alpha P_{is}} \right)^{1-\varepsilon} \frac{(\gamma - \tilde{\gamma}) Y_{is}}{\varepsilon \gamma c_{js}} \right]^{1/\tilde{\gamma}}, \tag{3.8}$$

where $\tilde{\gamma} \equiv \gamma - (\varepsilon - 1)(1 - \delta) > 0$ by the second order condition for profit maximization. Hence, only a fraction $G\left(a^*_{ijs}\right)$ of the N_{js} active firms would sell in country i. Note that this fraction is zero when no firm finds it profitable to enter destination i. This is the case when $a^*_{ijs} < a_L$, i.e., when the least productive firm that can profitably sell in i has a coefficient a below the support of $G(a)$.

When credit markets are imperfect, we need to distinguish two groups of firms among those exporting to country i: (*1*) firms for which the liquidity constraint is slack; and (*2*) liquidity-constrained firms. For the former group, revenue and cash flow are large enough to incentivize the creditor at financing the investment associated with the optimal quality. Since revenue and cash flow are increasing in productivity, this is the case for highly productive firms, with $a \in \left[a_L, \underline{a}_{ijs}\right]$. Hence, these firms make the same decisions as in a model without financial frictions, and their quality is still given by eq. (3.8).

Firms with $a \in \left(\underline{a}_{ijs}, a^*_{ijs}\right]$ would enter market i with the optimal quality if financial frictions were absent. But with imperfect credit markets, these firms are liquidity constrained and cannot achieve $q^o_{ijs}(a)$. Intuitively, they do not make enough revenue to incentivize the creditor at financing the investment associated with the optimal quality: even if they offered all of their revenue in case of repayment, the investor would

Figure 3.1: Firms' Decisions



not break even. Then, what do these firms do? In Appendix A.1, we show that some of them, i.e., those with $a \in \left(\underline{a}_{ijs}, \bar{a}_{ijs}\right]$, enter destination i with a quality below the optimum. Intuitively, the fixed cost of quality upgrading, FQ_{ijs}, is increasing in quality. Hence, by lowering quality, these firms reduce the value of the investment to be financed externally, and thus the payment F_{ijs} which is required by the investor. By doing so, they are able to meet their liquidity constraint, and enter.[18] Because revenue is increasing in productivity, less productive firms need to deviate more from the optimum. Accordingly, firms in this productivity range choose a quality level equal to a fraction $\beta_{ijs}(a) \in (0,1)$ of their optimum, with $\beta_{ijs}(a)$ smaller for less productive firms (i.e., $\partial \beta_{ijs}(a) / \partial a < 0$). Finally, firms with $a \in \left(\bar{a}_{ijs}, a_H\right]$ cannot profitably sell in destination i, as they are so unproductive that their revenue would always be too low for an investor to break even.[19]

3.1.3 Average Quality

We are now ready to study the aggregate implications of the model, regarding the relation between average quality and financial imperfections. To this purpose, we use the results of the previous section to derive an expression for the average quality of goods exported by country j to country i in industry s (labeled $\tilde{Q}_{ijs}$). Recall that liquidity-unconstrained firms (i.e., those with $a \in \left[a_L, \underline{a}_{ijs}\right]$) enter destination i with their optimal quality, denoted by $q^o_{ijs}(a)$ and given by eq. (3.8). Liquidity-constrained firms (i.e., those with $a \in \left(\underline{a}_{ijs}, \bar{a}_{ijs}\right]$) enter instead with a quality equal to a fraction $\beta_{ijs}(a)$ of the optimum. Then, using the distribution of a to aggregate across exporting firms, $\tilde{Q}_{ijs}$ is

[18] Since deviating from the optimum results in lower profits, a firm deviates by just as much as is needed to make its constraint hold as a strict equality.

[19] It is possible to show (see Appendix A.1) that $\bar{a}_{ijs} < a^*_{ijs}$. This implies that financial frictions lead to inefficient entry also when quality is endogenous.

equal to:

$$\tilde{Q}_{ijs} = \int_{a_L}^{\underline{a}_{ijs}} q_{ijs}^{o}(a) \frac{g(a)}{G(\bar{a}_{ijs})} da + \int_{\underline{a}_{ijs}}^{\bar{a}_{ijs}} \beta_{ijs}(a) q_{ijs}^{o}(a) \frac{g(a)}{G(\bar{a}_{ijs})} da$$
$$= \left[\left(\frac{\tau_{ij} c_{js}}{\alpha P_{is}} \right)^{1-\varepsilon} \frac{(\gamma - \tilde{\gamma}) Y_{is}}{\varepsilon \gamma c_{js}} \right]^{1/\tilde{\gamma}} \left(\int_{a_L}^{\underline{a}_{ijs}} a^{(1-\varepsilon)/\tilde{\gamma}} \frac{g(a)}{G(\bar{a}_{ijs})} da + \right.$$
$$\left. \int_{\underline{a}_{ijs}}^{\bar{a}_{ijs}} \beta_{ijs}(a) a^{(1-\varepsilon)\tilde{\gamma}} \frac{g(a)}{G(\bar{a}_{ijs})} da \right). \quad (3.9)$$

Eq. (3.9) shows that $\tilde{Q}_{ijs}$ varies along two margins. The first is an 'extensive margin', which reflects the selection of firms into market i, and is governed by the exporting cut-off ($\bar{a}_{ijs}$). The second is an 'intensive margin', which reflects the average quality of incumbent exporters' products, and is governed by the share of liquidity-unconstrained firms ($\underline{a}_{ijs}$) and by the quality level of liquidity-constrained firms ($\beta_{ijs}(a)$). In particular, $\tilde{Q}_{ijs}$ is ceteris paribus increasing in $\underline{a}_{ijs}$ and $\beta_{ijs}(a)$, and decreasing in $\bar{a}_{ijs}$. The intuition is that higher $\underline{a}_{ijs}$ or $\beta_{ijs}(a)$ imply that some of the firms that sell in country i choose a higher quality level. This raises $\tilde{Q}_{ijs}$ other things equal. In contrast, a higher $\bar{a}_{ijs}$ implies that more firms sell in i. Because the new exporters are less productive than the incumbents, they produce lower-quality goods. This reduces $\tilde{Q}_{ijs}$ other things equal.[20] Next, we discuss how each margin responds to the interplay between financial frictions and financial vulnerability.

3.1.4 Comparative Statics

We now study how $\underline{a}_{ijs}$, $\beta_{ijs}(a)$, and $\bar{a}_{ijs}$ depend on the degree of financial frictions in each country (as proxied by λ_j) and financial vulnerability in each industry (as proxied by d_s and t_s). Starting from $\underline{a}_{ijs}$ and $\beta_{ijs}(a)$, the comparative-statics results are summarized in the following two propositions.

Proposition 3.1.1 *(Intensive margin, $\underline{a}_{ijs}$) The threshold $\underline{a}_{ijs}$ below which firms choose the optimal quality is ceteris paribus increasing in financial development ($\partial \underline{a}_{ijs}/\partial \lambda_j > 0$), the more so in financially more vulnerable industries ($\partial^2 \underline{a}_{ijs}/\partial \lambda_j \partial d_s > 0$ and $\partial^2 \underline{a}_{ijs}/\partial \lambda_j \partial t_s < 0$).*

Proof. See Appendix A.2. ■

Proposition 3.1.2 *(Intensive margin, $\beta_{ijs}(a)$) The quality of liquidity-constrained firms is ceteris paribus increasing in financial development ($\partial \beta_{ijs}(a) / \partial \lambda_j > 0$), the more so in financially more vulnerable industries ($\partial^2 \beta_{ijs}(a) / \partial \lambda_j \partial d_s > 0$ and $\partial^2 \beta_{ijs}(a) / \partial \lambda_j \partial t_s < 0$).*

[20] Quality is increasing in firm productivity because more productive firms have higher revenue and can thus afford paying higher fixed costs of quality upgrading (see eq. 3.8).

Proof. See Appendix A.2. ■

The intuition behind these results is the following. Less harsh financial frictions correspond to a higher probability λ_j that the contract is enforced. Firms can thus promise the investors a lower payment F_{ijs}, while still guaranteeing that the investors break even in expectation. As a result, the share of firms that are liquidity unconstrained and achieve the optimal quality increases (higher $\underline{a}_{ijs}$). At the same time, the liquidity-constrained firms can raise quality closer to the optimum (higher $\beta_{ijs}(a)$). Both effects are stronger in industries that rely more on external financing (higher d_s) and have lower asset tangibility (lower t_s). *Ceteris paribus*, firms in these industries have to promise the investor a larger payment F_{ijs}. Hence, the same improvement in financial development λ_j induces a greater (absolute) reduction in such payment in financially more vulnerable industries, thereby allowing firms to finance relatively higher fixed costs of quality upgrading.

Turning to $\bar{a}_{ijs}$, the comparative-statics results are summarized in the following proposition.

Proposition 3.1.3 *(Extensive margin, $\bar{a}_{ijs}$) The exporting threshold $\bar{a}_{ijs}$ is ceteris paribus increasing in financial development ($\partial \bar{a}_{ijs}/\partial \lambda_j > 0$), the more so in industries with lower asset tangibility ($\partial^2 \bar{a}_{ijs}/\partial \lambda_j \partial t_s < 0$). The effect of financial development on $\bar{a}_{ijs}$ across industries with different external finance dependence is theoretically ambiguous ($\partial^2 \bar{a}_{ijs}/\partial \lambda_j \partial d_s \lesseqgtr 0$).*

Proof. See Appendix A.2. ■

The intuition for the first part of Proposition 3 follows the same argument as in the previous paragraph. The indeterminacy about the effect of d_s has to do with the fact that less productive firms produce lower-quality goods and can thus offer the investor a smaller revenue in case of repayment, but they also rely less on outside capital. As shown in Appendix A.2, depending on which effect prevails, $\partial^2 \bar{a}_{ijs}/\partial \lambda_j \partial d_s$ can be either negative or positive. The empirical analysis will tell which case is consistent with our data.[21]

[21] A similar indeterminacy emerges in some extension of the model in Manova (2013). In general equilibrium, the level effect of financial development on $\bar{a}_{ijs}$ would be ambiguous: an increase in λ_j cannot raise the entry threshold in all industries, as this would create positive expected profits and violate the free-entry condition. Financial development would increase $\bar{a}_{ijs}$ in financially more vulnerable industries and decrease it in financially less vulnerable ones. By raising the price index of the former industries relative to that of the latter, this would further increase the relative quality of incumbent exporters in financially more vulnerable sectors. Accordingly, we always emphasize the *differential* effects of financial development across industries, rather than its level effects.

3.2 Estimation

Our estimation strategy builds on Helpman et al. (2008) and Manova (2013). In a nutshell, we parametrize bilateral trade costs and the productivity distribution to derive an estimable version of (3.9), the equation that links average quality $\tilde{Q}_{ijs}$ to the financial variables (*quality equation*). We also derive a term that can be used to control for firm selection when estimating the quality equation, thereby separating the intensive-margin (Propositions 1 and 2) and extensive-margin contribution (Proposition 3) of financial imperfections. This term is constructed using predicted components from a first-stage equation (*selection equation*), which specifies the probability of observing trade between two countries in a given industry, as a function of the financial variables and bilateral trade costs.[22]

3.2.1 The Quality Equation

We start by rearranging eq. (3.9) to express $\tilde{Q}_{ijs}$ as follows:

$$\tilde{Q}_{ijs} = q^o_{ijs}\left(a_L\right) V_{ijs} E_{ijs}, \tag{3.10}$$

where

$$\begin{aligned} V_{ijs} &\equiv \frac{1}{G\left(\bar{a}_{ijs}\right)} \int_{a_L}^{\bar{a}_{ijs}} \left(\frac{a}{a_L}\right)^{(1-\varepsilon)/\tilde{\gamma}} g\left(a\right) da, \\ E_{ijs} &\equiv \frac{\int_{a_L}^{\underline{a}_{ijs}} \left(\frac{a}{a_L}\right)^{(1-\varepsilon)/\tilde{\gamma}} g\left(a\right) da + \int_{\underline{a}_{ijs}}^{\bar{a}_{ijs}} \beta_{ijs}\left(a\right) \left(\frac{a}{a_L}\right)^{(1-\varepsilon)/\tilde{\gamma}} g\left(a\right) da}{\int_{a_L}^{\bar{a}_{ijs}} \left(\frac{a}{a_L}\right)^{(1-\varepsilon)/\tilde{\gamma}} g\left(a\right) da}, \end{aligned}$$

and $q^o_{ijs}\left(a_L\right) = \left[\left(\frac{\tau_{ij} c_{js} a_L}{\alpha P_{is}}\right)^{1-\varepsilon} \frac{(\gamma - \tilde{\gamma}) Y_{is}}{\varepsilon \gamma c_{js}}\right]^{1/\tilde{\gamma}}$ is the quality of the most efficient firm, with coefficient a_L.

Eq. (3.10) shows that average quality $\tilde{Q}_{ijs}$ is proportional to the quality of the most productive firm, with factors of proportionality given by V_{ijs} and E_{ijs}. If all firms were endowed with the same coefficient a_L, then $\tilde{Q}_{ijs} = q^o_{ijs}\left(a_L\right)$. V_{ijs} and E_{ijs} scale down $\tilde{Q}_{ijs}$ to account for the extensive- and intensive-margin contribution of financial imperfections in the presence of firm heterogeneity. Specifically, V_{ijs} accounts for 'firm

[22] As discussed in Helpman et al. (2008), despite the fact that the two margins arise in the model due to the presence of heterogeneous firms, they can be separated using the information contained in aggregate trade data. The reason is that, according to the model, the characteristics of the marginal exporter to a given destination ($\bar{a}_{ijs}$), can be identified from the observed variation in trade costs and in other country and industry characteristics, including the financial variables (see eq. 3.17 below).

selection' (the extensive margin). When firms are heterogeneous in productivity, financial imperfections imply that only firms with $a < \bar{a}_{ijs}$ can profitably export from country j to country i in industry s. Because these firms are less efficient than the most productive firm, $V_{ijs} < 1$. When $\bar{a}_{ijs} < a_L$, no firm can profitably export, so V_{ijs} and $\tilde{Q}_{ijs}$ are not defined; otherwise, V_{ijs} is a decreasing function of $\bar{a}_{ijs}$. E_{ijs} accounts instead for 'average firm-level quality' (the intensive margin). Financial imperfections imply that some of the firms exporting from country j to country i in industry s do not achieve the optimal quality. Hence, $\underline{a}_{ijs} < \bar{a}_{ijs}$ and $\beta_{ijs}(a) < 1$, implying that $E_{ijs} < 1$. E_{ijs} is ceteris paribus increasing in $\underline{a}_{ijs}$ and $\beta_{ijs}(a)$.

Following Helpman et al. (2008), we assume that productivity $1/a$ follows a Pareto distribution, truncated over the support $[a_L, a_H]$.[23] Hence, we assume that $G(a) = \frac{\left(a^k - a_L^k\right)}{\left(a_H^k - a_L^k\right)}$, with $k > (\varepsilon - 1)/\tilde{\gamma}$. Under this assumption, we can re-write V_{ijs} as follows:

$$V_{ijs} = \frac{\tilde{\gamma}k}{\tilde{\gamma}k - \varepsilon + 1} W_{ijs}, \tag{3.11}$$

where

$$W_{ijs} \equiv \frac{\left(\frac{\bar{a}_{ijs}}{a_L}\right)^{k-(\varepsilon-1)/\tilde{\gamma}} - 1}{\left(\frac{\bar{a}_{ijs}}{a_L}\right)^{k} - 1}. \tag{3.12}$$

Using these expressions, we can re-write eq. (3.10) in log-linear form as follows:

$$\tilde{q}_{ijs} = \theta_0 + \frac{1}{\tilde{\gamma}} y_{is} - \frac{\varepsilon}{\tilde{\gamma}} \ln c_{js} + \frac{\varepsilon - 1}{\tilde{\gamma}} p_{is} - \frac{\varepsilon - 1}{\tilde{\gamma}} \ln \tau_{ij} + w_{ijs} + e_{ijs}, \tag{3.13}$$

where lowercase letters denote the natural logarithms of the corresponding uppercase variables.[24]

Next, we use a parametrization for variable trade costs similar to Helpman et al. (2008):

$$\frac{\varepsilon - 1}{\tilde{\gamma}} \ln \tau_{ij} \equiv \zeta d_{ij} - u_{ij}, \tag{3.14}$$

where d_{ij} is a matrix of observable bilateral trade frictions (i.e., distance and other standard gravity variables), ζ is the corresponding vector of elasticities, and u_{ij} is an unobserved, country-pair specific, i.i.d. trade friction, with $u_{ij} \sim N\left(0, \sigma_u^2\right)$. Following Manova (2013) we also assume that the production cost c_{js} is the product of a country-specific term c_j and an industry-specific term c_s:

[23] See also Bonfiglioli et al. (2015).

[24] In eq. (3.13), θ_0 is a constant that bundles a number of parameters: $\theta_0 \equiv \ln\left\{\frac{\tilde{\gamma}k}{\tilde{\gamma}k-\varepsilon+1}\left[\left(\frac{a_L}{\alpha}\right)^{1-\varepsilon}\left(\frac{\gamma-\tilde{\gamma}}{\varepsilon\gamma}\right)\right]^{1/\tilde{\gamma}}\right\}$.

$$c_{js} \equiv c_j c_s. \tag{3.15}$$

Using (3.14) and (3.15), we can finally write (3.13) as follows:

$$\tilde{q}_{ijs} = \theta_0 + \theta_{is} + \theta_j - \zeta d_{ij} + w_{ijs} + e_{ijs} + u_{ij}. \tag{3.16}$$

As explained above, the interplay between financial frictions and financial vulnerability influences both w_{ijs} and e_{ijs}, by affecting $\underline{a}_{ijs}$, $\beta_{ijs}(a)$, and $\bar{a}_{ijs}$. The terms $\theta_{is} \equiv \tilde{\gamma}^{-1}[y_{is} + (\varepsilon - 1)p_{is} - \varepsilon \ln c_s]$ and $\theta_j \equiv -(\varepsilon/\tilde{\gamma})\ln c_j$ are, respectively, importer-industry and exporter fixed effects, which subsume the general equilibrium variables of the model. Importantly, θ_j absorbs all characteristics of each exporting country that affect $\tilde{q}_{ijs}$ uniformly across destination markets and industries. Similarly, θ_{is} absorbs all characteristics of each importing country and industry that influence $\tilde{q}_{ijs}$ uniformly across exporters. Hence, these fixed effects eliminate confounding factors at the exporter and importer-industry level, and ensure that the effect of financial frictions be identified by their differential importance across industries with different financial vulnerability.

In Section 3.4, we will first estimate eq. (3.16) by replacing w_{ijs} and e_{ijs} with interactions between proxies for financial development (FD_j), external financial dependence (EF_s), and asset tangibility (AT_s). This specification will inform us about the overall effect of financial imperfections on average quality. Next, we will estimate the same specification controlling also for w_{ijs}. Because this term accounts for firm selection, any remaining effect of financial imperfections on $\tilde{q}_{ijs}$ will reflect their influence on average firm-level quality. This will allow us to quantify the relative contribution of the intensive and extensive margin. We now derive a consistent estimate for w_{ijs}.

3.2.2 The Selection Equation

Following Manova (2013), we define a latent variable Z_{ijs} as a function of the productivity of the most efficient firm, $1/a_L$, relative to the exporting productivity cut-off, $1/\bar{a}_{ijs}$:[25]

$$Z_{ijs} \equiv \left(\frac{\bar{a}_{ijs}}{a_L}\right)^{(\varepsilon-1)\gamma/\tilde{\gamma}} = \frac{\left(1 - d_s + \frac{d_s}{\lambda_j}\right)^{(\tilde{\gamma}-\gamma)/\tilde{\gamma}}}{\left(1 - d_s + \frac{d_s}{\lambda_j}\right) f_{Xij} - \frac{1-\lambda_j}{\lambda_j} t_s f_{Ej}} \frac{\tilde{\gamma}\left[\left(\frac{\tau_{ij} c_{js} a_L}{\alpha P_{is}}\right)^{1-\varepsilon}\left(\frac{\gamma - \tilde{\gamma}}{\gamma \varepsilon c_{js}}\right) Y_{is}\right]^{\gamma/\tilde{\gamma}}}{\gamma - \tilde{\gamma}}. \tag{3.17}$$

[25]To obtain this expression, divide the revenue of the most productive firm (see eq. A.6 in Appendix A.1) by the revenue of the marginal exporter (eq. A.14) and then use the condition that defines the exporting productivity cut-off $\bar{a}_{ijs}$ (eq. A.13).

Positive exports from country j to country i in industry s are observed if $Z_{ijs} > 1$. Moreover, Z_{ijs} is increasing in the exporting cut-off $\bar{a}_{ijs}$, and thus in the proportion of the N_{js} active firms selling in country i. Using eq. (3.17), we can re-write the expression for W_{ijs} (eq. 3.12) as follows:

$$W_{ijs} = \frac{Z_{ijs}^{(\tilde{\gamma}k-\varepsilon+1)/\gamma(\varepsilon-1)} - 1}{Z_{ijs}^{\tilde{\gamma}k/\gamma(\varepsilon-1)} - 1}. \tag{3.18}$$

Importantly, W_{ijs} is decreasing in Z_{ijs}, since $\varepsilon > 1$ implies that the exponent of Z_{ijs} at the numerator of eq. (3.18) is smaller than its exponent at the denominator. Hence, the more firms export to country i, the higher is the latent variable Z_{ijs}, and the smaller is the factor W_{ijs} that scales down average quality $\tilde{Q}_{ijs}$ to account for firm selection.

To obtain an estimable version of eq. (3.17), we parametrize the fixed export cost f_{Xij} as in Helpman et al. (2008):

$$f_{Xij} \equiv \exp\left(\varphi_i + \varphi_j + \xi_1\varphi_{ij} - \nu_{ij}\right).$$

This specification decomposes f_{Xij} into a term measuring the trade barrier imposed by the importing country on all exporters (φ_i), a term measuring a common fixed cost faced by the exporting country in all destination markets (φ_j), a term measuring any additional fixed export cost specific to the country pair (φ_{ij}), and some unmeasured, country-pair specific, i.i.d. trade friction ν_{ij}, with $\nu_{ij} \sim N\left(0, \sigma_\nu^2\right)$. Moreover, following Manova (2013), we assume that the first term in the RHS of eq. (3.17) can be expressed as a function of our proxies for financial development and financial vulnerability:

$$\frac{\left(1 - d_s + \frac{d_s}{\lambda_j}\right)^{(\tilde{\gamma}-\gamma)/\tilde{\gamma}}}{\left(1 - d_s + \frac{d_s}{\lambda_j}\right) f_{Xij} - \frac{1-\lambda_j}{\lambda_j} t_s f_{Ej}} = \exp\left(\chi_{is} + \chi_j - \xi_1\varphi_{ij} + \xi_2 FD_j \cdot EF_s - \xi_3 FD_j \cdot AT_s + \nu_{ij}\right), \tag{3.19}$$

where χ_j is an exporter fixed effect that captures: (*i*) the component φ_j of the fixed export cost; (*ii*) the sunk entry cost f_{Ej}; and (*iii*) the main effect of financial development (FD_j). Similarly, χ_{is} is an importer-industry fixed effect that captures: (*i*) the component φ_i of the fixed export cost; and (*ii*) variation in external finance dependence (EF_s) and asset tangibility (AT_s) across industries. Using the parametrizations in eq. (3.14), (3.15), and (3.19), we can finally re-write eq. (3.17) in log-linear form as follows:

$$z_{ijs} = \xi_0 + \xi_{is} + \xi_j - \gamma\zeta d_{ij} - \xi_1\varphi_{ij} + \xi_2 FD_j \cdot EF_s - \xi_3 FD_j \cdot AT_s + \eta_{ij}, \tag{3.20}$$

where $\xi_{is} \equiv \chi_{is} + (\gamma/\tilde{\gamma})\left[y_{is} + (\varepsilon - 1)\, p_{is} - \varepsilon \ln c_s\right]$ denotes the importer-industry fixed effect, $\xi_j \equiv \chi_j - (\varepsilon\gamma/\tilde{\gamma})\ln c_j$ denotes the exporter fixed effect, and $\eta_{ij} \equiv \nu_{ij} + \gamma u_{ij} \sim N\left(0, \sigma_\nu^2 + \gamma^2\sigma_u^2\right)$.[26]

Although z_{ijs} is unobserved, we do observe the existence of trade flows. Let T_{ijs} be a dummy equal to 1 when country j exports to country i in industry s, and 0 otherwise. Because $z_{ijs} > 0$ when $T_{ijs} = 1$ and $z_{ijs} = 0$ when $T_{ijs} = 0$, we can estimate eq. (3.20) by Probit. In particular, we specify the following Probit model for the conditional probability ρ_{ijs} of observing positive trade between country j and country i in industry s:

$$\begin{aligned}\rho_{ijs} &\equiv \Pr\left[T_{ijs} = 1|\text{covariates}\right] \\ &= \Phi\left[\xi_0^* + \xi_{is}^* + \xi_j^* - (\gamma\zeta)^* d_{ij} - \xi_1^*\varphi_{ij} + \xi_2^* FD_j \cdot EF_s - \xi_3^* FD_j \cdot AT_s\right], \quad (3.21)\end{aligned}$$

where the stars indicate the original coefficients divided by σ_η, Φ is the c.d.f. of the standard normal distribution, and the error term $\eta_{ij}^* \equiv \eta_{ij}/\sigma_\eta$ is distributed unit normal.

Using the estimates from eq. (3.21), we can construct the predicted probability $\hat{\rho}_{ijs}$. With the latter in hand, we can compute the predicted value of the latent variable $z_{ijs}^* \equiv z_{ijs}/\sigma_\eta$ as follows: $\hat{z}_{ijs}^* = \Phi^{-1}\left(\hat{\rho}_{ijs}\right)$. Then, a consistent estimate for W_{ijs} can be obtained from:

$$W_{ijs} = \frac{\left(Z_{ijs}^*\right)^{\kappa_1} - 1}{\left(Z_{ijs}^*\right)^{\kappa_2} - 1},$$

where $\kappa_1 \equiv \sigma_\eta\left(\tilde{\gamma}k - \varepsilon + 1\right)/\gamma\left(\varepsilon - 1\right)$ and $\kappa_2 \equiv \sigma_\eta\tilde{\gamma}k/\gamma\left(\varepsilon - 1\right)$.

Average quality $\tilde{Q}_{ijs}$ is only defined in the sub-sample of observations with positive trade flows. Thus, we in fact need an estimate for w_{ijs} conditional on observing positive trade. In other words, we need to consistently estimate $E\left[w_{ijs}|., T_{ijs} = 1\right]$, which in turn requires a consistent estimate for $\bar{\eta}_{ijs}^* \equiv E\left[\eta_{ij}^*|., T_{ijs} = 1\right]$. Since η_{ij}^* is distributed unit normal, a consistent estimate for $\bar{\eta}_{ijs}^*$ is obtained from the inverse Mills ratio, that is, $\widehat{\bar{\eta}}_{ijs}^* \equiv \phi\left(\hat{z}_{ijs}^*\right)/\Phi\left(\hat{z}_{ijs}^*\right)$. Then, $\widehat{\bar{z}}_{ijs}^* \equiv \hat{z}_{ijs}^* + \widehat{\bar{\eta}}_{ijs}^*$ is a consistent estimate for $E\left[z_{ijs}^*|., T_{ijs} = 1\right]$, so a consistent estimate for $E\left[w_{ijs}|., T_{ijs} = 1\right]$ can be obtained as follows:

$$\widehat{\bar{w}}_{ijs}^* = \ln\left\{\frac{\exp\left[\kappa_1\left(\hat{z}_{ijs}^* + \widehat{\bar{\eta}}_{ijs}^*\right)\right] - 1}{\exp\left[\kappa_2\left(\hat{z}_{ijs}^* + \widehat{\bar{\eta}}_{ijs}^*\right)\right] - 1}\right\}.$$

Finally, using the sub-sample of observations with positive trade flows can yield biased estimates of the coefficients of the quality equation, if the selection of country pairs

[26] ξ_0 is a constant that bundles a number of parameters: $\xi_0 \equiv \ln\left\{\frac{\tilde{\gamma}}{\gamma - \tilde{\gamma}}\left[\frac{\gamma - \tilde{\gamma}}{\varepsilon\gamma}\left(\frac{a_L}{\alpha}\right)^{1-\varepsilon}\right]^{\gamma/\tilde{\gamma}}\right\}$.

into trading partners is driven by unobserved bilateral trade frictions (u_{ij}) correlated with the explanatory variables. Following Helpman et al. (2008), this can be controlled for by including the inverse Mills ratio $\widehat{\overline{\eta}}^{*}_{ijs}$ as an additional regressor in the quality equation (Heckman, 1979).[27]

3.3 Data and Variables

We now describe our proxies for product quality (Section 3.3.1), financial development (Section 3.3.2), and financial vulnerability (Section 3.3.3).

3.3.1 Quality Estimates

The quality of a product depends on various attributes, both tangible and intangible, that influence the way in which consumers perceive the good, and thus their willingness to pay for it. In an influential paper, Khandelwal (2010) introduces a simple methodology for inferring quality from the information on prices and quantity contained in the trade data.[28] As explained below, this approach requires comparable time-series of bilateral trade at the product level. In this paper, we implement Khandelwal's (2010) methodology using data on imports into the EU. These data are sourced from *Comext*, a database administered by Eurostat. Two unique features make them particularly well suited to estimate quality using Khandelwal's (2010) approach. First, the data are readily comparable across importing and exporting countries. Second, their level of product disaggregation (8-digit) is higher than the one currently available for most other countries in public databases (6-digit).[29] We observe 6713 products, but following Khandelwal (2010) we restrict to manufacturing goods (5689 products). For each product, we observe imports (values and quantities) into 26 EU members from

[27] In the absence of firm heterogeneity, this would be the only correction needed, as all firms would be equally affected by observed country characteristics such as the financial variables. In the presence of firm heterogeneity, however, one also needs to account for the influence that such observables have on average quality $\tilde{q}_{ijs}$ by determining the selection of exporting firms (i.e., by affecting the exporting cut-off $\bar{a}_{ijs}$). This effect is captured by the additional control $\widehat{\overline{w}}^{*}_{ijs}$.

[28] Data on domestic production are not available and comparable for sufficiently many countries and years, and are insufficiently disaggregated at the product level. See Colantone and Crinò (2014) for a discussion.

[29] Eurostat employs the Combined Nomenclature (CN) classification. Up to the sixth digit, it coincides with the Harmonized System (HS) classification used by most countries. See Colantone and Crinò (2014) and Van Beveren et al. (2012) for a detailed discussion of product classifications in *Comext*.

all countries in the world between 1988 and 2012.[30] To match these data with our measures of financial vulnerability, we uniquely assign each product to a 4-digit SIC industry (273 overall) using a converter provided by the World Bank *World Integrated Trade Solution*.

The basic intuition behind Khandelwal's (2010) approach is that, conditional on prices, higher-quality products should command higher market shares in a given destination. Building on this intuition, he derives quality by estimating a system of demand functions, which reflect preferences for both the vertical and the horizontal attributes of the goods. Quality is the vertical component of the model. It represents the mean valuation that consumers in country i assign to a particular product l exported by country j at time t.[31]

As in Khandelwal (2010), we specify the following empirical version of the demand functions (the subscripts s and i are omitted, because eq. 3.22 will be estimated separately for each 4-digit industry and importing country):[32]

$$\ln s_{ljt} - \ln s_{0t} = \beta_{lj} + \beta_t + \beta_1 p_{ljt} + \beta_2 \ln ns_{ljt} + \beta_3 \ln pop_{jt} + \epsilon_{ljt}. \tag{3.22}$$

In eq. (3.22), s_{0t} is the market share of an outside variety (domestic product), which is computed as 1 minus import penetration in the industry. $s_{ljt} = x_{ljt}/MKT_t$ is the quantity market share of product l exported by country j in the corresponding 4-digit industry, with $MKT_t \equiv \sum_l \sum_j x_{ljt}/(1 - s_{0t})$. p_{ljt} is the price of the good, proxied by the c.i.f. (cost, insurance, and freight) unit value. $ns_{ljt} = x_{ljt}/\sum_j x_{ljt}$ is country j's share in the total imported quantity of product l ('nest share'). Finally, pop_{jt} is country j's population.[33] Log quality is given by $\ln q_{ljt} = \beta_{lj} + \beta_t + \epsilon_{ljt}$, where the fixed effect β_{lj}

[30]Eurostat aggregates Belgium and Luxemburg into a single unit, so our data include 26 rather than 27 EU members. For Austria, Finland, and Sweden, the data are available since 1995; for the 12 countries that joined the EU in 2004 or 2007, they are available since 1999. Given that, as explained in the next section, our preferred measure of financial development (private credit) is available up to 2011, our main estimation sample spans the period 1988-2011. However, in some specifications using alternative proxies, we will be able to also include the data for 2012. Appendix B provides more details on data and variables used in this section.

[31]See Hallak and Schott (2011), Di Comite et al. (2014), and Feenstra and Romalis (2014) for alternative approaches based on a similar intuition.

[32]Eq. (3.22) is derived from the nested logit framework, which encompasses CES preferences (Anderson et al., 1987). This equation also controls for horizontal attributes of the good (see below) that would bias the quality estimates if omitted. We estimate eq. (3.22) separately for each 4-digit industry because products are not comparable within more aggregated sectors.

[33]As discussed in Khandelwal (2010), different versions of the same good sold by different countries may be more substitutable than completely distinct products: controlling for the nest share prevents

captures the time-invariant valuation of product l exported by country j, the year fixed effect β_t captures a time trend common to all products, and the residual ϵ_{ljt} captures shocks to the valuation of the product in year t.[34]

We estimate eq. (3.22) by Two-Stage Least Squares (2SLS), to account for possible correlation between p_{ljt} and ns_{ljt} on the one hand, and ϵ_{ljt} on the other. We use the same instruments as in Khandelwal (2010): bilateral exchange rates, the interactions of bilateral distance with oil prices and product-specific transportation costs, the number of countries exporting product l to destination i, and the number of products exported by country j to country i.

Table 3.1 contains summary statistics on the estimation results. Column (1) refers to the 2SLS estimates. For comparison, column (2) reports the results obtained by estimating eq. (3.22) using OLS. We perform 8257 separate regressions using almost 22 million observations. The median 2SLS regression uses 1384 observations, corresponding to 225 'varieties' (exporter-product combinations). As expected, the median price elasticity is negative and the median coefficient on the nest share positive. The F-test indicates that the excluded instruments are highly correlated with the endogenous variables, and the Hansen J-test does not reject the validity of the over-identifying restrictions. Reassuringly, the price elasticity estimated by 2SLS is more negative than its OLS counterpart, implying that the instruments move the price coefficient in the expected direction. Moreover, the 2SLS estimates are close to those obtained by Khandelwal (2010), who uses import data for the US. In particular, he reports a median price elasticity of -0.58 and a median coefficient on the nest share of 0.46, while in our data these quantities equal -0.78 and 0.51, respectively.

The estimation procedure delivers quality estimates that vary by product, exporting country, destination market, industry, and year. Following the model (eq. 3.9), we construct $\tilde{Q}_{ijst}$ as the average of the individual quality estimates in levels, across all

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the quality estimates from being influenced by this different pattern of substitutability. Controlling for population accounts instead for the fact that larger countries tend to export more varieties of the same product, a feature that may artificially inflate their quality estimates. Together, ns_{ljt} and pop_{jt} therefore accommodate differences in horizontal characteristics across products.

[34]By conditioning on prices, the methodology accounts for many factors that may affect market shares independent of quality. For instance, a product may have a high market share simply because it comes from a nearby country. However, given that prices include transportation costs, they account for the effect of distance. A similar argument can be made regarding the influence of policy-related trade barriers such as tariffs, because the c.i.f. unit values include them. Finally, market shares may reflect heterogeneity in mark-ups across exporters. Conditioning on prices, however, also controls for this confounding factor.

Table 3.1: Descriptive Statistics on the Quality Estimates

	(1)	(2)
Coefficient on price (median)	-0.056	-0.010
Price elasticity (median)	-0.782	-0.128
Coefficient on nest share (median)	0.513	0.883
Observations per estimation (median)	1384	1397
Varieties per estimation (median)	225	231
R^2 (median)	0.15	0.85
Total estimations	8257	8257
Total observations	21,739,232	21,985,524
Hansen J-test (p-value, median)	0.157	-
F-test for excl. instr., price (p-value, median)	0.025	-
F-test for excl. instr., nest share (p-value, median)	0.000	-
Estimator	2SLS	OLS

products sold by a given exporter j to destination market i in a given industry s and year t.

3.3.2 Measures of Financial Development

In the model, countries are heterogeneous in terms of financial contractibility. This gives rise to heterogeneity in the extent to which the environment is able to provide credit to domestic firms. Empirically, this heterogeneity gets reflected in the different size of financial systems across countries. Accordingly, our main measure of financial development (FD_{jt}) is 'private credit', i.e., the amount of credit issued by commercial banks and other financial institutions to the private sector (as a share of GDP).[35]

We source data on private credit for 171 countries between 1988 and 2011 from the World Bank *Global Financial Development Database*. Table 3.2a reports the mean and standard deviation of private credit, both for the cross-section of country-level averages (column 1) and for the country-year panel (column 2). Private credit varies substantially across countries and over time. In the cross-section, it has a mean of 43.1% and a standard deviation of 39.3%, and ranges from a minimum of 1.3% (Democratic Republic of Congo) to a maximum of 195.1% (Cyprus). In the panel, private credit has

[35]This measure excludes credit issued by central banks, as well as loans to the government and public firms. As such, it is a close proxy for the ability of the financial system to facilitate transactions between private investors and firms, and to channel savings from the former to the latter. Private credit is indeed the standard measure of financial development used in the literature on finance, growth, and exports (e.g., King and Levine, 1993; Manova, 2013).

Table 3.2: Descriptive Statistics on Financial Development and Financial Vulnerability

	a) Financial Development (FD_j)		b) Financial Vulnerability	
	Cross Section	Panel	Ext. Fin. Dep. (EF_s)	Asset Tang. (AT_s)
	(1)	(2)	(3)	(4)
Mean	43.1	44.9	2.9	25.7
Standard Deviation	39.3	44.1	65.4	11.2

Notes: Private credit is the amount of credit issued by commercial banks and other financial institutions to the private sector (source: *Global Financial Development Database*). External finance dependence is the share of capital expenditure not financed with cash flow from operations. Asset tangibility is the share of net property, plant, and equipment in total assets. Both financial vulnerability measures are computed as the median value across all US firms in *Compustat* between 1988 and 2012. The statistics in columns (1) and (2) refer to the cross-section of country-level averages and to the country-year panel, respectively. The statistics in columns (3) and (4) are computed across 273 manufacturing industries.

a mean of 44.9% and a standard deviation of 44.1%, and ranges from a minimum of 0.01% (Zambia in 2010) to a maximum of 284.6% (Cyprus in 2011).

3.3.3 Measures of Financial Vulnerability

We measure an industry's external finance dependence (EF_s) and asset tangibility (AT_s) using, respectively, the share of capital expenditure not financed with cash flow from operations (Rajan and Zingales, 1998; Manova, 2013) and the share of net property, plant, and equipment in total assets (Claessens and Laeven, 2003; Manova, 2013). Both measures are constructed using *Compustat* data on all publicly-listed firms in the US. For each of the 273 manufacturing industries in our sample, we use the median value of asset tangibility and average external finance dependence across all firms in the industry over 1988-2012.[36]

As discussed in previous papers, the use of US data is imposed by lack of similar data for other countries. Yet, it also has two advantages. First, the US has one of the most advanced financial systems in the world. This makes it plausible that these measures reflect the true amount of outside capital and tangible assets desired by firms (Rajan and Zingales, 1998). Second, using US data mitigates the concern that these measures may endogenously respond to countries' financial development.[37] Even if EF_s and AT_s may differ across countries, the rankings of industries in terms of both

[36] *Compustat* reports information on the 4-digit SIC industry to which a firm belongs. For 4-digit industries with no firm in *Compustat*, we follow the conventional approach of using the value of each measure in the corresponding 3- or 2-digit industry.

[37] To further alleviate this concern, in a robustness check we will exclude the US from the sample, obtaining similar results.

measures are typically preserved, as most of the differences in the use of outside capital and tangible assets across industries depend on technological factors that persist in different economies (Rajan and Zingales, 1998).[38]

Table 3.2b reports descriptive statistics on EF_s and AT_s. Consistent with previous studies, both measures vary substantially across industries. EF_s has a mean of 2.9% and a standard deviation of 65.4%, while AT_s has a mean of 25.7% and a standard deviation of 11.2%. The industries with the lowest levels of EF_s and AT_s are 'cigarettes' (SIC 2111) and 'X-ray apparatus and tubes' (SIC 3844), respectively. Those with the highest levels are 'electromedical equipment' (SIC 3845) and 'sawmills and planing mills' (SIC 2421). EF_s and AT_s are only weakly correlated (-0.02).

3.4 Results

We now present the empirical results. We start by providing evidence that financial development increases the average quality of countries' products, especially in industries that are financially more vulnerable. Next, we quantify the effect of financial imperfections, and use the two-step estimation procedure laid out before to untangle and measure the contributions of the intensive and extensive margins. Finally, we discuss the implications of quality adjustments for the impact of financial development on aggregate trade flows and prices.

3.4.1 Financial Imperfections and Average Quality

Baseline Estimates

Table 3.3 contains the baseline estimates of the quality equation (3.16). Because the quality estimates are obtained from separate regressions for each importer-industry pair, they are comparable across exporters that sell in the same industry and destination country. Accordingly, we always control for a full set of importer-industry-year effects—the equivalent of θ_{is} in the model—so as to exploit only this source of variation. We adjust the R^2 by partialling out the contribution of these fixed effects, which is mechanical. As for inference, we correct the standard errors for clustering within exporter-importer pairs. This is motivated by the model, according to which the unobserved component of bilateral trade costs (u_{ij}) makes the residuals of eq. (3.16) cor-

[38]Indeed, using the rankings of EF_s and AT_s instead of their actual values yields the same results, as shown in Appendix C.

related within each country pair. Our findings are however robust to using alternative combinations of exporter j, industry s, and importer i for clustering the standard errors (results available upon request).

In column (1), we start by regressing log average quality ($\tilde{q}_{ijst}$) on private credit (FD_{jt}) and its interactions with external finance dependence (EF_s) and asset tangibility (AT_s).[39] The coefficient on FD_{jt} is positive and very precisely estimated. At the same time, the coefficient on $FD_{jt} \cdot EF_s$ is positive and that on $FD_{jt} \cdot AT_s$ negative; both coefficients are statistically significant at conventional levels. These results show that average product quality increases with financial development, relatively more in industries where firms rely more on outside capital and have less collateral.

In column (2), we add a full set of exporter-year effects—the equivalent of θ_j in the model. These fixed effects subsume the linear term in FD_{jt} and imply that the coefficients on $FD_{jt} \cdot EF_s$ and $FD_{jt} \cdot AT_s$ are now identified only from the combination of cross-country variation in FD_{jt} and cross-industry variation in EF_s and AT_s. The specification includes roughly 175,000 fixed effects (170,000 importer-industry-year effects plus 5,000 exporter-year effects) and is thus highly demanding. To deal with the high dimensionality of the regressors' matrix, we estimate this specification using the iterative approach developed by Guimarães and Portugal (2010) for the estimation of models with high dimensional fixed effects. The coefficients are similar to those obtained in column (1) and, if anything, they are now slightly larger and more precisely estimated.

In columns (3) and (4), we estimate the last specification including the two interactions one at a time. The coefficients are close to those in column (2), consistent with the fact that EF_s and AT_s are only weakly correlated and thus capture distinct aspects of financial vulnerability. Finally, in column (5) we add a large number of bilateral gravity variables—the equivalent of d_{ij} in the model, coefficients available upon request—thereby obtaining the specification in eq. (3.16).[40] The coefficients on $FD_{jt} \cdot EF_s$ and $FD_{jt} \cdot AT_s$ remain unchanged. Overall, these baseline estimates show that the interplay between financial frictions and financial vulnerability has strong explanatory power for predicting variation in average quality across countries and industries.

In Appendix C, we submit these estimates to an extensive sensitivity analysis,

[39] The linear terms in EF_s and AT_s are subsumed in the importer-industry-year effects.

[40] These controls include the log of bilateral distance and eight dummies for whether the exporting and importing countries have a common border, are landlocked, share the same language or legal system, have colonial ties, are both members of the European Monetary Union or the World Trade Organization, or are part of the same regional trade agreement. We use information from CEPII, the EU, and the WTO.

Table 3.3: Baseline Estimates

	(1)	(2)	(3)	(4)	(5)
FD_{jt}	1.267***				
	[0.082]				
$FD_{jt} \cdot EF_s$	0.316***	0.317***	0.319***		0.312***
	[0.025]	[0.024]	[0.024]		[0.024]
$FD_{jt} \cdot AT_s$	-0.256*	-0.476***		-0.530***	-0.477***
	[0.146]	[0.147]		[0.147]	[0.147]
Obs.	3,144,866	3,144,866	3,144,866	3,144,866	3,144,866
R^2	0.02	0.08	0.08	0.08	0.09
Imp-ind-year (*i*-*s*-*t*) FE	yes	yes	yes	yes	yes
Exp-year (*j*-*t*) FE	no	yes	yes	yes	yes
Gravity controls (*i*-*j*-*t*)	no	no	no	no	yes
N. of exporters (*j*)	171	171	171	171	171
N. of industries (*s*)	273	273	273	273	273
N. of clusters (*i*-*j*)	4099	4099	4099	4099	4099

Notes: The dependent variable is $\tilde{q}_{ijst}$, the log average quality of goods exported by country j to country i in industry s at time t. Gravity controls are the log of bilateral distance and eight dummies for whether the exporting and importing countries have a common border, are landlocked, share the same language or legal system, have colonial ties, are both members of the European Monetary Union or the World Trade Organization, or are part of the same regional trade agreement. The R^2 partial out the importer-industry-year effects. Standard errors are corrected for clustering within exporter-importer pairs. ***, **, and *: indicate significance at the 1%, 5%, and 10% level, respectively. See also notes to previous tables.

which addresses possible measurement and specification issues. In particular, we show that the results are robust to the use of alternative measures of financial frictions, alternative proxies for financial vulnerability, alternative parametrizations for variable trade costs, different sub-samples based on the characteristics of the importing country, and many alternative approaches to estimate quality.[41] Moreover, we use data on im-

[41] We also study the role of financial development in the destination market, as firms can borrow as well from investors located abroad through letters of credit. Because eq. (3.16) includes importer-industry-year effects, it already controls for the role of importers' financial development, so the latter does not contaminate our results. Nevertheless, it is still interesting to study how financial development at destination contributes to the variation in average quality observed in the data. In this specification, we therefore replace the importer-industry-year effects with importer-industry effects, so as to identify the terms involving importers' private credit. We find that importers' financial development has little explanatory power. This is consistent with the fact that letters of credit currently account for a moderate share of the total funding raised by exporting firms, and that their use still requires an active role by domestic credit institutions (Manova, 2013).

ports into the US, which are available for a shorter time period (1989-2006) but slightly more disaggregated at the product level (10 digits), to study if our findings are sensitive to the level of product disaggregation at which quality is estimated. The results confirm our baseline estimates for the EU and suggest that the level of aggregation has no implications for our evidence. Finally, we use average raw export prices (unit values, i.e., total value divided by total quantity) instead of Khandelwal's (2010) quality proxy as the dependent variable of eq. (3.16).[42] Unit values are an easy-to-observe variable but, unlike Khandelwal's (2010) measure, their use requires the assumption that variation in prices entirely stems from variation in quality, and does not reflect other factors such as production costs (see Khandelwal, 2010 for a discussion). Despite these caveats, the results are similar to those obtained with our preferred quality proxy.[43]

Competing Explanations

In this and the next section, we discuss two important aspects related to the interpretation of the baseline estimates: competing explanations and endogeneity. We start from the role of alternative explanations. Given that our specification controls for exporter-year and importer-industry-year effects, we need to consider factors that vary across exporters and may have differential effects across industries. In what follows, we extend the specification by adding proxies for these factors, and study how our main coefficients respond. The results are reported in Table 3.4.

Factor endowments and economic development Schott (2004) shows that capital- and skill-abundant countries produce higher-quality versions of the same product, the more so the higher is the capital and skill intensity of production. If skill- and capital-abundant countries have more developed financial systems, and if skill- and capital-intensive industries are financially more vulnerable, then our results may be picking up the effect of endowment-based comparative advantage. In column (1), we therefore add the interactions between the skill and capital intensity of each industry (SI_s and KI_s) and the relative endowments of skilled labor and capital in each exporting country

[42]In the model, CES preferences and monopolistic competition imply that firms set a price for each of their products equal to a constant markup over its marginal cost. Then, as long as the quality elasticity of marginal cost is positive ($\delta > 0$), the price of each firm is increasing in its product quality. See Schott (2004), Hummels and Skiba (2004), Kugler and Verhoogen (2012), Johnson (2012), Manova and Zhang (2012), Bastos and Silva (2010), Bastos et al. (2014), Fan et al. (2014), and Fan et al. (2015) for leading papers using unit values to proxy for quality.

[43]In Section 3.4.3 we will go back to the unit values to discuss the implications of different models.

(SE_{jt} and KE_{jt}).[44] Both interactions are positive and precisely estimated, in line with Schott's (2004) findings. However, the inclusion of these variables does not overturn our main results.[45] More generally, previous studies show that richer countries produce goods of higher quality (e.g., Hummels and Klenow, 2005; Hallak, 2006, 2010). To account for the effect of economic development, in column (2) we follow Manova (2013) and add the interactions between the measures of financial vulnerability and the log of each country's real per capita GDP (GDP_{jt}), sourced from the *World Development Indicators*. Our main evidence is unchanged.

Import competition Recent papers find that reductions in import tariffs raise the quality of a country's products, because firms respond to tougher competition from abroad by producing higher-quality goods (see, in particular, Amiti and Khandelwal, 2012, Martin and Mejean, 2014, and Fan et al., 2014). If financially more vulnerable industries were systematically more exposed to the competition of foreign countries, then our results could be contaminated by the effect of import competition on product quality. Lacking comprehensive tariffs data for most of the countries in our sample, we control for this explanation using import penetration as an inverse proxy for import tariffs. Thus, in column (3) we include the interactions between the measures of financial vulnerability and each country's import penetration ratio (IMP_{jt}), defined as merchandise imports over apparent consumption (i.e., production plus imports minus exports) and sourced from the *World Development Indicators*. The new interactions enter with small and not significant coefficients, suggesting the effects of import competition to be independent of industry characteristics. At the same time, our coefficients of interest are essentially identical to the baseline estimates.

Institutional quality A recent literature points to the quality of a country's legal institutions as an important source of comparative advantage. As discussed in Nunn and Trefler (2014), these institutions may affect not only specialization across industries,

[44] Capital intensity is measured by the log capital-labor ratio, skill intensity by the log ratio of non-production to production workers employment. Both variables are constructed using US data from the *NBER Productivity Database* and are averaged over the period of analysis. The relative endowments of skilled labor and capital are defined as the endowment of each factor in the exporting country relative to the importing country: the capital endowment is measured by the log capital stock per worker, the skill endowment by the log number of years of schooling; the data come from the *Penn World Tables 8.0*.

[45] In Appendix C, we reach similar conclusions when interacting SE_{jt} and KE_{jt} with EF_s and AT_s, to control for the fact that countries' factor endowments may shape the variation in product quality by interacting with industries' financial vulnerability rather than factor intensities (see Table C2).

but also within-industry specialization in terms of quality. To check that our results are not picking up the effect of institutional quality, in column (4) we add the interactions between the measures of financial vulnerability and each country's rule of law (RL_j), sourced from the *Worldwide Governance Indicators Database* and averaged over all available years (1996-2012). The coefficients on the new interactions are positive and precisely estimated, but controlling for institutional quality does not hinder our main evidence on financial imperfections.

Real exchange rate Financial development may be correlated with a country's real exchange rate (Russ and Valderrama, 2009), which in turn affects exports. Hence, in column (5) we include the interactions between the measures of financial vulnerability and the log of each exporter's real exchange rate (RER_{jt}), sourced from the *Penn World Tables 8.0*. The new interactions enter with positive and significant coefficients, but our main evidence is preserved.

R&D expenditure Countries differ substantially in the amount of resources devoted to R&D. Since quality upgrading entails investment in R&D and other innovation activities (Sutton, 2001, 2007), countries with higher R&D expenditure may have an advantage at producing higher-quality goods. To ensure that our results are not contaminated by this mechanism, in column (6) we add the interactions between the measures of financial vulnerability and the average ratio of R&D expenditure to GDP in each country (RD_j). Both interactions have positive and statistically significant coefficients, but controlling for them does not overturn our main results.

Foreign direct investment Multinational firms and domestic enterprises are differently exposed to credit constraints (Manova et al., 2015). If Foreign Direct Investment (FDI) is more prevalent in financially more developed countries, and if multinationals produce higher-quality goods especially in financially more vulnerable industries, then our results may reflect the effect of FDI on product quality. In column (7) we therefore include the stock of FDI in each exporting country (FDI_{jt}, sourced from *UNCTAD*) interacted with EF_s and AT_s. The new interactions are not very precisely estimated, and our main coefficients remain largely unchanged.

Quality ladder For technological reasons, the scope for quality differentiation varies across industries (Sutton, 2001, 2007). If financially more vulnerable industries have a greater scope for quality differentiation, then our results may pick up this characteristic instead of financial vulnerability. To control for this, in column (8) we add the interaction between private credit and Khandelwal's (2010) measure of each industry's quality ladder ($QLAD_s$), a direct proxy for the scope for quality differentiation.[46] As expected, this variable enters with a positive and significant coefficient, but controlling for it does not change our main evidence.[47]

Industry growth Financial frictions may be more important for rapidly-growing industries, where firms have higher investment rates to finance (Claessens and Laeven, 2003). To ensure that our results are not reflecting industry heterogeneity in growth rates, in column (9) we add the interaction of private credit with each industry's average growth rate of TFP over the sample period ($TFPG_s$), constructed with data from the *NBER Productivity Database*. Including this variable has no noteworthy implications for our main results.

Wrap-up Finally, in column (10) we include all variables discussed in this section in the same specification. Our evidence is preserved also in this demanding exercise.

[46]Using data on imports into the US, Khandelwal (2010) estimates the quality ladder of each product as the difference between its maximum and minimum quality across all exporting countries in the year 1989. Then, he constructs an aggregate ladder for each 4-digit SIC industry as the weighted average of the product-specific ladders, using products' import shares as weights. We use the normalized ranking of industries in terms of Khandelwal's (2010) estimates, estimating missing ladders for 4-digit industries with the median ladder in the corresponding 3- or 2-digit industry.

[47]In Appendix C, we show that similar results obtain when proxying the scope for quality differentiation using an indicator for whether the industry produces differentiated goods according to the Rauch (1999) classification (see Table C2).

Table 3.4: Competing Explanations

	Factor Endowm. (1)	Economic Develop. (2)	Import Compet. (3)	Institut. Quality (4)	Exchange Rate (5)	R&D Expend. (6)	Foreign Dir. Inv. (7)	Quality Ladder (8)	Industry Growth (9)	All Controls (10)
$FD_{jt} \cdot EF_s$	0.263***	0.152***	0.314***	0.141***	0.163***	0.165***	0.296***	0.252***	0.333***	0.069**
	[0.024]	[0.029]	[0.024]	[0.031]	[0.029]	[0.025]	[0.026]	[0.023]	[0.024]	[0.032]
$FD_{jt} \cdot AT_s$	-0.962***	-0.729***	-0.474***	-0.786***	-0.792***	-0.604***	-0.499***	-0.737***	-0.312**	-0.829***
	[0.149]	[0.196]	[0.147]	[0.211]	[0.192]	[0.165]	[0.161]	[0.150]	[0.146]	[0.223]
$KE_{jt} \cdot KI_s$	0.227***									0.254***
	[0.015]									[0.017]
$SE_{jt} \cdot SI_s$	0.755***									0.885***
	[0.122]									[0.139]
$GDP_{jt} \cdot EF_s$		0.106***								0.008
		[0.013]								[0.029]
$GDP_{jt} \cdot AT_s$		0.159*								-0.553***
		[0.093]								[0.187]
$IMP_{jt} \cdot EF_s$			-0.055							-0.037
			[0.039]							[0.048]
$IMP_{jt} \cdot AT_s$			0.189							-0.138
			[0.300]							[0.360]
$RL_j \cdot EF_s$				0.153***						-0.027
				[0.019]						[0.039]
$RL_j \cdot AT_s$				0.253**						0.489**
				[0.129]						[0.244]
$RER_{jt} \cdot EF_s$					0.278***					0.150***
					[0.035]					[0.056]
$RER_{jt} \cdot AT_s$					0.603**					0.226
					[0.239]					[0.331]
$RD_j \cdot EF_s$						14.060***				9.193***
						[1.299]				[1.677]
$RD_j \cdot AT_s$						17.036*				4.010
						[8.778]				[11.427]
$FDI_{jt} \cdot EF_s$							0.035*			0.032
							[0.021]			[0.024]
$FDI_{jt} \cdot AT_s$							0.151			-0.036
							[0.162]			[0.174]
$FD_{jt} \cdot QLAD_s$								0.557***		0.511***
								[0.055]		[0.057]
$FD_{jt} \cdot TFPG_s$									-7.687***	-9.492***
									[0.838]	[0.893]
Obs.	3,055,041	3,114,484	3,143,168	3,144,866	3,124,840	3,064,918	3,107,365	3,144,866	3,144,866	2,934,146
R^2	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09

Notes: The dependent variable is $\tilde{q}_{ijst}$, the log average quality of goods exported by country j to country i in industry s at time t. SE_{jt} and KE_{jt} are endowments of skilled labor and capital. SI_s and KI_s are skill and capital intensity. GDP_{jt} is per capita GDP. IMP_{jt} is import penetration. RL_j is rule of law. RER_{jt} is real exchange rate. RD_j is R&D expenditure. FDI_{jt} is FDI stock. $QLAD_s$ is quality ladder. $TFPG_s$ is TFP growth. All specifications include exporter-year effects, importer-industry-year effects, and gravity controls. Standard errors are corrected for clustering within exporter-importer pairs. ***, **, and *: indicate significance at the 1%, 5%, and 10% level, respectively. See also notes to previous tables.

Endogeneity

We now discuss remaining concerns with endogeneity. As already mentioned, some features of the empirical set-up make our estimates unlikely to pick up the effect of omitted variables. In particular, our specification controls for different sets of fixed effects, which absorb all time-varying characteristics of each exporter and importer-industry pair. Moreover, the analysis in the previous section shows that our estimates are also robust to controlling for many possible confounders at the exporter-industry level.

Other features of the analysis mitigate concerns with reverse causality. The latter requires that firms upgrade quality for factors other than finance, and that this, in turn, affects the financial variables in a way that could explain the pattern of our coefficients. Let us consider first the financial vulnerability measures. A possible story is that, once firms in an industry have decided to improve quality, they start accumulating intangible assets such as blueprints; as a result, the value of AT_s in the industry goes down. Firms may also become more dependent on outside capital, as they need to cover higher fixed outlays; as a result, the value of EF_s in the industry increases. In principle, this mechanism could explain the pattern of our coefficients. Recall, however, that EF_s and AT_s are kept constant over time, so they are little affected by yearly variation in average quality. Moreover, in Appendix C we show that the results are unchanged when using the rankings of EF_s and AT_s, which are even less sensitive to annual changes in quality (see Table C1). Also, because EF_s and AT_s are constructed using US data, they do not reflect firms' decisions in other countries; while the results might be driven by the US, excluding it from the sample makes no difference (Table C1). Finally, the results also hold when using pre-sample values of EF_s and AT_s, which are not influenced by firms' decisions over the period of analysis (Table C1).

Consider now the measure of financial development. A possible concern is that unobserved shocks to industries intensive in external finance may raise their average quality, as well as the amount of borrowing in the economy. This mechanism can explain the positive coefficient on $FD_{jt} \cdot EF_s$, even in the absence of financial frictions. However, it cannot explain the negative and significant coefficient on $FD_{jt} \cdot AT_s$. The reason is that, if financial markets were frictionless, the amount of collateralizable assets should not affect firms' ability to borrow. Hence, the negative coefficient on $FD_{jt} \cdot AT_s$ provides support for the role of financial frictions. Furthermore, in Appendix C we show that our results hold when replacing private credit with time-invariant indices of financial development, which are less likely to respond to industry-specific shocks to average quality (Table C1). Finally, we now show that our results continue to hold when exploiting two distinct sources of exogenous variation in the ability of the environment to provide credit: systemic banking crises and equity market liberalizations.

Banking crises Kroszner et al. (2007) revisit the seminal paper of Rajan and Zingales (1998) using banking crises (BC) as an exogenous, negative, shock to the ability of the financial system to provide credit. The argument is intuitive. BC undermine the correct functioning of financial intermediaries, limiting their ability to channel savings from investors to firms. Moreover, BC are systemic events triggered by major shocks at the national or international level, so their occurrence is arguably exogenous from the perspective of individual firms or industries.

Building on this argument, we now revisit our evidence by exploiting the negative shock induced by BC on countries' financial systems. We source data on systemic BC from Laeven and Valencia (2012); we have information for 113 countries over 1988-2011.[48] We construct a dummy equal to 1 for a country in the aftermath of a crisis (BC_{jt}) and interact it with our measures of financial vulnerability. Then, we re-estimate the baseline specification using the new interactions in place of $FD_{jt} \cdot EF_s$ and $FD_{jt} \cdot AT_s$. In an Instrumental Variables framework, this regression would illustrate the reduced-form relation between the dependent variable ($\tilde{q}_{ijst}$) and the instrument (BC_{jt}). The results are in column (1) of Table 3.5. The coefficient on $BC_{jt} \cdot EF_s$ is negative, that on $BC_{jt} \cdot AT_s$ positive, and both are very precisely estimated.

A possible concern is that BC may occur in periods of economic turmoil, and may be accompanied by other systemic events such as currency and sovereign debt crises (e.g., Broner et al., 2014). To ensure that our coefficients are picking up the effects of the financial shock induced by BC, rather than the effects of other contemporaneous shocks, we extend the specification by adding interactions between our measures of financial vulnerability and three dummy variables, which equal 1 for a country during a currency crisis (CC_{jt}), a sovereign debt crisis (SC_{jt}), and a recession (RE_{jt}).[49] The results

[48] A banking crisis is defined as systemic if the following two conditions are met: (*1*) there are significant signs of financial distress in the banking system, as indicated by significant bank runs, losses in the banking system, and/or bank liquidations; and (*2*) significant banking policy intervention measures are put in place in response to significant losses in the banking system; see Laeven and Valencia (2012, p. 4) for more details.

[49] Data on currency and sovereign debt crises come from Laeven and Valencia (2012). A currency crisis is defined as 'a nominal depreciation of the currency vis-à-vis the US dollar of at least 30% that is also at least 10 percentage points higher than the rate of depreciation in the year before' (Laeven and Valencia,

are reported in column (2). While the coefficients on the new controls are generally significant, those on $BC_{jt} \cdot EF_s$ and $BC_{jt} \cdot AT_s$ remain close to the baseline estimates. We conclude that the negative credit shock induced by BC has similar effects on average quality as a reduction in private credit.

Equity market liberalizations In a recent paper on the implications of financial frictions for the industrial composition of countries' exports, Manova (2008) uses episodes of equity market liberalizations (EML) to circumvent concerns with the endogeneity of private credit. She convincingly argues that EML, by suddenly allowing foreign capital to flow into the economy, raise the ability of firms to obtain external financing. She also argues that EML, being the outcome of complex political processes, represent exogenous and unanticipated shocks from the perspective of individual firms or industries.[50]

We source from Manova (2008) data on EML for 90 countries between 1988 and 1997. We define a dummy equal to 1 for a country in the official year of the liberalization, as well as in all subsequent periods (EML_{jt}). We then interact this dummy with EF_s and AT_s, and re-estimate the baseline specification using the new interactions in place of $FD_{jt} \cdot EF_s$ and $FD_{jt} \cdot AT_s$. As before, this regression can be interpreted as describing the reduced-form relation between $\tilde{q}_{ijst}$ and the EML_{jt} instrument. The results are in columns (3) and (4) of Table 3.5, where we respectively omit and include the controls for currency crises, sovereign debt crises, and recessions. The coefficient on $EML_{jt} \cdot EF_s$ is positive, highly significant, and stable across specifications, whereas the coefficient on $EML_{jt} \cdot AT_s$ is negative, very precisely estimated, and essentially unaffected by the inclusion of additional controls. Hence, the exogenous credit shock induced by EML has the same implications for average quality as an increase in private credit.

2012, p. 11). A sovereign debt crisis is defined as a sovereign debt default or restructuring episode. To identify the recessions, we first detrend the series of log nominal GDP from the *World Development Indicators*, using the Hodrick-Prescott filter with a smoothing parameter of 100 (as in Kroszner et al., 2007). Then, we define a recession as the period between a peak and the following trough in the cyclical component of the series.

[50]In any case, if firms were able to anticipate the date of the EML, they would likely raise quality prior to it, in the expectation of easier financing in the future. If anything, this would bias the coefficients downwards.

Table 3.5: Endogeneity

	Banking Crises		Equity Market Liberalizations	
	(1)	(2)	(3)	(4)
$BC_{jt} \cdot EF_s$	-0.204***	-0.199***		
	[0.028]	[0.029]		
$BC_{jt} \cdot AT_s$	0.345**	0.308**		
	[0.152]	[0.155]		
$EML_{jt} \cdot EF_s$			0.321***	0.304***
			[0.063]	[0.066]
$EML_{jt} \cdot AT_s$			-1.180***	-1.232***
			[0.297]	[0.299]
$CC_{jt} \cdot EF_s$		-0.138***		-0.150*
		[0.045]		[0.079]
$CC_{jt} \cdot AT_s$		0.534**		0.780**
		[0.209]		[0.337]
$SC_{jt} \cdot EF_s$		-0.117**		-0.129
		[0.050]		[0.080]
$SC_{jt} \cdot AT_s$		-0.152		0.684
		[0.308]		[0.427]
$RE_{jt} \cdot EF_s$		-0.017		0.004
		[0.011]		[0.021]
$RE_{jt} \cdot AT_s$		0.149**		0.149
		[0.058]		[0.119]
Obs.	2,922,117	2,838,060	583,097	545,324
R^2	0.10	0.09	0.10	0.09

Notes: The dependent variable is $\tilde{q}_{ijst}$, the log average quality of goods exported by country j to country i in industry s at time t. BC_{jt}, EML_{jt}, CC_{jt}, SC_{jt}, and RE_{jt} are dummies for banking crises, equity market liberalizations, currency crises, sovereign debt crises, and recessions, respectively. All specifications include exporter-year effects, importer-industry-year effects, and gravity controls. Standard errors are corrected for clustering within exporter-importer pairs. ***, **, and *: indicate significance at the 1%, 5%, and 10% level, respectively. See also notes to previous tables.

Economic Significance

We now evaluate the quantitative relevance of financial imperfections for explaining variation in average quality across countries and industries. We start with a comparative-statics exercise. We compute the differential change in average quality induced by a one-standard-deviation increase in private credit, across industries with different financial vulnerability. To perform this exercise, we use the coefficients from our richest specification (column 10 of Table 3.4) and report the results in columns (1) and (2) of Table 3.6. We find that average quality would increase by 12% more in the industry at the third quartile of the distribution by EF_s (relative to the industry at the first quartile) and by 10% more in the industry at the first quartile of the distribution by AT_s (relative to the industry at the third quartile). For comparison, the table shows the results of similar exercises conducted for the other country characteristics considered in Table 3.4.[51] In particular, columns (3) and (4) show that a one-standard-deviation increase in the endowment of skilled labor or capital would raise average quality by 10% or 22% more in the industry at the 75th percentile of the distribution by skill or capital intensity. A commensurate increase in per capita GDP would raise average quality by 16% more in the industry at the third quartile of the distribution by EF_s (column 5) and by 14% more in the industry at the first quartile of the distribution by AT_s (column 6). The other variables have smaller effects, as shown in columns (7)-(12).

[51] We disregard import competition and FDI because the coefficients on these variables are small and not significant.

Table 3.6: Economic Significance, Comparative-Statics Exercises, %

One-standard-deviation increase in country characteristic:	FD_j		SE_j	KE_j	GDP_j	
Differential effect across industries at different levels of:	EF_s	AT_s	SI_s	KI_s	EF_s	AT_s
	(1)	(2)	(3)	(4)	(5)	(6)
	12	10	10	22	16	14
One-standard-deviation increase in country characteristic:	RL_j		RER_j		RD_j	
Differential effect across industries at different levels of:	EF_s	AT_s	EF_s	AT_s	EF_s	AT_s
	(7)	(8)	(9)	(10)	(11)	(12)
	-10	-9	1	1	4	4

Notes: Columns labeled by EF_s show the differential change in average quality between the industry at the 75th percentile of the distribution by external finance dependence and the industry at the 25th percentile, following a one-standard-deviation increase in the country characteristic indicated at the top. Columns labeled by SI_s and KI_s do the same exercise, using the distributions by skill and capital intensity, respectively. Finally, columns labeled by AT_s compare the industry at the 25th percentile of the distribution by asset tangibility with the industry at the 75th percentile. The results are based on the estimates in column (10) of Table 3.4.

Next, we use our estimates (column 10 of Table 3.4) and the actual change in FD_{jt} over the period of analysis to predict the average quality of exports from country j to country i in industry s at the end of 2011, assuming that all other variables entering the specification remained constant at their initial levels. We label this counterfactual quality $\hat{\tilde{q}}_{ijs2011}^{Fin.\,Dev.}$. We then regress the actual value of average quality in 2011 ($\tilde{q}_{ijs2011}$) on $\hat{\tilde{q}}_{ijs2011}^{Fin.\,Dev.}$, absorbing the exporter and importer-industry effects. For comparison, we perform similar exercises using the counterfactual quality implied by the observed changes in factor endowments, $\hat{\tilde{q}}_{ijs2011}^{Fact.\,End.}$, and per capita GDP, $\hat{\tilde{q}}_{ijs2011}^{Econ.\,Dev.}$. The beta coefficient and R^2 from these regressions are reported in Table 3.7. The coefficient on $\hat{\tilde{q}}_{ijs2011}^{Fin.\,Dev.}$ is always positive and not smaller than those on $\hat{\tilde{q}}_{ijs2011}^{Fact.\,End.}$ and $\hat{\tilde{q}}_{ijs2011}^{Econ.\,Dev.}$. The three counterfactual qualities also have similar explanatory power in terms of the R^2. All in all, the results of this section suggest that financial imperfections are quantitatively no less relevant than other determinants of product quality considered in the literature.

Table 3.7: Economic Significance, Counterfactuals

	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{q}^{Fin.\ Dev.}_{ijs2011}$	0.287***			0.362***	2.999***	2.954***
	[0.006]			[0.013]	[0.145]	[0.155]
$\hat{q}^{Fact.\ End.}_{ijs2011}$		0.242***		-0.077***		-0.013
		[0.005]		[0.011]		[0.012]
$\hat{q}^{Econ.\ Dev.}_{ijs2011}$			0.281***		-2.523***	-2.469***
			[0.005]		[0.136]	[0.150]
Obs.	39,396	52,966	52,864	39,396	39,329	39,329
R^2	0.08	0.06	0.08	0.08	0.08	0.08

Notes: The dependent variable is $\tilde{q}_{ijs2011}$, the log average quality of goods exported by country j to country i in industry s, at the end of 2011. $\hat{q}^{Fin.\ Dev.}_{ijs2011}$ is the counterfactual value of quality that would arise only due to the observed change in financial development. This variable is constructed using the coefficients in column (10) of Table 3.4 and the change in FD_{jt} over the sample period, assuming that all other variables in the specification remained constant at their initial levels. $\hat{q}^{Fact.\ End.}_{ijs2011}$ and $\hat{q}^{Econ.\ Dev.}_{ijs2011}$ have a similar interpretation and are constructed analogously. All coefficients are beta coefficients. All specifications refer to the partial correlation after netting out the exporter and importer-industry effects. Standard errors are robust to heteroskedasticity. ***, **, and *: indicate significance at the 1%, 5%, and 10% level, respectively. See also notes to previous tables.

3.4.2 Margins

So far, our results show that financial development raises average quality relatively more in financially more vulnerable industries. According to the model, this suggests that the effect on average firm-level quality (the intensive margin, as per Propositions 1 and 2) dominates the effect on firm selection (the extensive margin, as per Proposition 3). Arguably, this is the most policy-relevant scenario. But how strong is the role of each margin? In this section, we implement the two-step estimation of the quality equation to untangle the two margins and quantify their contributions.

In practice, this task requires that we first estimate the selection equation (3.21), and then retrieve the predicted probability to trade $\hat{\rho}_{ijst}$, the control for firm selection $\widehat{w}^*_{ijst}$, and the inverse Mills ratio $\widehat{\eta}^*_{ijst}$. To avoid the identification of the second-stage coefficients to rely only on the joint normality assumption for the unobserved trade costs, we need a variable that enters the selection equation but is excluded from the quality equation. In this respect, eq. (3.16) and (3.21) show that φ_{ij} (the country-pair specific component of the fixed export cost) affects the probability to trade ρ_{ijs}, but has no direct effect on average quality $\tilde{q}_{ijs}$. Hence, φ_{ij} satisfies the exclusion restriction and can be used to identify the second-stage coefficients.

Building on Helpman et al. (2008) and Manova (2013), we proxy for φ_{ij} using measures of the regulatory costs associated with doing business in a country. In particular, we use two variables: the number of procedures for registering a business property and the costs of the official procedures for shipping a standardized cargo to/from the country.[52] For each variable, we compute the log average of its value in the importing and exporting country ($regprop_{ij}$ and $procs_{ij}$), to capture the fact that these costs are magnified when both trading partners impose high regulatory barriers. Because these variables reflect the fixed cost of doing business in a country, they satisfy the exclusion restriction of no direct effect on product quality.[53]

The selection equation is estimated in column (1) of Table 3.8. The excluded variables enter with the expected negative sign, implying that higher regulatory costs lower the probability that two countries trade with each other in a given industry. The coefficients are estimated with high precision. This shows that regulatory costs have strong explanatory power for predicting the formation of bilateral trade relations. The other coefficients also have the expected sign and are highly significant. In particular, the probability to trade increases with financial development relatively more in industries with lower asset tangibility and external finance dependence. The latter result implies that our data are consistent with $\partial^2 \bar{a}_{ijs}/\partial\lambda_j \partial d_s < 0$ (see Proposition 3).

Using the coefficients reported in column (1), we compute $\hat{\rho}_{ijst}$ and construct $\widehat{\overline{w}}^*_{ijst}$ and $\widehat{\overline{\eta}}^*_{ijst}$.[54] Then, we re-estimate the quality equation (3.16) including these two terms among the regressors. As already mentioned, the resulting coefficients on $FD_{jt} \cdot EF_s$ and $FD_{jt} \cdot AT_s$ measure the effect of financial frictions on 'average firm-level quality', after netting out firm and sample selection. According to the estimates of the selection equation reported in column (1), firm and sample selection should have opposite effects on the coefficients. In particular, controlling for firm selection should lower both coefficients, because worse financial frictions reduce the probability to trade (and thus

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[52]We use the ratings of countries in terms of each measure, sourced from the World Bank *Doing Business Database*. These ratings are time invariant.

[53]In untabulated regressions, we have used lagged participation in bilateral trade ($T_{ijst\text{-}1}$) as an alternative excluded variable. The argument is that past participation is a strong predictor of current participation, hinting at the existence of substantial fixed export costs. None of our conclusions changed. However, a concern with lagged participation is that it may be correlated with some unobserved determinants of the variable trade cost (u_{ijt}), and thus with average quality (Johnson, 2012). Hence, we focus here on the results using regulatory costs, which are not subject to this concern.

[54]For a minor share (0.04%) of observations, $\hat{\rho}_{ijst}$ is indistinguishable from 0 or 1. In order to infer $\hat{z}^*_{ijst} = \Phi^{-1}\left(\hat{\rho}_{ijst}\right)$, we follow Helpman et al. (2008) and Manova (2013) and set $\hat{\rho}_{ijst} = 0.9999999$ ($\hat{\rho}_{ijst} = 0.0000001$) for all observations with $\hat{\rho}_{ijst}$ above (below) this value.

Table 3.8: Margins

	Selection Equation	Quality Equation (dep. var.: $\tilde{q}_{ijst}$)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Probit				Dummies for Bins of $\hat{\rho}_{ijst}$		
	(dep. var.: T_{ijst})	Benchmark	NLS	Polynomial in $\widehat{\overline{z}}^*_{ijst}$	100	500	1000
$FD_{jt} \cdot EF_s$	-0.087***	0.312***	0.246***	0.246***	0.246***	0.246***	0.246***
	[0.002]	[0.024]	[0.012]	[0.012]	[0.012]	[0.010]	[0.014]
$FD_{jt} \cdot AT_s$	-1.128***	-0.476***	-0.321***	-0.330***	-0.328***	-0.330***	-0.330***
	[0.053]	[0.147]	[0.089]	[0.076]	[0.080]	[0.073]	[0.071]
$procs_{ij}$	-0.133***						
	[0.015]						
$regprop_{ij}$	-0.094***						
	[0.016]						
$\widehat{\overline{\eta}}^*_{ijst}$			1.737***	1.587***			
			[0.026]	[0.192]			
$\kappa_1 - \kappa_2$ (from $\widehat{\overline{w}}^*_{ijst}$)			-0.067**				
			[0.033]				
Obs.	27,452,622	3,144,311	3,144,311	3,144,311	3,144,311	3,144,311	3,144,311
R^2		0.09	0.10	0.10	0.10	0.10	0.10

Notes: $procs_{ij}$ is the cost of the official procedures for shipping a standardized cargo to/from the country (average between i and j). $regprop_{ij}$ is the number of procedures for registering a business property in the country (average between i and j). $\widehat{\overline{\eta}}^*_{ijst}$ is the inverse Mills ratio. $\widehat{\overline{w}}^*_{ijst}$ is a term accounting for firm selection. Both $\widehat{\overline{\eta}}^*_{ijst}$ and $\widehat{\overline{w}}^*_{ijst}$ are constructed using the predicted probability to trade $\hat{\rho}_{ijst}$ from column (1). All specifications include exporter-year effects, importer-industry-year effects, and gravity controls. The specification in column (3) is estimated by non-linear least squares (NLS). Column (4) includes a sixth-order polynomial in $\widehat{\overline{z}}^*_{ijst}$ (coefficients unreported). Columns (5)-(7) include full sets of dummies for bins of $\hat{\rho}_{ijst}$ (100, 500, and 1000 bins, respectively; coefficients unreported). Standard errors are corrected for clustering within exporter-importer pairs in columns (1) and (2), and bootstrapped (100 replications) in columns (3)-(7). ***, **, and *: indicate significance at the 1%, 5%, and 10% level, respectively. See also notes to previous tables.

the exporting cut-off $\overline{a}_{ijs}$) relatively more in industries with lower EF_s and AT_s. For the same reason, controlling for sample selection should increase both coefficients. Intuitively, if we observe positive trade when financial conditions are weak and EF_s or AT_s are low, the unobserved component of trade costs is likely to be small (i.e., u_{ijt} is likely to be large). Hence, excluding observations with zero trade flows induces a negative correlation between $FD_{jt} \cdot EF_s$ or $FD_{jt} \cdot AT_s$ and the error term of the quality equation (3.16), biasing the coefficients downwards. Ultimately, the relative strength of firm and sample selection depends on how strongly $FD_{jt} \cdot EF_s$ and $FD_{jt} \cdot AT_s$ are correlated with $\widehat{\overline{w}}^*_{ijst}$ and $\widehat{\overline{\eta}}^*_{ijst}$.

The results are reported in columns (2)-(7). In column (2), we re-estimate the baseline quality equation using the sub-sample of observations for which we can construct $\hat{\rho}_{ijst}$. The coefficients are essentially identical to those in column (5) of Table 3.3. In column (3), we add $\widehat{\overline{w}}^*_{ijst}$ and $\widehat{\overline{\eta}}^*_{ijst}$. Since $\widehat{\overline{w}}^*_{ijst}$ is a non-linear function of the parameters κ_1 and κ_2, we estimate the model by non-linear least squares (NLS). To account for the fact that $\widehat{\overline{w}}^*_{ijst}$ and $\widehat{\overline{\eta}}^*_{ijst}$ are based on an estimated variable ($\hat{\rho}_{ijst}$), we report bootstrapped standard errors based on 100 replications, re-sampling observations within clusters defined by exporter-importer pairs. As expected, the coefficient on $\widehat{\overline{\eta}}^*_{ijst}$ is positive and precisely estimated, pointing to the existence of sample selection bias.[55] Moreover, $\kappa_1 < \kappa_2$, which implies, consistent with the model, that the term W_{ijs} that scales down average quality $\tilde{Q}_{ijs}$ to account for firm selection is decreasing in the latent variable Z_{ijs}, and thus in the proportion of exporting firms (see eq. 3.18).[56] Turning to our main coefficients, they have the same sign as before, and are precisely estimated. The point estimates are smaller in absolute value than those in column (2), implying that quality adjustments within incumbent exporters in a given destination account for 70-80% of the overall effect of financial imperfections on average quality. Firm and sample selection explain the remaining 20-30% of the effect.

The functional forms of $\widehat{\overline{w}}^*_{ijst}$ and $\widehat{\overline{\eta}}^*_{ijst}$ hinge on our assumptions about the distributions of firm productivity and unobserved trade costs. These assumptions allowed us to derive and estimate a fully parametric model, which serves as our benchmark. However, they also induce non linearity, which implies that κ_1 and κ_2 are identified out of functional form. This may raise concerns with the robustness and stability of the results. Hence, we now progressively relax these assumptions, starting from the Pareto formulation for $G(a)$. This implies that we can no longer derive a closed-form expression for the term V_{ijs} in eq. (3.10). Rather, V_{ijs} is now an arbitrary decreasing function of the exporting cut-off $\overline{a}_{ijs}$, and thus of the latent variable Z_{ijs}. Accordingly, we approximate $v_{ijs} \equiv \ln V_{ijs}$ using a flexible function of $\widehat{\overline{z}}^*_{ijst}$; we choose a sixth-order polynomial, but this choice is irrelevant for our conclusions. The resulting model is semi-parametric and linear, and can thus be estimated by OLS. The results, reported in column (4), are close to those of the non-linear specification.

Next, we also relax the joint normality of the unobserved trade costs. This implies that we can no longer have two separate controls for firm and sample selection, because $\widehat{\overline{z}}^*_{ijst}$ and $\widehat{\overline{\eta}}^*_{ijst}$ were both constructed using the c.d.f. and density of the standard normal distribution. However, given that both terms depend on the predicted probability to trade $\hat{\rho}_{ijst}$, we can still jointly account for firm and sample selection using an arbitrary function of this probability.[57] To approximate this function as flexibly as possible, we

[55]Note that this coefficient is equal to $corr\left(u_{ijt}, \eta_{ijt}\right)\left(\sigma_u/\sigma_\eta\right)$.

[56]$\kappa_1 - \kappa_2$ is tightly identified in our data, while the level of each coefficient is more difficult to pin down due to the functional form of $\widehat{\overline{w}}^*_{ijst}$. Below, we show that the results are robust to relaxing our distributional assumptions, which determine the specific form of the controls for firm and sample selection.

[57]In principle, $\hat{\rho}_{ijst}$ could now be estimated using any c.d.f. at the first stage. In practice, using, e.g., a logistic distribution yields similar results. Hence, we keep on using the same $\hat{\rho}_{ijst}$ as before, estimated by Probit.

divide $\hat{\rho}_{ijst}$ into bins of equal size, and add a dummy for each of these bins. This yields a linear, fully non-parametric, model, which is estimated in columns (5)-(7) using 100, 500, and 1000 bins of $\hat{\rho}_{ijst}$, respectively. The results are similar across the board.

3.4.3 Implications for Aggregate Trade Flows and Prices

We now discuss the implications of our results for macroeconomic outcomes, in particular, for aggregate trade flows and average export prices (unit values). We start by revisiting, through the lens of our findings, the effect of financial development on exports, which has been the object of a large and important emprirical literature (see, in particular, Beck, 2002, and Manova, 2013). Our results provide a mechanism through which financial development could raise the relative exports of financially more vulnerable industries. In fact, the model implies that firms' export revenue is increasing in product quality, and our empirical results show that average quality rises with financial development relatively more in such sectors.

In this section we provide some evidence on this mechanism. To begin with, we show that our data replicate the main results of previous papers about how financial development affects exports across industries. To do so, we derive and estimate a gravity-like equation implied by the model. Aggregating revenue across firms and using $\beta^r_{ijs}(a) \in (0,1)$ to express the reduced sales of liquidity-constrained producers, total exports from country j to country i in industry s are given by:

$$\begin{aligned} M_{ijs} &\equiv N_{js}\left(\int_{a_L}^{\underline{a}_{ijs}} r^o_{ijs}(a)\, g(a)\, da + \int_{\underline{a}_{ijs}}^{\bar{a}_{ijs}} \beta^r_{ijs}(a)\, r^o_{ijs}(a)\, g(a)\, da\right) \\ &= N_{js} r^o_{ijs}(a_L)\, V^r_{ijs} E^r_{ijs}, \end{aligned} \tag{3.23}$$

where

$$\begin{aligned} V^r_{ijs} &\equiv \int_{a_L}^{\bar{a}_{ijs}} \left(\frac{a}{a_L}\right)^{(1-\varepsilon)\gamma/\tilde{\gamma}} g(a)\, da, \\ E^r_{ijs} &\equiv \frac{\int_{a_L}^{\underline{a}_{ijs}} \left(\frac{a}{a_L}\right)^{(1-\varepsilon)\gamma/\tilde{\gamma}} g(a)\, da + \int_{\underline{a}_{ijs}}^{\bar{a}_{ijs}} \beta^r_{ijs}(a) \left(\frac{a}{a_L}\right)^{(1-\varepsilon)\gamma/\tilde{\gamma}} g(a)\, da}{\int_{a_L}^{\bar{a}_{ijs}} \left(\frac{a}{a_L}\right)^{(1-\varepsilon)\gamma/\tilde{\gamma}} g(a)\, da}, \end{aligned}$$

and $r^o_{ijs}(a_L) = \frac{\varepsilon\gamma c_{js}}{\gamma-\tilde{\gamma}}\left[\left(\frac{\tau_{ij} c_{js} a_L}{\alpha P_{is}}\right)^{1-\varepsilon} \frac{(\gamma-\tilde{\gamma}) Y_{is}}{\varepsilon\gamma c_{js}}\right]^{\gamma/\tilde{\gamma}}$ is the revenue of the most efficient firm, with coefficient a_L. As in the quality equation (3.10), E^r_{ijs} and V^r_{ijs} adjust $r^o_{ijs}(a_L)$ to account for the intensive- and extensive-margin contribution of financial imperfections in the presence of firm heterogeneity. V^r_{ijs} is increasing in the exporting cut-off $\bar{a}_{ijs}$, as a higher proportion of exporting firms raises total exports *ceteris paribus*.

To derive an estimable version of eq. (3.23), we proceed as in Section 3.2.1: we take logs of (3.23), use the parametrization for τ_{ij} and c_{js} in eq. (3.14) and (3.15), and now also assume that $N_{js} = \varkappa_s N_j$, where $\varkappa_s$ is the share of industry s in the total number N_j of active firms in country j.[58] This yields the following empirical specification of the gravity equation:

$$m_{ijs} = \mu_0 + \mu_{is} + \mu_j - \gamma\zeta d_{ij} + v^r_{ijs} + e^r_{ijs} + \tilde{u}_{ij}, \tag{3.24}$$

where $\mu_{is} \equiv (\gamma/\tilde{\gamma})\left[(\varepsilon-1)\, p_{is} + y_{is}\right] + \left[(\tilde{\gamma}-\varepsilon\gamma)\,/\tilde{\gamma}\right]\ln c_s + \varkappa_s$ is an importer-industry fixed effect, $\mu_j \equiv \left[(\tilde{\gamma}-\varepsilon\gamma)\,/\tilde{\gamma}\right]\ln c_j + n_j$ is an exporter fixed effect, and $\tilde{u}_{ij} \equiv \gamma u_{ij} \sim N\left(0, \gamma^2\sigma_u^2\right)$.[59]

In column (1) of Table 3.9, we regress m_{ijst} on $FD_{jt} \cdot EF_s$ and $FD_{jt} \cdot AT_s$, plus all variables in eq. (3.24) except for v^r_{ijs} and e^r_{ijs}. We use the sub-sample of observations for which we observe all variables used in the table. This regression yields the overall effect of financial development on countries' exports. The coefficient on $FD_{jt} \cdot EF_s$ is positive and highly significant, whereas that on $FD_{jt} \cdot AT_s$ is negative and very precisely estimated. Hence, our data confirm that financially more developed countries export relatively more in industries where firms rely more on outside capital and have less collateral (Manova, 2013). In column (2), we control for the term v^r_{ijst}, which accounts for firm selection; we use a linear semi-parametric model, proxing for v^r_{ijst} with a sixth-order polynomial in $\widehat{\bar{z}}^*_{ijst}$. We also control for sample selection bias by including the inverse Mills ratio $\widehat{\bar{\eta}}^*_{ijst}$ as an additional regressor (coefficients available upon request). Our coefficients of interest have the same sign and approximately the same size as in column (1). Hence, in our data, changes in firm-level sales (the intensive margin) account for most of the effect of financial development on exports. This is broadly consistent with the evidence in Manova (2013), who finds the intensive margin to be predominant also in her data.

Having shown that our data are not special in any respect, we turn to the question of how adjustments in average quality contribute to the effect of financial development on countries' exports. An accounting identity implies that bilateral industry-level exports can be written as follows:

$$m_{ijs} = \tilde{q}_{ijs} + x_{ijs} + \tilde{p}_{ijs}, \tag{3.25}$$

[58] A more flexible approach would be to directly control for the number of firms in each country and industry. At the level of industry disaggregation at which we work, these data are unavailable for most countries and years.

[59] In (3.24), μ_0 is a constant that bundles a number of parameters: $\mu_0 \equiv \ln\left[\left(\frac{\gamma-\tilde{\gamma}}{\varepsilon\gamma}\right)^{(\gamma-\tilde{\gamma})/\gamma}\left(\frac{a_L}{\alpha}\right)^{(1-\varepsilon)\gamma/\tilde{\gamma}}\right]$.

Table 3.9: Average Quality, Export Flows, and Prices

	Tot. Exports (Overall) m_{ijst} (1)	Tot. Exports (Int. Marg.) m_{ijst} (2)	Average Quality $\tilde{q}_{ijst}$ (3)	Total Quantity x_{ijst} (4)	Average Qual.Adj. Prices $\tilde{p}_{ijst}$ (5)	Average Raw Prices $\bar{p}_{ijst}$ (6)
$FD_{jt} \cdot EF_s$	0.028***	0.031***	0.316***	0.024***	-0.312***	0.004***
	[0.003]	[0.002]	[0.007]	[0.004]	[0.007]	[0.001]
$FD_{jt} \cdot AT_s$	-1.703***	-1.629***	-0.488***	-1.549***	0.334***	-0.154***
	[0.022]	[0.008]	[0.044]	[0.023]	[0.044]	[0.008]
Obs.	3,136,714	3,136,714	3,136,714	3,136,714	3,136,714	3,136,714
R^2	0.42	0.46	0.09	0.39	0.09	0.11

Notes: The dependent variables are indicated in the columns' headings and are all expressed in logs. Column (2) includes a sixth-order polynomial in $\hat{\bar{z}}^*_{ijst}$ and the inverse Mills ratio (coefficients unreported). All specifications include exporter-year effects, importer-industry-year effects, and gravity controls. Standard errors are corrected for clustering within exporter-importer pairs. ***, **, and *: indicate significance at the 1%, 5%, and 10% level, respectively. See also notes to previous tables.

where $\tilde{q}_{ijs}$ is the log of average quality, $x_{ijs} \equiv \ln X_{ijs}$ is the log of total exported quantity, and $\tilde{p}_{ijs} \equiv \ln \left(M_{ijs} / X_{ijs} \tilde{Q}_{ijs} \right)$ is the log of the average quality-adjusted price. The properties of OLS imply that the coefficients obtained by regressing $\tilde{q}_{ijs}$, x_{ijs}, and $\tilde{p}_{ijs}$ on the RHS variables of the gravity equation (3.24) will add up to those for aggregate exports m_{ijst}. Hence, these coefficients can be used to gauge the *ceteris paribus* contribution of each term to the overall effect of financial development on exports.

The results of these regressions are reported in columns (3)-(5). The coefficients on $FD_{jt} \cdot EF_s$ and $FD_{jt} \cdot AT_s$ from the quality regression (column 3) are both large compared to the estimates in column (1). In particular, the point estimates show that adjustments in average quality account for 29% of the overall coefficient on $FD_{jt} \cdot AT_s$ and for more that 100% of the overall coefficient on $FD_{jt} \cdot EF_s$. Columns (4) and (5) show that the remainder of the effect of financial development passes through changes in total quantity and average quality-adjusted prices. According to the model, these variables respond to financial development because firms adjust their output quality in response to a change in credit conditions. The estimated coefficients are in line with the theoretical predictions. In particular, they imply that financial development increases quantity and decreases quality-adjusted prices relatively more in financially more vulnerable industries. This is consistent with the fact that firms raise quality more in such sectors when credit conditions improve.[60]

Quantity and prices could respond to financial development also in a model with

[60]Recall that in the model quantity is increasing in quality (see eq. 3.3) and quality-adjusted prices are decreasing in it (see footnote 11).

exogenous and homogeneous quality, provided that firms borrow from outside investors to finance also their variable costs (see Manova, 2013). In such a framework, liquidity-constrained firms would produce less than the optimal amount, and would charge a price above the optimum. The reason is that, by reducing quantity, these firms would lower their funding needs, and would thus be able to meet the liquidity constraint. Then, financial development would lead these firms to raise quantity and decrease prices, which would result in higher revenue; these effects would be stronger in financially more vulnerable industries.

We now confront the data with the predictions of a model in which quality is exogenous and homogeneous, as well as with the predictions of a model in which quality is endogenous. If quality is homogeneous, $\tilde{Q}_{ijs} = 1$ and eq. (3.25) becomes:

$$m_{ijs} = x_{ijs} + \bar{p}_{ijs},$$

where $\bar{p}_{ijs} \equiv \ln \left(M_{ijs} / X_{ijs} \right)$ is now the log of the average raw price. Column (4) reports the results of the quantity regression, which are the same as before. The results of the price regression are shown instead in column (6). The quantity regression is uninformative to discriminate the two models, because both imply the same pattern of coefficients. Instead, the price regression contains useful information. As mentioned above, in a model with exogenous and homogeneous quality, financial development would lead to a stronger reduction in prices in financially more vulnerable industries. This would imply a negative coefficient on $FD_{jt} \cdot EF_s$ and a positive coefficient on $FD_{jt} \cdot AT_s$. In practice, both coefficients are however wrongly signed. Instead, changes in raw prices line up better with the predictions of a model in which quality is endogenous as, in this framework, firms' raw prices are increasing in product quality. Changes in average quality and quality-adjusted prices are also in line with the predictions of such a model, as discussed before. Hence, the results of this section suggest that recognizing the role of product quality is important for understanding the mechanisms through which financial development affects aggregate trade flows and shapes the variation in export prices across countries and industries.

3.5 Conclusion

In this paper we do three things. First, we study how financial imperfections affect average product quality across countries and industries. Second, we investigate the mechanisms through which financial imperfections work. And third, we evaluate the role of quality in explaining the effects of financial development on aggregate trade flows and prices. Our results show that the interplay between country heterogeneity in financial frictions and industry heterogeneity in financial vulnerability is an important determinant of the geographical and sectoral variation in average quality. Most of this effect unfolds along the 'intensive margin', whereby financial imperfections alter the quality of incumbent exports in a given destination market. Finally, changes in average quality are an important mechanism through which financial development shapes the pattern of export flows and prices across countries and industries.

In recent years, we have substantially improved our knowledge of the measurement of product quality, but its determinants and implications are not yet fully understood. We hope that, by showing how financial imperfections affect average quality and, through this channel, shape the pattern of trade and prices, our results can shed new light on these issues. More broadly, our findings can offer a new lens through which to interpret other facts about the real effects of financial imperfections. For instance, they may provide a complementary explanation for why credit market frictions have strong effects on measured TFP (which also reflects product quality), and for why these effects are highly heterogeneous across countries and industries (Buera et al., 2011). We view this analysis as a promising avenue for future research.

A Theoretical Appendix

In this Appendix, we provide additional details and derivations for the baseline model. Then, we prove the theoretical propositions presented in Section 3.1.4. Finally, we show that the key theoretical insights hold under different formulations of the model.

A.1 Additional Details and Derivations for the Baseline Model

Firms' Problem

Given the assumptions laid out in the text, a country-j firm in industry s chooses a price p_{ijs}, quality q_{ijs}, and payment F_{ijs} to solve the following problem:

$$\max_{p,q,F} \left[\left(p_{ijs} - MC_{ijs}\left(a\right)\right) x_{ijs} - \left(1-d_s\right)\left(FQ_{ijs} + EX_{ijs}\right)\right] - \left[\lambda_j F_{ijs} + \left(1-\lambda_j\right) CO_{js}\right] \tag{A.1}$$

$$\text{subject to} \quad \left(p_{ijs} - MC_{ijs}\left(a\right)\right) x_{ijs} - \left(1-d_s\right)\left(FQ_{ijs} + EX_{ijs}\right) \geq F_{ijs} \tag{A.2}$$

$$\text{and to} \quad \lambda_j F_{ijs} + \left(1-\lambda_j\right) CO_{js} \geq d_s\left(FQ_{ijs} + EX_{ijs}\right), \tag{A.3}$$

where the demand x_{ijs}, the marginal cost $MC_{ijs}(a)$, the fixed costs FQ_{ijs} and EX_{ijs}, and the collateral CO_{js} are specified in the text (eq. 3.3-3.7, respectively).[1] Eq. (A.1) shows that each firm maximizes the difference between the cash flow from operations in market i (the first square-bracketed term) and the expected cost of the loan (the second square-bracketed term). The cash flow is equal to the operating profits earned by the firm in country i minus the fraction of the fixed costs funded internally. The expected cost of the loan is instead equal to the probability-weighted average of the payment made to the investor if the contract is enforced and the collateral seized by the investor if the contract is not enforced. Firms' decisions are subject to two constraints: (*1*) the liquidity constraint of the firm, which states that in case of repayment the firm can promise the investor at most its cash flow (eq. A.2); and (*2*) the participation constraint of the investor, which states that the value of the loan cannot exceed the expected return from the investment (eq. A.3).[2] With competitive credit markets, investors break even in expectation. Hence, firms adjust F_{ijs} so that eq. (A.3) always holds as an equality. Using this fact, we solve for F_{ijs} from (A.3), substitute the result into eq. (A.1) and (A.2), and get rid of the participation constraint.

Firms' Decisions

Benchmark case without financial frictions It is useful to start from a benchmark case without financial frictions. In this situation, $\lambda_j = 1$ and a country-j firm active in industry s simply chooses p_{ijs} and q_{ijs} to maximize profits in destination i:

$$\max_{p,q} \left(p_{ijs} - MC_{ijs}(a)\right) x_{ijs} - \left(FQ_{ijs} + EX_{ijs}\right).$$

Using eq. (3.3)-(3.6) in the text, the optimal price, quality, and revenue have the following expressions:

[1]The dependence of x_{ijs}, $MC_{ijs}(a)$, and FQ_{ijs} on q_{ijs} is understood, and is thus left implicit to avoid cluttering the notation.

[2]In keeping with the liquidity constraint in eq. (A.2), Paravisini et al. (2014) show that investors (banks) are highly specialized by destination market: when a firm increases exports to a certain country, it expands borrowing disproportionately more from banks specialized in that country. This result challenges the view that loans from different banks are perfectly fungible to finance export projects in a given destination. In Section A.3 we show, however, that the key insights of the model hold when firms choose a single quality for all destinations they serve, and thus pay a single fixed cost of quality upgrading and borrow from a single investor against their global cash flow. As discussed in Manova (2013), the model can also be easily extended to allow for an exogenous interest rate ι. In this case, the RHS of eq. (A.3) would become $(1+\iota)\, d_s \left(FQ_{ijs} + EX_{ijs}\right)$ and the qualitative predictions would remain unchanged.

$$
\begin{aligned}
p_{ijs}(a) &= \frac{\tau_{ij} c_{js} a q_{ijs}(a)^{\delta}}{\alpha}, && \text{(A.4)}\\
q_{ijs}(a) = q^{o}_{ijs}(a) &= \left[\left(\frac{\tau_{ij} c_{js} a}{\alpha P_{is}}\right)^{1-\varepsilon} \frac{(\gamma - \tilde{\gamma}) Y_{is}}{\varepsilon \gamma c_{js}}\right]^{1/\tilde{\gamma}}, && \text{(A.5)}\\
r_{ijs}(a) = r^{o}_{ijs}(a) &= \frac{\varepsilon \gamma c_{js}}{\gamma - \tilde{\gamma}} \left[\left(\frac{\tau_{ij} c_{js} a}{\alpha P_{is}}\right)^{1-\varepsilon} \frac{(\gamma - \tilde{\gamma}) Y_{is}}{\varepsilon \gamma c_{js}}\right]^{\gamma/\tilde{\gamma}}, && \text{(A.6)}
\end{aligned}
$$

where $\tilde{\gamma} \equiv \gamma - (\varepsilon - 1)(1 - \delta) > 0$ by the second order condition for a maximum. Eq. (A.4) shows that the profit-maximizing price is a constant mark-up, $1/\alpha$, over marginal cost. Eq. (A.5) shows instead that firms produce higher-quality goods for markets that are larger (higher Y_{is}), less competitive (higher P_{is}), and less costly to reach (lower τ_{ij}). It also shows that firms with higher productivity (lower a) sell higher-quality products in all the destinations they serve. As shown by eq. (A.6), the reason is that firm revenue is increasing in productivity, and with a larger revenue firms can afford paying higher fixed costs of quality upgrading. Finally, using the demand function and the optimal price, the quality-elasticity of revenue equals $(\varepsilon - 1)(1 - \delta)$, implying that revenue is increasing in product quality when $\delta \in [0, 1)$. Eq. (A.4) also implies that in this case quality-adjusted prices (p_{ijs}/q_{ijs}) are decreasing in quality, consistent with empirical evidence (see, e.g., Baldwin and Harrigan, 2011).

Country-j firms export to destination i as long as their profits exceed the fixed export cost. This is the case for all firms with $a \in \left[a_L, a^{*}_{ijs}\right]$, where a^{*}_{ijs} is defined by the following condition:

$$
\frac{r^{o}_{ijs}\left(a^{*}_{ijs}\right)}{\varepsilon} - FQ_{ijs}\left(a^{*}_{ijs}\right) = EX_{ijs}.
$$

Using eq. (A.5) and (A.6) together with the definitions of FQ_{ijs} and EX_{ijs} given in the text, the solution for a^{*}_{ijs} is:

$$
a^{*}_{ijs} = \left(\frac{\varepsilon c_{js} f_{Xij}}{1 - \frac{\gamma - \tilde{\gamma}}{\gamma}}\right)^{\tilde{\gamma}/[\gamma(1-\varepsilon)]} \left(\frac{\gamma - \tilde{\gamma}}{\varepsilon \gamma c_{js}}\right)^{(1-\delta)/\gamma} Y_{is}^{1/(\varepsilon - 1)} \frac{\alpha P_{is}}{\tau_{ij} c_{js}}. \qquad \text{(A.7)}
$$

Firms' decisions with financial frictions As mentioned in the text, liquidity-unconstrained firms make the same decisions as in a model without financial frictions, so their price, quality, and revenue are given by eq. (A.4), (A.5), and (A.6), respectively. Since profits and cash flow are increasing in productivity, the liquidity-unconstrained firms are those with coefficient a below the threshold $\underline{a}_{ijs}$ defined by the following condition:

$$
\frac{r^{o}_{ijs}\left(\underline{a}_{ijs}\right)}{\varepsilon} \left[1 - \left(1 - d_s + \frac{d_s}{\lambda_j}\right) \frac{\gamma - \tilde{\gamma}}{\gamma}\right] = c_{js} f_{Xij} + \frac{1 - \lambda_j}{\lambda_j} c_{js} \left(d_s f_{Xij} - t_s f_{Ej}\right), \qquad \text{(A.8)}
$$

which is obtained by using the optimal price (A.4) and the optimal quality (A.5) in the liquidity constraint (A.2), evaluating the resulting expression as an equality, and then making use of the expression for optimal revenue (A.6). Using eq. (A.8), the solution for $\underline{a}_{ijs}$ can be written as follows:

$$\underline{a}_{ijs} = \left\{ \frac{\varepsilon \left[c_{js} f_{Xij} + \frac{1-\lambda_j}{\lambda_j} c_{js} \left(d_s f_{Xij} - t_s f_{Ej} \right) \right]}{1 - \left(1 - d_s + \frac{d_s}{\lambda_j} \right) \frac{\gamma - \tilde{\gamma}}{\gamma}} \right\}^{\tilde{\gamma}/[\gamma(1-\varepsilon)]} \left(\frac{\gamma - \tilde{\gamma}}{\varepsilon \gamma c_{js}} \right)^{(1-\delta)/\gamma} Y_{is}^{1/(\varepsilon-1)} \frac{\alpha P_{is}}{\tau_{ij} c_{js}}. \tag{A.9}$$

By comparing eq. (A.9) and (A.7), note that $\underline{a}_{ijs} < a^*_{ijs}$ under the conventional assumption that $d_s f_{Xij} > t_s f_{Ej}$ (Manova, 2013), which in our case implies that firms' financing needs exceed their collateral for any level of quality.[3]

We now show that some of the liquidity-constrained firms have an incentive to choose quality below the optimum. Recall that the fixed cost of quality upgrading, FQ_{ijs}, is increasing in quality. Hence, by lowering quality, a firm reduces the value of the investment to be financed externally. While lower quality is also associated with lower revenue, the marginal reduction in revenue is initially smaller than that in the fixed cost.[4] For sufficiently productive firms, this extra cash flow is enough to satisfy the liquidity constraint. Because deviating from the optimal quality results in lower profits, each firm will deviate by just as much as is needed to make the constraint hold as an equality.

Formally, using the optimal price (A.4) in eq. (A.2), the liquidity constraint of these firms implies:

$$\frac{Y_{is}}{\varepsilon} \left(\frac{\tau_{ij} c_{js} a}{\alpha P_{is}} \right)^{1-\varepsilon} q_{ijs}(a)^{\gamma - \tilde{\gamma}} - \left(1 - d_s + \frac{d_s}{\lambda_j} \right) c_{js} q_{ijs}(a)^{\gamma} \leq c_{js} f_{Xij} + \frac{1-\lambda_j}{\lambda_j} c_{js} \left(d_s f_{Xij} - t_s f_{Ej} \right). \tag{A.10}$$

The RHS of eq. (A.10) does not depend on quality (i.e., it is a constant). At the same time, it can be shown that, for any level of productivity $1/a$, a reduction in quality below $q^o_{ijs}(a)$ initially increases the LHS. This reflects the fact that, for small deviations from the optimum, the reduced funding needs exceed the loss in revenue, resulting in higher cash flow. At some point, however, the second effect starts dominating; at this

[3]This assumption makes the problem non-trivial, because it implies that a firm must promise the investor a positive payment ($F_{ijs}(a) > 0$) even if it chooses the lowest quality level ($q_{ijs}(a) = 1$); see eq. (A.3). Since $\lambda_j < 1$, this is a sufficient but not necessary condition for $\underline{a}_{ijs} < a^*_{ijs}$.

[4]Recall that, by the second-order condition for a maximum, the quality-elasticity of the fixed cost, γ, is greater than the quality-elasticity of revenue, $(\varepsilon - 1)(1 - \delta)$.

point, further reductions in quality lower cash flow, reducing the LHS of (A.10). To see this, differentiate the LHS with respect to $q_{ijs}(a)$ and write the resulting expression in terms of $q^o_{ijs}(a)$. The result is:

$$\frac{\partial LHS}{\partial q_{ijs}(a)} = q_{ijs}(a)^{\gamma-1}\gamma c_{js}\left[\left(\frac{q^o_{ijs}(a)}{q_{ijs}(a)}\right)^{\tilde{\gamma}} - \left(1 - d_s + \frac{d_s}{\lambda_j}\right)\right]. \tag{A.11}$$

The second term in square brackets is a constant greater than 1, since $\lambda_j < 1$. Hence, there exists a range of quality levels below $q^o_{ijs}(a)$ for which eq. (A.11) is negative, i.e., for which the LHS of eq. (A.10) is decreasing in quality. Specifically, this is the case for all $q_{ijs}(a)$ between $q^c_{ijs}(a)$ and $q^o_{ijs}(a)$, where

$$q^c_{ijs}(a) = \left(1 - d_s + \frac{d_s}{\lambda_j}\right)^{-1/\tilde{\gamma}}\left[\left(\frac{\tau_{ij}c_{js}a}{\alpha P_{is}}\right)^{1-\varepsilon}\frac{(\gamma-\tilde{\gamma})\,Y_{is}}{\varepsilon\gamma c_{js}}\right]^{1/\tilde{\gamma}} \tag{A.12}$$

is the quality level at which eq. (A.11) is equal to zero, i.e., the quality level that maximizes the LHS of eq. (A.10).

Hence, a liquidity-constrained firm with coefficient a chooses the quality level between $q^c_{ijs}(a)$ and $q^o_{ijs}(a)$ that makes eq. (A.10) hold as an equality. Because less productive firms realize lower revenue, they need to deviate more from the optimal quality to achieve this goal. In fact, there exists a firm with coefficient $\bar{a}_{ijs}$ that barely meets the liquidity constraint by setting quality at exactly $q^c_{ijs}(\bar{a}_{ijs})$ (so $\beta_{ijs}(\bar{a}_{ijs}) = (1 - d_s + d_s/\lambda_j)^{-1/\tilde{\gamma}}$ from eq. A.5 and A.12). The cut-off $\bar{a}_{ijs}$ is defined by the following condition, which is obtained by using eq. (A.12) in (A.10) and evaluating the latter expression as an equality:

$$\frac{\tilde{\gamma} r^c_{ijs}(\bar{a}_{ijs})}{\gamma\varepsilon} = c_{js}f_{Xij} + \frac{1-\lambda_j}{\lambda_j}c_{js}\left(d_s f_{Xij} - t_s f_{Ej}\right) \tag{A.13}$$

with

$$r^c_{ijs}(\bar{a}_{ijs}) = \left(1 - d_s + \frac{d_s}{\lambda_j}\right)^{-(\gamma-\tilde{\gamma})/\tilde{\gamma}}\frac{\varepsilon\gamma c_{js}}{\gamma-\tilde{\gamma}}\left[\left(\frac{\tau_{ij}c_{js}\bar{a}_{ijs}}{\alpha P_{is}}\right)^{1-\varepsilon}\frac{(\gamma-\tilde{\gamma})\,Y_{is}}{\varepsilon\gamma c_{js}}\right]^{\gamma/\tilde{\gamma}}. \tag{A.14}$$

Finally, firms with $a \in (\bar{a}_{ijs}, a_H]$ cannot profitably sell in destination i. Intuitively, these firms are very unproductive, so their revenue is always too low for an investor to break even.[5,6]

[5]To see that $\bar{a}_{ijs} < a^*_{ijs}$, re-write eq. (A.10) for the firm with coefficient $\bar{a}_{ijs}$ as follows: $\frac{Y_{is}}{\varepsilon}\left(\frac{\tau_{ij}c_{js}\bar{a}_{ijs}}{\alpha P_{is}}\right)^{1-\varepsilon} q^c_{ijs}(\bar{a}_{ijs})^{\gamma-\tilde{\gamma}} - c_{js}\left(q^c_{ijs}(\bar{a}_{ijs})^{\gamma} + f_{Xij}\right) = \frac{1-\lambda_j}{\lambda_j}c_{js}\left[d_s\left(q^c_{ijs}(\bar{a}_{ijs})^{\gamma} + f_{Xij}\right) - t_s f_{Ej}\right]$. The LHS of this expression are the profits of this firm, which are strictly positive since the RHS>0. It follows that the least productive firm that can enter destination i is more productive than the marginal exporter in the absence of financial frictions.

[6]The assumption that only fixed costs are financed externally has no bearing on the qualitative

A.2 Proofs of Theoretical Propositions

We now prove the three propositions presented in Section 3.1.4.

Proposition 1 The cut-off $\underline{a}_{ijs}$ is defined by eq. (A.8). Differentiating both sides of this equation with respect to λ_j, $\lambda_j d_s$, and $\lambda_j t_s$ yields:

$$\begin{aligned}
&\frac{\partial LHS}{\partial \lambda_j} = \frac{r_{ijs}\left(\underline{a}_{ijs}\right) d_s}{\varepsilon \lambda_j^2} \frac{\gamma-\tilde{\gamma}}{\gamma} > 0 \quad \text{and} \quad \frac{\partial RHS}{\partial \lambda_j} = -\frac{c_{js}\left(d_s f_{Xij} - t_s f_{Ej}\right)}{\lambda_j^2} < 0;\\
&\frac{\partial^2 LHS}{\partial \lambda_j \partial d_s} = \frac{r_{ijs}\left(\underline{a}_{ijs}\right)}{\varepsilon \lambda_j^2} \frac{\gamma-\tilde{\gamma}}{\gamma} > 0 \quad \text{and} \quad \frac{\partial^2 RHS}{\partial \lambda_j \partial d_s} = -\frac{c_{js} f_{Xij}}{\lambda_j^2} < 0;\\
&\frac{\partial^2 LHS}{\partial \lambda_j \partial t_s} = 0 \quad \text{and} \quad \frac{\partial^2 RHS}{\partial \lambda_j \partial t_s} = \frac{c_{js} f_{Ej}}{\lambda_j^2} > 0.
\end{aligned}$$

Since the LHS of (A.8) is decreasing in $\underline{a}_{ijs}$, it follows that:

$$\frac{\partial \underline{a}_{ijs}}{\partial \lambda_j} > 0, \quad \frac{\partial^2 \underline{a}_{ijs}}{\partial \lambda_j \partial d_s} > 0, \quad \text{and} \quad \frac{\partial^2 \underline{a}_{ijs}}{\partial \lambda_j \partial t_s} < 0.$$

Proposition 2 For liquidity-constrained firms, eq. (A.10) holds as an equality. Because the RHS is the same as in eq. (A.8), its derivatives are the same as in the previous proof. The derivatives of the LHS are instead equal to:

$$\frac{\partial LHS}{\partial \lambda_j} = \frac{d_s c_{js} q_{ijs}(a)^{\gamma}}{\lambda_j^2} > 0, \quad \frac{\partial^2 LHS}{\partial \lambda_j \partial d_s} = \frac{c_{js} q_{ijs}(a)^{\gamma}}{\lambda_j^2} > 0, \quad \text{and} \quad \frac{\partial^2 LHS}{\partial \lambda_j \partial t_s} = 0.$$

Recall that the LHS is decreasing in quality for $q_{ijs}(a) \in \left[q^c_{ijs}(a), q^o_{ijs}(a)\right]$ and that we have expressed the quality of liquidity-constrained firms as a fraction $\beta_{ijs}(a)$ of the optimal quality $q^o_{ijs}(a)$. Hence, it follows that:

$$\frac{\partial \beta_{ijs}(a)}{\partial \lambda_j} > 0, \quad \frac{\partial^2 \beta_{ijs}(a)}{\partial \lambda_j \partial d_s} > 0, \quad \text{and} \quad \frac{\partial^2 \beta_{ijs}(a)}{\partial \lambda_j \partial t_s} < 0.$$

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implications of the model. Indeed, if variable costs were also partially financed with external capital, liquidity-unconstrained firms would continue to choose prices and quality as in eq. (A.4) and (A.5), respectively. Instead, liquidity-constrained firms would have two margins to meet the liquidity constraint: (1) they could reduce quality as in the baseline model; or (2) they could lower quantity and raise prices. The intuition is that lower output implies lower variable costs and thus lower borrowing (Manova, 2013). It is easy to show that firms use both margins. Indeed, for liquidity-constrained firms the first-order conditions for prices and quality can be written, respectively, as: $p_{ijs}(a) = \frac{\tau_{ij} c_{js} a q_{ijs}(a)^{\delta}}{\alpha} \frac{1+\mu\left(1-d_s+d_s/\lambda_j\right)}{1+\mu}$ and $q_{ijs} = \left[\left(\frac{\tau_{ij} c_{js} a}{\alpha P_{is}}\right)^{1-\varepsilon} \frac{(\gamma-\tilde{\gamma}) Y_{is}}{\varepsilon \gamma c_{js}}\right]^{1/\tilde{\gamma}} \left(\frac{1+\mu\left(1-d_s+d_s/\lambda_j\right)}{1+\mu}\right)^{-\varepsilon/\tilde{\gamma}}$, where $\mu > 0$ is the Lagrange multiplier on the liquidity constraint. The first terms in these expressions are the optimal price and quality, respectively. Because $\frac{1+\mu\left(1-d_s+d_s/\lambda_j\right)}{1+\mu} > 1$, liquidity-constrained firms raise prices above (and thus reduce quantity below) the optimal level. At the same time, they set a quality below the optimum as in the baseline model.

Proposition 3 The cut-off $\bar{a}_{ijs}$ is defined by eq. (A.13). The RHS is the same as in eq. (A.8) and (A.10), so its derivatives are the same as in the previous proofs. Differentiating the LHS with respect to λ_j, $\lambda_j d_s$, and $\lambda_j t_s$ yields:

$$\begin{aligned}\frac{\partial LHS}{\partial \lambda_j} &= \frac{r^c_{ijs}\left(\bar{a}_{ijs}\right) d_s\left(\gamma-\tilde{\gamma}\right)}{\varepsilon\gamma\lambda_j^2\left(1-d_s+\frac{d_s}{\lambda_j}\right)}>0, \quad \frac{\partial^2 LHS}{\partial \lambda_j \partial t_s}=0, \quad \text{and}\\ \frac{\partial^2 LHS}{\partial \lambda_j \partial d_s} &= \frac{r^c_{ijs}\left(\bar{a}_{ijs}\right)\left(\varepsilon-1\right)\left(1-\delta\right)\left[\lambda_j\tilde{\gamma}-\left(1-\lambda_j\right)\left(\varepsilon-1\right)\left(1-\delta\right)d_s\right]}{\varepsilon\gamma\lambda_j^3\tilde{\gamma}\left(1-d_s+\frac{d_s}{\lambda_j}\right)^2} \lesseqgtr 0.\end{aligned}$$

Since the LHS is decreasing in $\bar{a}_{ijs}$, it follows that:

$$\frac{\partial \bar{a}_{ijs}}{\partial \lambda_j}>0, \quad \frac{\partial^2 \bar{a}_{ijs}}{\partial \lambda_j \partial t_s}<0, \quad \text{and} \quad \frac{\partial^2 \bar{a}_{ijs}}{\partial \lambda_j \partial d_s} \lesseqgtr 0.$$

Recall that $\tilde{\gamma} \equiv \gamma-\left(\varepsilon-1\right)\left(1-\delta\right)$. Hence, $\partial^2 LHS/\partial\lambda_j\partial d_s$ is more likely to be negative the smaller is γ relative to $\left(\varepsilon-1\right)\left(1-\delta\right)$, i.e., the smaller is the quality-elasticity of the fixed cost compared to the quality-elasticity of revenue.

A.3 Alternative Formulations of the Model

Here, we show that the main insights of the baseline model hold under different assumptions on the liquidity constraint (Section A.3) as well as when firms choose a single quality across all destination markets (Section A.3).

Alternative Liquidity Constraint

Suppose that, instead of pledging collateral, firms can borrow up to a fraction λ_j of their cash flow. This fraction is higher in financially more developed countries, where financial frictions are weaker. In this case, a country-j firm active in industry s chooses the price p_{ijs} and quality q_{ijs} to solve the following problem:

$$\max_{p,q}\left(p_{ijs}-MC_{ijs}\left(a\right)\right)x_{ijs}-\left(FQ_{ijs}+EX_{ijs}\right) \tag{A.15}$$

$$\text{subject to } \lambda_j\left[\left(p_{ijs}-MC_{ijs}\left(a\right)\right)x_{ijs}-\left(1-d_s\right)\left(FQ_{ijs}+EX_{ijs}\right)\right] \geq d_s\left(FQ_{ijs}+EX_{ijs}\right). \tag{A.16}$$

Note that, if firms have no collateral ($CO_{js}=0$), the maximization problem in Section A.1 is analogous to the above one. It follows that the price, quality, and revenue of liquidity-unconstrained firms are the same as in eq. (A.4), (A.5), and (A.6), respectively. Using these expressions in the liquidity constraint (eq. A.16), the threshold coefficient

$\underline{a}_{ijs}$ below which firms are liquidity unconstrained and choose the optimal quality is then defined by the following condition:

$$\frac{r^o_{ijs}\left(\underline{a}_{ijs}\right)}{\varepsilon}\left[1-\left(1-d_s+\frac{d_s}{\lambda_j}\right)\frac{\gamma-\tilde{\gamma}}{\gamma}\right]=c_{js}f_{Xij}+\frac{1-\lambda_j}{\lambda_j}c_{js}d_sf_{Xij}. \tag{A.17}$$

Also in this case, some liquidity-constrained firms can enter market i by lowering quality below the optimum. By doing so, these firms lower the cash flow against which they can borrow, but they also reduce the fixed cost and thus the amount of the loan. By the second-order condition for a maximum, the reduction in cash flow is initially smaller than that in the fixed cost. Hence, small deviations from the optimum allow some of these firms to meet the liquidity constraint and enter market i. Formally, substituting the optimal price (A.4) in eq. (A.16), the liquidity constraint of these firms implies:

$$\frac{Y_{is}}{\varepsilon}\left(\frac{\tau_{ij}c_{js}a}{\alpha P_{is}}\right)^{1-\varepsilon}q_{ijs}\left(a\right)^{\gamma-\tilde{\gamma}}-\left(1-d_s+\frac{d_s}{\lambda_j}\right)c_{js}q_{ijs}\left(a\right)^{\gamma}\leq c_{js}f_{Xij}+\frac{1-\lambda_j}{\lambda_j}c_{js}d_sf_{Xij}. \tag{A.18}$$

Note that the RHS of eq. (A.18) is a constant while that the LHS is initially decreasing in $q_{ijs}\left(a\right)$ and is maximized at

$$q^c_{ijs}\left(a\right)=\left(1-d_s+\frac{d_s}{\lambda_j}\right)^{-1/\tilde{\gamma}}\left[\left(\frac{\tau_{ij}c_{js}a}{\alpha P_{is}}\right)^{1-\varepsilon}\frac{\left(\gamma-\tilde{\gamma}\right)Y_{is}}{\varepsilon\gamma c_{js}}\right]^{1/\tilde{\gamma}}. \tag{A.19}$$

Hence, a liquidity-constrained firm with coefficient a chooses the quality level between $q^c_{ijs}\left(a\right)$ and $q^o_{ijs}\left(a\right)$ that makes its liquidity constraint hold exactly as an equality. For convenience, we can express this quality level as $q_{ijs}\left(a\right)=\beta_{ijs}\left(a\right)q^o_{ijs}\left(a\right)$ where $\beta_{ijs}\left(a\right)\in\left(0,1\right)$ and $\partial\beta_{ijs}\left(a\right)/\partial a<0$.

Finally, using eq. (A.19) in (A.18) the exporting cut-off $\bar{a}_{ijs}$ is defined by the following condition:

$$\frac{\tilde{\gamma}r^c_{ijs}\left(\bar{a}_{ijs}\right)}{\gamma\varepsilon}=c_{js}f_{Xij}+\frac{1-\lambda_j}{\lambda_j}c_{js}d_sf_{Xij} \tag{A.20}$$

where

$$r^c_{ijs}\left(\bar{a}_{ijs}\right)=\left(1-d_s+\frac{d_s}{\lambda_j}\right)^{-(\gamma-\tilde{\gamma})/\tilde{\gamma}}\frac{\varepsilon\gamma c_{js}}{\gamma-\tilde{\gamma}}\left[\left(\frac{\tau_{ij}c_{js}\bar{a}_{ijs}}{\alpha P_{is}}\right)^{1-\varepsilon}\frac{\left(\gamma-\tilde{\gamma}\right)Y_{is}}{\varepsilon\gamma c_{js}}\right]^{\gamma/\tilde{\gamma}}.$$

The share of liquidity-unconstrained firms ($\underline{a}_{ijs}$), the quality of liquidity-constrained firms ($\beta_{ijs}\left(a\right)$), and the exporting cut-off ($\bar{a}_{ijs}$) are defined by eq. (A.17), (A.18), and (A.20), respectively. These equations differ from their counterparts in Section A.1 (eq.

A.8, A.10, and A.13, respectively) only due to the absence of asset tangibility t_s. It follows that this simplified model delivers the same comparative-statics results for the role of financial development λ_j and external finance dependence d_s, but has no predictions about the role of t_s.

Single Quality across Destinations

Suppose that firms target their global market (instead of individual destinations) in choosing quality. In this case, each firm produces a *single* quality for all the destinations it serves. Accordingly, the firm pays a single fixed cost of quality upgrading and borrows from a single investor against its global cash flow. Hence, a country-j firm in industry s solves the following problem:

$$\max_{p,q,F} \left\{ \sum_i \mathbf{1}_{ijs}(a) \left[\left(p_{ijs} - MC_{ijs}(a) \right) x_{ijs} - (1-d_s) EX_{ijs} \right] - (1-d_s) FQ_{js} \right\} - \left[\lambda_j F_{js} + \left(1-\lambda_j\right) CO_{js} \right] \tag{A.21}$$

$$\text{subject to } \sum_i \mathbf{1}_{ijs}(a) \left[\left(p_{ijs} - MC_{ijs}(a) \right) x_{ijs} - (1-d_s) EX_{ijs} \right] - (1-d_s) FQ_{js} \geq F_{js} \tag{A.22}$$

$$\text{and to } \lambda_j F_{js} + \left(1-\lambda_j\right) CO_{js} \geq d_s \left(FQ_{js} + \sum_i \mathbf{1}_{ijs}(a) EX_{ijs} \right), \tag{A.23}$$

where $\mathbf{1}_{ijs}(a)$ is an indicator variable equal to 1 if the firm sells in market i (i.e., $\mathbf{1}_{ijs}(a) = 1$ if $a \leq \bar{a}_{ijs}$). Eq. (A.3) shows that the firm maximizes the difference between its global cash flow across all destinations it serves (the first term, in curly brackets) and the expected cost of the loan (the second term, in square brackets). The cash flow equals total operating profits minus the internally-funded shares of the export costs and of the fixed cost of quality upgrading. In equilibrium, the participation constraint of the investor (eq. A.23) holds as an equality. Accordingly, we solve for F_{js} from (A.23) and substitute the result in the objective function (eq. A.3) and in the liquidity constraint (eq. A.22).

Firms enter markets in the same, decreasing, order of profitability, determined by market size (Y_{is}), competition (P_{is}), variable trade costs (τ_{ij}) and fixed export costs (f_{Xij}). It follows that, for any number I of destination markets, it suffices for us to study the conditions on the I-th market, the least profitable one. Using the fact that the optimal price is a constant mark-up over marginal cost in each destination, a firm that sells in I

markets has an optimal quality equal to:

$$q_{js}(a) = q_{js}^{o}(a) = \left[\sum_{i=1}^{I}\left(\frac{\tau_{ij}c_{js}a}{\alpha P_{is}}\right)^{1-\varepsilon}\frac{(\gamma-\tilde{\gamma})Y_{is}}{\varepsilon\gamma c_{js}}\right]^{1/\tilde{\gamma}}. \tag{A.24}$$

By comparing eq. (A.24) with (A.5), note that optimal quality is higher than it would be in each destination if firms targeted markets individually. The reason is that now firms pay a single fixed cost of quality upgrading against a higher (global, rather than market-specific) cash flow. Substituting eq. (A.24) and the optimal pricing rule into (A.22), the threshold coefficient $\underline{a}_{Ijs}$ below which firms enter the I-th market with the optimal quality is then defined by the following condition:

$$\frac{r_{js}\left(\underline{a}_{Ijs}\right)}{\varepsilon}\left[1-\left(1-d_s+\frac{d_s}{\lambda_j}\right)\frac{\gamma-\tilde{\gamma}}{\gamma}\right] = c_{js}\sum_{i=1}^{I}f_{Xij}+\frac{1-\lambda_j}{\lambda_j}c_{js}\left(d_s\sum_{i=1}^{I}f_{Xij}-t_s f_{Ej}\right) \tag{A.25}$$

where

$$r_{js}\left(\underline{a}_{Ijs}\right) = \frac{\varepsilon\gamma c_{js}}{\gamma-\tilde{\gamma}}\left[\sum_{i=1}^{I}\left(\frac{\tau_{ij}c_{js}\underline{a}_{Ijs}}{\alpha P_{is}}\right)^{1-\varepsilon}\frac{(\gamma-\tilde{\gamma})Y_{is}}{\varepsilon\gamma c_{js}}\right]^{\gamma/\tilde{\gamma}}$$

is the global revenue of the cut-off firm.

Some firms with $a > \underline{a}_{Ijs}$ can enter the I-th market by choosing a quality below the optimum. Indeed, substituting the optimal pricing condition into eq. (A.22), the liquidity constraint of these firms implies:

$$q_{js}(a)^{\gamma-\tilde{\gamma}}\sum_{i=1}^{I}\frac{Y_{is}}{\varepsilon}\left(\frac{\tau_{ij}c_{js}a}{\alpha P_{is}}\right)^{1-\varepsilon} - \left(1-d_s+\frac{d_s}{\lambda_j}\right)c_{js}q_{js}(a)^{\gamma} \leq c_{js}\sum_{i=1}^{I}f_{Xij}+\frac{1-\lambda_j}{\lambda_j}c_{js}\left(d_s\sum_{i=1}^{I}f_{Xij}-t_s f_{Ej}\right). \tag{A.26}$$

The RHS of eq. (A.26) is a constant, while the LHS is initially decreasing in $q_{js}(a)$ and is maximized at

$$q_{js}^{c}(a) = \left(1-d_s+\frac{d_s}{\lambda_j}\right)^{-1/\tilde{\gamma}}\left[\sum_{i=1}^{I}\left(\frac{\tau_{ij}c_{js}a}{\alpha P_{is}}\right)^{1-\varepsilon}\frac{(\gamma-\tilde{\gamma})Y_{is}}{\varepsilon\gamma c_{js}}\right]^{1/\tilde{\gamma}}.$$

Finally, using the last expression in eq. (A.26), the cut-off $\bar{a}_{Ijs}$ for exporting to the I-th market is defined by the following condition:

$$\frac{\tilde{\gamma}r_{js}\left(\bar{a}_{Ijs}\right)}{\gamma\varepsilon} = c_{js}\sum_{i=1}^{I}f_{Xij}+\frac{1-\lambda_j}{\lambda_j}c_{js}\left(d_s\sum_{i=1}^{I}f_{Xij}-t_s f_{Ej}\right) \tag{A.27}$$

with

$$r_{js}\left(\bar{a}_{Ijs}\right)=\left(1-d_s+\frac{d_s}{\lambda_j}\right)^{-(\gamma-\tilde{\gamma})/\tilde{\gamma}}\frac{\varepsilon\gamma c_{js}}{\gamma-\tilde{\gamma}}\left[\sum_{i=1}^{I}\left(\frac{\tau_{ij}c_{js}\bar{a}_{Ijs}}{\alpha P_{is}}\right)^{1-\varepsilon}\frac{(\gamma-\tilde{\gamma})\,Y_{is}}{\varepsilon\gamma c_{js}}\right]^{\gamma/\tilde{\gamma}}.$$

Eq. (A.25), (A.26), and (A.27) have the same form as eq. (A.8), (A.10), and (A.13) in Section A.1. It follows that a model in which firms produce a single quality for all destinations delivers the same comparative-statics results as a model in which firms can differentiate quality across markets.

B Data Appendix

In this Appendix, we provide details on data and variables used to estimate product quality in Section 3.3.1. We use product-level data on imports into 26 EU members from all countries in the world. These data are sourced from *Comext*. As for product disaggregation, the data come at the 8-digit level of the CN classification. The latter has undergone several changes over the period of analysis, as discussed in Colantone and Crinò (2014) and Van Beveren et al. (2012). Hence, we use a procedure developed by Van Beveren et al. (2012) to convert the original data into a consistent product classification. The original procedure covers the years 1988-2010, so we extend it to account for classification changes occurred in more recent years. This leaves us with 6713 products (of which 5689 are manufacturing goods) consistently defined between 1988 and 2013.

Turning to the other variables, we construct the market share of the outside variety (s_{0t}) using import penetration measures obtained by combining production data from *Euklems*, the *World Input Output Database*, and Eurostat with trade data from the OECD (*Stan Database for Industrial Analysis*). To have complete time series on import penetration for all industries and countries, we impute the missing values (6% of observations) through linear interpolation. As shown in Appendix C, the imputation has no implications for the main results. We measure exporting countries' population (pop_{jt}) using data from the *World Development Indicators*.

Finally, to instrument the price of each variety (p_{ljt}) and the nest share (ns_{ljt}) we follow Khandelwal (2010) and use bilateral exchange rates, the interactions of bilateral distance with oil prices and product-specific transportation costs, the number of countries exporting product l to destination i, and the number of products exported by country j to country i. Bilateral exchange rates are sourced from Eurostat and the *International Financial Statistics*. Bilateral distance is the population-weighted number of kilometers between the capital cities of countries i and j, sourced from CEPII. Oil prices are Brent prices from *FRED* (Federal Reserve Bank of St. Louis). To compute the product-specific transportation costs, we follow the same procedure as in Colantone and Crinò (2014). We start by sourcing data on bilateral transportation costs for the US, available at the 6-digit level of the HS classification. We regress these transportation costs on partner fixed effects, to remove the influence of distance from the US. Then, we average the residuals of this regression within each 6-digit product, across all trading partners of the US. Finally, we attribute the same transportation cost to all 8-digit products belonging to the same 6-digit code, and use the procedure of Van Beveren et al. (2012) to convert the resulting data in a consistent product classification. Following Khandelwal (2010), we estimate eq. (3.22) excluding extreme unit values in the 5% tails of the distribution within each importer and industry, as well as importer-industry combinations with less than 50 available observations.

C Empirical Appendix

In this Appendix, we provide details and estimation results for the robustness checks mentioned in Sections 3.4.1 and 3.4.1.

Alternative quality estimates In panel a) of Table C1, we show that the baseline estimates of the quality equation (column 5 of Table 3.3) are robust to using alternative data and estimation approaches for constructing average quality $\tilde{q}_{ijst}$. In row (1), we compute the product-specific quality estimates (see eq. 3.22) excluding the residuals ϵ_{ljt}, which might add some noise. In row (2), we depart from the original Khandelwal (2010) specification and use a different version of eq. (3.22), in which the time fixed effects (β_t) are replaced by exporter-time fixed effects (β_{jt}) to allow for differential trends in consumers' valuation for quality across exporting countries.[7] In rows (3) and (4), we construct $\tilde{q}_{ijst}$ as the value-weighted average of the product-specific quality estimates, using either an arithmetic mean of these estimates (row 3) or a geometric mean of their logs (row 4). This constitutes a slight departure from the theoretical definition of $\tilde{q}_{ijst}$, but allows us to give less weight to products with smaller import values, for which the quality estimates might be more noisy. In row (5), we re-estimate quality after excluding the observations for which the outside variety s_{0t} is based on interpolated import penetration. This reduces sample size but ensures that the results are not driven by

[7] Log quality is then given by $\ln q_{ljt} = \beta_{lj} + \beta_{jt} + \epsilon_{ljt}$. The coefficient β_3 in eq. (3.22) is not identified in this case.

the interpolation. In row (6) we exclude the years 2008-2011 to ensure that the quality estimates are not influenced by the sharp drop in trade volumes during the recent financial crisis. The results always confirm the baseline estimates.

Next, we estimate quality using data on imports into a different country: the US. These data are available for a shorter time period (1989-2006) and may raise some endogeneity concerns, given that EF_s and AT_s are also based on data for the US. However, because these data are slightly more disaggregated at the product level (10 digits), they can be used to study how the level of aggregation at which quality is estimated influences the results. In row (7) we estimate quality by aggregating the US data at the 8-digit level, the same available for the EU. In row (8), we instead use the original data at the 10-digit level.[8] In analogy with our baseline specification, we control for full sets of industry-year and exporter-year effects. Despite the use of data for a different country, the results confirm our baseline estimates for the EU. More importantly, the level of product disaggregation makes no difference for our results. If anything, using more aggregated data yields a *smaller* coefficient on $FD_{jt} \cdot AT_s$, suggesting that the 8-digit data we use for the EU may yield a *lower bound* for the effects of financial imperfections on average quality. Finally, in row (9) we use average export prices (unit values) instead of Khandelwal's (2010) quality proxy. The coefficients have the same sign as those obtained with Khandelwal's (2010) measure, and are both very precisely estimated.

[8]We estimate quality separately for each 4-digit SIC industry according to eq. (3.22). To compute the market share of the outside variety (s_{0t}), we calculate import penetration in each 4-digit industry using output data from the *NBER Productivity Database*, available up to 2009. The variety-specific transportation costs that we use as instruments are available up to 2006. Hence, our final sample spans the period 1989-2006.

Table C1: Robustness Checks

	$FD_{jt} \cdot EF_s$ Coeff.	Std. Err.	$FD_{jt} \cdot AT_s$ Coeff.	Std. Err.	Obs.	R^2
a) Alternative quality estimates						
1) No residuals ϵ_{ljt}	0.189***	[0.021]	-0.513***	[0.143]	3,141,432	0.08
2) Exporter-year effects β_{jt}	0.132***	[0.042]	-1.638***	[0.287]	3,329,847	0.06
3) Value-weighted estimates (arithmetic mean)	0.311***	[0.024]	-0.709***	[0.147]	3,145,065	0.10
4) Value-weighted estimates (geometric mean)	0.108***	[0.033]	-0.584**	[0.241]	3,478,549	0.04
5) No interpolated s_{0t}	0.314***	[0.024]	-0.426***	[0.150]	3,081,919	0.09
6) No 2008-2011	0.350***	[0.026]	-0.595***	[0.163]	2,477,070	0.09
7) US data (8 digits)	0.285***	[0.028]	-1.427***	[0.196]	188,857	0.04
8) US data (10 digits)	0.205***	[0.024]	-2.402***	[0.211]	209,134	0.05
9) Average unit values	0.012***	[0.004]	-0.266***	[0.065]	4,214,006	0.12
b) Alternative samples						
10) Trimming $\tilde{q}_{ijst}$	0.271***	[0.021]	-0.287**	[0.139]	2,986,149	0.07
11) Winsorizing $\tilde{q}_{ijst}$	0.291***	[0.022]	-0.375***	[0.132]	3,144,866	0.08
12) No extreme FD_{jt}	0.332***	[0.023]	-0.553***	[0.147]	3,126,446	0.09
13) No extreme EF_s and AT_s	0.395***	[0.027]	-0.441***	[0.150]	3,106,871	0.09
14) No small exporters	0.311***	[0.023]	-0.451***	[0.149]	2,784,379	0.08
15) No small importers	0.329***	[0.027]	-0.489***	[0.154]	2,733,228	0.09
c) Alternative measures of financial vulnerability						
16) Prior decade (1980-1987)	0.109***	[0.020]	-0.899***	[0.158]	2,943,862	0.08
17) Rankings of EF_s and AT_s	0.629***	[0.056]	-0.148***	[0.055]	3,144,866	0.09
18) No US	0.300***	[0.023]	-0.529***	[0.146]	3,056,163	0.09
d) Alternative measures of financial frictions						
19) Liquid liabilities	0.202***	[0.026]	-0.796***	[0.186]	3,179,775	0.09
20) Banks assets	0.296***	[0.023]	-0.568***	[0.143]	3,141,767	0.09
21) Comm./centr. banks asset ratio	1.191***	[0.106]	-2.913***	[0.561]	3,053,545	0.09
22) Domestic credit	0.310***	[0.022]	-0.515***	[0.140]	3,328,136	0.09
23) Capitalization ratio	0.114***	[0.012]	-0.188**	[0.073]	3,051,715	0.08
24) Investors protection	0.285***	[0.053]	-0.482*	[0.291]	3,394,836	0.09
25) Contracts enforcement	0.574***	[0.058]	-0.647*	[0.369]	3,394,836	0.09
26) Insolvencies resolution	0.788***	[0.055]	-0.680**	[0.339]	3,394,836	0.09
27) Getting credit	0.494***	[0.061]	-0.934**	[0.364]	3,394,836	0.09
28) Lending rate	-0.235***	[0.015]	0.274***	[0.084]	3,129,328	0.09

Notes: The dependent variable is $\tilde{q}_{ijst}$, the log average quality of goods exported by country j to country i in industry s at time t. All specifications include exporter-year effects, importer-industry-year effects, and gravity controls. Standard errors are corrected for clustering within exporter-importer pairs, except in rows (7) and (8) where they are clustered by exporter-year. ***, **, and *: indicate significance at the 1%, 5%, and 10% level, respectively. See also notes to previous tables.

Alternative samples In panel b), we show that our results are not driven by a handful of influential observations and are robust across alternative sub-samples. In rows (10) and (11) we trim and winsorize, respectively, the extreme 1% of observations for $\tilde{q}_{ijst}$. In rows (12) and (13), we instead exclude the countries with the extreme values of FD_{jt} (Democratic Republic of Congo and Cyprus) or the industries with the extreme values of EF_s and AT_s (SIC 2111, 2421, 3844, and 3845). Finally, in row (14) and (15) we drop exporting or importing countries with less than 5 million inhabitants in 2012, to check that the results are not driven by small economies. The coefficients are always close to the baseline estimates.

Alternative measures of financial vulnerability In panel c), we show that the results are robust to using alternative measures of financial vulnerability. In row (16), we recompute EF_s and AT_s using *Compustat* data for the period 1980-1987, the decade prior to the beginning of our sample. This serves two purposes. First, if our results were lost, it would mean that the US industrial structure of financial vulnerability is not persistent over time. It would then be unrealistic to expect the same structure to extend to different countries. Second, the US data for an earlier decade may be a better benchmark for countries at lower levels of development. In row (17), we use instead the rankings of industries in terms of EF_s and AT_s.[9] This implies some loss of information, but mitigates concerns with the stability of these measures across countries, because the rankings are more likely to be preserved than the actual values. Finally, in row (18) we exclude the US. In all cases, our main evidence is preserved.

Alternative measures of financial frictions In panel d), we show that the results hold when using different proxies for financial frictions. We start by considering the most common alternatives to private credit for measuring the size of the financial system. Following, among others, King and Levine (1993), we use liquid liabilities (row 19), banks assets (row 20), and the commercial-to-central banks assets ratio (row 21). Following Rajan and Zingales (1998), we use instead domestic credit (row 22) and the capitalization ratio (row 23).[10] All measures lead to the same conclusion as private

[9]To ease the interpretation of the results, we normalize the rankings to range between zero and one.

[10]Liquid liabilities is total liabilities by banks and other financial intermediaries as a share of GDP. This variable may include liabilities backed by credit to public institutions, and may entail some double counting. Banks assets is total assets of commercial banks as a share of GDP. It is a more comprehensive, yet imprecise, measure of size, because it also includes credit to the public sector and banks assets other than credit. The commercial-to-central banks assets ratio is commercial banks assets divided by the sum of commercial banks plus central banks assets. It is commonly viewed as a proxy for the relative importance of private financial intermediaries. Domestic credit is a broader, but possibly less precise,

credit.

So far, following a well-established empirical literature, we have used measures of size to proxy for λ_j. These variables give an objective and outcome-based indication of the ability of the financial system to provide funds (Manova, 2013). Moreover, they are all well measured, and comparable both across countries and over time. Next, we show that our results are preserved when using proxies for the effectiveness of institutions that may facilitate transactions between investors and firms. In particular, we use countries' ratings in terms of: investors protection (row 24), strength of contracts enforcement (row 25), and effectiveness at resolving insolvencies (row 26). We also use an index for the ease of getting credit, which exploits information on the strength of legal rights protection for borrowers and investors (row 27).[11] These indices are similar to some of the alternative measures used by Rajan and Zingales (1998) and Manova (2013), but are available for more countries; none of them varies over time. Note that the coefficients maintain the same sign as in the baseline specification, and remain significant at conventional levels.

Finally, in the model, worse financial frictions raise the cost of borrowing, because they increase the payment F_{ijs} that firms have to promise the investors to make them break even. Accordingly, in row (28) we use the log of the lending rate as an inverse proxy for λ_j.[12] We expect the opposite pattern of signs compared to when using private credit. Indeed, the coefficient on $FD_{jt} \cdot EF_s$ is negative and very precisely estimated, whereas that on $FD_{jt} \cdot AT_s$ is positive and highly significant.

Other issues In Table C2 we tackle other miscellaneous concerns with the baseline estimates. In column (1), we use an alternative parametrization for bilateral trade costs (eq. 3.14), which allows the latter to have differential effects across industries depending on financial vulnerability. To this purpose, we interact all gravity controls with EF_s and AT_s. Including these interactions (coefficients available upon request) does not overturn the main results. In column (2), we investigate the role of financial develop-

measure of size, because it may include credit issued by, and granted to, public institutions. Finally, the capitalization ratio is the sum of domestic credit and stock market capitalization. Unlike the other measures, it accounts for the role of equities; yet, it may be an imprecise measure of size, because stock market capitalization also reflects factors other than equity issuance, such as investors' expectations about firms' growth potential. All variables are sourced from the *Global Financial Development Database*.

[11]These indices are sourced from the World Bank *Doing Business Database*. We normalize them to range between zero and one, and so that higher values indicate a better position in the ranking.

[12]The lending rate is the average interest rate charged for loans to the private sector. It is a commonly used measure of the cost of borrowing in a country (e.g., Chor and Manova, 2012). We use data from the *International Financial Statistics* and the OECD over 1988-2012.

ment in the destination markets, as firms can also borrow from investors located in the importing country by using letters of credit. To this purpose, we replace the importer-industry-year effects with importer-industry effects, and add importers' private credit both linearly and interacted with industries' financial vulnerability. The coefficients on the new controls are small, not always precisely estimated, and opposite in sign to our main coefficients, which instead remain essentially unchanged. In column (3), we add interactions between countries' factor endowments (SE_{jt} and KE_{jt}) and industries' financial vulnerability, while in column (4) we interact exporters' financial development (FD_{jt}) with an indicator for whether the industry produces differentiated products according to the Rauch (1999) classification ($RAUCH_s$). Our main evidence does not change.

Table C2: Other Issues

	Heterog. Gravity (1)	Importer Fin. Dev. (2)	Endowm. Fin. Vuln. (3)	Rauch Classif. (4)
$FD_{jt} \cdot EF_s$	0.310***	0.305***	0.174***	0.324***
	[0.026]	[0.023]	[0.027]	[0.025]
$FD_{jt} \cdot AT_s$	-0.282*	-0.488***	-0.471***	-0.440***
	[0.162]	[0.145]	[0.174]	[0.152]
FD_{it}		-0.126***		
		[0.040]		
$FD_{it} \cdot EF_s$		-0.157***		
		[0.021]		
$FD_{it} \cdot AT_s$		-0.042		
		[0.112]		
$KE_{jt} \cdot EF_s$			0.117***	
			[0.023]	
$KE_{jt} \cdot AT_s$			-0.334**	
			[0.152]	
$SE_{jt} \cdot EF_s$			0.072	
			[0.106]	
$SE_{jt} \cdot AT_s$			2.964***	
			[0.617]	
$FD_{jt} \cdot RAUCH_s$				0.103*
				[0.055]
Obs.	3,144,866	2,929,405	3,055,041	3,068,160
R^2	0.09	0.09	0.09	0.09

Notes: The dependent variable is $\tilde{q}_{ijst}$, the log average quality of goods exported by country j to country i in industry s at time t. FD_{it} is financial development in the importing country. $RAUCH_s$ is a dummy equal to 1 if the industry produces differentiated products according to the Rauch (1999) classification. All specifications include exporter-year effects, importer-industry-year effects, and gravity controls, except for: column (1), which also includes interactions between the gravity controls and the financial vulnerability measures; and column (2), in which the importer-industry-year effects are replaced by importer-industry effects. Standard errors are corrected for clustering within exporter-importer. ***, **, and *: indicate significance at the 1%, 5%, and 10% level, respectively. See also notes to previous tables.

Sample splits Finally, in Table C3 we show that our results are also robust across different sub-samples, defined in terms of the characteristics of the importing country. We start by dividing the importers in two groups, based on whether per-capita income is above or below the sample median. The empirical literature finds that richer countries tend to import higher-quality products (see, e.g., Hallak, 2006, 2010), so one concern is that our estimates might by driven by the richest economies. However, columns (1) and (2) show that the coefficients are only slightly larger for the high-income group, and that the same qualitative pattern of results obtains in both sub-samples. Next, we divide the importers in two groups, based on whether private credit is above or below the median. While financial development at destination has little direct effect on average quality as previously shown, it may still be the case that financial frictions in the exporting country are relatively more important when the financial system of the importing country is weaker. However, columns (3) and (4) show that the coefficients are similar across the two sub-samples. Finally, we divide the importers in two groups, based on whether the quality of their legal systems (as proxied by the rule of law) is above or below the sample median. One may worry that financial imperfections may be more relevant when firms export to countries with a weaker contractual environment. For instance, sale contracts in such countries may be less likely to be enforced; by making revenue more uncertain, this may induce firms exporting to such markets to resort more heavily on their domestic financial institutions. However, columns (5) and (6) do not show any noteworthy difference between the results obtained on the two sub-samples.

Table C3: Sample Splits

	Importer Per Capita Income		Importer Financial Development		Importer Rule of Law	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
$FD_{jt} \cdot EF_s$	0.346***	0.227***	0.379***	0.266***	0.367***	0.216***
	[0.009]	[0.012]	[0.012]	[0.011]	[0.009]	[0.011]
$FD_{jt} \cdot AT_s$	-0.517***	-0.375***	-0.458***	-0.643***	-0.303***	-0.768***
	[0.055]	[0.074]	[0.074]	[0.072]	[0.057]	[0.071]
Obs.	2,166,848	978,018	1,268,829	1,155,259	2,014,016	1,130,850
R^2	0.10	0.08	0.08	0.12	0.10	0.09

Notes: The dependent variable is $\tilde{q}_{ijst}$, the log average quality of goods exported by country j to country i in industry s at time t. All specifications include exporter-year effects, importer-industry-year effects, and gravity controls. Importer per capita income and financial development refer to the year 2012; importer rule of law is the average between 1996 and 2012. ***, **, and *: indicate significance at the 1%, 5%, and 10% level, respectively. See also notes to previous tables.

Chapter 4

The Marginal Product of Capital: Documenting New Patterns across Countries and Over Time

Introduction

In an influential paper Caselli and Feyrer (2007) argue that the Marginal Product of Capital (MPK) is remarkably similar across countries with different per-capita income and capital-labor ratio. This result has far reaching implication. In particular, it can help explain one of the main puzzle in international economics, namely the Lucas (1990) puzzle, according to which capital surprisingly flows to rich countries instead of ending up in poor, capital-scarce, countries that should be characterized by higher MPK.[1]

In this paper I build on Caselli and Feyrer (2007) to document new patterns on the relations between MPK and per-capita GDP. Using a large dataset which includes more countries and years than Caselli and Feyrer (2007) I document two new interesting facts. First, the MPKs are not equalized across countries, rather the dispersion of estimated capital returns is still large and increasing over time (rising by about 20 percentage point in the last three decades).

Second, MPKs' dispersion is not random. Rather, MPKs are systematically higher in rich countries (high-income countries display MPKs that are, on average, twice as big

[1]This paper connects to a growing literature on the direction of capital flows and the possible explanation for the Lucas puzzle, see for example Alfaro et al. (2008),Alfaro et al. (2014) and Gourinchas and Rey (2007)

as the ones of low-income countries). Moreover, the positive relation between MPKs and per-capita GDP has become stronger over the last six decades. This results suggest that capital, in fact, may be flowing in the right direction, i.e. towards the countries that have higher returns to capital.

4.1 The MPK measure

In my analysis I use the same method employed by Caselli and Feyrer (2007) to build time-varying measures of countries' Marginal Product of Capital. Under the assumption of efficient domestic capital markets and a constant return to scale technology, $R - (1 - \delta) = MPK$. Defining α as the capital share in GDP, $\alpha = MPK \times K/Y$, and we can rewrite the marginal product of capital as:

$$MPK_{naive} = \alpha \frac{Y}{K},$$

where Y is GDP and K is the stock of reproducible capital. Caselli and Feyrer (2007) propose two relevant corrections for this measure. First, they add the relative price of capital with respect to output, to incorporate the intuition that agents investing in poor-countries need to be compensated with higher physical MPK, since capital goods are relatively more expensive in those countries. Second, they argue that the common approach of estimating the capital share of GDP as one minus the share of labor in GDP leads to an overestimation of the marginal productivity of reproducible capital thereby exacerbating cross-country differences in the MPKs. In particular, the common approach attributes to the share of capital also a part that does not pertain to reproducible capital and, since land and natural resources represent a much bigger share of GDP for poor countries, this severely bias upward the estimated returns for developing economies. Therefore they correct the above estimate (which is labeled *naive*) by a factor that represent the share of reproducible capital in total capital. Defining by α_k the corrected capital share, the *adjusted* measure of MPK becomes:

$$MPK_{Adjusted} = \frac{\alpha_k P_y Y}{P_k K}$$

4.2 Data

I construct the naive and the adjusted measure of MPK using data from Penn World Table (version 8.0). Overall I have data for 91 countries over 1950-2011, but in most of the analysis I exclude the years of the financial crisis (2008-2011). I measure Y as the output side real GDP at current PPP, Py as GDP deflator, K is the capital stock at current PPP, P_k as the price level of capital formation and α as $1 - labsh$ where $labsh$ is the labor share in GDP. In the current version of the Penn World tables the labor share of GDP is adjusted a la Gollin (2002) to account for the fact that employees compensations do not include self-employment and non-corporate employment, which in many countries constitute the bulk of the labor force. This information was not available in the version of the Penn World tables used by Caselli and Feyrer (2007), who then used the estimates provided by Bernanke and Gurkaynak (2001) for 53 countries. Thus I am able to almost double the number of countries in the analysis.

Finally, to build the adjusted capital share α_k, I implement the correction proposed by Caselli and Feyrer (2007) using data on the share of reproducible capital in total wealth from the World Bank *Wealth of Nations* dataset.[2].

4.3 Results

4.3.1 MPKs across space

I start by showing that the main effect of the correction is to reduce the MPK of developing countries. Figure 4.1 plots the measure of the *adjusted* MPK against the *naive* measure, both for the Caselli and Feyrer (2007) sample and for the whole 91-country sample. To be consistent with Caselli and Feyrer (2007) analysis I start by using year 1996. Note that, with a few exceptions, the blue dots (corresponding to the MPKs of low income countries) lay below the 45 degree line. On average, the *adjusted* MPK of the low-income countries is lower than the *naive* MPK by 17 percentage points (70% of the mean *naive* MPK). Instead, the *adjusted* and the *naive* MPK measures are close to each other for the developed countries. Hence, the correction does not substantially influence the measure of returns to capital for rich economies while significantly reducing it for poor ones.

[2]In most of the analysis I use data for the year 1995 to be consistent with Caselli and Feyrer (2007). Nevertheless, using the average share over 1995, 2000 and 2005, does not produce any noteworthy change in the results.

Figure 4.1: Adjusted vs Naive MPK Measures

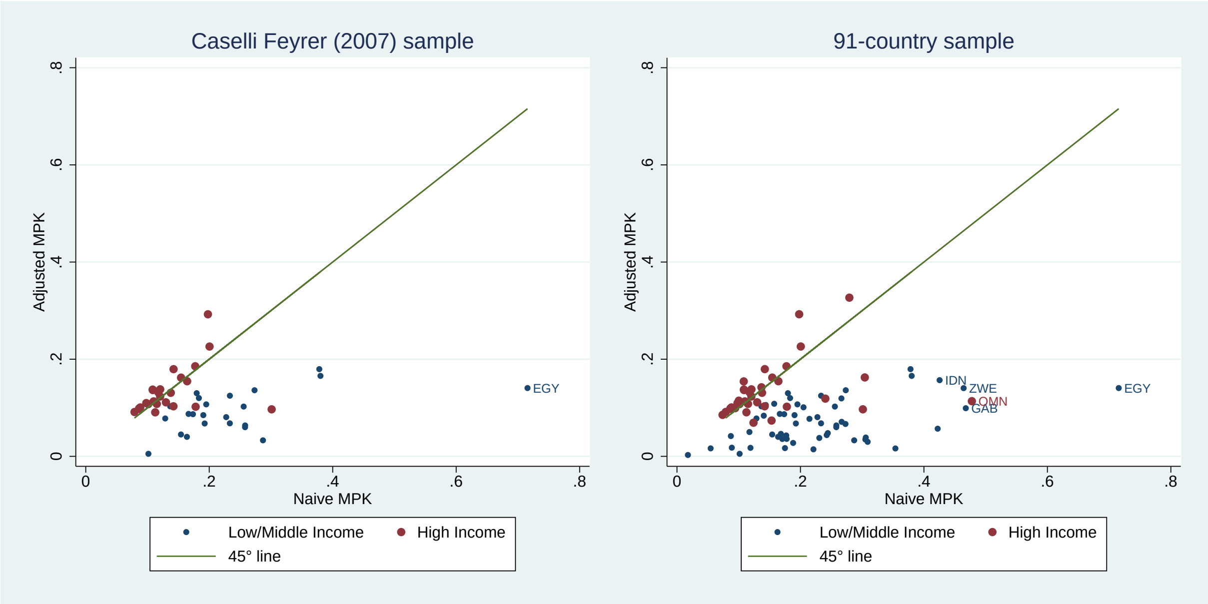
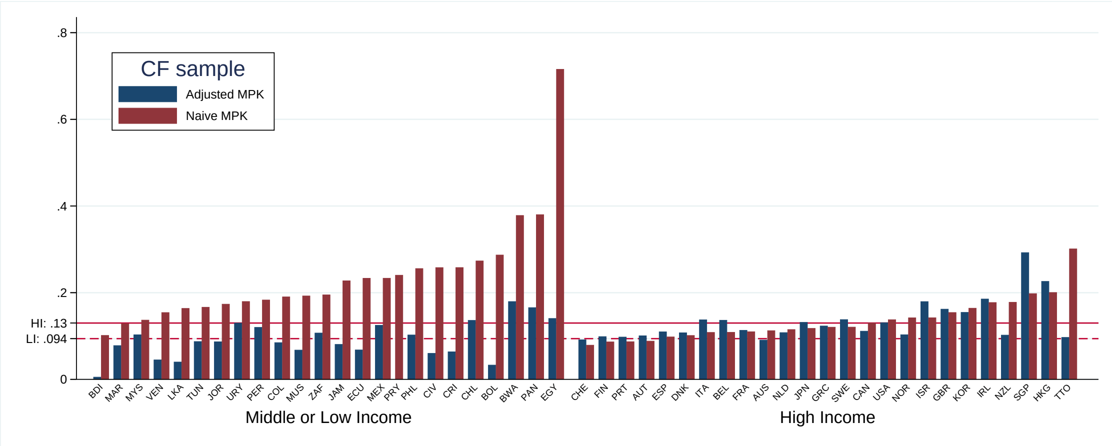


Figure 4.2 makes the same point by showing information on the *naive* and *adjusted* MPKs for each country in the two samples. Note that for many countries in the low-income group the difference between the two measures is extremely large. The low-income economies for which the difference is largest are Sub-Saharan African countries (Chad, Burundi, Central African Republic, Nigeria, Benin and Rwanda), whose *naive* MPKs exceeds the *adjusted* ones by almost 100%. Instead, the low-income economies for which the difference is smallest are Latin American and East-Asian countries (Peru, Uruguay, Argentina, Thailand and Malaysia) where the correction erodes about 30% of the *naive* MPK.

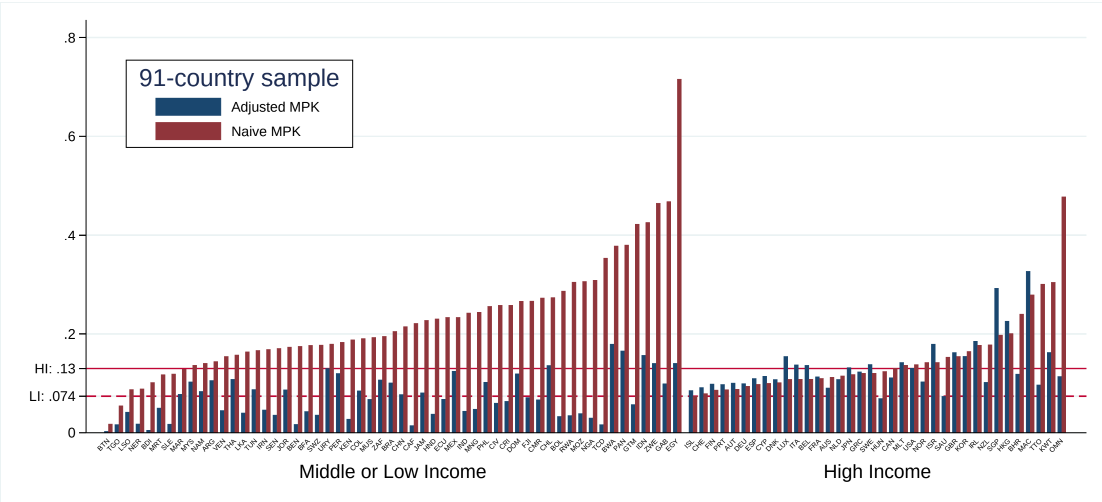
Importantly, figure 4.2 clarifies that the key difference between the Caselli and Feyrer (2007) sample and my new sample is that the latter includes many non-OECD countries that are not present in the former. The inclusion of these countries, especially the high-income ones, substantially increases the dispersion of the adjusted MPKs. In fact, as shown in panel (c), the *adjusted* MPKs of the high-income countries are roughly twice as high, on average, as those of the low-income countries, and range between 0.07 for Hungary and 0.33 for Macao.

The above evidence suggests that the result of Caselli and Feyrer (2007), according to which the MPKs are equalized around the world, may no longer hold in the extended sample. Figure 4.3 provides further evidence on this point by studying how the dispersion of MPKs had evolved over time. In particular, the figure plots the cross-country standard deviation of log *adjusted* MPKs and its 5-year moving average over

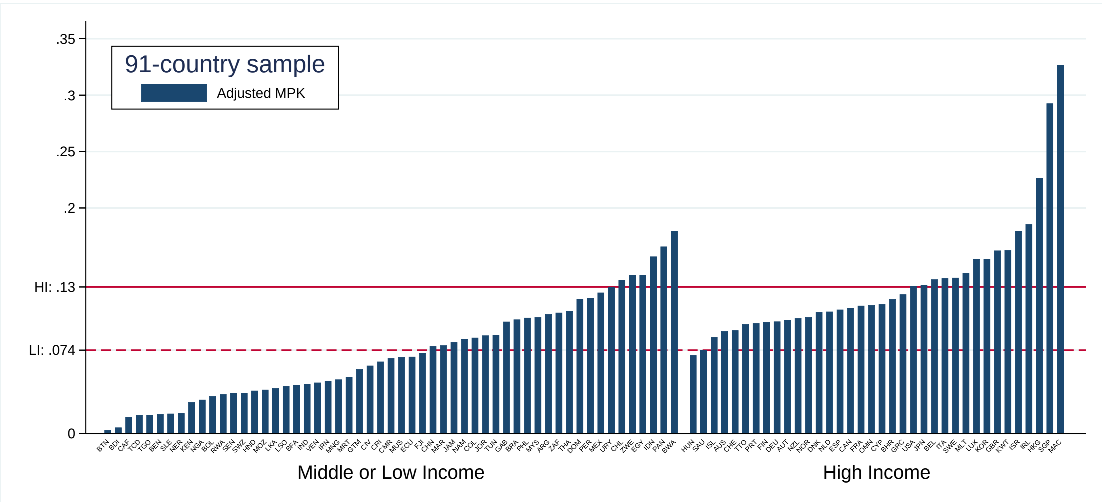
Figure 4.2: Distribution of Adjusted and Naive MPKs - Year 1996



(a) Adjusted and Naive MPKs by income group - Caselli and Feyrer (2007) Sample

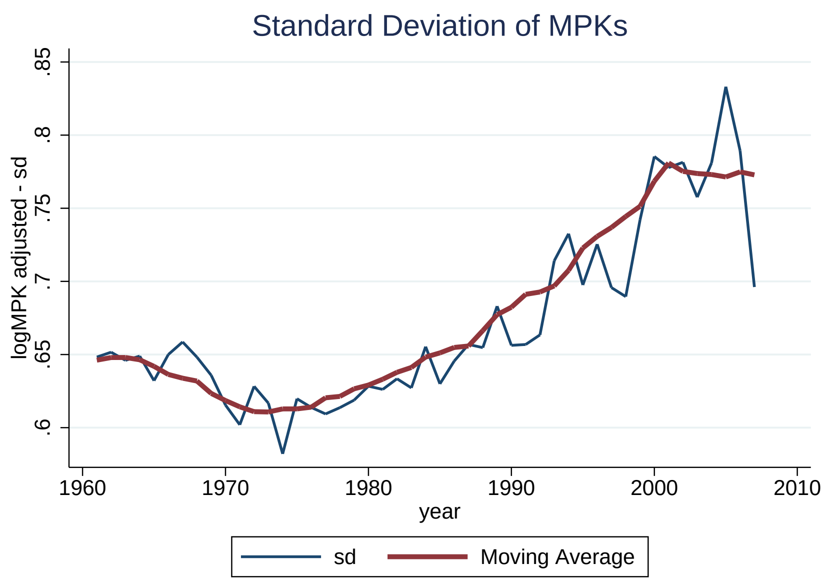


(b) Adjusted and Naive MPKs by income group - Extended sample



(c) Adjusted MPK by income group - Sorted time for the set of 81 countries that are present in all years. Note that, in 1996, the standard deviation is well above zero (0.72) and the coefficient of variation equals a substantial 0.6. Moreover, the figure suggests that there is no tendency for the MPKs to converge. Rather, the dispersion of MPKs has dramatically increased over time moving from 0.65 in the 1960s to 0.77 in the 2000s. The increase has taken place over the last four decades with an inflection point in the 1990s.

Figure 4.3: MPK standard deviation over time



I now argue that the heterogeneity in countries' MPKs is not random but is rather correlated with countries' level of development. To start off, figure 4.4 reports simple scatter plots of naive and adjusted MPKs on per capita GDP, both for the Caselli and Feyrer (2007) sample and for the extended sample. The top two graphs perfectly replicate the main result of Caselli and Feyrer (2007). In particular, per-capita GDP is negatively correlated with log *naive* MPK, suggesting that, wihout the correction, the returns to capital seem to be lower in rich countries. Instead, the *adjusted* MPKs are uncorrelated with per-capita GDP, implying that the corrected MPKs are equalized around the world. The bottom two graphs show, however, that this results are overturned in the extended sample. Specifically per-capita GDP is uncorrelated with the *naive* MPK but strongly positively correlated with the *adjusted* measure. Hence, not only are MPK not equalized around the world, but richer countries display higher returns.

Figure 4.4: MPK and per-capita GDP

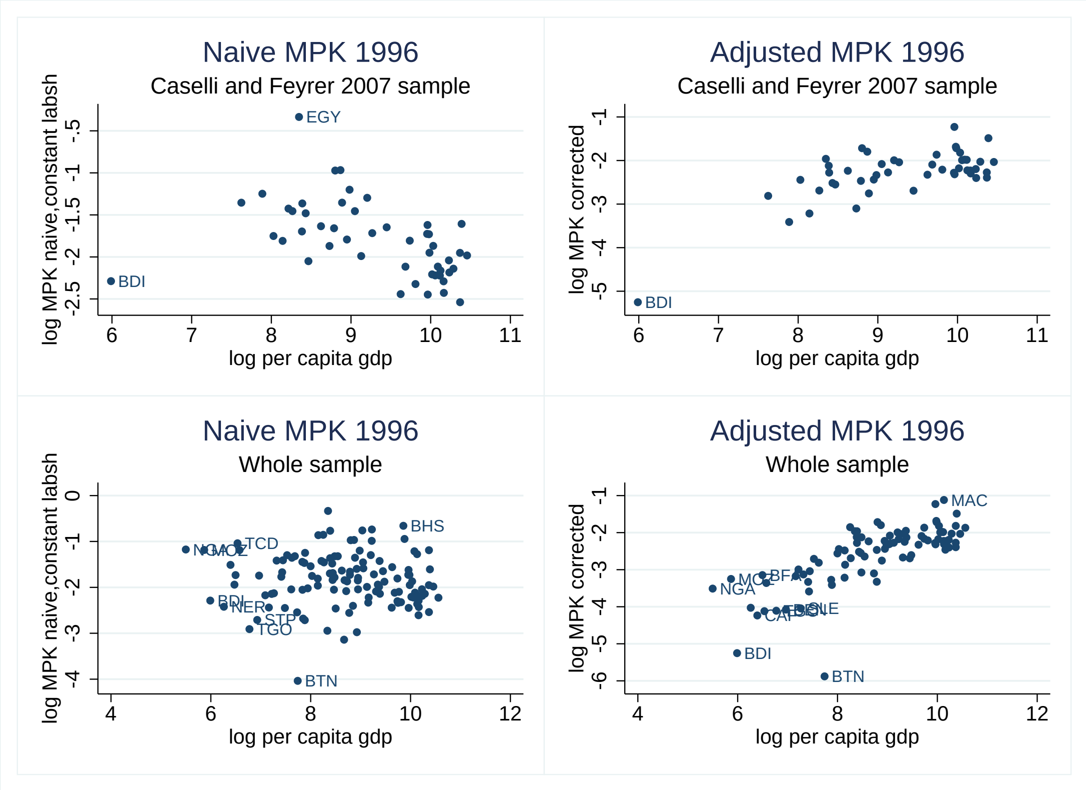


Table 4.1 provides more systematic evidence on the correlation between MPKs and per-capita GDP. The table reports coefficients obtained from OLS regression of log MPKs on log per capita GDP in different years. Note that, while the GDP-elasticity of MPK is weak and generally non significant in the Caselli and Feyrer (2007) sample (except for more recent years), this elasticity is always positive, large and significant in the extended sample. In the next section I dig deeper into this correlation and unveil an interesting pattern that emerges over time.

4.3.2 MPKs over time

In this section I show that the positive relation between MPKs and GDP is not only positive but also increasing over time. To this purpose I run decade-specific regression of average log *adjusted* MPK on average log per capita GDP. Hence I only exploit cross-country variation in the long-run values of the two variables to identify the GDP elasticity of MPK.

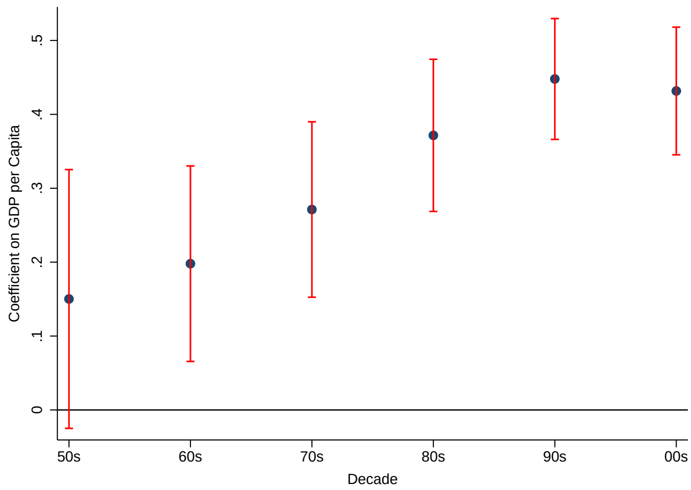
The baseline coefficients are reported in the first row of table 4.2 and visually shown in figure 4.5. The elasticity is always positive and significant at the 10% level or better, confirming the results in the previous section. Moreover, and strikingly, the elasticity

Table 4.1: Correlations MPKs and GDP per Capita - Cross Sections

	Adjusted MPK	Naive MPK	Adjusted MPK	Naive MPK
	CF Sample (47 countries)		Whole Sample (91 countries)	
	(1)	(2)	(3)	(4)
Cross Section 1956	-0.0227	-0.376***	0.112	-0.230*
	(0.0798)	(0.122)	(0.0822)	(0.119)
Cross Section 1966	-0.0887	-0.447***	0.181***	-0.272***
	(0.0732)	(0.106)	(0.0685)	(0.0633)
Cross Section 1976	-0.0455	-0.556***	0.309***	-0.157*
	(0.0919)	(0.107)	(0.0652)	(0.0822)
Cross Section 1986	0.166*	-0.456***	0.364***	-0.215***
	(0.0880)	(0.101)	(0.0663)	(0.0668)
Cross Section 1996	0.278***	-0.351***	0.476***	-0.0945**
	(0.0697)	(0.0647)	(0.0496)	(0.0451)
Cross Section 2006	0.208***	-0.134**	0.375***	-0.0454
	(0.0610)	(0.0558)	(0.0554)	(0.0424)
Sample Averages	0.095	-0.439***	0.381***	-0.1152*
1950-2007	(0.0922)	(0.0848)	(0.363)	(0.060)

increases almost monotonically over time. The variation across decades is large, with the elasticity rising from roughly 0.15 in the 1950s to more than 0.4 in the 2000s.

Figure 4.5: GDP Elasticities of MPK - Time Dynamics



In panel b) I control for different definition of the dependent and independent variables. Since the share of produced capital in total wealth from the World Bank is available for years 1995, 2000 and 2005, in row 2, I construct the *adjusted* MPK using the average value of this share in the three years, instead of the 1995 value, to check that the results are robust to possible fluctuation in the share of produced capital over time. The estimates are virtually identical.

Another concern with the previous results is that they may be driven by changes in the capital share of income occurred over the sample period, as shown in recent and influential literature (Karabarbounis and Neiman, 2013). In particular, the increasing pattern in the GDP elasticity of MPK may reflect a growing correlation between the capital share and per capita GDP. To account for this, in row 3, I reconstruct the *adjusted* MPK using a constant capital share, equal to the average over the whole sample period. While the capital share of income has increased in my sample, the pattern of GDP elasticities is unchanged. In row 4, I finally show that the results are the same when using per capita GDP in the first year of each decade rather than decade-specific means.

In panel c) I use different estimation methods to account for possible outliers. In particular, in row 5, I weight observations by the initial share of each country in world GDP, while in row 6, I use an outlier-robust estimator that assigns lower weighs to extreme observations. The qualitative pattern of results is preserved.

Finally in panel d) I show that the results are not driven by a specific group of countries. Indeed the coefficients are similar to the baseline specification when excluding one continent at the time (rows 7-11), OECD countries (row 12), offshore financial centers as defined by the IMF (row 13), oil-producing countries (row 14).

Table 4.2: GDP Elasticities of MPK - Decade Specific Regressions

	Decade					
	1950s	1960s	1970s	1980s	1990s	2000s
a) Baseline						
1) Adjusted MPK	0.150*	0.198***	0.271***	0.372***	0.448***	0.426***
	(0.0854)	(0.0663)	(0.0635)	(0.0595)	(0.0442)	(0.0426)
b) Dependent and Independent Variables						
2) Adjusted MPK - Av. Sh. Produced Capital	0.131	0.189**	0.243***	0.342***	0.438***	0.424***
	(0.0784)	(0.0720)	(0.0651)	(0.0627)	(0.0478)	(0.0428)
3) Adjusted MPK - Constant Labor Share	0.115***	0.201***	0.270***	0.369***	0.439***	0.403***
	(0.0259)	(0.0207)	(0.0200)	(0.0190)	(0.0144)	(0.0135)
4) Initial log GDP	0.154	0.163**	0.247***	0.341***	0.455***	0.422***
	(0.113)	(0.0696)	(0.0633)	(0.0584)	(0.0504)	(0.0418)
c) Alternative Estimation Methods						
5) Weighting by share of world GDP	0.254	0.137	0.176	0.240***	0.266***	0.249***
	(0.163)	(0.106)	(0.113)	(0.0666)	(0.0434)	(0.0343)
6) Robust Regression	-0.0241	0.170**	0.214***	0.298***	0.410***	0.405***
	(0.0453)	(0.0657)	(0.0547)	(0.0497)	(0.0364)	(0.0344)
d) Excluding Groups of Countries						
7) No Africa (27)	0.0555	0.0610	0.259**	0.368***	0.431***	0.440***
	(0.0875)	(0.0773)	(0.108)	(0.101)	(0.101)	(0.0863)
8) No Asia (22)	0.174*	0.199***	0.202***	0.311***	0.407***	0.402***
	(0.100)	(0.0706)	(0.0648)	(0.0588)	(0.0427)	(0.0453)
9) No Europe (20)	0.123	0.208**	0.337***	0.437***	0.516***	0.490***
	(0.115)	(0.0963)	(0.0784)	(0.0765)	(0.0531)	(0.0465)
10) No Latin America (17)	0.148	0.204***	0.266***	0.368***	0.444***	0.416***
	(0.0943)	(0.0680)	(0.0652)	(0.0617)	(0.0451)	(0.0443)
11) No North America (2)	0.162*	0.207***	0.280***	0.380***	0.455***	0.431***
	(0.0907)	(0.0694)	(0.0652)	(0.0614)	(0.0451)	(0.0430)
12) No OECD (20)	0.195	0.296**	0.410***	0.506***	0.575***	0.539***
	(0.150)	(0.121)	(0.0855)	(0.0866)	(0.0570)	(0.0473)
13) No OFC (3)	0.153*	0.196***	0.264***	0.360***	0.438***	0.418***
	(0.0871)	(0.0661)	(0.0628)	(0.0583)	(0.0433)	(0.0421)
14) No Oil Prod (20)	0.180*	0.218***	0.290***	0.382***	0.469***	0.440***
	(0.101)	(0.0733)	(0.0734)	(0.0654)	(0.0502)	(0.0458)

4.3.3 Unveiling the MPK-GDP Pattern

The previous section highlighted a new fact, namely a correlation between countries' marginal returns of physical capital and economic development. The correlation is strong, positive and increasing over time. This section delves more deeply into this relation trying to disclose the mechanism behind it.

I start off by analyzing how the two components of the adjusted MPK - the *naive* MPK and the correction term - correlate with GDP. In order to do so, I run OLS regressions of the log of each component on log per-capita GDP. Given that the OLS estimator is a linear operator, the resulting coefficients will sum to the coefficient obtained when the dependent variable is the *adjusted* MPK.[3] The results are reported in table 4.3. The dependent variables are the log *adjusted* MPK in column (1), the naive MPK in column (2) and the correction term in column (5). Note that the increasing correlation between the *adjusted* MPK and GDP is mainly driven by an increasing correlation of GDP with the correction term. At the same time, negative the correlation between the *naive* MPK and GDP declines over time and is even not significant in the last decade.

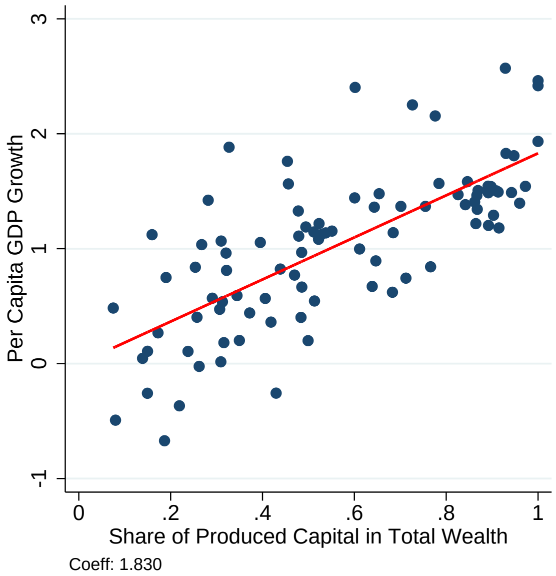
In column (3) and (4), I further decompose the naive MPK in the two components of output-capital ratio and capital share. The capital share is not correlated with development, which further shows that my results are not driven by the global decline of the labor share in the sample period. Instead, the correlation of the output-capital ratio with GDP slightly declines. Finally, columns (6) and (7) break down the correction term into the relative price of investment goods and the share of reproducible capital in total capital. Note that, as Caselli and Feyrer (2007) argue, capital is relatively more expensive in poor countries, especially so in the last 40 years. Note also that what seems to drive the positive relation between the correction term and the MPK is the estimate of the share of reproducible capital in total capital. By construction this share is constant over time. Hence, its increasing correlation with GDP means that per capita GDP must have risen more in countries with little non-reproducible capital. This evidence is further shown in figure 4.6, where I plot the partial correlation between the growth in per capita GDP over 1971-2007 against the estimated share of reproducible capital in total capital, controlling for initial GDP to account for convergence. Note that the relation is large and statistically significant (coefficient 1.830, s.e. 0.242 R^2 0.402).

[3]To perform the decomposition I re-construct the *adjusted* MPK using the country-level 10-year average of each component and then take logs. This measure correlates with the one presented above (the average of the log adjusted MPK) at the 99.8%.

Table 4.3: Adjusted MPK and GDP - Decomposition

	log Adjusted MPK	log Naive MPK			log Correction		
	Overall	Overall	log (Y/K)	log (1-labsh)	Overall	log (P_y/P_k)	log ($P_K K/W$)
log GDP per capita	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1950s	0.147*	-0.256**	-0.169*	-0.0865**	0.403***	0.0946	0.309***
	(0.0868)	(0.105)	(0.0859)	(0.0418)	(0.124)	(0.0850)	(0.0633)
1960s	0.194***	-0.257***	-0.204***	-0.0530	0.452***	0.0649	0.387***
	(0.0675)	(0.0660)	(0.0538)	(0.0364)	(0.0750)	(0.0541)	(0.0519)
1970s	0.272***	-0.177**	-0.186***	0.00901	0.450***	0.0874*	0.362***
	(0.0634)	(0.0842)	(0.0636)	(0.0394)	(0.0732)	(0.0459)	(0.0552)
1980s	0.367***	-0.193***	-0.202***	0.00969	0.560***	0.152***	0.408***
	(0.0598)	(0.0669)	(0.0534)	(0.0355)	(0.0624)	(0.0486)	(0.0424)
1990s	0.434***	-0.120**	-0.129***	0.00907	0.553***	0.154***	0.400***
	(0.0437)	(0.0479)	(0.0348)	(0.0315)	(0.0388)	(0.0243)	(0.0321)
2000s	0.427***	-0.0273	-0.0480	0.0208	0.454***	0.0878***	0.367***
	(0.0433)	(0.0415)	(0.0291)	(0.0295)	(0.0361)	(0.0159)	(0.0326)

Figure 4.6: GDP Growth and Share of Produced Capital - Partial Correlation



Note: Plot of the correlation between GDP growth over the period 1971-2007 and the estimates of the share of produced capital in total capital backed out from the World Bank, controlling for initial GDP.

4.4 Conclusion

In this paper I revisit the influential work by Caselli and Feyrer (2007). Expanding the dataset to more countries and more years I show two new interesting facts. First, the result the result that the MPK is equalized across countries does not branch out when considering a larger sample or different years. Second, the dispersion of the returns to capital is not random; rather, and surprisingly, the estimated returns to capital are systematically correlated with countries' per-capita GDP. This correlation is strong and increasing over the last two decades. These new patterns suggest that countries with better institutions have higher returns to production factors. Accordingly these new results may help explain one of the major puzzles in international economics, namely the Lucas Puzzle, according to which to little capital flows to developing countries. In fact, my results suggest that capital may be flowing in the right direction, i.e. towards countries where its returns are higher.

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