Linguistic Distance and Barriers to Economic Development in the Soviet Bloc

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Abstract

After the USSR dissolved in 1991, the Former Soviet Republics and their allies experienced different economic and political outcomes. In the economics literature, there is substantial evidence that technological improvements drive long-term economic growth, which in turn are impacted by a population's cultural proximity to the World Technology Frontier because of translation, adoption, and imitation costs. I investigate to what extent cultural - specifically linguistic - distance from the World Technology Frontier prevents technology diffusion, whether those effects are exacerbated by political tensions, and whether they have persisted in the post-Cold War Era. I find that linguistical distance from the World Technology Frontier is associated with barriers to technology adoption and lower economic growth, and that those effects are higher in the Soviet Bloc. Finally, there appears to be a negative Cold War legacy in terms of income growth, but not for technology adoption.

Acknowledgments

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Chapter 1

Introduction

For nearly seventy years, the Soviet Bloc existed behind the Iron Curtain, across the Eurasian continent, and under the umbrella of the USSR. Several of these republics were absorbed by the USSR following World War II in accordance with the Yalta Conference. However, when the USSR dissolved in 1991, the transitional countries underwent heterogenous economic development and various political reforms. Some have made astounding progress, such as Albania, who experienced a growth rate of 134 % between 1989 and 2016 while it had the lowest GDP per capita of the former USSR republics in 1989. On the other hand, several others have regressed in terms of economic development, such as Ukraine, which experienced a 36% decline in economic growth and had the lowest GDP per capita among the group of former USSR republics in 2016. Consequently, the tensions of the Cold War and the subsequent disintegration of the USSR created a natural experiment from which researchers may investigate many inquiries. The one in which I am interested in is determining the source of this heterogeneity of economic prosperity.

The previous literature (Spolaore & Wacziarg, 2009, 2011, 2013) has shown that measures of ancestral and cultural distance from the World Technology Frontier

capture barriers to the growth of a nation's income, commonly measured as per capita GDP. In particular, linguistic distance has a statistically significant effect on differences in income, indicating that it may be an important determining factor of national prosperity. Countries which are linguistically distant from the edge of innovation incur translation costs as information is transferred, as well as costs associated with the underlying levels of trust and bias. Yet, the existing research has not paid substantial attention to analyzing the impact of linguistic distance on the diffusion of technology, specifically. This is an important area to investigate because ever since Solow (1957) pioneered the concept of Total Factor Productivity (TFP), there have been numerous papers confirming its importance as a determinant of the income gap across countries, both theoretically (Romer, 1990) and empirically (Caselli, 2005; Comin & Hobijn, 2011; Spolaore & Wacziarg, 2009, 2011). Consequently, ascertaining the factors which drive technology has become a valuable avenue of research in determining what contributes to economic growth (Keller, 2001, 2004; Spolaore & Wacziarg, 2011).

In this paper, I attempt to provide an answer to this question by investigating the extent to which linguistic distance imposes barriers to the diffusion of technology. Specifically, I address: (1) to what extent linguistic distance impacts the diffusion of technology; (2) whether those effects are exacerbated by political tensions; and (3) whether there are lasting effects since the end of the Cold War. As a preliminary means of verifying the relationship between linguistic distance and economic growth, I examine the relationship between linguistic distance and per capita income, a common proxy for technology (as with Spolaore and Wacziarg (2009)), using a dataset of 80 Eurasian countries spanning from 1970 to 2017. Subsequently, I estimate the impact of linguistic distance on the diffusion of technology using the intensive margin of five technologies from 1975 to 1995. Finally, I test for lasting effects using a differences-in-differences framework.

While I do not claim causal relationships in my analysis, knowing the extent to which linguistic distance plays a role in determining TFP and per capita income across countries produces beneficial information. I find that increasing linguistic distance does correspond with lower income and technology growth, particularly for the Soviet Bloc countries during the Cold War indicating that the cultural barriers are compounded by political and or institutional barriers. In terms of whether it is more important to be close to the relevant or world technology frontier in this particular context, there is conflicting evidence. For the agricultural technologies, being close to the world technology frontier was most important, while for the communications technologies, it appears being *far* from the relevant technology frontier is most important. This latter conclusion may simply be a result of the confounding political, economic, and ideological difficulties associated with being close to Russia. Finally, I conclude that the negative political and cultural impact associated with the Cold War has persisted for income growth of the Soviet Bloc countries, but not for the adoption of the technologies included in my analysis. One interpretation of this is that the source of the remaining income gap is not originating from the diffusion of technology.

Given the current geopolitical climate between the modern superpowers of the US and China, my results carry important implications. Namely, with the increased tensions (particularly since the COVID-19 pandemic (D'Urbino, 2019)), the transfer of technology and economic growth are likely to be inhibited by the mounting political, economic, and cultural barriers. I suspect that the new "Cold War" will be particularly harmful for the small countries allied with China, who will reluctant to collaborate economically with the US and its other allies due to the pressures from China. The main contribution of my research is that it offers a methodology to address these questions in other contexts, particularly with that which faces the world today.

The layout of this thesis is as follows. First, I introduce the historical and economic context surrounding the period of interest and why it serves as an intriguing point of research regarding technology and linguistics in Chapter 2. This is followed by a review of the relevant literature on technology and linguistics (Chapter 3), and a description of the datasets (Chapter 4). Finally, I provide the empirical methodology (Chapter 5), a detailed discussion of the results I have observed (Chapter 6), and conclude with the relevance of my research and the implications for future research (Chapter 7).

Chapter 2

Historical Context

The purpose of this chapter is not to provide a comprehensive analysis of the many factors involved with the Collapse of the USSR, which officially occurred in 1991. Rather, I provide a brief overview of the immediately relevant political and economic conditions surrounding it and the Cold War. Below, I describe the international competition and mutual fear between the US and the USSR, the barriers inhibiting the transfer of technology, and the ultimate collapse and reconstruction of the Former Soviet Bloc.

2.1 Spheres of Influence

The Cold War Era was a period during the 20th century (1945-1991) most notable for the ebb and flow of the nuclear arms and space exploration race throughout the decades between two superpowers: the United States (US) and the Union of Soviet Socialist Republics (USSR). In response to and fear of the expansion of communism, the US pursued a "containment" policy of trying to simultaneously maintain its democratic sphere of influence, while inhibiting the expansion of the Soviet sphere. One means of pursuing that goal was to adopt the Marshall Plan following World War II, in which the US Government offered

financial assistance to the recently devastated countries of Europe. The USSR maintained and extended its influence from Asia to Eastern Europe through many avenues, including offering the Molotov Plan (their version of the Marshall Plan), annexing neighbor nations, and installing their own agents as heads of state to direct political and economic policies (East, 1963). Additionally, the Communist Party had an active role in determining trade and the adoption of Western technologies (Congress, 1979). Since they emphasized party control, alliance, and loyalty, many technology adoption requests were denied, and in fact, joint ventures with Western firms were generally prohibited, with the only exceptions being Yugoslavia, Romania, and Hungary. The US did not help in easing these relations since they controlled what US goods could be exported to Eastern Europe; in fact, the USSR was prohibited from importing the most advanced technologies, which tended to be those not easily or efficiently produced domestically (Congress, 1979).

The main methods of obtaining technology for the USSR included employing foreigners, training their workers in the West, and hosting trade fairs. Yet, trading with Western firms and purchasing Western “turnkey” factories were, in fact, major sources of technological adoption. "Turnkey" factories are those which are already equipped with the necessary technology for production, and in some cases, worker training was conducted by the former employees of the factory. Surprisingly, Italy provided nearly 27% of the Western factories in the chemical industry purchased by the USSR during the 1970’s, with France, West Germany, the US, and Japan providing 22%, 17.5%, 14.3% and 14%, respectively (Congress, 1979). Despite there being several Soviet countries with modest computer industries, Britain and France actively sought the USSR market, and even with that competition and the political tensions with the US previously discussed, the US made up 27.7% of the USSR’s Western imports from 1972-77 and 23.4% of the

USSR's Western energy equipment imports. These values are even likely underestimated as some of the USSR imports from non-US Western countries would have originated from the US. However, while there was more East-West trade than one might expect, there were a series of administrative, political, and economic hurdles to the Soviet adoption of Western technologies (Congress, 1979).

2.2 Barriers to Adoption

Among the hurdles faced during the Cold War, one arose from the overemphasis on the development of technology for the benefit of the nuclear arms race and space exploration. In order to counteract the US, the USSR channeled an inordinate amount of resources towards their military buildup even during times of slow or negative economic growth, at the expense of all other sectors and the people directly. The Academy of Sciences of the USSR, the headquarters of national research, was based in Moscow and foreign cooperation in the development of these technologies was largely discouraged, if not outright prohibited during the Cold War (Nettl, 1967). Consequently, the financial and human investment into research and development for the manufacturing sector was increasingly neglected, with goods and production advancements gradually declining with the advancement of computerization in the mid-1960s.

The administrative barrier associated with adopting technologies was the excessive use of bureaucratic red tape, largely due to the structure of its command economy. There was an overabundance of governmental organizations overseeing the sale, trade, and development of technologies. At the top was the Gosplan, which developed the 5-year plans, with annual trade decisions and currency allocations due to short-term market imbalances. Beneath was a large intricate web of national, regional, sectoral, and industrial ministries and departments to manage

research and development (R&D) and the trade of technologies (Congress, 1979). A key component was the Foreign Trade Organization, through which all communications between suppliers and consumers of technology had to be processed, leading to substantial delays in the adoption of technology. Moreover, one of the major institutions involved with the international trade of technology was the Ministry of Foreign Affairs within which there were three divisions: the trade-political administrations, the functional administrations, and single-commodity groups administrations. Worth noting is that there was a trade-political administration specifically for the US and another for the rest of the Western countries. This illustrates the depth of the political tensions involved with the US, and the political complications resulting from the Communist Party. Besides their indirect impact, they also were directly influential by ensuring that government employees were intensely loyal to their political ideology, thereby nurturing bias against the Western World. Moreover, the cultural Soviet mindset was influential in the decision-making process of the command economy; that is, they adopted the practice of technology imitators rather than innovators because they disapproved of the seeming waste of resources in failed ventures. In order to avoid sunk costs, their policy was to wait for the product to be vetted through the capitalist system, after which point they would attempt to adopt the new technology (Congress, 1979).

Additional barriers emerged from the structure of the firms and the incentive system of the centralized economy. Soviet firms engaged in vertical, rather than horizontal, production. That is, when producing a good, a firm produces not only the good meant for sale, but also the intermediate goods and frequently the necessary equipment. This is important since engaging in such a production chain inhibits the transfer of knowledge at the intra-industry level, let alone the inter-industry level. As a result, the transfer of knowledge and technology was

very slow in this environment and was exacerbated by the incentive system in the USSR, which was fundamentally different from that of the US. In a capitalist economy, entrepreneurs undertake risk because they are driven by the possibility of a positive profit. In a centralized economy, in contrast, the expectation is to meet the quota in order to avoid ramifications. Granted, if a firm produced output greater than the quota, then they were rewarded. However, the consequences for not achieving the quota deterred firms from taking on the personal risk of adopting new technologies that may not immediately increase productivity; likewise, even if they managed to produce above quota and earn a bonus, the firm could expect a higher quota required of them in the following years. The combination of these many factors contributed to the approximated adoption and diffusion lag of 5 to 7 years (Congress, 1979).

2.3 THE COLLAPSE & RECONSTRUCTION

While the USSR experienced significant growth early on, the Era of Stagnation followed close behind. The agricultural and mining sectors were severely neglected since the USSR prioritized first the military and second the industrial sectors, which was particularly harmful to the Former Soviet Republics. Since the government centralized the industrial sector in the heart of Russia, this left the Republics' economies to predominantly rely on the agricultural and mining sectors. This gross mismanaged of resources ultimately resulted in mass food shortages and increasing trade deficit. From this physical hunger, the growing intolerance of the military buildup, and a variety of other factors, political dissent blossomed, the satellite states regained autonomy and the USSR met its demise.

Subsequently, a few of the autonomous states underwent division, some peaceful and others through violent civil wars, which delayed economic stability and

growth in these countries and the surrounding regions. The Former Soviet Republics that experienced centrifugal tensions following independence include Yugoslavia, Czechoslovakia, and Moldova. The Russian Federation itself faced especially dire economic and societal consequences during the 1990s. While the 1990s were a struggle for most of the former satellite countries, they began to regain their economic and political strength and stability by the early 2000s. Much of their success may be attributed to the direct and indirect benefits gained from joining international trade organizations, such at the WTO (formerly the GATT) and NATO, and political and economic unions (the European Union, specifically) which helped relieve the East-West biases so heavily emphasized previously.

Chapter 3

Literature Review

Within this chapter, I present the relevant literature which provides the necessary foundation for my analysis and to which I hope to contribute with my research. In the first section, I provide an overview of the field of literature that investigates the sustainable impact of technology on economic growth and the resulting consensus of its benefits. Since I investigate whether linguistic distance affects economic growth through the channel of technology adoption by acting as a barrier, the second section outlines the role that cultural distance plays as a barrier to technology diffusion and economic development, including what the previous research has determined thus far using linguistic distance.

3.1 Technology & Economic Growth

Solow (1957) theoretically divided the determinants of economic growth into short-run and long-run factors. Capital and labor are short-run determinants since changes in these factors do not shift the aggregate production function. Technology, or Total Factor Productivity (TFP), on the other hand, results in long-run improvements as technological changes result in shifts of the growth trajectory. Since then, there has been substantial research on technology itself,

including the work of Romer (1990) work which assumed that technology is endogenously determined since it is a nonrival and partially excludable good. It is partially excludable because legal protections for intellectual property, such as patents, may be enacted. I further posit that its feature of excludability may be augmented by distrust and bias caused by political and cultural divisions (Comin & Hobijn, 2011; Spolaore & Wacziarg, 2011; Keller, 2004), transportation costs due to geographic distance (Keller, 2004), and translation costs due to communication (Keller, 2001). In the last instance, Keller presents support that countries whose populations with a greater percentage of bilateral language skills had a higher percentage of technology transfer when using research and development (R&D) as the measure for technology.

Comin and Hobijn (2010, 2011) empirically analyzed the relationship between economic growth and technological progress, as well as the rate of adoption of specific technologies. Their results support that differences in technology adoption lags accounted for nearly one-fourth of income per capita differences for their sample of 166 countries over the nineteenth and twentieth centuries (Comin & Hobijn, 2010). And when considering the Western European and Japanese economies during the post-World War II era, they found evidence for the economic growth benefits resulting from technology transfers, especially for countries which participated in the Marshall Plan since this political association facilitated technology adoption (Comin & Hobijn, 2011). Their analysis also suggests that the technology transfers from the US, the World Technology Frontier, did not simply allow the countries to move along their pre-war growth path but transition to a higher one.

Given the abundant evidence presented in these and other papers that long-run economic growth is driven by technological improvements, Spolaore and Wacziarg (2009, 2011) investigated the influence of cultural distance on technology transfer; they utilized genetic distance as their measure for cultural distance,

which is described in greater detail in the following section. For technology, they utilized income per capita as a proxy (2009) and measures of technology (2011). These measures were at the extensive and intensive margins; the former notes the mere existence of specific technologies within a country while the latter records the per capita presence. The estimated technology differences across country pairs on genetic distance, even controlling for geographic features, suggested that cultural distance from the World Technology Frontier creates a barrier to technological diffusion, which they attributed predominantly to people's proclivity to appropriate information from those more similar to themselves.

3.2 CULTURAL & LINGUISTIC DISTANCE

Much of the literature thus far has investigated the relationships between culture, institutions, ethnicities, and a variety of political economy outcomes, including economic growth. Alesina and Fuchs-Schundeln (2007) in their analysis of East and West German preferences following the Cold War found that institutions impact individual preferences as they observed that those who lived longer under the Communist regime had higher and more persistent preferences for redistribution and high government intervention than younger East Germans or any West Germans, while the preferences of East Germans converged to those of West Germans over time. Here is a perfect illustration of how influential the underlying institutions and cultures are for human behavior and calls into question people's willingness to adopt foreign technologies. Additionally, Alesina and Giuliano (2015) investigate the bilateral causal relationship between culture and institutions, and they emphasize their impact on determining economic development. Furthermore, the work of Desmet, Le Breton, Ortuño-Ortín, and Weber (2011) solidifies, along with the previous two articles, the importance of

culture heterogeneity on preferences, political stability, and economic success as they developed and empirically analyzed the negative consequences of polarized cultures and public goods provisions within a country. It becomes evident that both culture and institutions are important factors to control for when estimating economic growth.

The actual measurement of culture is a topic of hot debate because culture in and of itself is a broad term lacking clear, defined lines of its composition. Therefore, finding a logical measure has become a common subject of research. Most measures are qualitative in nature and derived using the World Values Survey; other researchers attempt to dissect cultural distance between societies into subcategories more easily and quantitatively defined, such as genetic, ethnolinguistic, or religious distance. Spolaore and Wacziarg (2016) argue that genetic distance can be interpreted as a summary statistic for culture and an appropriate measure of historical relatedness because it is positively correlated with cultural, linguistic, and religious distances. To clarify, genetic distance is a measure of the time since two populations were the same population and is commonly computed using genes randomly determined to exclude variation due to habitat adaptation. Moreover, Spolaore and Wacziarg (2009) found that genetic distance, as measured in distance from the World Technology Frontier, negatively affects economic growth, a result explained as that people are more willing to learn and cooperate with people more similar to themselves; consequently, people who are genetically close to the Frontier are more willing to trade and learn from the people at the Frontier than those who are more genetically distant.

In this literature, linguistic (or ethnolinguistic) distance is used as a control and frequently found to be a statistically significant factor. In fact, (Desmet, Ortuño-Ortín, & Wacziarg, 2017) found it to be associated with conflict and public goods provision, and in another paper (2012), the same authors found that

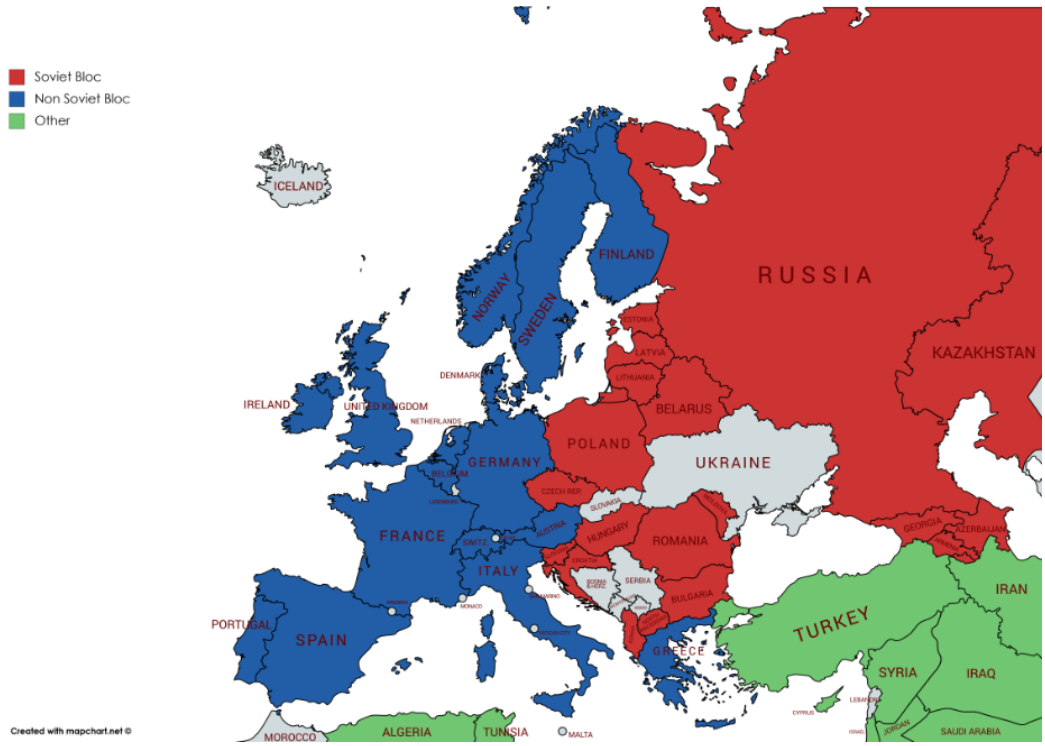
recent divisions in linguistics are more deterministic of economic growth than are ancient divisions, because the populations' ability to interact, cooperate, and communicate hinders their ability and willingness to trade goods and information. Therefore, it seems to follow that linguistic distance would impede the transmission of technology. To my knowledge, there is no existing literature that evaluates the channel through which linguistic distance affects economic growth, and specifically in the context of the Former Soviet Bloc. Given the literature presented here, I suspect it functions as a barrier to technology adoption. It is in this vein I aim to contribute with my research.

Chapter 4

Data

This chapter contains a detailed description of the the construction of the main variables of interest, as well as an evaluation of the stylized facts for both

Figure 4.1: Countries in Analysis



Note: Figure 4.1 illustrates a partial list of Eurasian countries used in my analyses. Please see Table A.1 for entire list. Red countries are Former Soviet Bloc Members; Blue countries were allied with the Western World; Green countries were not officially allied; Grey countries I excluded due to a lack of data.

datasets I compile. In each instance, I compare the Soviet Bloc countries with the set of Western European countries, hereafter referred to as the "non-Soviet Bloc." Figure 4.1 partially illustrates the Soviet Bloc and the non-Soviet Bloc countries located on the Eurasian continent used in my analyses (see Table A.1 for complete list). It is important to note that the Soviet Bloc consists of more than just the former Soviet Republics, but also all countries which fell behind the Iron Curtain.

Table 4.1: Summary Statistics of Main Independent Variables

Panel A: Income Dataset				
	Mean	Std. Dev.	Min	Max
LDd, Russian	0.98	0.03	0.89	1.00
LDw, Russian	0.97	0.04	0.79	1.00
LDd, English	0.95	0.16	0.00	1.00
LDw, English	0.95	0.16	0.00	1.00
SB (=1)	0.31	0.46	0.00	1.00
Panel B: Technology Dataset				
LDd, Russian	0.98	0.03	0.89	1.00
LDw, Russian	0.97	0.05	0.79	1.00
LDd, English	0.95	0.16	0.00	1.00
LDw, English	0.95	0.16	0.00	1.00
SB (=1)	0.33	0.47	0.00	1.00

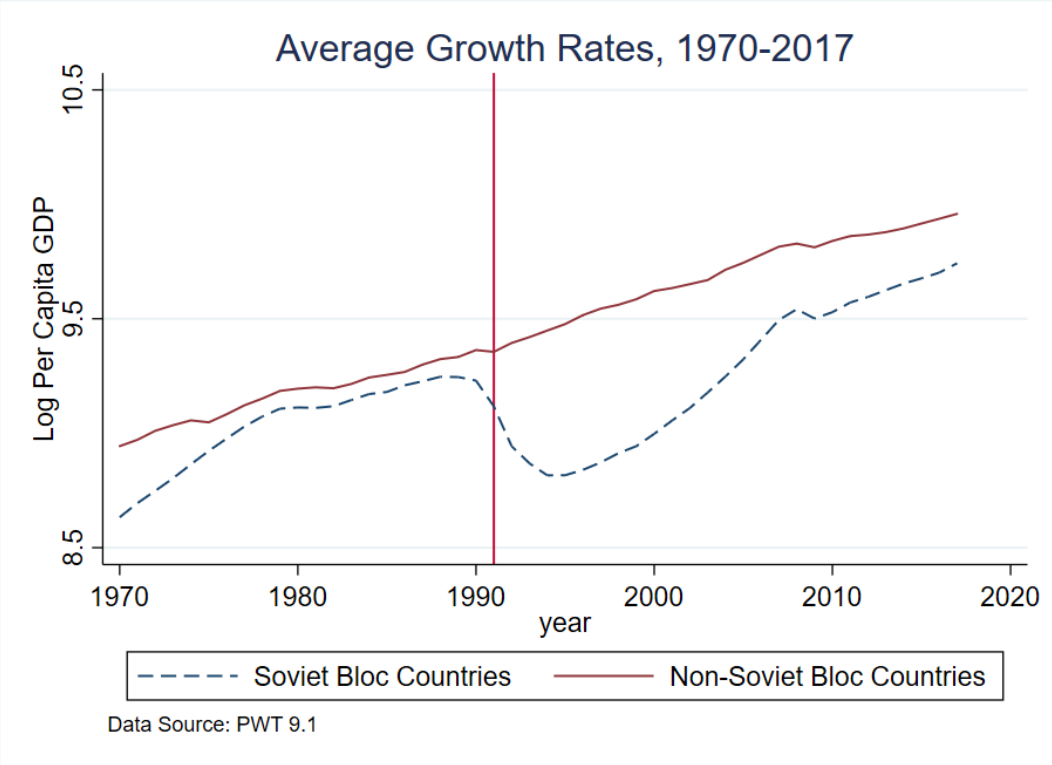
Note: The "d" and "w" denote "dominant" and "weighted"

My analysis is conducted after compiling two unbalanced panel datasets at the country level for the Eurasian continent, where these datasets differ by technology measure, country list, and time frame, but have the same independent variables (listed in Table A.2). The first, "Income", spans the period starting in 1970 and ending in 2017, while the second, "Technology", covers the period 1975-1995. From Table 4.1, note that the statistics are comparable across both datasets for the main explanatory variables.

4.1 INCOME & TECHNOLOGY

I initially follow the methodology of Spolaore and Wacziarg (2009) and use real GDP per capita, which may be considered as a proxy for technology adoption since technology leads to higher levels of income. I collect real GDP, measured in 2011 US dollars, and population from the Penn World Tables, version 9.1, to construct real per capita income (Feenstra, Inklaar, & Timmer, 2017). The resulting "Income" dataset consists of 31% of former Soviet Bloc countries after merging it with the independent variables (see Table 4.1).

Figure 4.2: Growth Rates



After graphing the logged per capita income over time (Figure 4.2), annually averaged by membership of the Soviet Bloc, the difference in trends is clear. For the non-Soviet Bloc countries, they experienced a higher, more consistent increase in growth rates than the Soviet Bloc. For the Soviet Bloc countries, there is a gradual increase in per capita income growth over time until the dissolution

of the USSR, at which point there is a drastic drop. The average reached and surpassed its 1990 level by around 2005. Both sets of countries have a slight downturn around 2009, which corresponds with the Great Recession. Overall, the former Soviet Bloc countries have not yet been able to close the income gap.

While per capita income is an appropriate proxy for technology, my question still lies with technology itself. Consequently, in the same manner as previous research (Comin & Hobijn, 2010, 2011; Spolaore & Wacziarg, 2016), I utilize the Cross-country Historical Adoption of Technology (CHAT) database (Comin & Hobijn, 2009). Focusing on the Eurasian countries, I select five technologies, measured at the intensive margin, which are available consistently from 1975-1995 for at least 25 countries, which I separate into two categories: Agriculture and Communications. The Agriculture technologies include the total number of tractors used in the agriculture sector, and the area with automated irrigated systems (total and percent); Communications technologies are the number of daily circulated newspapers and the number of radios. Ultimately, former Soviet Bloc countries make up 33% of the resulting "Technology" dataset (Table 4.1).

As reported in Table 4.2, the average growth rate for each technology during the Cold War was negative for Soviet Bloc countries and positive for the non-Soviet Bloc countries. During the decade surrounding the collapse of the USSR, the non-Soviet Bloc technology growth rates become negative, possibly driven by the recession of the early 1990s. Additionally, those countries' economies are not based on the agriculture sector. While communication technologies became more negative for the Soviet Bloc countries during that decade, the agriculture technologies either became less negative (*Agr. Tractor*) or positive (*Total* and *Percent Area Irrigated*).

Table 4.2: Summary Statistics of Technology Growth

	1975-1985		1985-1995	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Panel A: Soviet Bloc				
Agr. Tractor	-0.07	0.03	-0.06	0.10
Total Area Irrigated	-0.07	0.08	0.02	0.11
Percent Area Irrigated	-0.05	0.08	0.06	0.19
Newspaper	-0.06	0.06	-0.08	0.12
Radio	-0.06	0.03	-0.12	0.13
Panel B: Non-Soviet Bloc				
Agr. Tractor	0.04	0.12	-0.09	0.15
Total Area Irrigated	0.02	0.08	-0.08	0.12
Percent Area Irrigated	0.02	0.08	-0.07	0.10
Newspaper	0.03	0.08	-0.06	0.16
Radio	0.04	0.11	-0.13	0.14

4.2 LINGUISTIC DISTANCE

The main variables of interest are dominant and weighted linguistic distance (*LD*). I acquired them from the world dataset of Spolaore and Wacziarg (2009), who follow the methodology of Fearon (2003), obtain the linguistic data from Ethnologue, and calculate the indices, ranging from 0 to 1, as follows:

$$LD_{ij} = \sqrt{\frac{15 - CN_{ij}}{15}}$$

where *CN* is the number of common nodes shared between either the dominant languages or the weighted average of the languages within each country across countries *i* and *j*. *CN* essentially measures the linguistic similarity of two populations, and 15 is the maximum possible nodes shared. The dominant measure is particularly useful because it rarely changes over time, while the weighted is dependent on the local population at the time of measurement. Both are phylolinguistic measures, which are the language analogs of family trees (see Figure

A.1 for an illustration).

Since I am interested in seeing how the linguistic distance from the World or Relative Technology Frontier affects the adoption of technology, it is necessary to look at linguistic distance relative to those frontiers. Spolaore and Wacziarg (2009) have bilateral and relative to the UK measures for their world dataset, but not relative to Russian, which I construct. I chose Russia as the frontier to test the importance of linguistic proximity to the relevant technology frontier since Moscow would have been the technology frontier for the countries segregated behind the Iron Curtain during the Cold War. Table 4.3 reports the correlations between the linguistic measures for both datasets, which are all large, with the smallest being between the dominant *LD* from Russian and the weighted *LD* from English at 0.81 and 0.85 for the Technology and Income datasets, respectively. It is not surprising that the dominant and weighted measures within a language are strongly and positively correlated since these measures are closely related. Additionally, the strong positive correlations between the Russian and English measures suggest that the two languages, which are distinct, are moderately close using this phylolinguistic tree measure.

Table 4.3: Correlation Matrix of Main Variables

Panel A: Income Dataset

	Income per Capita								*LDd, Russian*	*LDw, Russian*	*LDd, English*	*LDw, English*
	Level						**Growth**					
	1970	1980	1990	2000	2010	2017	1970-1991	1992-2017				
LDd, Russian	-0.44	-0.40	-0.39	-0.34	-0.34	-0.35	0.04	0.10	1.00			
LDw, Russian	-0.45	-0.43	-0.38	-0.33	-0.32	-0.34	0.09	0.09	0.88	1.00		
LDd, English	-0.54	-0.50	-0.49	-0.44	-0.43	-0.44	-0.01	0.11	0.95	0.87	1.00	
LDw, English	-0.53	-0.52	-0.46	-0.42	-0.40	-0.41	-0.01	0.10	0.85	0.96	0.90	1.00

Panel B: Technology Dataset

	Technology Growth					*LDd, Russian*	*LDw, Russian*	*LDd, English*	*LDw, English*
	Agr. Tractor	*Area Irrigated (Total)*	*Area Irrigated (%)*	*Newspaper*	*Radio*				
LDd, Russian	0.00	0.05	0.04	-0.02	-0.05	1.00			
LDw, Russian	0.02	-0.03	0.01	-0.06	-0.08	0.89	1.00		
LDd, English	-0.05	0.14	0.14	-0.07	-0.05	0.86	0.85	1.00	
LDw, English	-0.01	0.06	0.10	-0.10	-0.07	0.81	0.93	0.93	1.00

Note: The "d" and "w" denote "dominant" and "weighted", respectively.

In relation to income levels over time, there are moderate negative correlations that diminish over the last fifty years, regardless of the *LD* measure. This

is what should occur if linguistic distance from a technology frontier inhibits technology adoption and, in turn, economic prosperity. In contrast, the unconditional correlations increase in magnitude in the post-Cold War era for income growth: relative to Russian, there is always a positive correlation and doubles for the dominant measure after the collapse; likewise, relative to English, the correlations are weakly negatively correlated during the Cold War, but become positive and increase tenfold in magnitude (in absolute terms, the correlations are still weak). These growth correlations are weak support for the convergence theory of economic development. In terms of the communications technology growth rates, the correlations are negative and generally greater when relative to English. The correlations differ in sign across the frontiers only for the growth of the *Agr. Tractor*, where it is positive for Russian (as it is for the other agriculture technologies' growth) and negative for English. However, it is necessary to acknowledge that Russian - like English - is an Indo-European language, and these correlations could simply be a result of that relationship. My empirical methodology (Chapter 5) and analysis (Chapter 6) helps to separate these competing effects.

4.3 CONTROLS

The geographic and regional controls come from the same dataset compiled by Spolaore and Wacziarg (2009) from which I collected the linguistic measures. They include factors which would influence trade, communication, and technology transfer, such as differences in latitude and longitude, geodesic distance, transportation costs, whether two countries share a common body of water or are landlocked, and if the country is located in Asia or Africa. A detailed description of each of these is presented in Table A.2.

Finally, I use the country-level dominant and genetic distance measures of

FST from the later work of Spolaore and Wacziarg (2018), which is a more precise measure of historical relatedness with more variation from Pemberton, DeGiorgio, and Rosenberg (2013) in place of Cavalli-Sforza, Cavalli-Sforza, Menozzi, and Piazza (1994). Each constructs their phylogenetic dataset based on genetic drift that is random (i.e., not due to natural selection), where the latter evaluates using genetic markers (e.g., blood types) and the former uses human microsatellite variation (repetitive DNA tracts). As with the linguistic measures, I constructed the measures relative to Russian with the given data since the geographic and genetic measures were calculated only bilaterally or relative to the UK.

Chapter 5

Empirical Strategy

In this chapter, I describe the econometric methodology I employ to estimate the impact of linguistic distance on technology adoption. I use three different measures of technology during different time periods. In each case, I estimate the impact using dominant and weighted measures of cultural distance, and in relation to each frontier. Given the time invariant nature of linguistic, cultural, and geographic data, using panel analyses is ineffective and instead, I use a cross-sectional technique. Finally, I detail the difference-in-difference approach implemented to uncover the existence of persistent negative effects on adoption resulting from the Cold War.

5.1 Model 1: Per Capita Income

For the first specification, I estimate Equation 1 (below) at several points in time and record the standardized coefficients which are allowed to vary across time:

$$Y_{it} = \beta_{0t} + \beta_{1t} LD_{if} + \beta_{2t} SB_i + \beta_{3t} SB_i \cdot LD_{if} + \beta_{4t} X_{ift} + \epsilon_{ift} \tag{5.1}$$

Variable Y is real GDP per capita for country i in year t as a function of lin-

guistic distance between that country and technology frontier *f*, whether it was a former member of the Soviet Bloc, *SB*, the interaction of the two, and a series of geographic and cultural controls, *X*. Year *t* for this regression is once every ten years from 1970 to 2010, and once for 2017. For year *t*, β_1 reports the impact of being linguistically distant from the frontier for non-Soviet Bloc countries, and β_3 reports the additional impact for Soviet Bloc countries. I anticipate β_1 to be negative based on the theory that the further a country is from the technology frontier, the lower its adoption of technology, and on the empirical literature discussed previously. If this is so, then the further a country is from the frontier linguistically, the lower that country's expected per capita income level. It should also be insignificant when measured from Russian. If β_3 is negative, then that would support the hypothesis that being far from the frontier is especially harmful for Soviet Bloc countries because their well-being is directly lower than the non-Soviet Bloc.

5.2 MODEL 2: PER CAPITA INCOME GROWTH

Additionally, $Growth^{inc}$, the growth rate for real GDP per capita for country i in period p in Equation 2, is regressed on linguistic distance, Soviet Bloc status, and other covariates including initial income level:

$$Growth_{ip}^{inc} = \alpha_{0p} + \alpha_{1p} LD_{if} + \alpha_{2p} SB_i + \alpha_{3p} SB_i \cdot LD_{if} + \alpha_{4p} X_{ifp} + \upsilon_{ifp} \quad (5.2)$$

The time period p in this regression is either during the Cold War era (1970-1991) or the post-Cold War era (1992-2017). For period p, α_1 again reports the impact of being linguistically distant from the frontier for non-Soviet Bloc countries, and α_3 the additional impact for Soviet Bloc countries. For per capita income growth rate, I expect α_1 to be positive (and insignificant when measure relative

to Russian) since the countries further linguistically from the World Technology Frontier are expected to have lower rates of technology adoption, then they should follow the theory of convergence. In contrast, due to the political tensions associated with the Soviet Bloc, I anticipate α_3 to be negative during the Cold War and positive afterwards.

5.3 MODEL 3: TECHNOLOGY GROWTH

Finally, I estimate $Growth^{tech_j}$, which is the growth rate of technology *j* in decade *d*, where *j* is any one of the five technologies and *d* is either the decade immediately preceding the collapse (1975-1985) or the decade encompassing it (1985-1995):

$$Growth_{id}^{tech_j} = \gamma_{0d} + \gamma_{1d} LD_{if} + \gamma_{2d} SB_i + \gamma_{3d} SB_i \cdot LD_{if} + \gamma_{4d} X_{ifd} + \nu_{ifd} \quad (5.3)$$

It is estimated using the aforementioned variables of interest, controls, and initial levels of technology. Again, γ_1 reports the impact of being linguistically distant from the frontier *f* for non-Soviet Bloc countries in decade *d*, and γ_3 the additional impact for Soviet Bloc countries. For the same reasons listed under Equation 2, I expect γ_1 will be positive (and insignificant for Russian) and γ_3 to be negative for the communications technologies. However, for the agricultural technologies, I anticipate γ_3 to be positive since the regions close to Moscow were dedicated to industrialization and those further were dedicated to agriculture and mining; consequently, those former Republics linguistically further from Russian would have a greater demand for the technology than their non-Soviet counterparts.

5.4 DIFFERENCE-IN-DIFFERENCE ANALYSES

In each of these cases, I expect the coefficients for *LD* to be larger in magnitude when measured relative to English versus Russian since they represent the impact for the non-Soviet Bloc countries; consequently, it should matter only that they are distant from the language of the World Technology Frontier. Moreover, to support the hypothesis that being close to the relevant technology frontier is more important, then the coefficients for the interaction term would be larger in magnitude when measured relative to Russian compared to English. To test the hypothesis that linguistic distance for the Soviet Bloc diminished after the fall of the Berlin Wall, I pursue a differences-in-differences approach using Equations 2 and 3.

To investigate the existence of a Soviet Bloc legacy resulting from political or linguistic/cultural barriers, I test if the "after-before" difference of the coefficients for the Soviet Bloc dummy variables (α_{2p}, γ_{2d}) and the interaction terms (α_{3p}, γ_{3d}) is equal to zero, respectively. That is:

Tests for Political Barriers:

$$H_0 : \alpha_{22} - \alpha_{21} = 0 \qquad H_0 : \gamma_{22} - \gamma_{21} = 0$$

Tests for Linguistic/Cultural Barriers:

$$H_0 : \alpha_{32} - \alpha_{31} = 0 \qquad H_0 : \gamma_{32} - \gamma_{31} = 0$$

If neither of the first two null hypotheses cannot be rejected, that implies there has been no change and there is a a persistent legacy of the Cold War due to political biases. If they can be rejected and thus eliminating the possibility of political barriers, but the neither of the latter two null hypotheses cannot be

rejected, then the legacy is a result of cultural biases. This is similarly true if the estimated difference is negative, since that would imply that those countries are worse off than previously. If, however, it is positive, that would suggest that the political and/or cultural biases are diminishing, which allows those countries to adopt and grow at a greater pace than previously permitted.

Chapter 6

Results

This chapter is divided into four main sections, the first three of which are devoted to each of the models presented in Chapter 5 and the corresponding evidence for a persistent Cold War legacy. The last section is a discussion of the limitations of my econometric analysis which prevent me from claiming causal relationships, along with potential solutions for further research to explore.

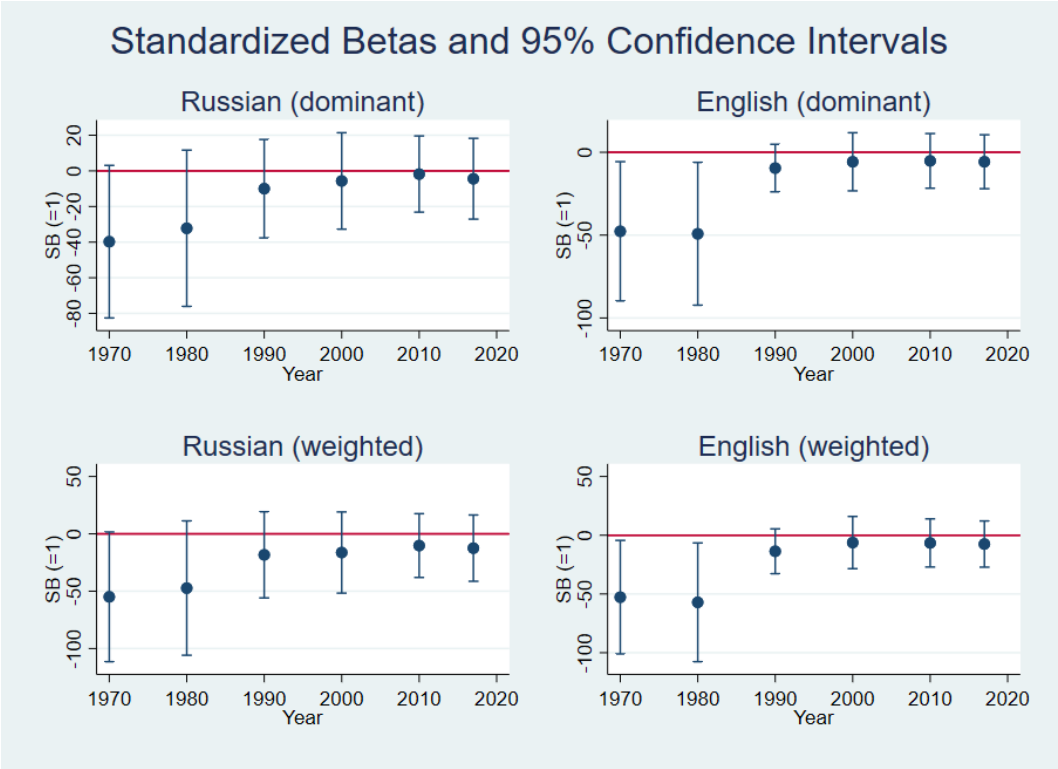
6.1 Per Capita Income

Tables 6.1 and 6.2 [1] report the results over time from Model 1 outlined in Chapter 5 relative to Russian and English, respectively, and the columns are separated by *LD*, dominant and weighted. Each controls for geographic, regional, and cultural covariates, and reports the standardized coefficients, which are illustrated in Figures 6.1 through 6.3.

As expected, Soviet Bloc countries have consistently lower income per capita levels compared to non-Soviet Bloc countries, regardless of the model specification or the time period. During the Cold War, the incomes of Soviet Bloc countries were substantially smaller and marginally statistically significant on occasion; in

[1] Displayed at the end of this section

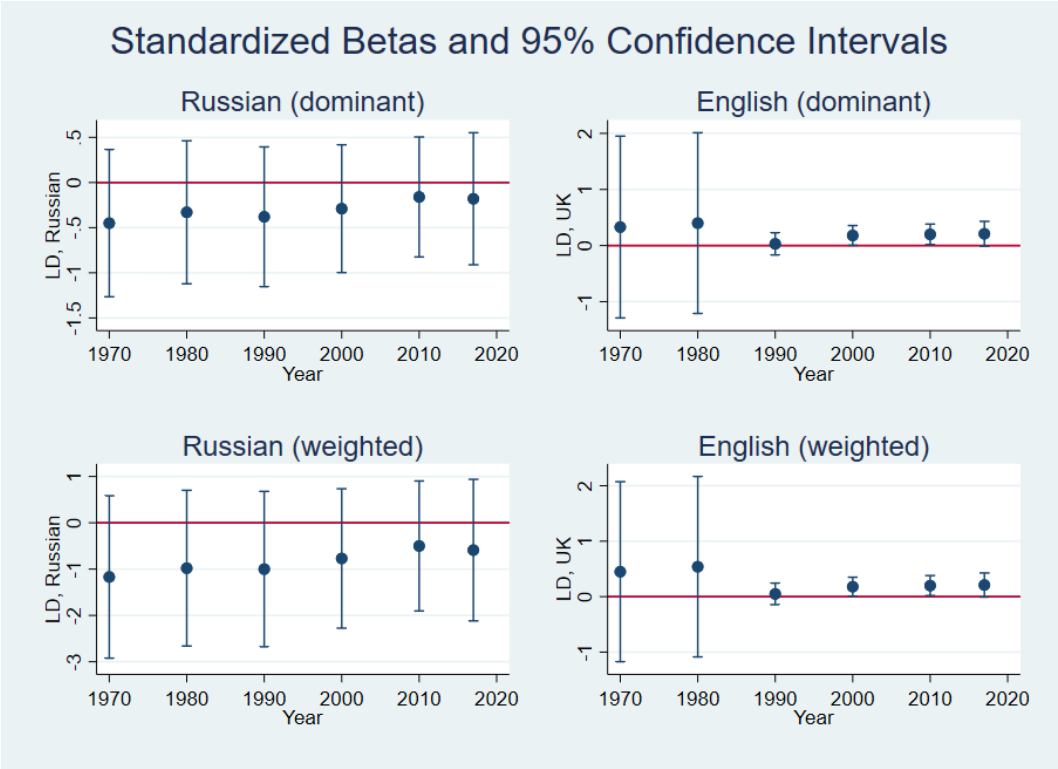
Figure 6.1: The Effect of the Soviet Bloc (Model 1)



1990 just prior to the collapse, however, the estimated difference drops drastically and continues to diminish through today. In some instances, the change in income differences is estimated to be between 60% and 80% (Figure 6.1; Tables 6.1 and 6.2). While at first glance this seems promising that the end of the Cold War brought about an immediate increase in income for the Soviet Bloc countries, it is more likely that the reduction is a result of the negative income shock to the Western World from the early 1990s recession.

For the non-Soviet Bloc countries in the simple case of Equation 1, linguistic distance (*LD*), relative to Russian is statistically insignificant as expected (see Figure 6.2). Relative to English, it has a negative correlation with income levels that is generally statistically insignificant and declined considerably in 1990, as the USSR collapsed. This suggests that the further linguistically a non-Soviet Bloc country was from the World Technology Frontier, particularly during the tensions

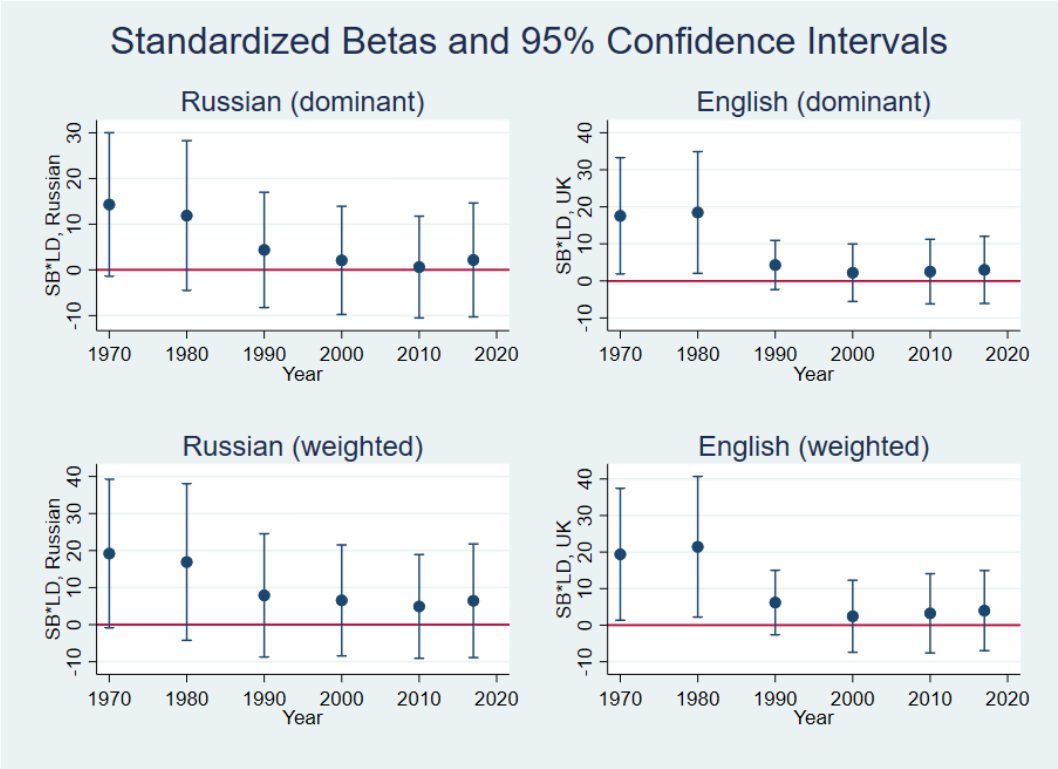
Figure 6.2: The Effect of Linguistic Distance (Model 1)



of the Cold War, then the lower its income would be. This is not unexpected given the previous literature and the correlations previously reported (Table 4.3).

For the Soviet Bloc countries, *LD* has a positive correlation with income levels which are economically significant and experience a drastic reduction in importance in 1990 (illustrated in Figure 6.3). For countries within the Soviet Bloc, the ones further linguistically from English during the Cold War had higher incomes, while after the Cold War, those further from Russian had higher incomes. One possible explanation is that the Soviet Bloc countries which were more dissimilar to the English would necessarily be closer to Russian, if even marginally, and thus benefit by lower imitation costs associated with their relevant technology frontier. Likewise, after the fall of the Berlin Wall and all the international barriers embodied by it, the closer a former Soviet Bloc country is to the English and the Western World, the lower the imitation costs to enter the world stage for them

Figure 6.3: The Effect of Soviet Bloc * Linguistic Distance (Model 1)



and the greater the benefit. The impact for *LD* from Russian decreased by more than 60% in 1990, and by over 75% for *LD* from English; these estimates have since diminished by approximately another 45%. Moreover, the estimates for the Soviet Bloc are much larger than those for the non-Soviet Bloc, suggesting that linguistic distance from either frontier is more important for a former Soviet Bloc country, even now, and offers minor support that the tensions emphasized by the Iron Curtain were important in willingness or ability to adopt from the World Technology Frontier and that being close to the relevant frontier was significant.

Table 6.1: Model 1 Temporal Analysis, Relative to Russia

	1970		1980		1990		2000		2010		2017	
	dominant	***weighted***	***dominant***	***weighted***	***dominant***	***weighted***	***dominant***	***weighted***	***dominant***	***weighted***	***dominant***	***weighted***
Point Estimates												
LD, Rus	-21.66	-33.04	-15.66	-27.20	-14.67	-22.51	-11.59	-18.16	-5.52	-9.79	-5.89	-11.10
	(19.95)	(25.24)	(18.99)	(23.74)	(15.15)	(19.29)	(14.46)	(18.09)	(11.41)	(14.15)	(11.90)	(14.63)
SB (=1)	-39.75*	-54.93*	-32.22	-47.29	-10.00	-18.31	-5.66	-16.30	-1.78	-10.23	-4.42	-12.47
	(21.85)	(28.86)	(22.39)	(29.88)	(14.09)	(19.16)	(13.81)	(18.05)	(10.91)	(14.18)	(11.57)	(14.74)
SB*LD, Rus	40.17*	55.69*	32.70	48.12	9.81	18.32	4.87	15.88	1.21	10.01	4.05	12.45
	(22.49)	(29.68)	(23.02)	(30.69)	(14.44)	(19.68)	(14.17)	(18.53)	(11.18)	(14.52)	(11.86)	(15.10)
Constant	30.60	42.49	25.28	37.26	23.12	31.55	20.99	28.06	15.03	19.58	15.67	21.03
	(19.99)	(25.34)	(19.06)	(23.85)	(15.31)	(19.31)	(14.65)	(18.22)	(11.65)	(14.37)	(12.12)	(14.84)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	46	46	46	46	59	59	59	59	59	59	59	59
R-squared	0.46	0.46	0.42	0.42	0.38	0.38	0.46	0.44	0.41	0.38	0.36	0.35
Std. Coefficients												
LD, Rus	-0.45	-1.17	-0.33	-0.98	-0.38	-1.00	-0.29	-0.77	-0.16	-0.50	-0.18	-0.59
SB*LD, Rus	14.31*	19.19*	11.88	16.91	4.37	7.90	2.08	6.55	0.62	4.92	2.17	6.45

Dependent Variable is log of GDP per capita. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6.2: Model 1 Temporal Analysis, Relative to UK

	1970		1980		1990		2000		2010		2017	
	dominant	***weighted***	***dominant***	***weighted***	***dominant***	***weighted***	***dominant***	***weighted***	***dominant***	***weighted***	***dominant***	***weighted***
Point Estimates												
LD, UK	2.64	3.57	3.16	4.23	0.22	0.30	1.17*	1.20**	1.14**	1.15**	1.13*	1.13*
	(6.59)	(6.63)	(6.43)	(6.52)	(0.64)	(0.64)	(0.60)	(0.59)	(0.52)	(0.52)	(0.60)	(0.60)
SB (=1)	-47.71**	-52.73**	-49.19**	-57.12**	-9.55	-13.67	-5.75	-6.24	-5.21	-6.58	-5.73	-7.52
	(21.44)	(24.65)	(21.99)	(25.79)	(7.33)	(9.73)	(8.94)	(11.34)	(8.42)	(10.45)	(8.31)	(10.03)
SB*LD, UK	48.47**	53.63**	50.03**	58.18**	9.44	13.67	5.10	5.62	4.86	6.28	5.47	7.32
	(22.13)	(25.47)	(22.70)	(26.63)	(7.48)	(9.96)	(9.13)	(11.62)	(8.61)	(10.73)	(8.50)	(10.30)
Constant	9.97***	9.94***	10.16***	10.13***	10.33***	10.32***	10.55***	10.54***	10.58***	10.58***	10.67***	10.68***
	(0.38)	(0.35)	(0.37)	(0.33)	(0.25)	(0.22)	(0.23)	(0.22)	(0.16)	(0.16)	(0.16)	(0.17)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	43	43	43	43	58	58	58	58	58	58	58	58
R-squared	0.35	0.35	0.36	0.37	0.31	0.31	0.40	0.40	0.34	0.33	0.27	0.27
Std. Coefficients												
LD, UK	0.33	0.45	0.40	0.54	0.03	0.05	0.18*	0.18**	0.20**	0.20**	0.21*	0.21*
SB*LD, UK	17.55**	19.39**	18.47**	21.44**	4.28	6.18	2.21	2.43	2.51	3.24	2.98	3.98

Dependent Variable is log of GDP per capita. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

6.2 GROWTH OF PER CAPITA INCOME

Table 6.3 reports the results for the pre- and post- USSR collapse from Model 2 outlined in Chapter 5, relative to each frontier, including all covariates, and the columns are again separated by dominant and weighted *LD*. The standardized coefficients for the Soviet Bloc and interaction term variables are reported in the lower panel. Table 6.4 records the F-statistics to test the joint significance

of the null hypothesis that α_{21}=α_{22} and α_{31}=α_{32}, none of which are statistically significant and are thus indicative of a persistent Cold War legacy.

Table 6.3: Model 2 Pre- and Post-USSR Collapse Analysis

	Relative to Russia				**Relative to UK**			
	1970-1991		1992-2017		1970-1991		1992-2017	
	dominant	***weighted***	***dominant***	***weighted***	***dominant***	***weighted***	***dominant***	***weighted***
Point Estimates								
LD	0.14	0.15	0.25	0.25	0.01	0.03	0.04*	0.03
	(0.32)	(0.39)	(0.19)	(0.24)	(0.08)	(0.09)	(0.02)	(0.02)
SB(=1)	-0.06	-0.13	0.11	0.04	-0.61	-0.87	0.04	0.07
	(0.49)	(0.64)	(0.21)	(0.25)	(0.52)	(0.58)	(0.25)	(0.24)
SB*LD	0.05	0.12	-0.11	-0.04	0.60	0.87	-0.04	-0.07
	(0.51)	(0.66)	(0.21)	(0.26)	(0.53)	(0.59)	(0.26)	(0.24)
Constant	-0.08	-0.08	-0.09	-0.12	0.14**	0.14**	0.12***	0.12***
	(0.31)	(0.39)	(0.18)	(0.23)	(0.06)	(0.06)	(0.03)	(0.03)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	46	46	59	59	43	43	58	58
R-squared	0.54	0.52	0.48	0.53	0.43	0.43	0.42	0.42
Standardized Coefficients								
LD	0.13	0.23	0.39	0.67	0.05	0.16	0.34*	0.30
	(0.31)	(0.64)	(0.29)	(0.65)	(0.46)	(0.50)	(0.18)	(0.18)
SB*LD	0.74	1.84	-2.95	-0.96	9.87	14.24	-1.00	-1.87
	(8.20)	(10.31)	(5.74)	(6.77)	(8.72)	(9.76)	(6.98)	(6.56)

Dependent Variable is growth of GDP per capita. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

When evaluating the average difference in income growth rates, those of the Soviet Bloc countries during the Cold War tended be lower relative to the non-Soviet Bloc; in the post-Cold War period, they experienced slightly higher growth rates, regardless of the linguistic measure specified (Table 6.3). However, this change is not statistically significant (Table 6.4). The correlation corresponds to how economic growth of the Former Soviet Bloc was inhibited during the Cold War, and after liberation they follow a path of economic convergence. Prior to the fall of the Iron Curtain, their ability to adopt technologies and engage in international trade was restricted by both the East and West, which was compounded by a number of other economic, political, institutional, and ideological factors as described in Chapter 2. After the political and economic collapse of the 1990s, many gained sufficient independence to adopt more technologies and become members of broader trade alliances, such as the GATT/WTO or NATO. The relative-

to-English estimates are five to eight times larger than the relative-to-Russian estimates during the Cold War, but are comparable in the time since. This suggests that being close to the UK (and thus, the Western Bloc) was much more important for a country's growth than being close to Russia, particularly during the Cold War.

Table 6.4: Model 2 DID Analysis

	dominant		***weighted***	
	SB	**SB*LD**	**SB**	**SB*LD**
Russia	0.883	0.907	0.808	0.825
UK	0.528	0.549	0.471	0.489

Note: Reporting F-statistics for Model 2.

There are similar patterns for both the relative-to-Russian and -to-English *LD* measures as there were with income levels, with the former being considerably greater. Prior to the collapse, an increase in *LD* from Russian corresponded with approximately a 0.14 percentage point increase in the growth rate and a 0.25 percentage point increase after the collapse but are statistically insignificant. This is as expected and outlined in Chapter 5 that linguistic distance from Russian should have no bearing on the economic well-being of the non-Soviet Bloc countries. Relative to English, the impact on growth rates was as little as 0.01 percentage point increase prior to the Cold War; subsequently, it rose to a marginally statistically significant increase of 0.04 percentage points that is economically significant with a standardized coefficient of 0.34, which is not surprising given the low correlations between these variables (Table 4.3).

Similar to the impact on income levels, Soviet Bloc countries experienced higher growth rates the further linguistically they were from the frontier particularly from the English during the Cold War. After the collapse, the further a Soviet Bloc country was from either frontier corresponded with a lower income growth rate, ranging from a negative growth rate of 0.04 to 0.11 percentage points (though

again this change was not statistically significant). This first finding is in line with the theory of convergence discussed previously in that countries with developing economies have higher growth rates, and the second potentially suggests an adverse legacy of the Cold War.

6.3 GROWTH OF TECHNOLOGY

Finally, I extend my analysis to estimate the impacts on technology growth as defined in Model 3 in Chapter 5, which is reported in Tables 6.5, 6.6, and 6.8. Tables 6.5 and 6.6 record the results for the agriculture technologies, relative to Russia and the UK, respectively; Table 6.8 presents those for the communications technologies. Table 6.7 records the χ^2 statistics to test the joint significance of the null hypotheses of γ_{21}=γ_{22} and γ_{31}=γ_{32}, the significance of which I discuss below.

Table 6.5: Model 3 Growth of Agriculture Technologies, Relative to Russia†

	Agr. Tractor		***Area Irrigated (Total)***		***Area Irrigated (%)***	
	1975-1985	1985-1995	1975-1985	1985-1995	1975-1985	1985-1995
Point Estimates						
LD, Rus	-2.28	-8.51	-1.96	-1.51	-1.41	3.58
	(2.08)	(5.38)	(2.42)	(2.09)	(1.26)	(2.11)
SB(=1)	-31.30	-13.66	-0.43	1.16	38.26***	3.34
	(30.53)	(8.04)	(2.73)	(2.64)	(12.25)	(3.15)
SB*LD, Rus	32.24	13.87	0.38	-1.24	-39.59***	-3.40
	(31.47)	(8.19)	(2.75)	(2.71)	(12.65)	(3.22)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	2.35	7.70	0.50	2.07	1.43	-5.52**
	(2.98)	(5.64)	(2.42)	(2.44)	(1.36)	(2.27)
Standardized Coefficients						
LD, Rus	-0.29	0.28	0.77	-3.61	-0.22	-0.07
SB*LD, Rus	1.84	-9.48	0.21	0.34	-0.18	-5.04
Observations	32	29	26	25	32	27
R-squared	0.15	0.61	0.72	0.45	0.62	0.59

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; † Linguistic measures are weighted

Relative to Russia, the model estimating $Total\ Area\ Irrigated$ (AI) illus-

trates a negative, insignificant relationship for the non-Soviet Bloc countries that diminishes or becomes positive in the second period. For Soviet Bloc countries, it is a little more complicated. As linguistic distance increases from Russian, the growth rate of $Total\ AI$ is insignificantly positive while the growth rate of $Percent\ AI$ is significantly negative at the 1% level and economically significant. These change significantly during the period of the collapse (Tables 6.5 and 6.7). In other words, relative to non-Soviet Bloc countries, the Soviet Bloc nations further linguistically from Russian had higher growth rates of $Total\ AI$ but the growth of $Percent\ AI$ was significantly lower. This may be because the comparatively large agriculture sector adopted the technologies more rapidly, and consequently, experienced diminishing marginal improvements.

Table 6.6: Model 3 Growth of Agriculture Technologies, Relative to UK†

	Agr. Tractor		***Area Irrigated (Total)***		***Area Irrigated (%)***	
	1975-1985	1985-1995	1975-1985	1985-1995	1975-1985	1985-1995
Point Estimates						
LD, UK	0.84	-0.77	0.50	0.19	-0.44	-0.15
	(1.03)	(1.41)	(1.13)	(0.36)	(0.95)	(0.37)
SB(=1)	-102.82	-6.31	236.33*	-1.15	192.73	2.41
	(125.53)	(5.06)	(120.74)	(1.53)	(120.45)	(3.03)
SB*LD, UK	106.46	6.33	-244.66*	1.24	-199.54	-2.41
	(129.98)	(5.14)	(124.99)	(1.58)	(124.69)	(3.10)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-1.42	0.99	-0.27	0.10**	1.03	-0.06
	(1.57)	(0.62)	(1.61)	(0.04)	(1.28)	(0.06)
Standardized Coefficients						
LD, UK	0.40	0.04	-1.25	-0.08	-1.77	-0.05
SB*LD, UK	60.29	12.13	-149.29	9.48	-221.62	6.97
Observations	27	27	26	25	26	25
R-squared	0.51	0.50	0.55	0.76	0.52	0.35

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; † Linguistic measures are weighted

In the first period, the populations further from English had the smallest $Total\ AI$ and marginally statistically significant but became insignificant and minute in the next period. While the point estimates for the latter decade are

statistically insignificant (and still negative in the case of $Percent\ AI$), the improvement in the second period from the first is statistically significant for both the indicator and interaction terms (Table 6.7). This suggests that not only was it important to be close to the UK in terms of this instance of technology adoption, but there appears to be no adverse legacy of the Cold War, either politically or culturally.

Table 6.7: Model 3 DID Analysis

	Russia		**UK**	
	SB	**SB*LD**	**SB**	**SB*LD**
Agr. Tractor	0.026	0.023	0.652	0.661
Area Irrigated (Total)	0.001	0.000	0.000	0.000
Area Irrigated (%)	0.725	0.738	0.000	0.000
Newspaper	0.009	0.009	0.052	0.052
Radio	0.000	0.000	0.261	0.265

Note: Reporting χ^2 statistics for Model 3

The average growth rate of the communication technologies (*Newspapers* and *Radios*; Table 6.8) of the Soviet Bloc countries was substantially less than that of the non-Soviet Bloc countries during the decade prior to the collapse, and when measured relative to Russia, this difference is statistically and economically significant. During the period of the collapse, the magnitude diminishes substantially (and becomes positive for $Radios$, relative to Russia), and is statistically different from the previous period, offering additional evidence against a negative persistent legacy of the Cold War for technology adoption (Table 6.7). Since the previous decade experienced substantial stagnation, the intense difference is to be expected, but what is interesting is that the magnitude diminished so much despite the turmoil leading up to and following the collapse, which may be attributed again to the recession affecting the Western countries in the early 1990s.

Relative to Russian (the first four columns of Table 6.8) during the first period,

Table 6.8: Model 3 Growth of Communication Technologies[†]

	Russia				UK			
	Newspaper		Radios		Newspaper		Radios	
	1975-1985	1985-1995	1975-1985	1985-1995	1975-1985	1985-1995	1975-1985	1985-1995
Point Estimates								
LD	-1.10	-2.01	-3.09	1.57	0.06	-0.03	0.20	-0.66
	(1.00)	(2.42)	(2.27)	(3.52)	(0.28)	(0.63)	(1.41)	(0.93)
SB(=1)	-51.46***	-2.95	-61.23**	2.99	-51.33	-2.98	-105.36	-4.04
	(16.99)	(4.22)	(25.38)	(5.28)	(82.47)	(2.89)	(129.02)	(5.87)
SB*LD	53.01***	3.06	63.06**	-2.96	53.17	3.10	109.11	4.23
	(17.51)	(4.31)	(26.15)	(5.40)	(85.42)	(2.98)	(133.59)	(6.05)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.62	-3.31	2.03	-2.33	-0.19	0.20	-0.36	0.10
	(1.88)	(2.68)	(3.46)	(3.36)	(0.40)	(0.19)	(2.16)	(0.31)
Standardized Coefficients								
LD	-0.29	-0.48	-0.27	0.56	-2.09	0.26	-0.37	0.3
SB*LD	-0.06	2.52	-5.22	-5.99	144.81	-7.61	172.52	18.72
Observations	33	31	32	33	30	30	29	32
R-squared	0.47	0.57	0.21	0.36	0.24	0.26	0.34	0.21

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; [†] Linguistic measures are weighted

the point estimates for linguistic distance as regressors estimating the communication technology growth rates were small, negative, and statistically insignificant for non-Soviet Bloc countries, but were large, positive, and statistically significant at the 5% level at least for the Soviet Bloc countries. What this suggests is that in the years prior, the further linguistically from Russian a nation was, the greater the pace at which communications were growing. Afterwards, the impact of linguistic distance tapered and lost its significance even for the Soviet Bloc, the transition of which is statistically significant at the 1% level. This interesting finding is reflective of several potential and non-mutually exclusive scenarios which would permit such an occurrence in these populations: (1) they experienced greater independence from the central authority; (2) Russia's direct influence was weakening; and (3) Western influence was mounting. While not statistically significant when estimated relative to English, linguistic distance was minuscule for the non-Soviet Bloc countries and transitioned from a large to small impact for the Soviet Bloc countries.

6.4 LIMITATIONS & ECONOMETRIC CONCERNS

Evidently, a large majority of the results I present here are statistically insignificant and I am unable to claim causality in these analyses. The lack of statistical significance may originate from a variety of sources, including endogeneity issues, limited sample size and variation, and non-monotonicity of the relationship.

The potential endogeneity arises because those countries within the Soviet Bloc have a historical and cultural predisposition to be allied with Russia and other Eastern European countries, functioning as a barrier between Russia and the Western World; after WWII, it is then not unusual that Russia aimed to gain control over these countries as a buffer. Additionally, since the analyses are conducted at the country level for the Eurasian continent, the sample size and variation of the linguistic distance measures is restricted; due to time restrictions, I was unable to conduct any analysis at the subnational regional level, which would be ideal for increasing the variation and establishing causality. Finally, it is possible that the relationship between linguistic distance and technology diffusion may be non-monotonic. For instance, technology adoption decreases as distance increases from the World Technology Frontier until it enters within range of the relevant technology frontier - a possibility suggested by the results presented within this paper.

Chapter 7

Conclusion

In this thesis, I have investigated the effects of cultural distance on economic prosperity, particularly in the form of linguistic distance impacting certain technologies. Under the context of the collapse of the Former Soviet Union, I attempt to answer three main questions: (1) to what extent does linguistic distance impact the diffusion of technology; (2) are those effects exacerbated by political tensions; and (3) have those Cold War tensions been extended on through today? I estimate the temporal impact of linguistic distance on agriculture and communication technologies and GDP per capita, an acceptable proxy, and allowing those effects to vary by political affiliation – namely, whether a country was a former member of the Soviet Bloc.

Of course, we must be cautious about inferring direct causal effects of cultural and linguistic variables from the regression analysis, because of issues of endogeneity, limited sample size and variation, and potential non-monotonicity. Nonetheless, the empirical results are suggestive of systematic differences between countries within and outside the Soviet Bloc, and between countries at different cultural and linguistic distances from the World Technological Frontier – and the effects of linguistic distance are larger for Soviet Bloc countries. Specif-

ically, I find that Soviet Bloc countries, when compared to the non-Soviet Bloc, have consistently lower per capita income levels but do not have higher average income growth rates until after the Cold War.

After the collapse, the further a Soviet Bloc country was from either frontier corresponded with a decreased income growth rate, where it was especially important to be close to the English; the closer to the World Technology Frontier, the lower their imitation costs were to adopt technologies. The countries within the Soviet Bloc who were further from Russian had lower adoption rates of agricultural technologies in general, but higher for communication technologies. Additionally, being linguistically distant was more detrimental to the adoption of the agricultural technologies, while being linguistically close to Russia was more detrimental for the adoption of communication technologies. Some possible explanations for the latter revelation are that those countries further from Russia were experiencing greater independence, a weakening of Russian central authority, or an increasing of Western influence.

Since the fall of the Berlin Wall, my research provides conflicting evidence on whether there is a persistent legacy associated with the Cold War that inhibits economic or technological growth. Relative to the most important frontier according to each set of technologies, there is no evidence suggesting a legacy; however, in terms of income growth, there is seemingly a persistent negative impact resulting at least from the political biases. A possible interpretation of this is that technology adoption is not contributing to the lingering income gap between the Former Soviet Bloc and the Western Bloc.

These results are relevant to our modern day "Cold War" between the US and China (Bar, 2019), the tensions of which have recently been mounting since the Coronavirus (COVID-19) pandemic (D'Urbino, 2019). The US-China relationship is more complex than that of the US-USSR struggle because for the USSR Cold

War, there was near isolation between the superpowers with limited interaction. In contrast, the China Cold War is different as there is a significant amount of economic integration; for instance, US-China trade was approximately 2 billion US dollars forty years ago, which is what daily US-China trade is presently (Bar, 2019). Yet, the increasing Chinese import competition to the US manufacturing sector (Autor, Dorn, & Hansen, 2013) has been a continuous source of great contention. Over the last few years, in particular, the situation has worsened due to the restriction of financial investments by both sides (Lin, 2018), the trade war in 2019, the expansion of the Chinese military and its influence (Myre, 2019), and the political disputes, all of which has increased distrust and heightened geopolitical tensions. In light of my results, the current circumstances will - and likely already do - inhibit economic and technological growth, particularly for China's allies in the developing world. While there is no "Iron Curtain" in this instance, China's strategy of intimidation is an effective deterrent of the small countries allied with China from cooperating the US or its allies.

The results of my research therefore may act as a base for further research, for which there is a variety of avenues. Assuming the current geopolitical climate either continues or worsens in the coming years, my methodology could be applied to the context of China and its allies, using the outbreak of COVID-19 as a quasi-natural experiment to evaluate the impact of barriers due to cultural distance and political and ideological differences on economic prosperity.

Additionally, for the purposes of establishing causality either in the context of the Cold War or the current geopolitical climate, attention should be paid by repeating the analysis by evaluating subnational regions rather than at the country level, and to investigate the possible non-monotonic relationship between cultural distance and the World Technology Frontier. Another avenue would be to analyze firm-level outcomes, particularly for the manufacturing sector, from

which the effects of the incentive system of the Communist Regime may be uncovered.

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Appendix A

Supplementary Tables & Graphs

Table A.1: Countries

Soviet Bloc	**Non-Soviet Bloc**	**Other**	
Albania	Austria	Afghanistan	Myanmar
Armenia	Belgium	Algeria	Nepal
Azerbaijan	Denmark	Bahrain	Oman
Belarus	Finland	Bangladesh	Pakistan
Bulgaria	France	Bhutan	Philippines
Croatia	Germany	Cambodia	Saudi Arabia
Czech Republic	Greece	China	Singapore
Estonia	Ireland	Cyprus	Sri Lanka
Georgia	Italy	Egypt	Syria
Hungary	Netherlands	India	Taiwan
Kazakhstan	Norway	Indonesia	Thailand
Kyrgyzstan	Portugal	Iran	Tunisia
Latvia	Spain	Iraq	Turkey
Lithuania	Sweden	Israel	U.A.E.
Macedonia	Switzerland	Japan	Vietnam
Moldova	U.K.	Jordan	
Poland		Korea	
Romania		Kuwait	
Slovakia		Laos	
Slovenia		Lebanon	
Tajikistan		Libya	
Turkmenistan		Malaysia	
Ukraine		Mongolia	
Uzbekistan		Morocco	

Table A.2: Variable Names and Descriptions

Variable Name	Description	Source
Dependent Variables		
GDPpc	Real Gross Domestic Product at constant 2011 national prices (2011US$), divided by Population	PWT, 9.1
Growth	Non-marginal growth rate of real GDP per capita	PWT, 9.1
Agr. Tractor	Number of wheel and crawler tractors (excluding garden tractors) used in agriculture	CHAT
Total Area Irrigated	Area equipped to provide water to crops, including those with full and partial control irrigation or spate irrigation and equipped wetland or inland valley bottoms	CHAT
Newspaper	Number of newspaper copies circulated daily. Note that there is a tendency for news circulation to be under-reported, since data for weekly and biweekly publications are not included	CHAT
Percent Area Irrigated	Irrigated area (as defined above) as a share of cultivated land, which includes land used for permanent and temporary crops, pasture, land used for temporary crops, and land lying temporarily fallow	CHAT
Radio	Number of radios	CHAT
Independent Variables of Interest		
LD	Linguistic Distance, measured in dominant and weighted forms from frontier	S&W, 2009
SB (=1)	(=1) if country is a member of the Soviet Bloc	
Controls		
FST	FST distance, Human Microsatellite Variation	S&W, 2018
Latitude Differences	Difference in Latitudes, from frontier	S&W, 2009
Longitude Differences	Difference in Longitude, from frontier	S&W, 2009
Geodesic Distance	Geodesic distance, from frontier	S&W, 2009
Surface Freight Cost	Freight rate (surface transport), 1000kg, from frontier	S&W, 2009
Landlock (=1)	(=1) if country is a landlocked	S&W, 2009
Common Water (=1)	(=1) if country shares a common body of water with frontier	S&W, 2009
Africa (=1)	(=1) if country is located in Africa	S&W, 2009
Asia (=1)	(=1) if country is located in Asia	S&W, 2009

Note: "PWT, 9.1" refers to Feenstra et al. (2017); " CHAT" refers to Comin and Hobijn (2009);
"S&W, 2009" and "S&W, 2018" refers to Spolaore and Wacziarg (2009, 2018), respectively

Figure A.1: Indo-European Phylolinguistic Tree

Image Source: Violatti (2014)