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Cultural Acceptance of Digitalization and Growth of an Economy: A Comparison of East and West Germany

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By

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Abstract

In the following paper aims to analyze the significance and relevance that change in cultural acceptance of digitalization has on the output gap (in terms of GDP) between East and West Germany based on the borders that existed between WWII and reunification in 1989. Culture will be measured by taking Google Trend data for the search term "Facebook," broken down by State (16) between the years 2004 and 2014. Google Trend data will be taking the place of technology in a standard Swan-Solow Model. The model will then be regressed using a simple GLS sample population equation. Following will be a section examining what the results show us as they relate to the research question.

Introduction

How does cultural acceptance of digitalization differ between the East and West German Economies and what impact does it have on the growth of their economies? Digitalization is defined as the integration of digital technologies into everyday life of all things that can be digitized. In my time abroad in Germany, I found that many people were adverse to digitalization and technological changes that would impact their daily life. Not everybody had a smartphone, many people did not have a facebook and there was a general unsettled feeling towards the notion of giving up your personal data and receiving something positive in return. Additionally, East and West Germany have operated as almost separate economies since the reunification. This is largely due to period of manufacturing success the West had in the 60s and the disappearance of the majority of East German businesses with the dissolvement of Soviet Block. I believe that Germany has a significant space to grow their digital economy in both

consumer tech and as parts of the manufacturing industry (in the form of Internet of Things (IOT)). I believe that the culture of Germany has been the significant barrier to digitalization and as culture changes tech can grow. My research question looks to answer whether a positive change in German digital culture has a positive effect and whether it is more significant in the East German economy.

This paper will use the Solow growth model (Solow 1956) in an adapted form firstly established by Karras (2009). The Solow model is significant in answering the research question because it attributes long-term growth to the positive shift in technology. Karras (2009) establishes that GDP is adequate for measuring output as well as the variables used for determining capital. Additionally, Stephens-Davidowitz (2014) was the first to use Google Trends to measure culture. He did so by searching for race related terms in states pertaining to the 2008 US presidential election and was able to empirically predict outcomes. This paper will use a similar method and collect data for the search term "Facebook" for each state in Germany. Pakura et al (2015) establishes that the majority of small businesses (over 70%) are discouraged from using Facebook because they are concerned about privacy and deem it unnecessary.

The purpose of this paper is to analyze the difference in impact that cultural acceptance of digitalization is having on the German economy: for the whole country, West Germany and East Germany. Additionally, this paper aims to understand the impact that digitalization is having on the economy compared to standard measures (unemployment and capital) to understand how big a role digitalization plays.

The contribution of this work are to use the altered Solow model developed by Karras (2009) and replace the technology variable with that of cultural acceptance. This work aims to build off the research of Pakura et al (2015) and more empirically analyze the impact cultural

acceptance of digitalization has on the economy. Additionally, this work will try to answer the questions given by Schleife (2010) and understand the economic impact that regional differences in internet access has on the German economy and further expand on the significance of such difference in regard to the East and West German boundaries. Furthermore, the results aim to verify the findings of Billon et al (2010), which found that Germany was behind other "high developed countries" in regard to digitalization.

The results of this paper finds that cultural acceptance of digitalization is significant in all of Germany when used in the Solow model. This includes when data is regressed specifically for East and West Germany. Additionally, this paper finds that cultural acceptance has a bigger effect on the East German economy than that of the West German economy. All other control variables expected to be significant are and hold expected signs. The results indicate that the East German economy is more greatly benefiting from the cultural shift. The results also confirm that in comparison to the other variables the impact of the cultural shift is negligible further confirming the need for a motivation to push cultural towards full acceptance--perhaps found in the form of government intervention.

The following section of the paper will review relevant literature, followed by the analytical framework used in this paper. In the third section, the data will be further defined along with the expectations for each variable. In the fourth section, the methodology will be discussed followed by the results of the model including concluding remarks regarding policy implications and further research.

Lit Review

First and foremost, I look to find what effects digitalization has on an economy. In the literature by Michael Indergaard, the effects of an a digital economy is examined in the face of economic shocks. This paper assesses the consequences of the crash for cultural and creative industries (CCIs) in New York City by drawing on the productionist approach and extending its consideration of the context of creativity to include speculative cycles and policy responses. The paper finds that while the CCI have taken an increasing role in the New York economy in the long term, they have been more vulnerable than the rest of the economy in the immediate aftermath of the crash. It also shows the importance of context in good as well as bad times. Those CCI that were most directly linked to particular episodes of financial speculation had the most explosive rises during boom and the most dramatic falls when the boom ended. In addition, specific industrial conditions (e.g., digitalization) can constrain growth in a CCI segment during a boom, or conversely, provide a boost even after the boom ends.

This and the next paper both point to the effects that digitalization and specifically in this case, creative industries, have on an economy when it is suffering. This suggests that Germany would benefit from a stronger digital economy specifically in tech.

In the article Effects of Facebook activities on the performance of start-ups by Stephanie and Adalbert Pakura, the case is made that Facebook activities by small and middle sized businesses in Germany have a positive effect on their business. The paper initially talks about the previous empirical studies that have been done that prove that networking, as a business, is always positive. A network allows your business to build social capital. Facebook is highly relevant, because in my experience, German's were highly skeptical of using it based on privacy

concerns, necessity etc. Therefore making its use an accurate indicator in judging cultural acceptance of digitalization.

Interestingly, the study used the dependant variable of number of employees to measure the success of a business as financial components have too many external inputs that could cause the figure to be altered. The independent variables that are used are whether or not a business has a facebook page, how much time is spent updating and using facebook, and the amount of friends or people that have liked a certain page.

The findings were statistically significant with $t = 4.095$, $p < .001$. While most of the analysis using the OLS model found that their hypothesi of " 1. Being engaged in Facebook as an entrepreneur of a micro or small enterprise is positively associated with his firm's performance, 2. Having strong marketing capabilities regarding Facebook as an entrepreneur is positively associated with firm performance, 3. The number of friends on Facebook is positively associated with a firm's performance, 4. Spending time interacting with friends on Facebook as an entrepreneur is positively associated with firm performance." came out (predictably) to all test correct, what was interesting was this... "while only 27.5 percent of the participants are active on Facebook, it shows that the other 72.5 percent apparently are missing out on a lot of opportunities and are potentially harming their own business by ignoring Facebook and stigmatizing it as an »unnecessary« tool."

This finding is exactly what I found in my personal experience in Germany. Germans were so averse and failed to see the potential benefits that could come with having an active online presence. The paper goes further to reiterate what I was consistently told in Germany, which is that many chose not to use Facebook because they fear the loss of their own "privacy." While this is a study of businesses, it specifically is examining the role that Facebook plays in

the performance of small and micro businesses, which can have very few employees and are still evident of a mindset help by a specific demographic.

There might be some merit in the fact that Germans (especially businesses) find Facebook unnecessary and this has to do with Germany lacking internet access across all cities, towns, and villages. A potential problem could be that Germany does not have universal internet access. It is undetermined whether or not it is by choice or simply because it is not in the interest of a provider to push lines out to smaller villages. In her study, she lays out her hypothesis as it relates to the rurality effect on digitalization (measured by internet usage). She separated it into Regional and Individual determinants. For regional determinants she hypothesized that: a greater rurality leads to a smaller regional proportion of home Internet users, the impact of rurality declines when additional regional characteristics are considered, the proportions of highly qualified employees, of young people, and of one-person households are positively correlated with the regional proportion of Internet users, a higher unemployment rate and a larger proportion of foreigners in a county lead to a smaller proportion of Internet users, differences between East and West German counties can explain part of the correlations. For Individual she hypothesized: Young and highly qualified individuals have a higher probability of starting home Internet use, individuals living in rural areas are less likely to become a home Internet user than individuals in urban areas, there is a positive network effect: in counties with large proportions of experienced Internet users non-using individuals have a higher probability of accessing the Internet for the first time.

The article finds that population density cannot explain the difference but rather attributes it to difference in individual characteristics. Findings underline the importance of the "Network Effect." Age, employment and education are are also highly relevant in whether or not a person

will become a new user. The article also finds that "The results of the previous estimations reveal that differences between East and West Germany cannot explain differences in the probability of becoming a new Internet user." While this article is useful, it only mentions, without empirical evidence, that there might be cultural barriers, accelerated by the network effect, that is preventing internet usage.

Much literature has been written about the effectiveness of using Google Trends to measure culture of a specific region. Most notably, is the work done by Stephens-Davidowitz (2013). His research used racially charged slurs to account for vote shares while accounting for the previous amount of votes recieved in the 2004 presidential election by John Kerry. His results find that Google Trends for racially charged slurs were significant in predicting Republican voter turnout and Democratic voter turnout. Additionally, Conti et al (2007) finds that Google Trends is an accurate representation compared to the queries generated by other search engines as over 92% of all internet users prefer Google. What is more interesting is that Conti et al (2007) also finds that internet users are more forthcoming when using Google (or other search engines) because they are not aware that their data and searches are being tracked. This literature provides the basis for the use of Google Trends as the indicator for cultural acceptance of digitalization in this paper's model.

In the paper Differences in digitalization levels: a multivariate analysis studying the global digital divide by Margarita Billon, Fernando Lera-Lopez and Rocı´o Marco Germany is put into the context of other countries in regard to digitalization. It is undisputable that Germany has a lower level of digitalization as seen in this study. Additional findings from this paper confirm that Germany has an aging population and that it could potentially be having a negative effect on digitalization in a highly digitalized country like Germany. What is unexplained is that

the study found that high economic development, quality regulatory of the internet and good internet pricing all positively correlate to the development of e-commerce. All of these aspects are found in Germany, but it seems to function as an anomaly. This goes to further my theory of the cultural element greatly impacting the role of e-commerce and digitalization.

The paper concludes by stating that out of all the factors and variables included in the model for 142 countries, using an ICT index as a marker for digitalization, it was only GDP that had a significant effect on levels of ICT. That is not to say that once groups were made of low, middle, and highly digitalized countries were made, there were additional variables that were significant in ICT. In accordance with my personal findings, GDP was more significant in middle-developed ICT countries and played a lower factor in already higher digitalized countries, where non-economic factors were increasingly significant.

Interestingly, the paper studied whether population between 15 and 64 had a significant impact on ICT. For highly developed countries, like Germany, it was found to be negative. The paper identifies that this might have something to do with the fact that there is variance in the distribution of ages within that range. This is would make sense considering that *Katrin Schliefe* finds her paper, *What Really Matters: Determinants of the Regional Digital Divide,* that an older population correlates to lower amount of a regional population using the internet. Considering Germany has an aging population, these sets of findings seem to support each other.

Evidence and literature continues to point at the fact that there needs to be a government initiative to increase digitalization and potentially spur a culture change. In Digitalization as Formalization: a view from below, we find the benefits of formalizing digitalization with the example of India. In the article, the subject matter is television in India and the role the government plays in creating a federal demand that the digital infrastructure be implemented.

The article focuses on the area of India called Patna. Before there was no digital infrastructure and after the implementation of the lines, the economy in both in the whole of India and the area took off. Businesses had the ability to advertise, people were paid to fix televisions, etc. The article argues that when it is forcibly implemented, the digital economy accelerates.

There are many implications relative to my thesis and Germany. There are still towns in Germany that exist with no access to internet. This would argue that the German government would do well to create a federal mandate to create internet connectivity in all of Germany. Businesses who operate online would have more access to customers and people living in that area would have the ability to engage in e-commerce.

In 2015, delegates from Germany created a manifesto at the 10th annual IT summit stating that Germany is falling behind in the race to digitalize. The problems with access to internet and cultural barriers to digitalization are not limited to personal use, but are highly present in the economy.

Germany has a high manufacturing base with 22% of its economy being factory oriented. The Economist as well as the delegates at the IT summit have written extensively on the dangers of a traditional business model, sometimes called a “pipeline” system. This is where a customer has a need and that need is fulfilled by the manufacturer. This means that the manufacturer only gets business when there is a need from the consumer. What is suggested is that German manufacturers switch to a “closed-loop system.” This is a type of system where once a consumer is a customer the relationship is such that they are constantly in business with the manufacturer. This can be achieved by adding a digital component to manufacturing.

An example is Trumpf Gmbh. Trumpf has made high end laser cutters for manufacturing and in the past five years they have added an Internet of Things (IOC) component to their

business. Now they sell a software with all their equipment that self monitors and notifies the customer when a product needs repairs or needs to be replaced. This is an example of the "closed-loop" system.

The German government put digitalization at the top of the political agenda with the first German IT summit in 2006. But a decade later, industry representatives consider the achievements to be too few - and say the government isn't doing its job. A "push toward digitalization through policy, the economy and society" needs to happen, the manifesto says.

The manifesto calls for the German government to do more saying that in they are still in the "mid field" of the digital age and that they "have been overtaken by the small Baltic states." Germany has the opportunity to learn from India. Where India made a significant impact on their economy by wiring the entire country for television, Germany should do the same thing with access to internet. Additionally, I believe, that the government should create a single regulating body for internet. Currently, there are many sub-regions of Germany that regulate their own access to internet. We know that Germans are highly concerned with privacy and intruder-access to their data. If the federal government were to create a national organizing body that streamlined access and security, I believe that they would be more successful in positively shifting Germans view of digitalization. It might also be beneficial for the German government to subsidize internet access, making it more accessible to all Germans. We know from the first article review that Germans do not see Facebook or e-commerce as a necessity but rather an extemporaneous expense. A government funded program would reduce these concerns.

We can already see the effects that certain government programs have had on the German economy, specifically in the East they seem to be most effective with the federal government instituting programs to assist in business development in a post soviet society.

In the paper The Rise of the East and The Far East, a period in the German economy between 1988-2008. It uses administrative data from domestic and foreign economies to analyze the effect that the rise of the East has had on the German economy. It finds that the East German economy suffered during this time period and that manufacturing in Germany, which is primarily in the West was affected positively with over 400,000 jobs being created in this time period. The paper says specifically "overall, the rise in trade exposure has led to substantial employment gains in the German economy. But these gains are highly unevenly distributed across space."

This reaffirms my point that the west German economy will gain while the east suffers. The issue is that when looked at as a whole country, this analysis would show that Germany is only being positively affect.

Additional literature by Michael Fritsch looks at how, since the reunification, entrepreneurship has risen in East Germany. It is uses West Germany as a benchmark and finds that it took East Germany over 15 years to reach the levels of self-employment found in the west. While the levels are similar, the papers finds discrepancies between the two regions noting that there seems to be a continuing legacy from the socialist period. The paper goes further to say that the differences can be attributed to cultural differences between the regions. East Germans are found the be less educated and skilled than west germans, which can be attributed the type of industry that prevailed during the socialist era. Formal governmental institutions were found to be beneficial to self-employment. Shocks and transformation in the economy in certain areas of the east positively correlate to the presence of start-ups, which would suggest that this self-employment was due to necessity.

As I've established that there is an issue with digitalization in Germany and that the cultural view of digitalization by Germans seems to be impeding Germany's ability to progress

it's technology industry, I believe the most applicable model to understanding the effects that technology has and will have on the economy can be found in the Swan-Solow Model. Much literature has used the Swan-Solow Model to measure growth.

The basic, original, version of the model can be found in Solow's original paper: A Contribution to The Theory of Economic Growth. In this paper he claims, based upon empirical findings that there is only one output in the form of Y, which he calls rate of production. In my analysis, I will be measuring this in the form of GDP per state.

In the paper Economic Growth Convergence in Asia, 1970-2003: Empirical Evidence from the Solow Model by George Karras, a slightly altered version of the model was used to measure growth across 21 Asian countries over a 33-year time period. In using the altered model by Mankiw, the paper finds that there is much evidence to suggest that savings and population growth only account for 44% of the total growth across the asian continent and that there is much empirical evidence to suggest that disposable income per household is highly relevant in creating a more accurate model. The paper takes its data from the Penn World Table; a dataset that is ran by the University of Groningen in Holland.

This paper allows me to create the precedent of measuring growth across Germany, in a similar way that Karras measured growth across Asia. Each individual state will be treated as its own entity and data will be collected as such. My model will include disposable income per household as I believe that it will be highly relevant (in a similar way that is was for Karras) in measuring stronger correlation.

Overall tech provides an opportunity for Germany to flourish. As research has shown there are inefficiencies found when a country has such varied wage and a strong tech industry could bring Germany up to par with Japan and China in output per capita. Considering the rise of

xenophobia in Germany, (especially the East) tech companies provide an opportunity for talent to come from abroad and successfully integrate. Literature leads us to believe that government programs are especially integral in creating a digital economy, and in the case of Germany, could break down the cultural barriers holding back digitalization.

Analytical Framework

My research question primarily focuses on the role that technology plays in the growth of GDP in Germany. I need to analyze the way that positive growth in technology, in the case of my paper, cultural acceptance of technology, will positively impact growth of the economy. This is why I will be using the Swan-Solow model as the core of my analytical framework for determining whether increasing cultural acceptance of digitalization in Germany is leading to growth in GDP. The Swan-Solow model is an exogenous economical growth model that attributes growth the productivity, with normal practice having this be a function of change in technology (Solow 1956). The Swan-Solow model shows the impact these factors have on the economy in both the short-run as well as the long-run.

In the short-run, growth can only be achieved when capital is increased as well as the labor pool. The increase in capital coming from the increase in the amount of savings that an economy has. In the long-run, the model shows that economic growth per capita can only be achieved when there is a positive change in technology. Positive change in technology is normally defined as technological innovation that allows an economy to more efficiently use its resources (capital and labor). This is based off Given a fixed amount of stock of labor, each additional unit of capital will always produce less growth than the last, assuming there is no

technological progress, and accumulation of capital will only be enough to make up for the depreciation of the current capital that is held, keep growth steady.

Much literature has been written about effectiveness of using the Solow model to capture the role of technology in economic growth. Karras (2012), in his paper researching the impact of technological advances on GDP on the Asian continent, establishes that the Solow Model is best when examining the role of technology. Additional Literature suggests along with technological innovation, Digitalization has a pivot role in economic growth (Billon et. al 2010).

It is usually coupled with a Cobb-Douglas function, which shows the breakdown of capital and labor within an economy. The idea here is that as technology progresses, our ability to use the fixed amount of capital and labor become more efficient and economic growth is to follow. The function is normally written as:

$$Y(t) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha}$$

Where Y denotes growth, t is time, K is capital, A is technology and shows us the division between labor and capital as is normal practice for use in a Cobb-Douglas function.

Additionally, there is a depreciation of capital over time. This normally captured in what is commonly written as

$$\dot{K}(t) = s \cdot Y(t) - \delta \cdot K(t)$$

Where K-dot is shorthand for the derivative for the change of capital, s is savings and delta is the rate in which capital decreases over time.

Methodology

1. *Sample Population Model*

To create the sample model here, I will be drawing on much previous literature regarding the role of the Solow Model, specifically digitalization, and its effect on the growth of GDP. Initially, the model will be ran as a GLS regression, not accounting for panel data. Previous literature has established that there is a role for use or acceptance of technology (A) in regard to the traditional Solow model (Jimenez et. al 2014). Additionally, I will be including both depreciation of capital (DK), formation of captial (FK), GDP (GDP), and unemployment (U). The letter *t* will be denoting time and ε denote the error term. The following sample population results.

$$GDP_t = \beta_0 + \beta_1 A_t + \beta_2 U_t + \beta_3 DK_t + \beta_4 FK_t + \varepsilon_t$$

As will be explained the *Expectations* and *Data* section below, because of the nature of the capital data, all other variables had to be changed into derivative form with all being taken in regard to time using the d(variable)/dt form. As Dauth et al (2014) states, the economy of West Germany is far greater than that of East Germany. This largely is due to vast manufacturing sector that West Germany built in the 60s that has persisted until now. To fully understand the effect of each of the following independent variables, I will be taking the log of GDP broken down by state so that I can see the percentage increase each variable has on GDP. Essentially, this creates a form of equality among the coefficients making them more easily comparable. The follow equation results.

$$ln(GDP)_t = \beta_0 + \beta_1 (dA/dt)_t + \beta_2 (dU/dt)_t + \beta_3 (DK)_t + \beta_4 (FK)_t + \varepsilon_t$$

Additionally, I want to control for whether the state(s) in question are East or West Germany. This is done by determining if each state falls within the pre-1989 border or East Germany. As my research question looks to examine whether positive change in the cultural acceptance of digitalization is decreasing the output gap between East and West Germany, it is

important that the model control for regionality of each observation. Research shows that internet usage is less prevalent in East Germany (Pakura 2015).

Because my regression used fixed effects, any inclusion of a dummy variable for East Germany was eliminated. To correct for this, I decided to create three different regressions. One for the whole of Germany, one for East Germany, and one for West Germany. This would allow me to compare more precisely the difference that my *Trend* variable has on each economy. Ultimately, this will assist in directly answering my research question of whether or not the cultural acceptance of digitalization is more significant in the East than the West.

Because *Depreciation of Capital* and *Formation of Capital* are highly correlated with each other, there were severe issues with multicollinearity in my initial equation (above). To solve this issue, I created two sets of regressions, each one using a different variable for capital. Each set will have the three regressions controlling for regionality as described above. Table 1 will use *Average Formation of Capital* and Table 2 will use *Average Depreciation of Capital.*

After separating out the capital variables in separate regressions, I had problems with achieving statistical significance. Based on literature by Simionescu (2015), *Unemployment* variable and the *Trend* variable are squared to achieve significance as well as capture any nonlinear relationship that the variables might have with the dependant variable . The follow final equation results:

$$ln(GDP)_t = \beta_0 + \beta_1(dA_{it}/dt) + \beta_2(dA_{it}/dt)^2 + \beta_3(dU_{it}/dt) + \beta_4(dU_{it}/dt)^2 + \beta_5(DK)_t + \beta_6(FK)_t + \varepsilon_t$$

It should be noted at this time that these additions of squared variables did not cause any multicollinearity, with the *vif* test delivering values all below 5. This can be seen in Test 1 and Test 2, with Test 1 using average formation of capital and Test 2 using average depreciation of capital.

Test 1

Variable	VIF	1/VIF
dtrend	2.02	0.495089
dtrendsq	1.99	0.50336
dunemploy	1.34	0.746907
dunemploysq	1.31	0.760645
avecapformst	1.03	0.975383
Average VIF	1.54	

Test 2

Variable	VIF	1/VIF
dtrend	2.01	0.49641
dtrendsq	1.98	0.504302
dunemploy	1.36	0.734777
dunemploysq	1.34	0.747003
avedepcapst	1.03	0.974058

Average VIF	1.54

Additionally, the Hausman test was ran to determine whether the model should use fixed or random effects. The test indicates that the model should use fixed effects. The results of this test can be seen below.

Hausmann

Prob>chi2	0.0000

2. *Expectations*

Over the past couple years, the economic community has begun to accept Google Trend data as the best possible measurement I can find for culture. It has been used in the past to measure racism in the times leading up the 2008 presidential election. Additionally, it has been found that Google Trend data is more telling than survey data. This is typically attributed to people not recognizing that the searches they run on Google are being measured. This causes people to often be less inhibited by social pressures and true findings of culture are therefore more present in the Trend data. By 2008, it was found that in the US (and similar) in other developing countries, that almost 70% of people were using Google Search on a daily basis. While previously the searchers were more affluent, the high accessibility of the internet now means that Google Search is a tool that is being used across most demographics (Stephens-Davidowitz 2014).

When talking about the Google Trend data, as an economic metric for change in culture, based on the literature, a positive correlation between acceptance of digitalization and GDP growth is expected. Based on the study done by Pakura and Pakura (2015), I know that the amount of time a small or middle sized firm spends engaging with their customer base on social

media directly correlates with positive firm performance. Additionally, Pakura and Pakura find that over 70% of firms that fall within this category, do not engage in Facebook activity because they deem it unnecessary or worry that it will sacrifice the security of their data. This points to the role that the Google Trend data will play in what I would expect with the regression. Based on this research: as people become more open to digitalization, I would expect an uptick in online firm activity and therefore an uptick in performance, ultimately leading to a growth in the economy. This would also then apply to expectations regarding *dtrendsq*.

Literature has also been written In regard to capital depreciation and capital formation. The paper *The aggregation of capital over vintages in a model of embodied technical progress* by Erwin Diewert (2010) gives an in depth look at the reasons why I should expect, in a normal Solow Model based regression, capital depreciation and capital formation to be negative and positive accordingly. While this does not have significant implications for the research question, the correct direction and significance present in the regression goes to further verify the findings of the regression.

Unemployment is also included as a variable. Much literature has been written regarding the importance and expectations associated with including unemployment (employment) as a variable in the Solow Growth Model. I know that unemployment, due to the limited distribution of resources between capital and labor, determines the capital-output ratio (Akerlof et. al 1969). This means that looking forward in the regression I would expect that the variable accounting for unemployment, *unemploy*, be negatively correlated with the dependant variable (ln(*GDP)).* We know this because as the stock of labor in an economy decreases, holding all other variables constant, the amount of output that is able to be generated will fall (Solow 1956). This would also then apply to the squared form of the variable *unemploy*.

The implications are not solely limited to the growth of individual firms. As digitalization becomes more accepted and the infrastructure is demanded in more areas of Germany, distribution can increase. Formalization of television in India caused a change in the ecological nature of what was previously a rural town, there are many economic implications pertaining to Germany (Koshy et. al 2016). Delegates of Germany's Federal IT Council wrote a manifesto in 2016 stating the need for a nation-wide government initiative to increase digitalization and bring Germany up to speed, digitally, with the rest of the developed world. They argue that an increase in internet access, cellular service, etc. will allow for e-commerce and other digitally based businesses to thrive in Germany (DW 2012). The increase in digital infrastructure would allow for better distribution. In the case of the Solow model, it would mean that consumption would increase bringing the steady-state up higher in the short-run.

Much literature would indicate that cities (Berlin especially) is the center of the tech industry within Germany (Verhoog 2016). This would indicate that if the model were to be compared between city-states and non-city-states[1], Trend-related variables would be of a higher significance and would have a higher coefficient. We would expect that all other control variables will hold significance and have their expected signs.

3. *Data*

The data for this project was collected from three different sources. The first of which was Destatis.de. Destatis is the federal statistics office for the federal government of Germany. Data on GDP growth, disposable income per household, disposable income per household per person, population, and unemployment was collected from this source. These data point directly

[1] Germany has 16 states, three of these (Hamburg, Berlin, and Bremen) are both cities and states. While these are three of the larger cities in Germany, big cities like Munich, in regard to this data, can only captured on the a state wide level.

correspond the the variables *gdp, popul, and unemploy*. All this data was taken for the years between 2004 and 2014. The data is broken down into the 16 states of germany.

Google Trends is a free service of Google Inc. that allows a user to track traffic for specific search term. The data is displayed in a relative form, meaning that every single comparison of any term will have a "100" value because all values are relative to that of the maximum.

In regard to this paper, data was collected for the search term "Facebook" for each individual state of Germany between the years 2004-2014. It is worth noting, that the data for the years 2004 and 2005, for all states, are 0 for the trend variable. This is due to Facebook not existing in Germany until mid-2007. The data is only available at monthly intervals so the values that were retrieved were averaged by year for each state to allow the data to be parallel with other gathered data. In the coming regressions this variable will show simply as the word *trend*.

Based on the findings of Karras, data regarding the growth and depreciation of capital was gathered from the Penn World Table. For this paper, I used the measurements given for average rate of capital depreciation as well as average rate of capital formation, again, for the years 2004-2014. I had to take some liberties with this data because it was not broken down by state, unlike the rest of the data. I opted to take each individual state's population and divide it by the total population of Germany for that year, giving me a fraction equal to that state's proportion of the population for that year. I then multiplied that by the data collected for capital giving me an average per year of capital depreciation and formation broken down by state.

Furthermore, due to the fact that the capital data that was retrieved being in relative form (to time), all other variables needed to be changed into a derivative form. This includes unemployment and the Google Trend data.

Results

I chose to run the regression in three specifications. (1) All of Germany including the dummy variable for East Germany with variables ln(gdp), dUnemployment, dUnemploymentsq, dTrend, dTrendsq, and Avedepcapst/Avecapformst, (2) filtered for observations only pertaining to those of East Germany still including dGDP, dUnemployment, dTrend, Avedepcapst (or Avecapformst) (3) filtered for observations only pertaining to those of West Germany still including ln(gdp), dUnemployment, dUnemploymentsq, dTrend, dTrendsq, and Avedepcapst/Avecapformst.

When looking at Table 1 we can see that for the Whole of Germany, the variable *dtrendsq* gives us the expected outcome, being positive at 8.96e-05 with a significance value of 99%, additionally all other values hold expected sign including *dunemploysq* and *avecapformst*. We can compare these results of Table 2, remembering that the difference between the two tables is that Table 1 is regressed with capital formation and Table 2 is regressed with capital depreciation. We find that there is not a significant change between the variables. Notable is that *avedepcapst* shows a positive sign. This is unexpected and possibly due to the use of population percentage breakdown to fill the variable for each state.

Table 1

VARIABLES	(1) Whole Germany	(2) East Germany	(3) West Germany
dtrend	-0.00238***	-0.00250***	-0.00224***
	(0.000370)	(0.000563)	(0.000430)
dtrendsq	8.96e-05***	0.000111***	7.09e-05***
	(1.22e-05)	(1.92e-05)	(1.41e-05)
dunemploy	3.92e-08	-1.82e-06*	-1.98e-08
	(1.61e-07)	(1.06e-06)	(1.55e-07)
dunemploysq	-0*	-8.17e-11***	-0**
	(0)	(0)	(0)
avecapformst	5.260***	18.59***	4.632***
	(1.070)	(3.876)	(1.040)
Constant	18.12***	17.28***	18.41***
	(0.0658)	(0.125)	(0.0821)
Observations	160	60	100
R-squared	0.476	0.652	0.515

Number of state1	**16**	**6**	**10**

Standard errors in parentheses
***** p<0.01, ** p<0.05, * p<0.1**

Table 2

	(1)	(2)	(3)
VARIABLES	**Whole Germany**	**West Germany**	**East Germany**
dtrend	**-0.00276*****	**-0.00314*****	**-0.00267*****
	(0.000387)	**(0.000646)**	**(0.000456)**
dtrendsq	**0.000102*****	**0.000132*****	**8.52e-05*****
	(1.26e-05)	**(2.18e-05)**	**(1.48e-05)**
dunemploy	**-8.10e-08**	**-2.68e-06****	**-1.18e-07**
	(1.81e-07)	**(1.20e-06)**	**(1.78e-07)**
dunemploysq	**-0*****	**-1.04e-10*****	**-0*****
	(0)	**(0)**	**(0)**
avedepcapst	**2.527****	**10.20****	**2.277****
	(1.152)	**(4.382)**	**(1.138)**
Constant	**18.28*****	**17.53*****	**18.58*****

	(0.0743)	**(0.149)**	**(0.0943)**
Observations	**160**	**60**	**100**
R-squared	**0.405**	**0.539**	**0.429**
Number of state1	**16**	**6**	**10**

Standard errors in parentheses
***** p<0.01, ** p<0.05, * p<0.1**

Figures 1, 2, and 3 show the average Trend score broken down by year. Figure 1 shows the whole of Germany, 2 West Germany, and 3 East Germany. The purpose of these graphs is to show that although the results are varying within the model, the Trend data collected is seemingly similar. Both West and East Germany show that the searches for "Facebook" peak in 2012, while suffering a drop between the years of 2010 and 2011. After 2012, both East and West show a slow decline in the amount of "Facebook" queries. When looking at the whole of Germany, the trend is rather similar. It peaks around 2012, and then begins to decline. The main difference being that Figure 1 does not have as many peaks and troughs as those of Figure 2 and 3.

Figure 1 Germany

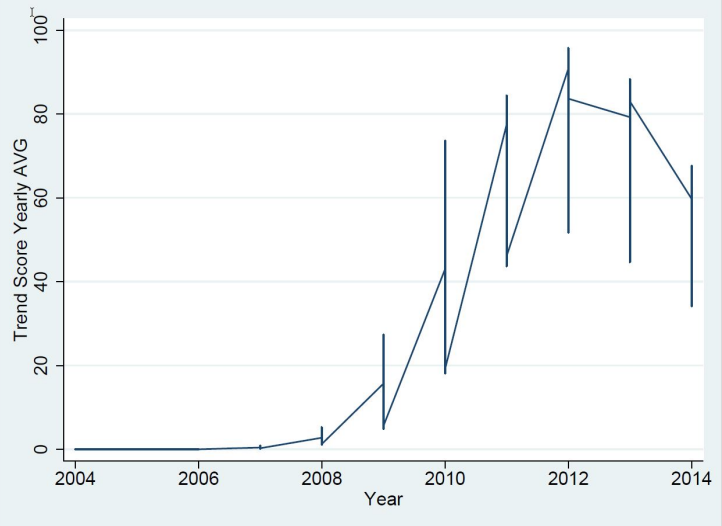


Figure 2 West

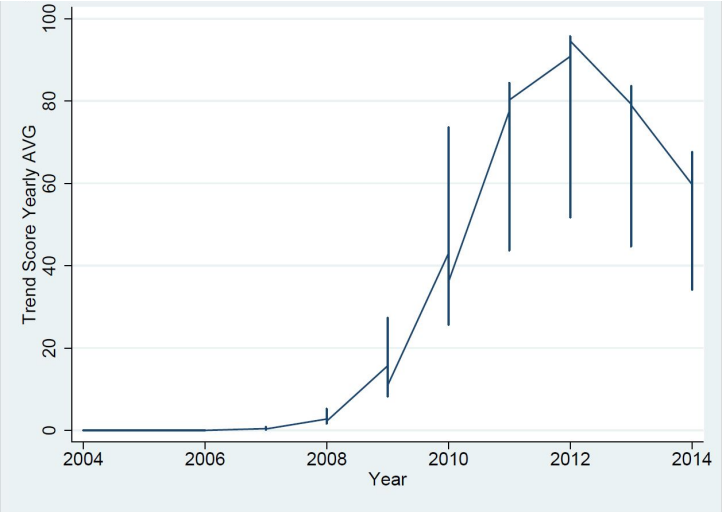
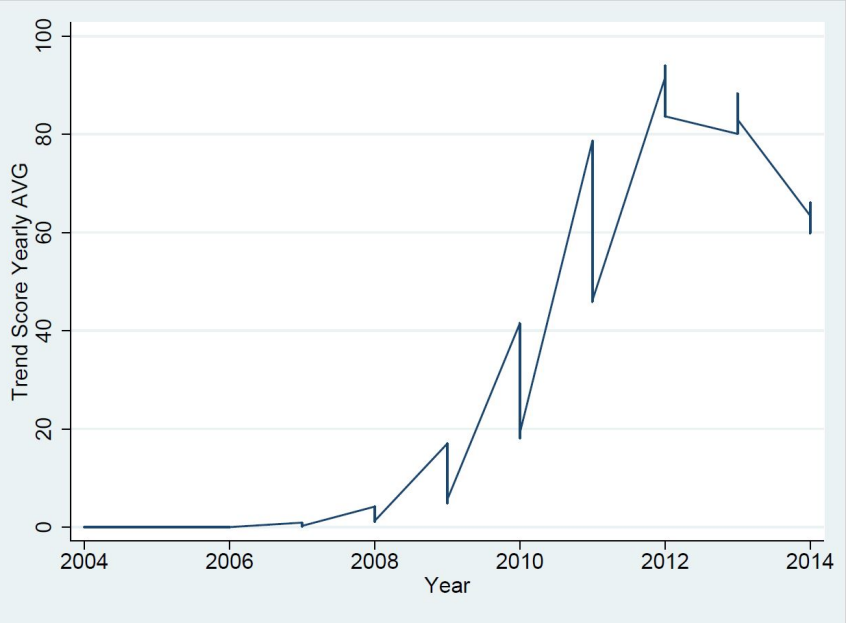


Figure 3 East



We see that *unemployment* is significant and carries the expected sign , but does not have a large coefficient. Much literature has been written about unemployment in Germany. Fuchs (2016) finds that there is diminishing unemployment in East Germany and very steady low unemployment in West Germany. This could explain why, although significant, the coefficient is essentially 0. Fuchs (2016) further shows that government programs have been highly effective in East Germany as far as reducing unemployment and that the government initiatives are based on those used in the 60s by the West German government.

What is worth noting in regard to *unemploy* and *unemploysq* is that the coefficient is larger in East Germany than that of West Germany. East Germany was at -8.17e-11 with a significance level of 99% for *avecapformst* and at -1.04e-10 at a 99% significance level for *avedepcapst*. While still small, it has a greater effect than in West Germany, potentially indicating that the East German economy is less secure than that of West Germany.

When looking to compare the regressions separated for West and East Germany we find that *dtrendsq* changes not in significance but rather changes in coefficient size. For East

Germany, in Table 1 using *capital formation* the value is .000111 and .000132 in Table 2 using *capital depreciation* both with a significance level of 99%. West Germany has values of 7.09e-05 for Table 1 and 8.52e-05 for Table 2 both having a significance of 99%.

Tables 3 and 4 show us the results of the model when accounting for city-states vs. non-city-states. The two tables (in a similar fashion to Tables 1 and 2) are separated by control of capital variable. The tables indicated that at a 99% confidence level, Trend related data has a bigger impact on GDP in non-city-states. This goes against both previous literature and the expectations of this paper. While we can see that there is a greater effect that cultural acceptance of digitalization has on non-city-state's than that of city-state's, the results of this comparison confirm the previous findings that the coefficients for Trend related variables are almost negligible in comparison with capital related variables. This further indicates that digitalization and therefore the tech industry, is not playing a significant role in the makeup of the German economy.

Table 3 City vs. Non-City (Average formation of capital)

	(1)	**(2)**

VARIABLES	City	Non-City
dtrend	-0.00280***	-0.00228***
	(0.000714)	(0.000398)
dtrendsq	6.41e-05***	9.23e-05***
	(2.04e-05)	(1.35e-05)
dunemploy	-2.28e-06**	3.03e-08
	(9.76e-07)	(1.61e-07)
dunemploysq	-1.98e-10***	-0*
	(0)	(0)
avecapformst	12.95**	4.771***
	(5.582)	(1.068)
Constant	17.68***	18.21***
	(0.129)	(0.0748)
Observations	29	131
R-squared	0.747	0.494
Number of state1	3	14

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4 City vs Non-City (Average depreciation of capital)

VARIABLES	(1) City	(2) Non-City
dtrend	-0.00312***	-0.00266***
	(0.000763)	(0.000418)
dtrendsq	7.23e-05***	0.000106***
	(2.16e-05)	(1.40e-05)
dunemploy	-2.80e-06**	-8.87e-08
	(1.02e-06)	(1.81e-07)
dunemploysq	-2.33e-10***	-0***
	(0)	(0)
avedepcapst	7.597	2.165*
	(5.641)	(1.151)
Constant	17.79***	18.39***
	(0.137)	(0.0846)
Observations	29	131

R-squared	**0.708**	**0.423**
Number of state1	**3**	**14**

Standard errors in parentheses
***** p<0.01, ** p<0.05, * p<0.1**

Conclusion

The data shows us that when looking at average formation of capital, positive cultural change in digitalization increases GDP by .0001% in East Germany compared to .00007% in West Germany. The data draws a similar conclusion when looking at average depreciation of capital as *dtrendsq* impacts GDP by .00013% in East Germany and .00009% in West Germany. From this we can draw a conclusion relating back to the initial research question. Verhoog (2016) tells us that Berlin will become a hub for technology companies, but has yet to achieve this goal. We can see this based on the evidence of the results. While small the coefficient of East Germany capturing the Google Trend data has a greater impact on the economy than that of West Germany. This backs up my hypothesis that East Germany will benefit greater than West Germany from the rise of the technology industry in Germany.

Additionally, the results go further to confirm that although cultural acceptance of digitalization is having a greater effect in East Germany, it is not making up a significant part of GDP in both East and West Germany. This is confirmed by Manifesto written by Germany's committee to the World IT summit (DW) as well as Billion et al (2010). They explicitly state that Germany is behind in digitalization and that the government has to step in and create an initiative to change the current climate of digitalization.

Across Germany, there are examples of businesses pivoting their business to align with the rise of digitalization and specifically IOT. Trumpf GmbH. is an excellent example of such a company that other German manufacturers should model themselves after. Trumpf manufactured industrial grade laser cutting equipment for use in factories. After realizing that there was a decline in demand for their product (this is largely due to other countries, such as china, being able to produce similar products at a lower cost), they created an IOT software that accompanied their product. The software would tell the consumer if a part needed to be replaced, how efficiently the machines were working etc. This is the type of initiative that German companies need to take. There is a danger that is confirmed by this data that shows that German manufacturers are at risk of falling behind. The small amount of digitalization being incorporated into their economy means that "Made in Germany," which for so long has been coveted as a sign of quality, might cease to be relevant in the current market.

Pakura (2015) confirms that most Germans do not use the internet or Facebook because they are concerned about security and deem it unnecessary. Michael et al (2014) adds to this by stating that after the initial reunification of Germany, government programs focused on encouraging entrepreneurship in East Germany were highly effective and goes further to point out that government programs, in general, are highly effective in Germany. We saw this with the literature written about the programs created by the federal government to suppress unemployment.

I believe that my research confirms that there is an opportunity for growth, specifically in the realm of technological industries. This industry will not be able to grow until the German people fully accept that their manufacturing industry is not able to sustain their current economic status (Economist 2015) and believe that technology as an industry will only benefit their

economy. Based on my findings as well as the literature, this will only happen when the federal government of Germany creates a government body pertaining to digitalization to alleviate people's doubts about personal privacy, security, and relevance.

Parathasarathi et al (2016) confirms that there is great effectiveness found when a government intervenes to drive digitalization forward. While India is not the most similar to Germany, this does not mean that standardized internet connection would not be greatly beneficial to Germany as television was to India. Additionally, we can see the success that South Korea has had on creating what they call a "smart city" Kyunam et al (2016). This studies finds that a relationship between a highly advanced technological infrastructure (like the one found in South Korea where wireless internet is free and faster than that of most western countries) coupled with an economy that has a need for high digital connectivity has overwhelmingly positive effects on the economy. While Germany does not have to strive for such a high standard, their high population density would easily allow for a high level of internet connectivity.

While this study has added to the previous literature by measuring all of Germany's culture as it pertains to digitalization (this is in contrast to Pakura et al who only measured usage of Facebook by small business owners in Germany), there is still room for further research.

If one were to answer the same research question as this paper, Facebook usage and new account creation in proportion to the population would deliver a better understanding of how much of the population is participating in the new age of digitalization. This has the potential to deliver a better dataset on the cultural perception of digitalization than Google Trends.

Additionally, if this study could be replicated between similar countries in Europe, the data would deliver a better understanding of the true meaning behind the variables coefficients. Based on this study alone, we cannot empirically confirm that Germany is behind other countries

in regard to digitalization or if the perception of digitalization in Germany is drastically different than that of other European countries.

The final recommendation for further research would be to include the technology variable in the Solow Growth model. In contrast to this paper where technology was completely replaced by the Google Trend data, a model that also includes change in technology in addition to Google Trend data could potentially solve the issue of a significant constant. It would also give further significance to any results generated by the model as it relates to cultural acceptance of digitalization.

Limitations

The results indicate that there limitations to the model. In every single iteration of the model the constant is significant. This could potentially indicate that there are omitted variables from this model as the mean when all explanatory variables are zero is significant. This is rather expected as the Solow model normally uses a variable for technology or rather change in technology. Had the model used a variable for technology in addition to the variable account for cultural acceptance of digitalization, this could have potentially been avoided.

Additional limitations are the sample size and the form that the data was available in. Because Facebook was has only been available in Germany since 2007, there was a limit on data observations with meaningful data. Destatis was also only available until 2014 meaning that the range of data having meaningful observations for *Trend* as well as all other control variables was 2007-2014. The range from 2004-2006 had no observations for the Google Trend variables. Due to all capital related data being in derivative form and therefore having to change all other

variables into derivative form, this means that 2007 all Trend related observations were changed to "0." This constriction on the sample size of Macro-based model could mean that the results are not entirely accurate.

Another limitation of this paper is found in the way Trend variables were created. Based on the research done by Pakura (2015), a majority of Germans were deterred from using Facebook and therefore Trend data was only collected for the search term "Facebook." While an accurate indicator of the current digital climate in the western world, we cannot say for sure that this captured all of a culture as it pertains to digitalization.

Finding data for capital broken down by state also proved to be a limiting factor for this paper. Based on the literature written by Karras (2009), data for capital was collected using the Penn World Table. Unfortunately, data could only be collected on a country-wide basis. The data was then broken down by state by taking each state's individual proportion of the total population. This is not entirely accurate as literature and the results indicate that there is strong economic inequality across German, especially between East and West.

In addition, the data available through the Penn World Table pertaining to capital did not have a single set of observations. It is unclear based on previous literature whether depreciation of capital should be used or formation of new capital. As one can see from the results there is an unexpected sign when using the depreciation of capital. This most likely indicates that there is an issue using this variable within the augmented Solow model, which potentially decreases the significance and validity of the findings.

This paper encounters an additional limitation when running the regression looking at city-states vs. non-city states. Hamburg, Berlin, Bremen are both states and major cities. Destatis data was available on the statewide level but not for individual cities. This means that looking at

Table 3 and 4 there are other major cities that are captured in the "Non-City-States," such as Munich, Cologne, Stuttgart, Dresden etc. This means that Table 3 and 4 are not completely accurate representations of the impact cultural perception of digitalization has on growth of GDP when looking at cities.

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