ABSTRACT

In theory, patents may have negative effects. The implementation of a mandatory WTO agreement that strengthened patents serves as a natural experiment that occurred simultaneous to the HIV/AIDS Crisis. Pharmaceuticals play a key role in HIV/AIDS survival, so we would expect to see the effect of patents here. We find an increase in HIV/AIDS related deaths of 2.117 per 10000 upon the treaty's implementation, significant below the 1% level. Using interaction terms, we find even larger effects on least developed countries, which serve as a proxy for weak patent laws. These results are significant at the 1% level.

I. INTRODUCTION

In 1995, the World Trade Organization (WTO) adopted an agreement that set minimum standards regarding patent laws in signatory countries. The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) required that signatories recognize patents from other signatories, adopt a patent term of 20 years, and mandates the institution of patents on pharmaceuticals, amongst other requirements. All members of the WTO are required to sign TRIPS, which has led nearly every nation on Earth to adopt patent standards in line with TRIPS. (WTO, 2017) Hence, TRIPS could lead to a decrease in the quantity supplied of patented products including life-saving pharmaceuticals, such as those used in combatting the global HIV/AIDs crisis. This prompts the question of whether TRIPS has triggered an increase in the number of HIV/AIDs related deaths, especially in the poorest countries, which had the weakest patent protections prior to TRIPS.

Simultaneously to the introduction of TRIPS, infections and deaths related to HIV/AIDs were growing globally and the disease became a global priority – leading to some of the most effective measurement of an epidemiological crisis in history. A notable feature of HIV/AIDs is that it can be managed through pharmaceuticals, extending the lifetime and quality of life of an individual indefinitely. Given the effectiveness and usage of pharmaceuticals on HIV/AIDs, policy related to pharmaceuticals would likely influence individuals dealing with this disease, affecting the number of people who die due to this disease.

By looking at the relationship between the HIV/AIDs crisis and the natural experiment TRIPS adoption allows, this paper aims to explore the relationship between patents and a high-quality quantifiable health outcome which should be affected.

III. MATERIALS AND METHODS

Data was collected from several public sources. As a proxy for patent strength in a country, the date that TRIPS came into force for a given country was taken from the World Intellectual Property Organization. The number of AIDs related deaths by country by year was taken from UNAIDS AIDSInfo. This was combined with population by country, which was taken from The World Bank, to create a measure of HIV/AIDs-related deaths per 10000. In several instances, a range containing upper and lower bounds was given for HIV/AIDs-related deaths, as well as an estimate. In these instances, the estimate was used. Any country without data on deaths or population in a single year was dropped from this analysis. This leaves us with 3348 observations from 124 countries across the years 1995 to 2016, inclusive. Country classifications were taken from two sources. Least developed countries (LDCs) were taken from the WTO. Developing countries (DCs) were taken from Deere (2009).

Figure I was constructed by averaging HIV/AIDs-related deaths per 10000 by country category by year. Figure I tells a relatively straightforward story: HIV/AIDs had the largest impact in LDCs, and a smaller impact on developed countries. Additionally, the HIV/AIDs crisis slowly got worse before getting better. This trend holds both of the aggregated data and when the data is divided by country category.

Figure II presents the changes in adoption of TRIPS over time, by country category. Initially, TRIPS was adopted in 73 countries in 1995. This is 58% of the countries within the data set. By the end of 2016, 111 countries within the data set had TRIPS in force. This is 89%

of the countries within the data set. Adoption by DCs was done by 2000,[1] while developed and LDCs adopted more gradually over time following the high number of initial adopters in these categories. This is displayed in Figure II.

By comparing Figure I to Figure II, we would might expect to see some evidence of TRIPS influencing HIV/AIDs related deaths. A cursory glance indicates that this isn't the case. It is possible that the HIV/AIDs crisis is severe enough that any change due to implementation of TRIPS is small relative to the changes due to the spread of the disease and efforts by nations and international bodies to combat the disease. This would indicate that there may be other omitted variable affecting the spread of HIV/AIDs. A regression may be more effective at picking up any potential effects of TRIPS.

IV. RESULTS

A panel regression with interaction terms was performed. The specification is as follows:

$$D_{cy} = \alpha + \beta_1 T_{cy} + \beta_2 DC_c + \beta_3 DC_c * T_{cy} + \beta_4 LDC_c + \beta_5 LDC_c * T_{cy} + \delta_y + \delta_c + \epsilon_{cy}$$

D_{cy} is HIV/AIDs-related deaths per 10000 in country c in year y. T_{cy} is a dummy variable which is 1 if country c has joined the TRIPS agreement in year y and is also referred to as TRIPS in force. LDC_c is a dummy variable which is 1 if country c is a LDC, and DC_c is a dummy variable which is 1 if country c is a DC. Interaction terms using T_{cy} and both LDC_c and DC_c were also

[1] DCs were a special category of country created for early adoption of WTO agreements by countries which did not fall into the UN's LDC category but had cofounding factors that put them at a disadvantage in treaty adoption compared to a significant subset of developed countries. Once the early adoption period of the WTO ceased, countries would either be categorized as DEV countries or LDCs, since the advantages provided to DCs ceased.

used. δ_y and δ_c represent year and country fixed effects, respectively. Country fixed effects allow for country specific effects to be considered, such as a high initial prevalence of HIV/AIDs in a country. Year fixed effects will consider global factors of the disease, such as efforts by international bodies to combat the disease. The results of this regression are presented in Table I. Note that either the LDC and DC dummy variables were used, or country fixed effects were used, as the country classifications attempt to capture the same factors that would be measured by a country fixed effect.

Under all specifications used with this model, TRIPS in force has very significant positive coefficients. In the model using interaction terms, countries which had TRIPS in force experienced 4.014 more deaths per 10000 than a country that didn't, a result which is significant at the 1% level. Given that the mean number of deaths per 10000 is 2.565 across all observations when TRIPS was not in force, implementing TRIPS is expected to increase HIV/AIDs related deaths by 156%. This result is in line with the theoretical impact as well: granting a monopoly for a lifesaving drug would reduce the quantity of life-saving medication sold and as a result increase deaths related to HIV/AIDs.

Another key result revolves around the interaction terms LDCxTRIPS in force. The coefficient means that LDCs experience an additional 3.582 deaths per 10000 when TRIPS was in forace as compared to a developed country. This result is significant at the 1% level. This means that an LDC which has implemented TRIPS experiences 7.596 more HIV/AIDs related deaths relative to another LDC which has not implemented TRIPS. This number is even higher when compared to DCs or DEV. The equations needed to derive this result follow below.

$$E(D|TRIPS\_in\_force = 1, LDC = 1) = \alpha + \beta_1 + \beta_4 + \beta_5$$

$$E(D|TRIPS\_in\_force = 0, LDC = 1) = \alpha + \beta_4$$

$$E(\Delta D|\Delta TRIPS\_in\_force, LDC = 1) = \beta_1 + \beta_5$$

In least developed countries, where the average number of HIV/AIDs related deaths per 10000 is 4.276 in years in which TRIPS was not implemented, we would expect to see a 177% increase in HIV/AIDs related deaths due to TRIPS implementation. Theory supports this outcome: Most developed countries already had strong patent systems in place prior to TRIPS, while many LDCs did not. This would mean that TRIPS would disproportionately affect LDCs. In essence, LDC can be thought of as a proxy for a weak initial patent system. It is also notable that switching between using country fixed effects and dummy variables for LDCs and DCs changes the coefficients but doesn't change the sign or the significance category a result falls into.

The HIV/AIDs crisis and patent laws are both complex items that have many factors affecting them. This leads to a possibility of omitted variables. One key omitted variable is the issuance of compulsory licenses. TRIPS contained a provision allowing the licensing of drugs for crises. This was provided to potentially offset the negative effects of patents. A regression using a dummy variable for compulsory licenses was also performed. Instances of compulsory licensing were taken from Beall and Kuhn (2012). A dummy variable was created, called compulsory license. This variable is 1 in a country and year when a compulsory license was issued for HIV/AIDs related drugs. The results of that regression are presented in Table II. Note that this data only reflects instances of compulsory licensing prior to 2011, and that the corresponding regression was only performed on data from 2011 an prior.

In theory, it would be expected that compulsory licenses would reduce HIV/AIDs related deaths by making pharmaceuticals more available. Additionally, it would also be expected to decrease the value of TRIPS in force, since the most severe instances of HIV/AIDs outbreaks would be addressed by a compulsory license. Only one regression found a significant coefficient for compulsory licenses. While this mechanism may work in theory to reduce the negative effect of increased patent protection, the results of the regression do not support that, potentially because of the correlation of a spike in HIV/AIDs and the likelihood a country would issue a compulsory license. Additionally, there were only 19 country-year instances where compulsory licenses were issued in 1990-2010, indicating that the tool is rarely used.

One might observe that HIV/AIDs was increasing over the years, particularly in 1995 when many countries signed onto TRIPS. This increase may be correlated with TRIPS in force, even though it was already occurring prior to TRIPS. Running the same regression with all years prior to 2005 removed from the sample results in coefficients of similar values and significance to earlier regressions, indicating that this upward trend from 1990 to 2004 wasn't being captured by the TRIPS in force variable in prior regressions. The results are presented in Table III.

V. DISCUSSION

The results of regressions used within this paper suggest TRIPS introduction is highly correlated to deaths due to HIV/AIDs. The use of a difference in difference regression combined with the natural experiment of the TRIPS agreement provides stronger – but not conclusive – evidence of causality. This lines up with the negative theories regarding patents and more broadly, monopolies. The granting of monopolistic rights for a patent would reduce the quantity sold of an item, and if that item is a lifesaving item, it may increase deaths. Additionally, TRIPS seems to have disproportionately affected LDCs, which is a similar conclusion that Gold et al

(2009) found in their work as well. LDCs may be seen as a proxy for weak patent laws, further suggesting the potential damage stringent patent laws may cause.

While the results of this paper seem to paint a negative portrait of patents, more research into the area would be needed to be more conclusive. Instead of using TRIPS as a proxy for patent strength, finding individual, country level patent information would provide a stronger explanatory variable. Additionally, the HIV/AIDs crisis is very complex, and additional omitted variables are something that should be further addressed.

One key way to improve the results of this paper would be to find the exact dates TRIPS related laws went into effect in a country. Currently, the date that a country joined TRIPS is included in this paper – but the exact dates that these reforms were implemented would paint a more accurate picture. This task would be difficult, as it would involve acquiring and reading through patent laws – historical and modern – for most of the globe, in a variety of languages.

An alternative mechanism which could provide even more accurate regressions would be acquiring the length of the term of patents by country by year. This would involve a similar process to the above but would require even more details from said patents broken out by year and a keen attention to detail in the local laws of a variety of countries. Creating such a data set, however, could be invaluable to future analyses regarding patent effectiveness.

The HIV/AIDs crisis is a complex event and there may be omitted variables. Other variables should be found and incorporated. These additional variables may include price controls and other mechanisms which countries can use under TRIPS to reduce the price of

pharmaceuticals.[2] Incorporating the effect of patents into epidemiological papers regarding the HIV/AIDs crisis may also serve a similar function.

Similar research on other diseases or other measures which may be heavily influenced by patents could be done to verify these effects using similar methods to this study. Research could also be done in a different area of the economy to get further insight into the effects of the TRIPS agreement and patents on the more general economy.

[2] Compulsory licensing is only one such tool, but it is the most explicitly defined and studied.