**The Ebola Epidemic on West African Inequality**

**Abstract**

This paper examines the effect of the Ebola epidemic on Income Inequality in West Africa using data from mainly The World Bank and World Inequality Database. The Ebola epidemic in 2014 increased unemployment by disrupting production chains and decreasing foreign direct investment through scaring off investors. The model employs multiple regression and finds some evidence to support the claim that income inequality was not worsened as a result of the Epidemic.

1. **Introduction:**

The economic growth in West Africa over the past 10 years has been explosive and in 2018, West Africa housed 3 of the 10 fastest growing economies in the world and 6 of the top 10 African countries. The richest country per capita is Mauritius, and it has experienced 195% growth in total wealth over the past 10 years (Coulibaly). Cote d’Ivoire, exhibiting the second fastest growth wealth per capita, grew by 43%. The entire region’s real GDP growth is 6% since 2014, excluding a shock and a conflict prone Nigeria (REO 2019, 7). Despite these growth trends, West Africa has the largest number of countries with greater than 30% below the $1.90 international poverty line. These trends have also been accompanied by a steadily rising income inequality, as a large share of the growth has gone to few. The bottom 99% of the entire West African region owns less than the top 1%. The largest economy in Africa and West Africa is Nigeria, and the richest man earns roughly 150,000 times more than the bottom 10% spends in yearly consumption. Nigeria is also the most populous country in West Africa, while approximately 53% of the population lives below the $1.90 absolute poverty line as of 2019 (WAIC 2019, 4). The second largest economy in West Africa is Ghana and the top 10% of Ghanaians consume more than the bottom 60% (World Bank data). This trend in inequality is not exclusive to income. In educational and gender inequality, a poor woman in Ghana is 14 times less likely to attend school than a rich woman and a poor woman in Niger only has a 70% chance of attending school. Only 50% of Niger women attend primary school (GDHS, 33). According to the Gender Inequality Index, West African countries are all ranked the in the bottom 30 countries worldwide (UNDP, GII). This inequality is also reflected in the United Nations Human Development Index, where each country falls into the lowest category of gender equality, focusing on healthcare, education and living standard inequalities (UNDP, HDI).

Amidst the trend of rapidly increasing inequality, the largest Ebola epidemic began on December 6th, 2013 in a small town within Guéckédou prefecture, Guinea. By August 2014, the World Health Organization had declared this outbreak as a Public Health Emergency of International Concern. This delay in international assistance was due to the lack of leadership in these West African Countries. Figure 1. illustrates the spread of Ebola after reaching Liberia and Sierra Leone using Centers for Disease Controls data. The only other West African country to see Ebola cases was Nigeria with 20 cases. The Nigerian national response was immediate. The Nigerian CDC was mobilized, and all national entry points were monitored using infra-red temperature checks (Alexander, PMC). In Ghana, organizations like the World Health Organization, UNICEF, the World Food Programme and International Federation of Red Cross worked in concert with the Ministry of Health of Guinea to combat Ebola Virus Disease (EVD). The Red Cross, for instance, handled the burials, ensuring the burials safety and cultural dignity because traditional burial practices involve the physical handling of the deceased. Unsanitary burial practices in Guinea has been linked with 60% of the transmissions, as the women in Guinean communities wash the deceased and then return to their families (Chan). UNICEF was the lead in sanitation infrastructure, such as clean water and better hygiene, and the World Food Programme supplied food to disrupted food supply chains. The second country to confirm EVD was Sierra Leone. The operation to fight EVD was named Operation Northern Push. The strategy was to “identify, contain and eradicate” Ebola using contact tracing with which the operation traced the social contacts of infected persons (GEP, Guinea). Again, external countries provided aid to the Sierra Leone Government. For example, the U.S. CDC sent teams to train healthcare

A screenshot of a cell phone

Description automatically generated

Figure : Ebola cases in Guinea, Liberia and Sierra Leone time series

workers and oversee policies to combat EVD. Sierra Leone was the hardest hit country, as hospitals reached capacity and bodies were thrown into rivers or slums. In 2014, Sierra Leone implemented a three-day lockdown, intended to alleviate pressure from healthcare workers and provide them with more time to monitor for and trace infections (CDC). Liberia was the third country to have cases of EVD, and its medical infrastructure had been damaged by two civil wars and general political instability. Stunningly, there were only 30 physicians left to combat EVD and, 7 months into the onset of the disease, Liberia experienced a 40% decrease in persons working (WAEC). In all three countries, EVD response begins at the local level and is meant to be supported by international aid only after state, regional and federal resources are at capacity.

An epidemic which is as infectious and fatal as this strain of EVD was, will disrupt a developing nation’s economy deeply. As borders become restricted, such as the Senegal-Guinea border in 2014, trade and transportation across borders will be affected. The 2012 Africa Economic Brief found that cross-border activity is a source of income for 43% of Africa’s population (AEB, 1). Additionally, high risk areas in Sierra Leone had quarantine restrictions and curfews imposed. A large share of economic activity in the region is from agricultural production because of marketing, processing, transport, importation, etc. Agricultural production as a percentage of GDP ranges from 20 to 50% in this region16. Farmers faced difficulty in transporting their goods to areas of consumption. Rice producing areas in Guinea and Sierra Leone were also areas of high EVD incidence, so consumers believed that these sources of rice were potentially unsafe. Consumer behavior changed, as did labor. The region experienced a labor shortage, as fear of contamination from working in collective farming affected the labor supply. Traders of rice, the link in the production chain that is responsible for transporting the rice to consumers, were afraid to collect rice from these areas (FAOUN). Another affected industry was the mining industry due to labor shortages from travel restrictions and fear of infection. A World Bank report shows that the prices of gold and iron declined by 30-60% during 2015 (WAECIU). Rio Tinto, a mining company, halted work on a $20 billion-dollar iron mine due to the labor shortage (McGroarty, WSJ). This is an example of the Ebola epidemics’ scare effect. Investors lost confidence in the region, halting funding to operations across the region. As economic activity declined, so did revenues from tariffs and taxes. In 2015, the World Bank estimated that the deficit as a percent of GDP was 7.6% averaging over the three affected countries (World Bank data).

The effect of the EVD outbreak is complicated, and the following economic decline has unclear consequences on the region’s income inequality. In this paper I will use a multiple regression model in an attempt to determine the Ebola epidemic’s effect on overall income inequality as a function of higher unemployment from the disruption of production markets and lower foreign direct investment (FDI) due to investors losing confidence in the region.

1. **Literature Review:**

Much of the literature devoted to the economic impact of disease focuses on labor outcomes following early life shocks such as Malaria, or hookworm (Bleakley 2007, Almond 2006). Bleakley used a Hookworm eradication campaign to study 5-year outcomes. Almond uses cohorts born during the civil rights era to study long run and intergenerational impact of the 1918 influenza pandemic. Both find that early shocks reduce income, education attainment, and physical ability, among other outcomes. Examining the effect of an Ebola outbreak on income inequality seems to be a novel study. Walter Scheidel, In The Great Leveler, asserts that plagues change the ratio of land labor. Workers are better off because their labor is more valuable. One of the plagues that he examines is the Black Death. He uses tax records to conclude that wage inequality was compressed for close to a century before it started to rise again and came to a similar conclusion regarding the Antonine and Justinian plagues. However, these analyses are not supportive of a claim that Ebola similarly suppressed wage inequality in West Africa because comparing disease effects in an agrarian pre-modern society to a modern society is untenable. Bowles et al. use a difference in difference approach with data from firm surveys to determine Ebola’s effect on economic activity in Liberia. They find that 12% of Liberian firms closed due to EVD, and that 24% more Liberians are unemployed (Bowels et al.).

There is one interesting paper on the “fear” effect of the EVD outbreak. Fuente, Jacoby and Lawin 2019 used household survey data to estimate the effect of fear on the income of families in the affected regions. The fear effect as a mechanism describes a family losing sources of income as workers choose avoid jobs that bring them in close proximity of others. They used a fixed effect regression to find that rural poverty in Liberia increased from 70% to 82% (De la Fuente, et al., 19).

* 1. **Mechanisms**

The first mechanism to study is foreign direct investment, as it is known to be a substantial indicator of income inequality. *In Does Foreign Direct Investment Lower Income Inequality? New Evidence and Discussion on the Role of Service Offshoring*, Couto gathers data on 94 countries from 1990 to 2013 and uses an OLS regression. They finds that on average, FDI increases income inequality. The intuition behind their insights is “FDI raises the relative demand for higher-skilled labor, which in turn leads to an increase in both the wages and employment levels of high-skilled workers relative to those of low-skilled workers (Couto, 23).” Gorg 2006 uses a similar method to investigate the relationship between wage inequality and FDI, but for developed and developing countries. The main difference is that Gorg focuses only on the manufacturing sectors of countries and includes more countries than Couto in his analysis. Gorg’s results support Couto’s, but only for developing countries. Gorg finds that FDI increases wage inequality for only developing countries, while FDI decreases wage inequality for developed countries (Gorg, 16). A third study on FDI focuses on Eastern European and Asian countries in the period from 1990 to 2002. Bhandari employs a fixed effects OLS regression model and finds that FDI reduced capital income inequality and exacerbated wage income inequality (Bhandari, 17).

The second mechanism is the effect of unemployment on income equality. Jantti 1994 uses a generalized least squares model to find that structural unemployment causes income inequality using household decile data similar to the world inequality database (Jantti, 375). This view is supported by Mocan 1999 and he concludes that "increases in structural unemployment have a substantial aggravating impact on income inequality (Mocan, 134)." Ronald Schettkat discusses the relationship of inequality and unemployment in the context of the Natural Rate Theory. Schettkat uses value decomposition to show that countries with high inequality have higher intergenerational income elasticity which he interprets as how opportunistic a market is (Schettkat, 20). Menendez and Gonzalez 2000 use a micro-stimulation approach to create a probability distribution for the unemployed. This method decomposes changes in the distribution of individual earnings in an attempt to find the source of changes in observed inequality. The data they use is micro-data from Buenos Aires and the period is 1991 to 1998. They then can create inequality measures from the actual and simulated populations to show changes in unemployment on earnings inequality. They find that higher unemployment has a strong positive relationship with the Gini coefficient (Menendez and Gonzalez, 14).

1. **Methods:**
   1. **Data**

The compiled time series dataset includes the years 2010 to 2017 on all West African countries excluding Cote d’Ivoire due to data sparsity in World Bank data. Much of the data is comprised of World Bank data, but data involving shares of income is gathered from the World Inequality Database (WID). The WID is a database that attempts to estimate the income share of each decile of the population. As useful as this data is, I collected as little as possible because the estimation strategy for missing data is to use the previous year’s estimate, which results in many constant estimates for entire deciles. For Foreign Direct Investment and GDP estimates, I used Index Mundi. The World Health Organization had monthly data on Ebola cases by affected country.

The independent variable for my first model is the number of reported cases of EVD in each affected country. The number of cases is likely more representative of the EVD’s scale than the number of deaths especially because the ‘scare’ effect from an EVD outbreak is tangible, seen in the disruption of agricultural markets. GDP is a typical control when comparing countries of differing sizes. West Africa is a politically unstable region, so the presence of conflicts are controlled for. Demographic controls such as the urban population and population density are necessary to include. More densely populated and urban areas will have higher physical proximity which will increase EVD transmission rate, and the urban population is an indicator of urban economic activity. Ideally, I would have estimates for the percentage of GDP spent on healthcare, but many countries in the World Bank data didn’t have these estimates for the timeframe. Instead I included total government spending as it includes the amount of resources spent on healthcare but also on expenditures such as redistributive policies which affect inequality.

|  |  |  |
| --- | --- | --- |
| Label | Variable | Measure |
| conflict | Indicator for presence of war, revolution, or coup | Binary |
| epi | Cases of Ebola divided by the population | Percentage Value |
| fdi | The net inflows of foreign investments | Dollars |
| gdp | Macroeconomic variable for economic activity | Dollars |
| gini | Macroeconomic variable for inequality | Percentage Value |
| govSpend | Total government Expenditure | Dollars |
| palma | Ratio of 10% incomes shares to 40% income shares | Ratio |
| popDens | The population divided by land area | Density |
| unemploy | Unemployment rate, percentage of labor | Percentage Value |
| urbanPop | Urban population | Percentage Value |

*Table 1: Defined Variables*

The independent variable for my second model is the Palma ratio, an alternative to the Gini. It is comprised of the top 10% income share over the bottom 40%. If the Palma ratio is 1, both groups have equal income shares. If the Palma ratio is 2, the top 10% has double the income share of the poorest 40%. I included this alternative inequality measure over concerns about the estimation of the Gini, especially with data in this region because the survey infrastructure is weaker than in developed countries.

The independent variable for the third model was *fdi*. Foreign direct investment is a strong indicator of income inequality, so the third model is intended to support *fdi* as a mechanism for EVD to influence income inequality through.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Min | Mean | Max | sd |
| conflict | 0 | 0.1727 | 1 | NA |
| epi | 0 | 215.5 | 9446.0 | 1204.964 |
| fdi | 190000 | 1035906310 | 8841114000 | 1507533679 |
| gdp | 2173545984 | 16035571250 | 1.3e+14 | 3.022e+13 |
| gini | 0.5011 | 0.5764 | 057 | 0.0512 |
| govSpend | 100 | 32869980000 | 5.4e+11 | 97919475612 |
| palma | 8.528 | 13.416 | 22.336 | 3.64 |
| popDens | 3.39 | 75.897 | 218.76 | 57.08515 |
| unemploy | 0.317 | 5.195 | 11.909 | 3.048001 |
| urbanPop | 16.208 | 44.076 | 71.646 | 13.38134 |

*Table 2: Descriptive Statistics*

**3.2 Models:**

**Model 1:** The first model is a multiple regression examining the impact of EVD at the macro level.

gini = b0 + b1*epi* + b2*gdp* + b3*govSpend* + b4*popDen* + b5*urbPop* + b6*unemploy* + b7*fdi* + b8*conflict*

**Model 2:** The second model is the same multiple regression, but the independent variable is the Palma Ratio, a different measure of inequality. The Palma ratio is the ratio between the top 10% and the poorest 40%.

Palma Ratio =

palma = b0 + b1*epi* + b2*gdp* + b3*govSpend* + b4*popDen* + b5*urbPop* + b6*unemploy* + b7*fdi* + b8*conflict*

**Model 3:** The third model is a multiple regression which examines the relationship between the paper’s most direct mechanism on income inequality, the foreign direct investment. This is somewhat meant to be a sanity check.

fdi = b0 + b1*epi* + b2*gdp* + b3*govSpend* + b4*popDen* + b5*urbPop* + b6*unemploy* + b7*palma* + b8*conflict*

1. **Results:**

**4.1 Model 1:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Estimate** | **Std. Error t** | **value** | **Pr(>|t|)** |
| (Intercept) | 11.02 | 0.96 | 11.48 | < 2e-16 |
| epi | -0.33 | 0.40 | -0.82 | 0.42 |
| gdp | 0.00 | 0.00 | -3.71 | 0.00 |
| govSpend | 0.00 | 0.00 | 3.55 | 0.00 |
| popDen | 0.01 | 0.01 | 0.78 | 0.44 |
| urbPop | 0.12 | 0.03 | 4.33 | 0.00 |
| unemploy | -0.38 | 0.12 | -3.08 | 0.00 |
| fdi | 0.00 | 0.00 | -1.87 | 0.06 |
| conflict | -1.59 | 0.94 | -1.69 | 0.09 |
| R-squared | 0.24 |  |  |  |

*Table 3: Model 1 estimates*

The relationship between EVD cases and the Gini is not statistically significant in Model 1. The only variable with a non-zero statistically significant coefficient is the unemployment rate. The model finds that unemployment has a negative relationship with Gini, which is a contradictory result to how I frame unemployment as a mechanism.

**4.2 Model 2:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Estimate** | **Std. Error** | **t value** | **Pr(>|t|)** |
| (Intercept) | 11.03 | 0.95 | 11.65 | < 2e-16 |
| epi | 0.00 | 0.00 | -2.01 | 0.05 |
| gdp | 0.00 | 0.00 | -2.87 | 0.00 |
| govSpend | 0.00 | 0.00 | 3.16 | 0.00 |
| popDen | 0.01 | 0.01 | 0.92 | 0.36 |
| urbPop | 0.12 | 0.03 | 4.47 | 0.00 |
| unemploy | -0.40 | 0.12 | -3.30 | 0.00 |
| fdi | 0.00 | 0.00 | -2.05 | 0.04 |
| conflict | -1.83 | 0.91 | -2.01 | 0.05 |
| R-squared | 0.26 |  |  |  |

*Table 4: Model 2 estimates*

Model 2 finds that the relationship between the Palma ratio and the EVD infection rate is 0, with a significantly lower p-value than model 1. Model 2 also finds a significant relationship in unemployment. As thePalma ratio increases, unemployment decreases. This result is again contradictory of the framework for unemployment as a mechanism. Urban population also has a significant relationship. As the top 10% increase their income share, the population in cities increases. This relation makes sense as cities are economic hubs. In both models, GDP, and government spending were found to have no effects. The only difference between models 1 and 2 is the measure of inequality. I suspect that the Palma ratio is a more sensitive variable for countries with substantial inequality than the Gini coefficient.

**4.3 Model 3:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Estimate** | **Std. Error** | **t value** | **Pr(>|t|)** |
| (Intercept) | -8571000000.00 | 3153000000 | -2.72 | 0.01 |
| epi | -78470.00 | 76410.00 | -1.03 | 0.31 |
| gdp | 0.00 | 0.00 | -0.64 | 0.52 |
| govSpend | 0.01 | 0.00 | 6.17 | 0.00 |
| urbPop | 23260000.00 | 9689000.00 | 2.40 | 0.02 |
| unemploy | -140500000.00 | 38440000.00 | -3.65 | 0.00 |
| gini | 24390000000.00 | 8094000000 | 3.01 | 0.00 |
| palma | -373600000.00 | 108500000.00 | -3.44 | 0.00 |
| R-squared | 0.53 |  |  |  |

*Table 5: Model 3 estimates*

The third model doesn’t find a statistically significant relationship between the infection rate and foreign direct investment. However, of the three models, it explains the most random variation. The urban population, unemployment percentage, and both inequality measures show a significant statistical significance. Interestingly, Gini’s relationship to foreign direct investment is positive while thePalma ratio’s is negative. Model 3 did indicate that there is an inverse relationship between foreign direct investment and unemployment

1. **Discussion:**

Only one of the three models showed a statistically significant result from the infection rate of EVD in West Africa. Model 1 doesn’t provide strong evidence that the Ebola epidemic affected income inequality. Due to the size of the p-value, the null hypothesis cannot be rejected, but this cannot be interpreted as evidence that income inequality decreased as a result of the Ebola Epidemic. Model 2, however, does provide evidence that EVD did not affect income inequality. Through changing the measure of inequality to the Palma ratio, the p-value dropped from 0.42 to 0.05. The Gini is known to be insensitive at the tails and overly sensitive to changes in the middle of the distribution. The drop in p-values of *epi* between the two models suggests that the Palma ratio is better suited to study developing regions like West Africa which already face high inequality. The Palma ratio is especially suited to shocks like the Ebola epidemic which disproportionately affect the poorest groups. The middle of the distribution likely has a stronger safety net through savings or access to credit.

Model 3 did not find strong evidence that EVD affected the net inflows of foreign direct investment. Instead, model 3 did support the claim that unemployment and foreign direct investment are inversely related. Unemployment’s large negative association with foreign direct investment can be exemplified in the mining operations in Liberia. When the initial mining operations began with foreign funding, job opportunities were created for both skilled and unskilled workers. As the Ebola epidemic began, the foreign funding for the projects declined, causing unemployment to increase. Model 3 also supports the claim that the urban population is an indicator of economic activity in cities.

This paper’s flaws are archetypal flaws in inequality research. The first is omitted variable bias. Inequality measures such as the Gini and the Palma Ratio are highly complex in their components. An incredible number of factors determine the result of those variables. The omissions of proper controls will cause an overestimation of the effect of my dependent variable, the number of Ebola cases. Some of the controls in these models are not sufficient as well. The *conflict* variable is simply a dummy for the presence of wars, revolutions and military coups. Controlling for the effects of these events would be arduous with suitable data, and infeasible with sparse data. Conflict will also have a large effect on the political economy of a region, and these models do not control for differing policies which may affect income inequality and Ebola. Another control that is insufficient is *govSpend*, but there is a lack of data on healthcare spending in West Africa.

The second archetypal flaw present in this paper is that of simultaneity bias. Without a suitable instrument for the intensity of the Ebola Epidemic, my coefficients will be biased. It wouldn’t be an issue if disease outbreaks were random, but they are not. Regions with poorer healthcare infrastructure and sanitation will generally be more prone to disease. Regions that have large inequality may be more prone to poorer healthcare infrastructure and sanitation, as the presence of inequality indicates that there are impoverished groups who may not have access to health services or proper sanitation. Simultaneity will also bias the coefficients for *unemploy* as change in wealth inequality may directly affect unemployment.

The World Bank estimates paired with the World Inequality Database estimates uncover a few non-intuitive relationships such as the relationship between unemployment and inequality measures. In both Models 1 and 2, unemployment’s p-value is statistically significant and inversely associated with income inequality. Respectively, *unemploy*’s beta coefficients were -0.38 and -0.40. These are large influences on both inequality measures, but they are a direct contradiction to the unemployment mechanism used in this model. Supposedly, as unemployment rises, inequality will rise as the poorest groups become worse off. This relation is not seen in the data. The data shows that unemployment is declining in the face of rising income inequality. First, we should look at the inequality trends. Figure 2 shows that both the Gini coefficient and the Palma ratio are declining, despite a large body of literature describing West Africa’s inequality at crisis levels. The relationship between the unemployment rate and the inequality measures seen in models 1 and 2 may be the result of the natural rate theory on unemployment. Natural rate theory predicts that the distortion of markets through institutional organizations will create a unique economic equilibrium. Unemployment will always return to this equilibrium. Friedman argued that defining unemployment as natural means that monetary policy cannot reduce unemployment below the equilibrium in the long run and that the natural rate of unemployment is determined by the incentive structure of economic agents (Friedman, 7). In the case of West Africa, unemployment may be returning to its natural unemployment rate from below while simultaneously income inequality is in decline. However, the literature wouldn’t support this theory as inequality is generally recognized to be rapidly increasing. Ronald Schettkat, whose work was seen in the Literature Review, supports the theory that there are multiple equilibria which depend on the arrangements between institutions.

Figure : Average Palma Ratio 1990-2017

Another notable insight that this pairing of databases showed was in model 3. The Palma ratio had a strong negative association with foreign direct investment while the Gini had a strong positive association, and both were statistically significant. The Palma coefficient supports foreign direct investment as a proper mechanism in this model, but the Gini coefficient does not. Additionally, model 3 highlights how different the outcomes can be given differing measures of inequality. Using the Palma interpretation, foreign direct investment may increase the income share of the bottom 40% by increasing the number of unskilled jobs available without increasing the income share of the top 10%, because the groups benefiting the most are the foreign investment suppliers. Under the Gini interpretation, foreign inflows widen inequality by supplying the top of the distribution capital, and the bottom of the distribution receive income through “trickle down” effects.

Figure : The average gini estimate 1990-2017

A third weakness in this paper is the proximity of the Ebola epidemic to the end of the data. The last reported case was in 2016, and the study extends only a year after. Any effects that manifest in a term longer than a year will not be accounted for by this model. As the Gini coefficient and the Palma ratio are comprised of so many other variables, it is possible that the true effect of the epidemic on West Africa has yet to be revealed.

1. **Conclusion:**

The data on the Ebola epidemic in West Africa have presented interesting contradictions. I posited that income inequality worsened through unemployment rising from disruptions due to the epidemic and through foreign investors halting their funds to the region. However, the data shows that there was little to no effect on inequality. A significant statistical relationship was found between inequality and the number of EVD cases when using the Palma ratio as opposed to the Gini, but that relation was that the number of EVD cases had no effect on the income shares of the top 10% and the bottom 40%. My data also contradicts the theory that unemployment and inequality have a positive association, which was a key theory in developing causality.

Future inequality studies pertaining to developing countries with large inequalities ought to use the Palma Ratio in the Gini’s stead. Additionally, a multiple regression model without proper instruments may not be suitable to causally establishing the effect of a disease on a region’s income inequality due to the inherit endogeneity issues. This paper will contribute to a literature that is quickly gaining importance in the past few months as COVID-19 has racked contemporary society.

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