Estimating the Cost of Not Having a Stock Exchange: A Synthetic Control Approach

Etsub Tekola Jemberu

***Abstract*—Despite the flourishment of the financial markets all around the world as a strategy of financial reforms in the last century, 20% of the world nations are still without a stock exchange. This study examines the economic cost of not having stock exchanges in one of the largest of these countries, Ethiopia. Using a transparent data-driven econometric technique - the synthetic control method (SCM), it estimates the counterfactual GDP per capita Ethiopia would have enjoyed, had it established stock exchange in 1998. Based on a weighted average of the pre-intervention characteristics and income per capita of similar countries with a stock exchange, SCM constructs synthetic control unit that imitates the characteristics of the treated unit in the pre-treatment period and compares the counterfactual outcome path against the actual outcome path of the treated unit. The estimation results indicate that the synthetically constructed Ethiopia outperformed actual Ethiopia in the post-treatment year, suggesting an establishment of a stock exchange in Ethiopia would have led to a substantial increase in income per capita of the country. Specifically, on average, Ethiopia's GDP per capita would have been 54.84 percent higher over the period of 12 years had it established a stock exchange in 1998.**

***Index Terms*—Economic growth, income per capita, stock market, synthetic control method.**

I. Introduction

Over the years, the relationship between finance and the many aspects of economic growth has gained a considerable amount of attention among researchers as well as policymakers. Relatedly, the relative importance of bank-based and market-based financial systems has been a subject of considerable debate as well. Even though in the grand scheme of the researches on the subject, the focus initially has been dominantly on the role of the banking sector, it later expanded to include stock markets. And mostly these research works find a positive association between efficient exchanges and economic growth, e.g., [1]-[4], etc. Financial reforms in both developed and developing countries in the last century have been characterized by an enormous growth of stock markets. Currently, there are numerous stock exchanges in operation all over the globe through which securities can be bought or sold. Nonetheless, according to Shalifay [5] as of 2014, 20% of the world's nations (both official and partially recognized) did not have a stock exchange. From 2014 till the day this paper is written two more countries have established theirs as well. Ethiopia, with a population of over 105 million is the largest country in the world without a stock exchange. Even though there was a history of some activities of stock exchange once during the imperial regime, the military government that replaced the monarchy abolished it completely and there was not any kind of capital market in place after that [6]. While growth can be explained by a number of factors, having in mind the findings of the aforementioned studies regarding the positive link between the stock market and economic growth, it is not unexpected that the economic performance of countries without a stock exchange, in general, Ethiopia, in particular, in terms of key macroeconomic indicators like GDP and capital formation is far behind than countries with a stock exchange.

One key feature of stock markets is their complexities. The decision to establish a stock market is not one that can be made lightly, considering the ongoing debate regarding whether it is better to have no stock market at all than having an inefficient one. And, the lessons from other countries' experiences suggest that establishing an efficient stock market requires a prior existence of certain economic, legal, institutional, social, and political conditions. To list some; political and monetary stability, enforceable and transferable property rights, an independent regulatory and supervisory entity, well-defined accounting and auditing standards are the least pre-requirements for setting up an efficient stock market. All in all, it involves a huge commitment and requires the devotion of a considerable amount of scarce public resources Therefore, the contemplation of its benefit and cost to the fullest extent is crucial.

The research aims to investigate the effect of having a stock market by looking at a country that does not have one yet, Ethiopia. By studying the stock exchange impact on economic growth, one question that naturally arises is whether the economic growth of the countries without stock exchange would have been higher if those nations had created one. By comparing the difference between the economic performance of a pair of comparable countries with and without a stock exchange, it is indeed possible to provide an estimate of the causal effect of having a stock exchange. Yet again, if the country in question and its potential counterfactuals are inherently different, the estimate would be significantly distorted. Thus, the reliability of the estimate ultimately depends on the selection of a credible counterfactual. For this reason, this study uses the synthetic control method (SCM) developed by Abadie and Gardeazabal [7] and extended in Abadie, Diamond [8] and Abadie, Diamond [9]. The method provides a systematic way by which a counterfactual unit is synthetically constructed as the

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linear combination of potential comparison units that have the most similar characteristics to the unit of interest, before the intervention. Hence, in this study context, SCM can be used to estimate what Ethiopia has lost due to the absence of intervention, i.e., the establishment of a stock exchange, by looking at the outcome trend of the synthetic control.

The remainder of this paper is divided into 4 sections. The next section gives an overview of previous literature on the subject followed by a description of the Synthetic Control Method and the data. The fourth section presents the results and the final section gives the conclusion.

II. Overview of Prior Literature

There is a moderate number of theoretical and empirical literature that depicts a link between stock market activity and economic performance, directly or indirectly. Essentially, theorists identified five main channels by which the financial market can facilitate economic growth; saving mobilization and allocation, liquidity and risk-sharing, information acquisition about firms, and corporate governance, [1]. Singh [10] and Greenwood and Smith [11], for instance, show that stock markets increase domestic savings which in turn boost investment.

Likewise, Levine [12] adapts the endogenous growth model that portrays the positive impact of stock markets through their facilitation of easy equity trading and risk-sharing. According to this model stock markets encourage investors to invest in long-run higher return projects since it enables them to trade ownership easily and to diversify their portfolio which in turn eliminates idiosyncratic risk. Moreover, stock markets can also boost growth through the regular provision of information about firms. As suggested by Holmstrom and Tirole [13] in an efficient, liquid stock market, firms' performance information is reflected by the price of the shares. Thus, the institution reduces the additional cost of obtaining such data which further enhances information-acquisition. This ends up improving efficient-data-driven-resource allocation and accelerating economic growth. Relatedly, in terms of corporate governance, the fact that the performance of the firm's equity price and its managers' pay being tied motivate the managers to maximize the firm's performance [14].

On the other hand, some theorists have a different take on the impact of stock exchanges and economic growth. For instance, Bhide [15] argues that the benefit of stock markets in terms of liquidity comes at the expense of losing strong corporate governance and internal monitoring in firms. These further impacts firms' growth and then economic growth negatively.

Empirical studies also have examined the link between a stock market and macroeconomic indicators and made significant inroads into trying to understand the relationship. And except few exceptions, they largely show some degree of a positive link. To specify some, Atje and Jovanovic [16], Levine and Zervos [17], Caporale, Howells [18], Enisan and Olufisayo [3], Cooray [4], and many more find evidence supporting the positive association of stock market and economic growth. Nevertheless, these studies suffer from various statistical weaknesses. For one, the commonly used standard estimation techniques used by cross-country studies are prone to suffer from multiple endogeneity issues. Inferring a conclusion from the hardly generalizable analysis of individual country case studies that lack a clearly defined counterfactual, on the other hand, would be misleading. To resolve this problem this study uses the synthetic control method. Unlike most of the estimators used in the literature, this method can deal with endogeneity from omitted variable bias by accounting for the presence of time-varying unobservable confounders [8].

III. Synthetic Control Method

Measuring the causal effect of an intervention is an issue of common interest across a diverse range of fields. On a conceptual level, the ideal approach to address this would be through the differences in outcomes of a unit under treatment and in the absence of treatment. In reality, however, the outcome that can be observed is either one of the two; either the unit of interest is treated or not treated. To sort this impediment out, one either has to find a counterfactual that can validly mimic the unit of interest or construct one. Researchers have been using various statistical techniques ranging from experimental to non-experimental approaches. In this study, a recent data-driven econometric technique, the Synthetic control method (SCM) introduced by Abadie and Gardeazabal [7] and extended in Abadie, Diamond [8] and Abadie, Diamond [9] is applied to perform a comparative case study. The method provides a systematic way of constructing a synthetic control unit or counterfactual that imitates the characteristics of the treated unit in the pre-treatment period. This synthetic control unit is constructed based on a weighted average of the units in the donor pool - a set of potential comparison units that did not receive the treatment, in which the weight represents the contribution of each comparison unit to the counterfactual of interest. Then, the causal effect of the intervention can easily be measured by comparing the difference in the outcome variable between the unit of interest and the synthetic control unit. The intuition behind this is that a combination of non-treated units provides a better counterfactual than just one non-treated unit alone, hence makes the method more credible than the traditional comparative case study methods.

More formally, suppose we are observing a panel of $J+1$ countries over the period $t = 1,2,\cdots,T_0,\ T_0+1,\cdots,T$. And let us assume that only the first country remains unchanged while all the other J countries started their stock exchange at year T_0, given that $1 \le T_0 < T$, thus representing the donor pool. Let Y_{it} denotes the outcome of interest for country i at time t. The observed outcome variable can be written as:

$$Y_{it} = \begin{cases} Y_{it}(0) = Y_{it}(1) + \tau_{it} D_{it} & \textit{without stock exchange} \\ Y_{it}(1) & \textit{with stock exchange} \end{cases}, \qquad D_{it} = \begin{cases} 1 \ \textit{if} \ t > T_0 \\ 0 \ \textit{otherwise} \end{cases} \tag{1}$$

where τ_{it} is the lost treatment effect for the country i because of the absence of a stock exchange at time t that can be defined as:

$$\tau_{it} = Y_{it}(0) - Y_{it}(1) \quad (2)$$

The statistic of interest is the vector of these missing dynamic treatment effects $(\tau_{i,T_0+1}, \tau_{i,T_0+2}, \cdots, \tau_{i,T})$. However, country i is actually without stock exchanges and the counterfactual outcome, $Y_{it}(1)$ cannot be observed. Subsequently, Abadie, Diamond [8] propose identifying the above treatment effects under the following factor model for potential outcomes;

$$Y_{it}(1) = \delta_t + \theta_t Z_i + \lambda_t \mu_j + \varepsilon_{it} \quad (3)$$

where δ_t is an unknown common factor with constant impact across all countries, Z_i is a vector of relevant observed covariates (which can be time-variant or time-invariant but should not be affected by the absence or the presence of stock exchange in the country of interest), and θ_t is the related vector of parameters. λ_t denotes unobserved common factor with μ_j representing a vector of country-specific unobservable. And, finally ε_{it} are transitory shocks with zero mean. What is crucial here is, unlike other fixed effects models of impact evaluation methods, SCM allows the effects λ_t of the unobserved predictors μ_j to vary over time.

Let further define $W = (w_2, w_3, \ldots w_{J+1})$ as $(J \times 1)$ vector of weights such that $w_j \geq 0$ and $\sum w_j = 1$ for $j = 2, \ldots, J+1$, and $\bar{Y}_j^k = \sum_{s=1}^{T_0} k_s Y_{js}$ as the linear combination of pre-intervention output values where $K = (k_1, \ldots, k_{T_0})$ is a $(T_0 \times 1)$ vector. Then Abadie, Diamond [8] show that if there exists an optimal W^* such that:

$$\sum_{j=1}^{J} w_j^* \bar{Y}_j^k = \bar{Y}_1^k \text{ and } \sum_{j=1}^{J} w_j^* Z_j = Z_1 \quad (4)$$

then the unbiased estimator of the treatment effect, τ_{it} is given by;

$$\hat{\tau}_{it} = \sum_{j=1}^{J} w_j^* Y_{jt} - Y_{it}(0), \quad t \in \{T_0 + 1, \cdots, T\} \quad (5)$$

The condition of a perfect match on pre-treatment outcomes and on time-invariant observed covariates in equation (4) can only hold if and only if $(\bar{Y}_j^k, Z_j)$ belongs to the "convex hull"[1] of $[(\bar{Y}_1^k, Z_1), \cdots, (\bar{Y}_{J_c}^k, Z_{J_c})]$, which in reality is very unlikely. Hence in practice, the synthetic control W^* is selected so that the above conditions in equation (4) hold approximately. Particularly, it should be chosen in a way that minimizes the discrepancy between the pre-intervention covariates of Ethiopia and the potential synthetic control or countries with a stock exchange.

$$\min_W \|X_E - X_C W\| V = \sqrt{(X_E - X_C W)' V (X_E - X_C W)}$$
$$\text{subject to } w_j \geq 0 \text{ and } \sum w_j = 1, \; j = 2, 3, \ldots, J_c + 1 \quad (6)$$

where X_E and X_c denotes $(K \times 1)$ vectors of pre-intervention covariates and outcomes of Ethiopia and countries in the control group, respectively, and V is a $(K \times K)$ positive semi-definite matrix that weighs the importance of all explanatory variables. the study chose the weights in such a way that Abadie and Gardeazabal [7] state that the resulting analysis is valid for any predictor weight, V. In this study, it is determined by the minimization of root mean square prediction error (RMSPE) of the outcome variable in the pre-intervention period, which measures the fit or lack of it between the path of the outcome variable for the treated country and its synthetic counterpart. It's defined as;

$$\text{RMSPE} = \sqrt{\frac{1}{T_0} \sum_{1}^{T_0} \left(Y_{it} - \sum_{1}^{J} w_j^* Y_{jt} \right)^2} \quad (7)$$

Finally, the Synthetic Control estimator of the lost treatment effect, τ_{it}, can be defined as;

$$\hat{\tau}_{it} = Y_{it}(0) - \hat{Y}_{it}(1) \; for \; all \; t \in \{1, \cdots, T\} \quad (8)$$

A. Construction of the Donor Pool

To select a comparable control group that can provide reasonable counterfactual (i.e., income per capita would have evolved in Ethiopia if it had had a stock exchange), following Abadie, Diamond [9], the countries in the donor pool are restricted in several ways.

TABLE I: COUNTRIES IN THE DONOR POOL

Country	*Name of the stock exchange*	*Founded*
Algeria	Algiers Stock Exchange	1997
Belarus	Belarusian Currency and Stock Exchange	1998
Côte d'Ivoire	Bourse Régionale des Valeurs Mobilières	1998
Georgia	Georgian Stock Exchange	1999
Jordan	Amman Stock Exchange	1999
Mozambique	Bolsa de Valores de Mozambique	1999
Russia	Saint Petersburg Stock Exchange	1997
Tanzania	Dar es Salaam Stock Exchange	1998
Uganda	Uganda Securities Exchange	1997

First, for a country to be considered in the donor pool, it needs to start its stock exchange at the year chosen as a treatment year or at least one year prior or later. Second, if there are any missing values for the outcome variables in the years considered for the analysis then that country will be dropped from the donor pool. Furthermore, countries that went through large idiosyncratic shocks to the outcome of interest during the study period are eliminated from the donor pool. And finally, the countries selected for the control group have to be in the same income group as the countries in the treated group based on the World Bank classification during the year of treatment. Even though SCM constructs a synthetic control by selecting a weighted average of the outcome variable from a group of units, selecting units that are similar to the treated unit is important to avoid

[1] In mathematical sense, the convex hull of a set is the set of all convex combinations of the points in the set. Bringing this to SCM, the method assumes that the outcomes and observed covariates of the synthetic control at any pre-intervention period lies within the range of outcomes experienced by the donor countries in the pre-intervention period.

interpolation bias and overfitting, in which case the treated units matched with the resulting synthetic control by combining peculiar difference of the untreated units [9].

Having in mind these restrictions, the treatment year is selected to be 1998. The reason for this is relatively more than few countries had started their stock exchange either during this year or one year earlier or later. This leaves us with 9 countries that form potential controls (see Table I) for each case study.

B. Data and Sample

A cross-country panel data set for the period between 1990 and 2010 is created by combining multiple data sources. The length of the study is limited to this period because of data limitations. Since some countries in the donor pool (i.e., Georgia, Belarus, and Russia) were under USSR before 1990, it is not possible to find data on the outcome variables of interest before that year. The primary data source is Penn World Table (PWT) version 10.0 [19] which is supplemented by the World Development Indicators dataset [20].

To capture the countries' evolution of economic performance the study uses real GDP per capita as an outcome of interest. Furthermore, in virtue of previous literature, variables that are predicted to affect the outcomes both before and after the state of having a stock exchange are selected as predictors. These variables include an indicator of economic openness (the sum of exports and imports as a share of GDP), human capital, democracy, and population growth. The data for these variables comes from World Bank Development Indicator.

IV. Results and Inference

Table II presents the average composition of the synthetic counterfactuals for Ethiopia. Unit weights illustrate how the synthetic counterfactual is constructed, i.e., what the weights of each donor country are. On average, synthetic Ethiopia is constructed only from the yields of Mozambique (0.87), Uganda (0.087), and Côte d'Ivoire (0.043). The result that the best comparison countries for Ethiopia are mainly the other sub-Sahara African countries is quite intuitive.

TABLE I: Countries Weights

Country	*Synthetic Control Weight*
Algeria	0
Belarus	0
Côte d'Ivoire	0.043
Georgia	0
Jordan	0
Mozambique	0.87
Russia	0
Tanzania	0
Uganda	0.087

Source: Synthetic control methods (Synth) powered by Stata 16 MP

The SCM's main output is a pre-intervention and post-intervention path for the synthetic control country's outcome variable that can be compared with the treated country outcome variable path. The ideal output would be the two paths following each other closely till the treatment year, so that divergence after that point can represent the treatment's effect. Abadie, Diamond [8] have stated that the pre-treatment fit depends on the span of the pre-treatment period, as well as on the explanatory power of the predictor values. Taking the limited length of the pre-intervention years considered for the study due to data limitation into account, one can see in figure 1 that the pre-treatment fit is fairly good. Relatedly, the goodness-of-fit in the pre-intervention period measured by the RMSPE is 35.14.

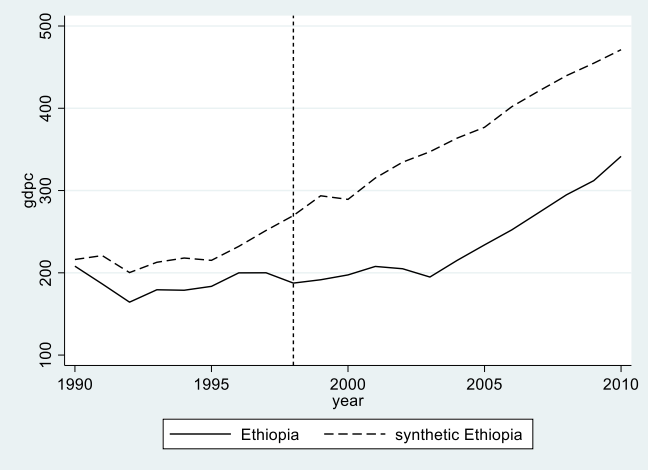

Fig. 1. Trends in GDP per-capita: Ethiopia vs. synthetic Ethiopia.

Fig. 1 illustrates the GDP per capita trajectory of Ethiopia and its synthetic counterpart for the period 1990-2010. Y-axis shows the GDP per capita evolution value. While the solid line shows the evolution for actual Ethiopia, the dotted line shows the trend of the same variable for the synthetic control unit. Before the intervention year, 1998, even though there is a noticeable difference between the two lines, it is relatively minor. After 1998, however, the gap widens up significantly. To put it more into perspective, before 1998, the discrepancy in terms of GDP per capita was between 31.62 (in 1995) and 35.96 (in 1991). It only reached 51.44 dollars in 1997. Note that by 1997, some countries in the donor pool have started their stock exchange. But after the intervention year, these differences become more prominent. For instance, in 1999 Ethiopia's GDP per capita was 191.57 dollars, which, according to the synthetic control analysis, is estimated to be 102.04 dollars less than the value it would have been had the country established a stock exchange by 1998. In general, the study's results suggest that, over the period 1998-2010, due to the absence of an exchange Ethiopia has lost around 54.84% increment in its GDP per capita.

In order to ensure the reliability of the result obtained from the SCM experiment, following Abadie, Diamond [8] a placebo test is performed. This involves applying SCM to the units in the control group and estimating the "placebo" treatment effect. Then, if the placebo tests (for the countries with stock exchanges) exhibit a smaller treatment effect compared to the effects estimated for the actual countries of interest (countries without a stock exchange), the study will conclude that there is no statistically significant evidence of a lost effect of the stock exchange in the countries without one.

Fig. 2 displays the results of the placebo test. During the whole pre-intervention period the treatment effect for Ethiopia (the difference between the synthetic and actual Ethiopia), which is represented by the orange line, was around zero. But after 1998, it noticeably dropped down and over the period 1998 to 2010, it becomes lower than any of

the lines showing the placebo treatment effect for the countries in the donor pool. This implies Ethiopia is indeed an outlier in the distribution of the placebo effects.

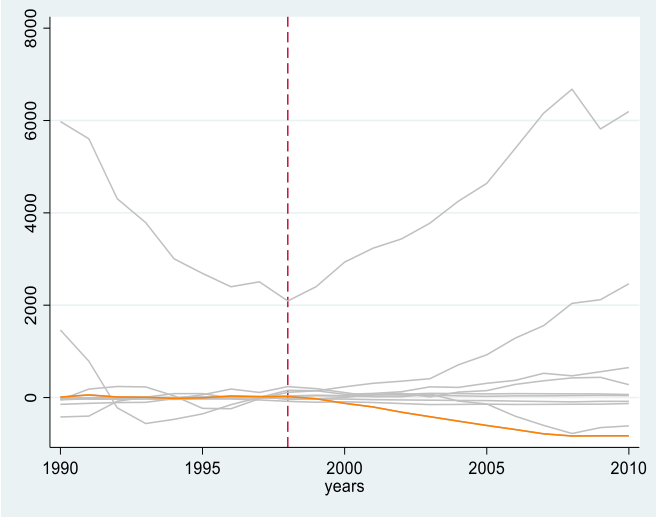

Fig. 2. In-space placebo test.

V. Conclusion

Despite the significant development of the financial market around the world in recent years, 20% of the world nations are still without stock exchanges. By considering one of the largest countries without stock exchanges, Ethiopia, as a subject of interest, the main purpose of this paper was to estimates the levels of GDP per capita the country would have enjoyed had it established a stock exchange by 1998. Using the synthetic control method, the study constructed a credible counterfactual unit obtained as a convex combination of countries that start their stock exchange in 1998 or one year prior/later than 1998. The study's findings revealed that SCM-constructed synthetic Ethiopia outperformed the real Ethiopia in the post-intervention period indicating the country would have enjoyed a higher income per capita had it had a stock exchange. Specifically, the results suggest that over the years 1998 to 2010 on average GDP per capita of Ethiopia would have been 54.84 percent higher had it established stock exchange in 1998. While these results are not produced in a complete simultaneous model, they suggest that the inactions of countries towards the development and formation of the stock markets are costing them substantially.

Conflict of Interest

The author declares no conflict of interest.

Author Contributions

All of the research reported in this paper, including analyzing the data, writing the paper, and approving the final version is done by the named author.

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