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Abstract

Essays in International Finance

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This dissertation studies topics of international finance. The focus is on Türkiye, an open emerging economy in G-20. Türkiye is a growing economy with financial vulnerabilities. The country's energy dependency and related current account deficit create pressure on the economy. Also, the country's geographic region leads to severe disaster and climate risks. This dissertation studies how these risks could affect the economy.

The first chapter focuses on constructing an Exchange Market Pressure (EMP) index from literature for Türkiye, an open emerging market, and exploring its relation with international capital flows. EMP is successful at capturing the stress periods of the Turkish Lira. I use the Autoregressive Distributed Lag Model (ARDL) and find that portfolio investment and other investment inflows help decrease pressure in the exchange market. In contrast, the effects of foreign direct investment (FDI) inflows are insignificant, but outflows increase the pressure on the exchange rate market.

The second chapter uses freely available data from The World Bank Sovereign ESG Data Portal to build an Environmental, Social and Governance (ESG) score and then applies panel data estimation to examine the relationship between ESG score and macroeconomic variables for the 1999-2020 sample period. Industrial production negatively correlates with ESG scores; emerging markets have lower scores than developed

countries. Self-employment has a positive relationship with the ESG score, which may imply that working conditions are better than other work modes.

The third chapter explores the effects of the 2023 Kahramanmaras earthquakes in Türkiye on Turkish GDP by using Synthetic Control Method (SCM). With SCM, I construct a synthetic Türkiye, taking countries that have similar economic structures and checking whether there is a difference between Türkiye and synthetic Türkiye in terms of Gross Domestic Product (GDP) right after the earthquake. The results show that earthquakes did not significantly affect Turkish GDP during the sample period.

To every human who is kind enough to help me and to all dogs that did not bite me.

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As I mentioned, I had a very different PhD story due to personal reasons. This

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I thank everyone once again for their help, and I hope this research will be beneficial to the literature.

Chapter 1

International Capital Flows and Their Effect on Exchange Market Pressure for Türkiye, an Empirical Study

1.1 Introduction

Exchange rate markets have been an important part of macroeconomic analysis. Different metrics were used to calculate the stress in the exchange rate market. One of the most used metrics is the Exchange Market Pressure Index, or shortly EMP, which was first calculated by Girton and Roper (1977) for the Canadian economy with a fixed exchange rate. EMP started as an index estimating changes in exchange rates and international reserves, and since then, researchers sophisticated this index by taking more variables into account. Literature also focused on what factors could be affecting the EMP. In this paper, using the standardized EMP index used in Aizenmann & Binici

(2015), I calculate EMP for Türkiye between 1994 and 2023. I also check for whether international capital flows have an important effect on EMP for Türkiye.

This study aims to contribute to the literature by investigating how capital flows affect the exchange rate market pressure in an emerging market with specific economic and political fundamentals and problems, and since the range of problems faced in economic and political space varies greatly, the results found in this paper could be helpful for other emerging markets while supporting the existing literature.

I use EMP as the dependent variable. The main question of this study is how capital flows affect the EMP of Türkiye between 1994 Q1 and 2020 Q4, using quarterly data. For that reason, I build models with capital inflows and outflows and fundamental macroeconomic variables. I follow Pesaran (1999) and use Autoregressive Distributed Lag (ARDL) for the study.

I try to understand what is the relationship between EMP and fundamental variables first. The fundamental variables I am looking at are real GDP growth rate, inflation, domestic credits, and short-term external debt variables. For risk indicators, I use VIX as a global risk variable. EMP, however, due to its components exchange rate, international reserves, and interest rate, could both affect and get affected by the independent variables. That is why, for the empirical analysis, I follow Pesaran (1999). After looking at Augmented Dickey-Fuller tests for variables and checking for the Akaike Information Criterion, I used ARDL to regress the models. ARDL is used to avoid endogeneity problems between EMP, fundamental variables, and capital flow variables. I use foreign direct investment, portfolio investment, and other investment inflow and outflow

values for capital flow variables. Regarding capital inflow and outflow definition, I follow Kalemli-Ozcan (2019) and many others, considering the BPM6 of IMF. Inflows mean an increase in liabilities, so nonresidents acquire capital from Türkiye, and outflows mean an increase in the assets of residents of Türkiye and mean that residents acquire capital abroad. The results show that, while real GDP growth is not statistically significant for EMP, inflation is increasing the EMP, which is substantial.

I aggregate capital inflows and outflows and find the net capital flows as the difference of inflows and outflows for both aggregate and separate capital flows. According to the results, aggregate capital inflows effectively decrease the EMP, while aggregate capital outflows increase the EMP. Net capital flows also decrease the EMP and are significant. When I look at separate capital flows, meaning when I look at FDI, portfolio, and other investments separately, I get FDI inflows insignificant. At the same time, FDI outflows have an upward pressure on EMP at 0.1 significance level. Net FDI is also insignificant, though its sign is negative. We could conclude that FDI outflows have an upward pressure on EMP.

Portfolio inflows help EMP to fall, so there is a negative relationship between EMP and portfolio inflows. The portfolio outflows have a positive sign, but they are not significant; hence, it could be concluded that portfolio outflows do not affect EMP.

Other investment is a residual category that gives all other transactions that FDI and portfolio investments do not cover, reserve assets and could include trade credits, currency, deposits, and loans such as repo agreements (IMF, 2009). While other investment inflows reduce the EMP, other investment outflows increase the EMP.

Net other investment flows also decrease EMP. These results are generally in line with emerging market EMP literature.

The results show that Turkish EMP is affected mostly by portfolio and other investment inflows, so one policy implication is that to decrease the pressure on exchange market, Turkish authorities could focus on ways to attract foreign investors to these capital investments.

1.2 Literature Review

The exchange market pressure literature starts with Girton and Roper (1977). This first wave of EMP literature generally focuses on the definition of EMP (Girton & Roper, 1977; Weymark,1995) and how to measure EMP under a fixed exchange rate regime (Girton & Roper, 1977; Weymark,1995; Eichengreen et al., 1994). The first papers mainly discuss advanced economies, but with 90's twin crisis period, EMP once again takes an important part in the literature, and emerging markets are included in the studies together with advanced economies (Sachs et al.,(1996); Kaminsky & Reinhart (1999)). These studies generally formulate EMP as a difference between exchange rate changes and international reserves (Girton & Roper, 1977; Weymark,1995). Later ones also add the differences in interest rates between the countries in practice with a haven currency country, with the end of fixed exchange rate regimes.

After the 2008 Global Financial Crisis (GFC), the focus of the literature shifts toward what affects the exchange market rather than how to measure it (Aizenmann

& Hutchison,2010; Aizenmann et al., 2012; Aizenmann & Binici, 2015). These papers use EMP measures by Girton and Roper (1977) and Eichengreen et al. (1994) and identify how the exchange market is affected by macroeconomic variables. All the papers mentioned study advanced and emerging economies or take a group of emerging economies. For advanced countries, given that most of them are safe haven currency countries, exchange market pressure is less vital than it is for emerging markets. When we look at the emerging markets, taking these countries as a group can result in an underestimation of what affects the EMP. This is due to differences between emerging economies regarding current account balance, production capacities, and energy dependency. That is why, in my paper, I only take Türkiye, an open emerging economy in G-20, that has a current account deficit with a growing economy, to see which capital flows and other macroeconomic variables are influential in exchange market pressure. Also, Türkiye had currency volatility unrelated to the 2008 GFC, which is essential to study. My paper adds to the literature by finding which capital flows are essential to overcome exchange market pressure when the exchange market is volatile, and there is cash outflow due to trade.

Next section discusses the aforementioned papers in detail to show the evolution and results of the studies.

1.2.1 Brief Summary of the EMP Literature

Girton and Roper (1977) study exchange market pressure in Canada using a monetary model that investigates money demand and supply and the independence

of monetary policy. They use a small economy with rational expectations where the inflation rate is affected by the foreign inflation rate and exchange rate, and GDP and foreign inflation are exogenous. It is also pointed out that the change in reserves results from exchange market changes. The exchange market pressure index (EMP) by taking the difference between exchange rate change and change in international reserves divided by monetary base. Authors define exchange market pressure as the change in the exchange rate or international reserves needed to bring the money market back to equilibrium aftershocks.

Another paper also looking at exchange market pressure in Canada is Weymark (1995). Weymark (1995) defined exchange market pressure as the required change in the exchange rate to eliminate the excess demand for a currency in international exchange rate markets without a foreign exchange market intervention, and this explanation is still valid for most of the studies in the literature. The exchange market pressure index is similar to Girton and Roper(1977), but it is made to be more generalized. So, the definition of the exchange market pressure index is the summation of change in international reserves multiplied by an elasticity coefficient and change in the exchange rate. The elasticity coefficient is the derivative of the change in exchange rate concerning change in international reserves. An important result of this paper is that under rational expectations, the exchange rate market pressure could be used to measure external shock and the magnitude of speculative attacks.

Eichengreen et al. (1994) look at 22 countries between 1967 and 1972, the balance of payments crisis in these countries, and the results of speculative attacks.

They separated the countries according to their inclusion in Exchange Rate Mechanism (ERM). In the countries that are not in ERM, before speculative attacks, authors observe changes in fiscal deficits, export/import ratios, domestic credit growth, and international reserves behaviors of countries, but these changes are not observed in ERM countries. The authors explain that this difference is due to capital movements and abundant international liquidity. To measure the balance of payments crisis, authors use EMP to compare exchange rate changes from changes in international reserves and the difference between the country's and the U.S. policy interest rates.

Sachs, Tornell, and Velasco (1996) study how financial crises like the Tequila crisis occur and why some countries are affected more than others. They find that fundamental economic variables are vital for the magnitude of how countries are affected by currency crises. They also looked at the reasons for the contagions of the crisis and found that trade increases contagion. Their EMP index takes the weighted exchange rate change and its difference with the weighted change of international reserves.

When the balance of payment crisis became an issue once again in the 1990s, Kaminsky and Reinhart (1999) looked at a twin crisis, the episodes of banking and balance of payments crisis occurring simultaneously. To look at the magnitude of the balance of the payments crisis, the authors formed an index which ended up being an EMP index. EMP index is again the difference between weighted exchange rate change and international reserves change.

Before the 2008 crisis, the EMP literature generally focuses on how to define EMP measures. After the 2008 crisis, literature again looks at different ways to measure

the EMP and also what factors affect the EMP. Aizenmann and Hutchison (2010) point out that emerging markets with a higher ratio of external liabilities to GDP have higher EMP, and the both exchange rate depreciation and international reserves absorb pressure of exchange market pressure. Hence, countries have a fear of reserve loss in addition to a fear of floating. Aizenmann, Lee, and Sushko (2012) study the factors that affect EMP. Authors calculate the EMP as the sum of the changes in the nominal exchange rate and changes in international reserves. They found that low-income growth, high inflation, high domestic credits, external deficit, and portfolio outflows affect EMP adversely, and the results are in line with Tanner (2002), which is another EMP study by IMF. Aizenmann, Cheung, and Ito (2015) look at reserve hoarding after the Global Financial Crisis and how it affected exchange market volatility after the Taper Tantrum.

Patnaik, Felman, and Shah (2017) claim that the EMPs from earlier studies do not give valid results due to unrealistic assumptions, and they change the EMP index formula. They take Weymark (1995) index as a base and define the EMP index as the sum of the change in the exchange rate and intervention to exchange rate markets in US dollars multiplied by the conversion factor, which is the change in the exchange rate associated with 1 billion US dollars of intervention.

Goldberg and Krogstrup (2018) use a theory-based model depending on the balance of payments conditions and try to get an EMP that is less biased than the ones in the literature. Their EMP index includes net financial assets and liabilities, as well as changes in exchange rates and international reserves. The authors find that capital

flows affect countries with greater floating exchange rates.

Aizenmann and Binici (2015) look at a set of emerging markets and try to understand what affects EMP. They use three different EMP measures: Girton and Rope (1977) EMP and another EMP that subtracts interest rate differential and international reserves change from a change in the exchange rate. The other EMP measure they use is the standardized version of the latter EMP.

These papers study EMP measures and generally take both advanced and emerging countries into studies. Patnaik et al. (2017) and Aizenman and Binici (2015) are exceptions but they take a set of emerging economies into these studies. Depending on their current account status, energy dependency and production capacities, the effects of capital flows on EMP could change for different countries. Taking all these countries together might result in understatement of the capital flows' effects on EMP. That is why I take one country with current account deficit to see effects of capital flows on exchange rate market.

There is also an impressive literature on currency crisis in Türkiye. One important example is Crisis and self-fulfilling expectations: The Turkish experience in 1994 and 2000–2001 (2010) by Ünay Tamgaç, where the author studies the effect of self-fulfilling expectations on currency devaluation. My study partly contributes to this literature by identifying the crises with EMP index but it is partly different from crises literature in a sense that it is not focusing on the structure of the crises.

My study contributes to this literature in several ways. I am using an EMP measure in the literature for a country that has volatile currency and inadequate re-

serves. I also study the effects of capital flows' effects in this country that has balance of payments deficit. My results show that capital flows are effective on EMP and Turkish EMP is affected mostly by portfolio and other investment inflows, which is in line with literature. The EMP index I use is able to capture the currency crisis in the country. In addition, the time series is long enough to capture multiple currency crisis of different natures, which shows that the study also adds to literature on EMP and emerging market currency crisis. Countries like Türkiye, Argentina, and Venezuela still have currency volatility. EMP literature is relevant to their problems, and my paper contributes to this literature. Given the results of the paper, I also contribute to the literature on policy recommendations to exchange market volatility.

1.3 Background

1980s was era of liberalization. Emerging markets start to adapt economic liberalization policies, mostly due to failure of previous strategies to enhance their economies. Fall of Communist Block increased the speed of liberalization. With fast implementation of liberal policies, capital also started to move more freely between countries, even though exchange rate regimes did not change altogether for all countries, and emerging markets seemed to enjoy their new economic policies. But with 1990s, emerging markets started to have what Kaminsky and Reinhart (1999) called "twin crisis", banking and balance of payments crisis simultaneously. Mostly they had a vicious cycle where both crisis feed each other. Emerging markets that have poor economic fundamentals were under constant speculative attack from international investors, were not able to defend their fixed exchange rate regimes, they had weak banking sector that liberalized too quickly and most of the major emerging markets had destructive currency crisis that led to recessions in their countries. Some examples are Tequila crisis, Asian crisis and Russian crisis that happened during end of 1990s. Argentina and Türkiye also had currency crisis and International Monetary Fund (IMF) involved into these two situations. Türkiye signed a standby agreement with IMF and changed the fixed exchange rate regime to flexible exchange rate regime. The economy entered into a deep recession due to both economic and political problems, and the structural reforms started. Both Türkiye and other major emerging markets had a relatively stable economic activity after big crisis they had during 1990s and the beginning of 2000s. The literature shifted

attention from twin crisis and exchange rate market problems of emerging markets, and then Global Financial Crisis (GFC) in 2008 happened.

2008 GFC and its aftermath increased the attention to emerging markets, international reserves and exchange rate markets. With very low policy interest rates in the advanced economies, investors raised interest to emerging markets offering higher yield. Searches of higher yield led to increase in capital inflows to emerging markets and emerging market exchange rates appreciated. In 2013, Federal Reserve Chair Bernanke announced Taper Tantrum and this announcement started to reverse the capital flows' direction. With expectations of higher yield in advanced economies, investors started to leave the emerging markets. The emerging economies which hoarded international reserves in the low yield environment was more ready to the shock of Taper Tantrum and capital outflows on their exchange rate market but countries that did not increased their reserves became more vulnerable to shocks of Taper Tantrum and a higher yield environment in advanced economies to their exchange rate markets.

Türkiye increased its reserves after 2001 economic crisis, given more stable economic and political environment and exchange rate market was relatively stable. With Taper Tantrum, Turkish exchange rate market had a shock and the exchange rate started to depreciate. The reserves of Türkiye is not adequate when we use IMF's short term debt roll over ratio (IMF), and the increasing yields in the world affected Turkish exchange rate market adversely. Between 2013 and 2018, both increase in yields, commodity price volatility and geopolitical environment affected Turkish exchange markets adversely and exchange rate depreciated. Syrian War became more intense and mil-

lions of refugees came to Türkiye, which also affected risk appetite of investors toward Türkiye.

With the geopolitical risks and political tension between Türkiye and United States, fears of sanctions towards Türkiye increased and exchange rate depreciated sharply. With increased pressure from both inflation and exchange rate, Central Bank of Türkiye (CBRT) increased the policy interest rate, 1 week repo rate, from 8 per cent to 24 per cent during 2018. Decreased tensions and increase in interest rates helped to appreciation of Turkish Lira but Lira could not return to pre-2018 levels even with this high rate increase and improved relations with U.S. Between 2018-2020, CBRT saw its first dismissal of governor since its establishment in 1930. Markets priced the dismissal but since the new governor was deputy governor before, the shock was mostly due to unexpected dismissal and trust to institutions. During 2019-2020, even though the exchange rate was still relatively high with respect to its pre-2018 value, to promote economic growth, CBRT started to decrease the policy interest rate. Given high inflation, the real interest rate became very low and close to advanced economies' real interest rate, which made Türkiye a less attractive economy for capital flows and exchange rate started to depreciate one more time, reaching all time highs again. The low rate environment might have added to this pressure in the exchange rate market in one other possible way, domestic agents are said to borrow at this low rate and buy foreign exchange with the loans, since the return of foreign exchange was higher than the borrowing cost of Turkish Lira loans. This is not an empirically backed hypothesis, but the logic is one that is worth to think about. In order to help the sharp depreci-

ation of Turkish Lira, CBRT used international reserves to stabilize the exchange rate markets and reserves started to decrease, catching attention of general public. After this depreciation and decrease in international reserves, governor again dismissed and a name outside CBRT, a previous Minister of Finance was appointed as governor.

New governor sent a hawkish stance message to markets. The dismissal of previous governor and change of Minister of Treasury due to resignation of the previous minister were read as sign of more hawkish policy by the markets and with the rate hikes and hawkish verbal guidance with emphasis of price stability by the new economic governance helped Turkish Lira to appreciate and gain some of the losses, but again the appreciation was limited. After several months, new governance continue to increase the interest rates while in U.S, effects of pandemic on economics were fading and inflationary pressures started. The inflationary environment in U.S made pressure on the exchange rate markets for almost all emerging markets and Turkish Lira started to depreciate towards its 2018 levels. In response CBRT made a surprise rate hike of 200 bps in March 2021 where the market expectation median was 100 bps. In the following days, new governor also dismissed.

After dismissal, a new governor is appointed. New governor was not from CBRT and also did not work at the economic governance before. He was also known for his dovish stance due to his articles in newspapers. Also, dismissal was not expected, so the exchange rate depreciated further, reaching close to all time highs and Türkiye was left with one of the highest interest rates among emerging markets and a sharply depreciated exchange rate. Even though new governor made emphasis of following a path to

ensure price stability, the removal of "continuation of monetary policy stance until price stability is restored" statement was removed from Monetary Policy Committee minutes and investors showed the reaction via exchange rate market.

The pandemic also affected Turkish economy and the exchange rate market of Türkiye. One of the biggest source of foreign exchange for Türkiye is tourism and due to pandemic the revenues of tourism declined dramatically (TURKSTAT). The reduction in tourism revenues together with the big macroeconomic shock that pandemic put on almost all countries, affected Turkish exchange market adversely.

Türkiye has a great reputation for being agile and recover fast after big economic shocks. Türkiye has also a reputation for currency crisis. Exchange rate market volatility has been a problem for Türkiye especially from 1990s and Türkiye still has exchange rate volatility. Given that Türkiye is a country with current account deficit and high amounts of energy imports, and also exports depending partly on imports, the exchange rate markets have a big effect on the economy, even the daily life of ordinary agents are very much affected by the volatility in the exchange rate. Being one of those ordinary agents, I am interested in what exactly drives the pressure in the exchange rate markets and what could be done to avoid it. The literature generally advises reduction of foreign debts and do structural reforms with freely floating exchange rates but when we look at emerging markets' economic fundamentals and the problems in these fundamentals coming from economies' pasts, volatile politic environments and dependency on foreign debts and capital inflows one could not avoid to think if these suggestions are applicable in the medium term. That is why, the motivation of this paper is to study

what variables are affecting the exchange market pressure of Türkiye. Even though the paper is taking Türkiye as variable of interest, it should be noted that Türkiye is one of the major emerging economies and has a continuous problem of exchange rate given its specific economic features. This makes the results of this study applicable to other emerging economies, especially the ones with similar economic features with Türkiye.

1.4 Data

1.4.1 Main Variables of EMP

To be able to check the changes in the exchange rate, exchange market pressure index (EMP) for Türkiye is constructed as following, whic is a standard definition in the literature since Eichengreen, Rose and Wyplosz(1994) :

$$EMP_t = \frac{\Delta e_t - \mu e_t}{\sigma e_t} - \frac{\Delta ir_t - \mu ir_t}{\sigma ir_t} - \frac{\nabla i_t - \mu i_t}{\sigma i_t}$$

where e_t is nominal exchange rate of Turkish Lira against US dollars, ir_t is international foreign exchange reserves of Türkiye and ∇i_t is the difference between Turkish policy rate and US Federal Funds rate.

For the EMP index, the policy interest rate of Türkiye, the interest rate of the advanced economy that is chosen as an anchor, in this case, US, international reserves of Türkiye and nominal exchange rate of Turkish Lira against US Dollars data are needed. The study focuses on the 1990-2019 time period quarterly due to liberalization and currency crisis episodes in Türkiye and all available data collected for this period. When not available, it is noted.

The policy interest rate, Effective Fed Funds rate of US is available by Federal Reserve Bank on quarterly basis between 1954 to present, on Federal Reserve Bank of St Louis FRED database.

For international reserve data of Türkiye, data is available on Central Bank of Republic of Türkiye's (CBRT) database system called Electronic Data Delivery System (EDDS).

International foreign exchange reserves are essential tools to combat devaluation in the exchange rate. Türkiye has used this tool excessively during the last few years. Almost all of the increases in reserves after the 2001 economic crisis and IMF standby agreement have been used to avoid depreciation in the exchange rate in the last few years. Still, it could only accommodate the depreciation in small amounts.

Interest rate data for Türkiye is collected from the International Monetary Fund's International Financial Statistics (IFS) database; the data match CBRT records and is up-to-date.

USD/TRY nominal exchange rate data is collected from Bloomberg Terminal, which allows for the earliest data compared to other datasets.

1.4.2 Explanatory Variables to Estimate Effects of Capital Flows

The main interest of this study is to find whether international capital flows affect Turkish EMP and the sign and magnitude of this effect. For this reason, models will be built where EMP is the dependent variable, and major macroeconomic indicators and international capital flows for Türkiye will be independent variables with global risk indicators.

International Capital Flows: Since the study looks at the effects of international capital flows on EMP, capital inflows and outflows data of Türkiye and subcategories of capital flows: foreign direct investment, portfolio investment and other investment inflows and outflows is used as explanatory variables. These data are available quarterly from the IMF IFS database; all investment types also have asset/liability

or, in other words, inflow/outflow breakdown. Data also complies with the BPM6 methodology of IMF, so the coverage and sign of these inflows and outflows align with the newest balance of payments (BoP) methodology. Portfolio liabilities have one helpful breakdown, which is debt securities and equities. Aizenmann, Lee, Sushko (2012), Aizenmann and Binici (2015), and Goldberg and Knogstrup (2018) use capital flows as an explanatory variable for EMP and find net capital flows affect EMP.

Risk Indicators: VIX is used as global risk indicator for this study, following aforementioned studies and Kalemli-Ozcan (2019). VIX data is compiled from FRED.

Inflation is used as an explanatory variable in Aizenmann et al. (2012,2015) and Goldberg and Knogstrup (2018); although the results are inconclusive, inflation is also used as an explanatory variable in this study. The data is taken from the Turkish Statistical Institute. Both inflation and interest rate for Türkiye before the 2001 economic crisis are volatile and sometimes three-digits.

Following Aizenamnn and Binici (2015) and Goldberg and Knogstrup (2018), real GDP growth of Türkiye is included in explanatory variables. This data is compiled from Bloomberg Terminal, which uses IMF as a database.

Short-term external debt stock is one of the indicators for how adequate the foreign reserves of a country are. To roll these debts, a country needs an adequate amount of foreign currency inflow. This indicator is also used in the aforementioned studies of Aizenmann et al. and found to affect EMP. This data for Türkiye is available as time series at CBRT EDDS.

One worth noting relationship for Türkiye is the co-movement of Türkiye CDS

and VIX (Figure 1.1). The relationship implies that Türkiye has a high external risk exposure apart from internal and geopolitical risks, which could result in more foreign exchange market pressure relative to peers in times of global uncertainty.

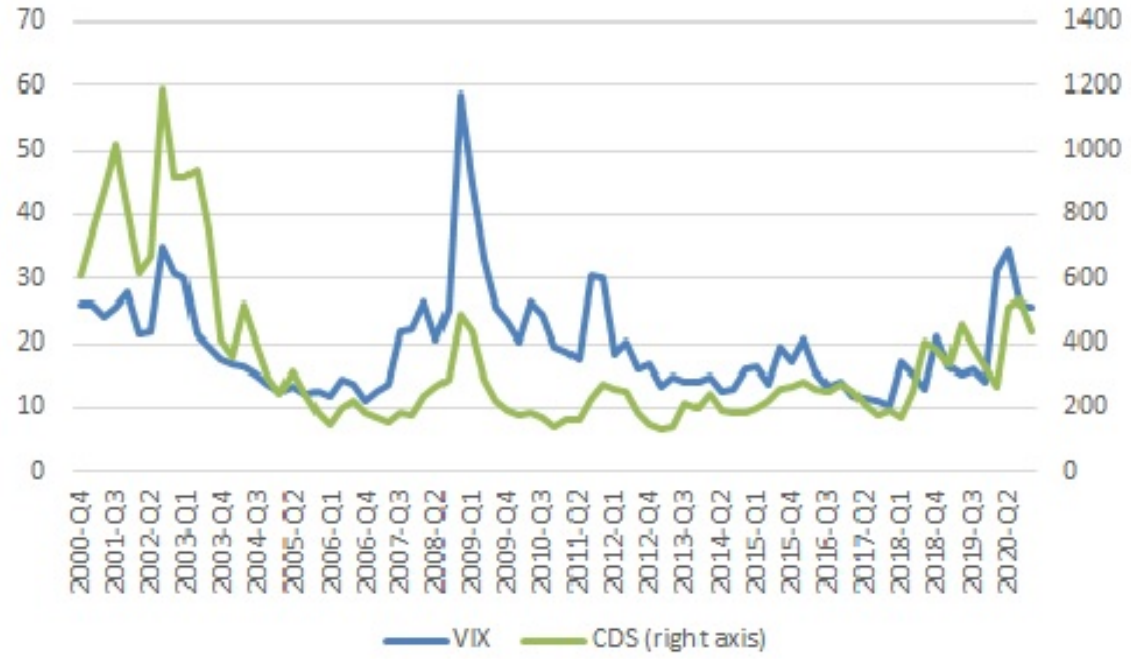

Figure 1.1: CBOE VIX Index and Turkish CDS

1.5 Empirical Results

1.5.1 Exchange Market Pressure Index for Türkiye

This study is looking at the EMP measure of Türkiye and whether capital flows affect this measure. To do that, the first step is to construct an EMP measure.

There are different ways to construct EMP in the literature. From Girton and Roper (1977) to Goldberg and Krogstrup (2018), economists investigate different ways to measure the pressure in exchange rate markets. EMP measure used in this study is the EMP standardized following Aizenmann and Binici (2015) that includes both interest rate and foreign exchange rate reserves:

$$EMP_t = \frac{\Delta e_t - \mu e_t}{\sigma e_t} - \frac{\Delta ir_t - \mu ir_t}{\sigma ir_t} - \frac{\nabla i_t - \mu i_t}{\sigma i_t}$$

where e_t is the nominal exchange rate of Turkish Lira against US dollars, ir_t is the international foreign exchange reserves of Türkiye and ∇i_t is the difference between the Turkish policy rate and US Federal Funds rate.

Figure 1.2 shows that EMP is able to capture the currency crisis for Türkiye starting from 1990. In 1994, Türkiye had a sovereign debt crisis. Turkish Lira depreciated almost 70 percent against US Dollar, and overnight interest rates reached 700 percent from a pre-crisis level of around 70 percent. GDP growth declined by 6 percent. Inflation was around 118 percent. Central Bank of the Republic of Türkiye (CBRT) intervened in the foreign exchange market, and reserves declined (Özatay, 2000). This crisis ended with a stand-by agreement with the IMF and contractionary monetary policy. Figure 1.2 shows the volatility of EMP during the crisis.

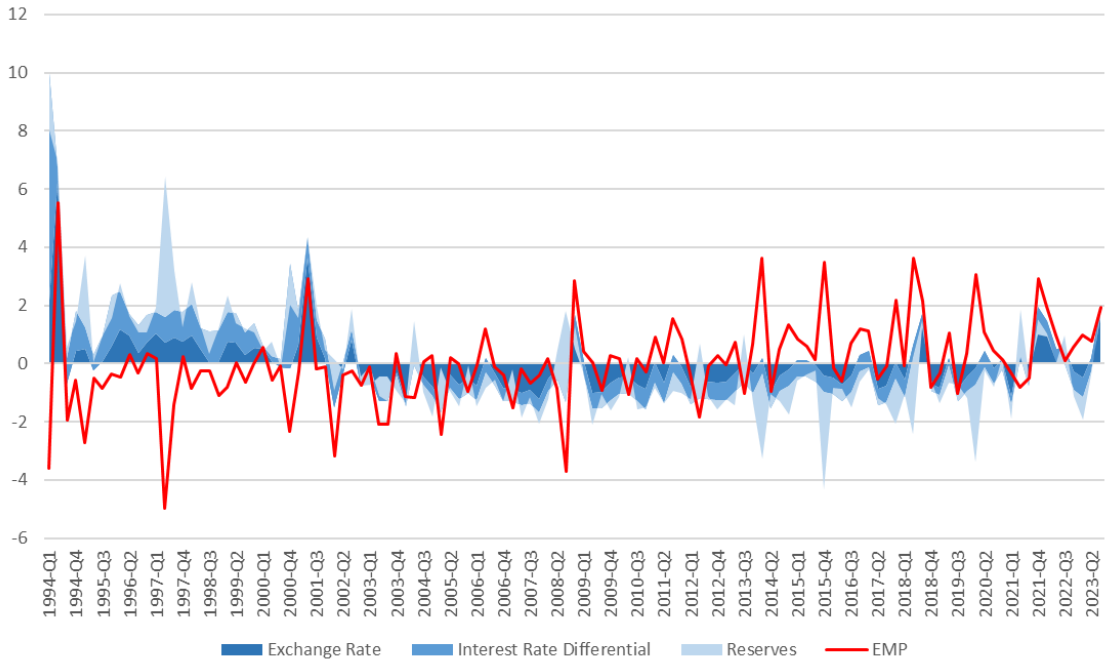

Figure 1.2: EMP and Components for Türkiye

2001 crisis started with a deterioration in the current account balance. Inflation was around 36 percent. Reserves were declining even before the crisis hit the real economy, leading to recession (Comert, 2018). The economy suffered from the reversal of capital flows during the 1994 and 2001 crises, and the exchange rate depreciated significantly in both crises. As seen in Figure 4, there was a spike in EMP during the 2001 crisis. With the crisis, Türkiye switched to a floating exchange rate regime rather than a fixed exchange rate regime, and a series of economic reforms started in line with the IMF stand-by agreement. After this crisis, both reforms and the Federal Reserve's less tight monetary policy helped EMP to fall.

2008 Global Financial Crisis (GFC) affected the Turkish economy more after

the collapse of Lehman Brothers, and the economy entered into a recession. CBRT started to decrease the policy rate. The exchange rate started to depreciate. GDP growth declined by approximately 5 percent. Greece's sovereign debt crisis affected the Eurozone, one of the biggest trade partners of Türkiye, and affected investor risk sentiment adversely, which also affected the Turkish Lira.

In 2013, the Taper Tantrum affected most of the emerging economy currencies and Turkish Lira also affected by the more hawkish Federal Reserve stance. EMP started to rise with the depreciation of the Turkish Lira.

In 2016, a coup attempt occurred, and even though it was successfully battled, the risk appetite of investors towards Türkiye decreased, and the Turkish Lira depreciated sharply and immediately, which led EMP to rise.

In 2018, there was an increase in geopolitical stress and worries about sanctions on Türkiye, which led to a capital flight and a very sharp depreciation in Turkish Lira. CBRT responded with a sharp increase in the policy rate, which helped ease EMP's response.

The policy rate stayed high for a while, which helped EMP to remain low, but after a while, the dismissal of CBRT governors, lowering policy rates, and high credit growth, together with pandemic effects, increased the volatility of Turkish Lira and EMP raised.

All in all, EMP can capture economic stress, and this study aims to find the determinants of EMP to understand if EMP and the determinants could be used as warnings of increased stress in markets.

1.5.2 Determinants of EMP of Türkiye

Türkiye has a volatile EMP. The exchange rate market volatility affects the real economy, especially with the import channels. Türkiye is a primary energy-importer country with a current account deficit. Hence, the country is dependent on capital flows, and if the IMF's short-term debt reserve adequacy ratio is used, it is seen that Türkiye does not have adequate reserves. These properties make the exchange rate market important for Türkiye and other similar emerging markets. Also, in the exchange market of Türkiye, it could be possible that exchange market worries become a self-fulfilling prophecy and trigger capital outflows, which will lead to pressure in the exchange rate market. That is why this study aims to understand if capital flows could be the driving forces of EMP.

To measure the effects of capital flows on EMP, data on net capital flows, total inflows and outflows, FDI inflows and outflows, portfolio investment inflows and outflows and other investment inflows and outflows data compiled. The regressions are formed and analyzed using the Autoregressive Distributed Lag (ARDL) method following Pesaran (1999), taking EMP as the dependent variable, macroeconomic variables, and capital flows as an independent variable. The reason for using ARDL is that the dependent and independent variables could have a relationship and result in an endogeneity problem.

In Model 1, I look at effects of all capital flow assets and liabilities on EMP. Model 2 expands this analysis with macroeconomic variables. Model 3 looks at the

effects of net capital flows on EMP. Model 4 analyzes the effects of net portfolio flows and macroeconomic variables on EMP. Model 5 analyzes the effects of net FDI flows and macroeconomic variables on EMP and Model 6 analyzes effects of net other flows and macroeconomic variables on EMP. Model 7 has the total capital flows assets and liabilities with macroeconomic variables. I use ARDL for these models (table 1.1).

Model 8, 9 and 10 are robustness tests for Model 1, by using FMOLS, DOLS and OLS (Table 1.2).

Model 11 breaks down the portfolio liabilities into debt securities and equities liabilities. Model 12 removes the capital flows and only takes short term debt to see its effects on EMP. (Table 1.3) Model 13 looks at the effects of CDS (Table 1.4). Models 11, 12 and 13 are ARDL models.

The general formulation for regressions that try to measure the effects of capital flows on EMP is as follows:

$$EMP_t = \sum_{i=1}^{n-1} EMP_{t-i} + \sum_{i=0}^{n} FDIA_{t-i} + \sum_{i=0}^{n} FDIL_{t-i} +$$

$$\sum_{i=0}^{n} PORTA_{t-i} + \sum_{i=0}^{n} PORTL_{t-i} \sum_{i=0}^{n} OTHERA_{t-i} + \sum_{i=0}^{n} OTHERL_{t-i}$$

where BPM6 notation is used for the capital flow variables. FDIA means the foreign direct investment (FDI) asset of Türkiye, meaning the FDI by Turkish residents in other countries. FDIL means FDI by non-residents in Türkiye, so they are Türkiye's liabilities. The same logic applies for PORTA and PORTL, where PORT means the portfolio investment, and OTHERA and OTHERL, where OTHER means other investments cannot be included in FDI or portfolio investment.

When EMP index is multiplied by 1000 (to make coefficients easier to read),

used as dependent variable, and FDI, portfolio investment, and other investment inflows and outflows as independent variables, taking data from 1994Q1 to 2023Q3, it is seen that portfolio inflows and other inflows decrease the exchange market pressure whereas portfolio outflows are not statistically significant. On the other hand, other investment outflows increase the pressure on the exchange market. FDI inflows, however, do not have any effect on EMP, while FDI outflows have an upward effect on EMP. This might be because FDI needs a significant amount of foreign exchange, and a one-time flow of this high amount of foreign exchange increases the stress on the market. While net FDI flows do not have a significant effect on EMP, both net portfolio and net other investment flows decrease EMP and are significant(Table 1.1).

Taking macroeconomic variables into the equation, it is seen that for 1994-2020, real GDP growth does not significantly affect EMP, whereas both inflation and VIX increase EMP, though CPI is not significant until 2001. It is worth noting that the inflation of the previous quarter decreased the EMP. This effect could be due to an increase in interest rates caused by an increase in inflation during one quarter (Table 1.1).

When portfolio investments are divided into debt liabilities and equity liabilities, it is seen that debt securities decrease EMP, but even though equity has a negative sign, there is no significant effect of equities on EMP, which is an unexpected result (Table 1.3).

Another model estimates the effects of total capital inflows and total capital outflows on EMP. Total capital inflows, meaning the summation of FDI, portfolio in-

vestment, and other investment inflows, decrease the EMP, while total capital outflows, calculated the same way as inflows, increase the EMP. To conclude, when there is an inflow, meaning non-residents acquire Turkish financial assets, pressure on the exchange rate market declines. In contrast, when Turkish residents acquire assets abroad, pressure on the exchange rate market increases (Table 1.1).

According to the results, portfolio investment and other investment inflows are effective in reducing the pressure in the exchange rate market, and FDI inflows do not have a significant effect on EMP. FDI outflows seem to increase EMP. Inflation and VIX exacerbate EMP after 2001, but before 2001 CPI seems to be insignificant for EMP even though the sign is positive. Considering that Türkiye is a country with a current account deficit and both short-run and long-run foreign exchange debt holders, portfolio investment and other investment liabilities are crucial to stabilizing the exchange rate market.

For robustness of ARDL results, I conducted Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Least Squares (DOLS). Except for CPI and FDI inflows, the signs are the same, and magnitudes are close to each other. When I run OLS with ARDL's estimation output and check for stability with the CUSUM test, the model with capital flows and macroeconomic variables turns out to be stable(Figure 1.3 and Figure 1.4). For the model with net capital flows and macroeconomic variables, all signs except for net FDI flows are the same, and magnitudes are similar. The significance of the variables is also similar. Similar magnitudes and the same signs also hold for models that only look at the capital flows (Table 1.2). Results are given in the tables,

and CUSUM graphs are provided in the annex.

I also conducted ARDL analysis with macroeconomic variables (GDP, CPI, VIX) and Turkish CDS and short-term debt data separately. According to these studies, CDS increases EMP, and short-term debt of the quarter decreases the EMP, whereas short-term debt of the previous quarter increases EMP. This could be due to the payment of the previous quarter's debt (Table 1.3 and Table 1.4).

1.6 Conclusion

This study aims to understand what variables could be driving the exchange market pressure in Türkiye, an open emerging market with a current account deficit. Türkiye is vulnerable to pressures causing depreciation of the Turkish Lira, so the determinants of exchange market pressure are essential not only for Türkiye but also for other similar emerging economies. In this study, EMP for Türkiye is calculated for 1990-2020. Threshold study shows that EMP can capture all significant currency crises. Using the calculated EMP index, the paper studies the factors affecting EMP in Türkiye. Using data from 1994 to 2020, it can be seen that capital flows are significant in exchange market pressure. Capital inflows decrease the EMP while outflows increase. Inflation and VIX increase the EMP, while real GDP growth is insignificant. Total capital inflows help decrease EMP, but outflows are increasing EMP. FDI inflows and outflows are not significant on EMP. Portfolio investment inflows are decreasing EMP together with other investment inflows, but other investment outflows increase the EMP.

From the results, it can be seen that the portfolio investment and other investment inflows help decrease the pressure of depreciation. Given that Türkiye has a current account deficit, it is vital that there is a flow of portfolio investment and other investments into the country so that the exchange rate is not volatile. If not, the exchange rate usually depreciates. Exchange rate depreciation could be handled without intervention, but Türkiye's current account, short-term foreign debt stock, and dependency on imports do not allow for significant depreciation in the currency. CBRT intervenes

with policy interest rates and international reserves, but these should be only extreme measures rather than used continuously, or else international reserves could be depleted, and interest rates could hurt economic growth. There should be a continuous flow of investments from non-residents to sustain lower stress in the exchange rate market. To provide the flow, Türkiye could increase the credibility of the institutions, make policy communication more straightforward, and continue to implement structural reforms. Turkish economy should focus on pull and push factors of flows and decrease dependency on imports for lower EMP. Single economy studies like this study are important for policy makers to decide how to balance stress in the exchange markets.

1.7 Appendix

This section provides the table of models and their results have been already discussed in previous sections.

1.7.1 Model Tables

This section provides ARDL models that were used to check the effects of capital flows and macroeconomic variables on EMP. In Model 1, I look at effects of all capital flow assets and liabilities on EMP. Model 2 expands the analysis with macroeconomic variables. Model 3 looks at the effects of net capital flows on EMP. Model 4 analyzes the effects of net portfolio flows and macroeconomic variables on EMP. Model 5 analyzes the effects of net FDI flows and macroeconomic variables on EMP and Model 6 analyzes effects of net other flows and macroeconomic variables on EMP. Model 7 has the total capital flows assets and liabilities with macroeconomic variables. I use ARDL for these models.Models are provided in Table 1.1.

For all models (-n) shows the number of lags and D(Variable): first difference of the variable.

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
EMP(-1)*1000	-0.11	-0.09	0.02	-0.01	-0.02	0.02	-0.04
	(0.09)	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
EMP(-2)*1000		-0.08					
		(0.08)					
FDI Liabilities	0.05	0.006					
	(0.08)	(0.08)					
FDI Assets	0.51*	0.74***					
	(0.3)	(0.3)					
FDI Assets(-1)	0.87***	0.45					
	(0.3)	(0.3)					
Portfolio Liabilities	-0.07**	-0.06**					
	(0.03)	(0.03)					
Portfolio Assets	-0.03	-0.08					
	(0.14)	(0.14)					
Other Liabilities	-0.1***	-0.1***					
	(0.03)	(0.03)					
Other Liabilities(-1)	0.05 *						
	(0.03)						
Other Assets	0.05	0.06**					
	(0.03)	(0.03)					
Other Assets(-1)		-0.1***					
		(0.03)					
Net FDI			-0.05		-0.06		
			(0.1)		(0.09)		
Net FDI(-1)			0.18 *		0.18*		
			(0.1)		(0.1)		
Net Portfolio			-0.07**	-0.06*			
			(0.03)	(0.03)			
Net Other			-0.09***			-0.1***	
			(0.03)			(0.03)	
Net Other(-1)			0.09***			0.06**	
			(0.03)			(0.03)	
Capital Liabilities							-0.09***
							(0.02)
Capital Liabilities(-1)							0.03
							(0.02)
Capital Assets							0.07**
							(0.03)
Capital Assets(-1)							-0.08**
							(0.03)
C	-442.2*	85.1	-109.5	434.5**	471.1	434.3**	860.9***
	(191.9)	(341.4)	(190)	(193.3)	(298)	(197.4)	(282.8)
D(VIX)		39.96*		41.3	57.7***	44.0**	31.6
		(21.8)		(23.2)	(22.9)	(21.1)	(24.3)
D(VIX(-1))				32.8	43.2**	35.5*	
				(23.2)	(22.6)	(21.1)	
CPI		22.5		16.99	14.7	-15.03***	55.5***
		(18.2)		(20.7)	(20.9)	(3.95)	(16.8)
CPI(-1)		-35.05**		-31.98	-29.7		-72.96***
		(18.2)		(20.3)	(20.8)		(17.1)
GDP		22.2*		5.9	2.3	6.3	14.8
		(13.7)		(14.8)	(14.8)	(14.1)	(15.3)
N	118	106	118	106	106	106	107
R^2	0.35	0.44	0.18	0.21	0.19	0.3	0.35

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 1.1: EMP and Capital Flows, ARDL

1.7.2 Robustness Tables

This section provides robustness tests for Model 2, which studies effects of capital flows and macroeconomic variables on EMP. Model 8 replicates Model 2 with Fully Modified Least Squares (FMOLS). Model 9 replicates Model 2 with Dynamic Ordinary Least Squares (DOLS). Model 10 replicates Model 2 with OLS. Models are provided in Table 1.2.

For all models (-n) shows the number of lags and D(Variable): first difference of the variable.

Variable	**Model 8**	**Model 9**	**Model 10**
	FMOLS	**DOLS**	**OLS**
FDI Liabilities	-0.015	-0.008	0.022
	(0.07)	(0.083)	(0.079)
FDI Assets	1.027***	0.77***	0.828***
	(0.24)	(0.28)	(0.305)
Portfolio Liabilities	-0.050**	-0.06**	-0.056*
	(0.026)	(0.03)	(0.034)
Portfolio Assets	-0.202*	-0.196	-0.186
	(0.12)	(0.14)	(0.16)
Other Liabilities	-0.08***	-0.077***	-0.074***
	(0.02)	(0.027)	(0.030)
Other Assets	0.054*	0.07**	0.062
	(0.03)	(0.033)	(0.038)
C	123.9	218.3	
	(286.6)	(332.8)	
CPI	-8.76**	-7.87	-5.319*
	(4.22)	(4.77)	(3.135)
D(VIX)	40.4**	39.7*	39.3*
	(18.8)	(21.9)	(24.96)
GDP	-3.65	-4.33	-3.58
	(11.84)	(13.49)	(15.34)
N	107	104	107
R^2	0.35	0.52	0.24

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 1.2: Robustness Checks, FMOLS, DOLS and OLS

1.7.3 Additional Variable Tables

This section provides models with additional variables.Model 11 breaks down the portfolio liabilities into debt securities and equities liabilities. Model 12 removes the capital flows and only takes short term debt to see its effects on EMP.Model 13 looks at the effects of CDS. Models 11, 12 and 13 are ARDL models.

Variable	Model 11	Model 12
EMP(-1)*1000	0.07 (0.09)	-0.1 (0.1)
EMP(-2)*1000		-0.157* (0.09)
FDI Liabilities	0.005 (0.08)	
FDI Assets	0.64** (0.3)	
Debt Securities	-0.08*** (0.03)	
Equity	0.05 (0.1)	
Equity(-1)	-0.09 (0.1)	
Equity(-2)	0.2** (0.12)	
Equity(-3)	-0.12 (0.12)	
Equity(-4)	0.21* (0.12)	
Portfolio Assets	0.05 (0.1)	
Other Liabilities	-0.1*** (0.03)	
Other Liabilities(-1)	0.06** (0.03)	
Other Assets	0.05* (0.03)	
Other Assets(-1)	-0.1*** (0.03)	
C	-495.6*** (179.9)	-944.1*** (392.2)
CPI		-2.0 (4.99)
D(VIX)		34.23 (21.9)
D(VIX(-1))		32.3 (21.5)
D(VIX(-2))		35.7* (21.7)
GDP		-3.95 (13.61)
STDEBT		-0.07*** (0.025)
STDEBT(-1)		0.09*** (0.025)
N	115	105
R^2	0.44	0.35
Prob	0.000	0.000

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 1.3: Additional Variables,ARDL

Table 1.4: Additional Variables,CDS,ARDL

Variable	**Model 13**
EMP(-1)*1000	-0.308***
	(0.122)
EMP(-2)*1000	-0.06
	(0.107)
EMP(-3)*1000	0.024
	(0.117)
EMP(-4)*1000	0.200*
	(0.117)
FDI Liabilities	-0.119
	(0.104)
FDI Liabilities(-1)	0.089
	(0.104)
FDI Liabilities(-2)	0.175*
	(0.106)
FDI Liabilities(-3)	-0.235**
	(0.109)
FDI Assets	0.287
	(0.330)
FDI Assets (-1)	0.563*
	(0.326)
Portfolio Liabilities	-0.07***
	(0.036)
Portfolio Liabilities(-1)	0.059
	(0.04)
Portfolio Liabilities(-2)	0.027
	(0.039)
Portfolio Liabilities(-3)	-0.065*
	(0.038)
Portfolio Liabilities(-4)	0.099***
	(0.038)
Portfolio Assets	-0.178
	(0.154)
Portfolio Assets (-1)	0.226
	(0.15)
Other Liabilities	-0.129***
	(0.03)
Other Assets	0.073**
Continued on next page	

Table 1.4 – continued from previous page

Variable	Model 13
	(0.035)
Other Assets(-1)	-0.06*
	(0.036)
Other Assets(-2)	-0.082**
	(0.037)
Other Assets(-3)	-0.057
	(0.038)
Other Assets(-4)	0.04
	(0.037)
C	768.2
	(599.6)
CPI	129.9***
	(40.99)
CPI(-1)	-180.2***
	(57.46)
CPI(-2)	21.77
	(34.23)
D(VIX)	36.07
	(26.33)
D(VIX(-1))	98.2***
	(26.9)
D(VIX(-2))	50.04**
	(25.07)
GDP	43.78
	(41.12)
GDP(-1)	28.7
	(48.32)
GDP(-2)	-79.25**
	(39.24)
D(CDS)	1.004
	(0.31)
N	80
R^2	0.70
Prob	0.0001

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 1.4: Additional Variables,CDS,ARDL

1.7.4 CUSUM Graph

For Model 1 and Model 2, CUSUM graph shows that the model parameters are stable:

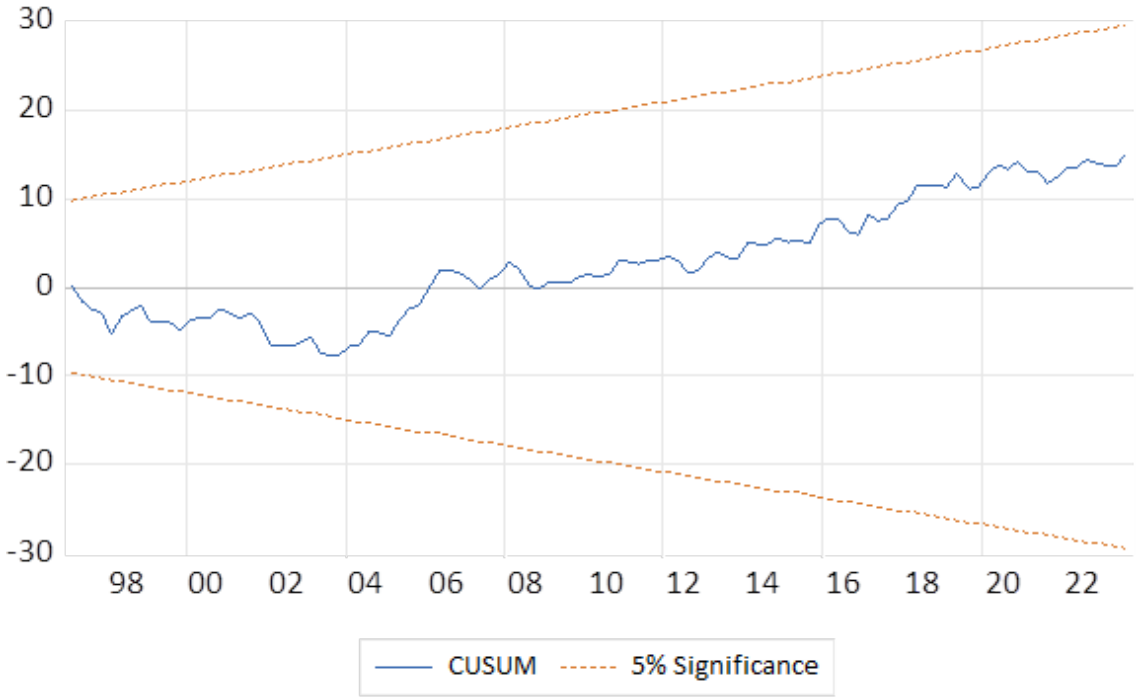

Figure 1.3: CUSUM Graph for Model 1

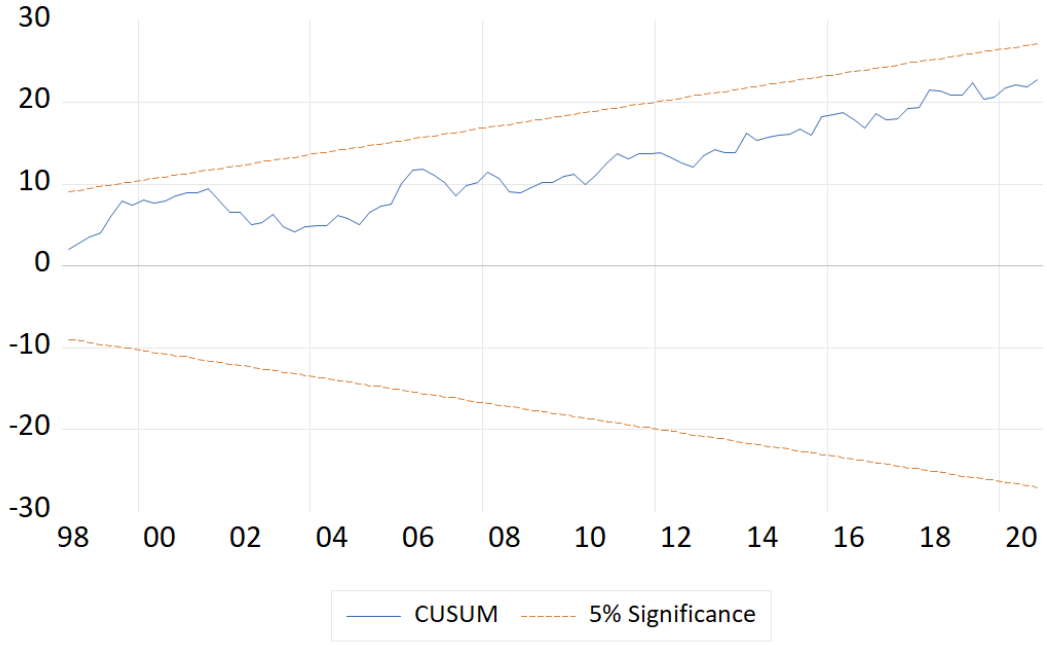

Figure 1.4: CUSUM Graph for Model 2

Chapter 2

ESG Index and Its Macroeconomic Determinants

2.1 Introduction and Literature Review

Financial tables and the financial stability of companies and countries have been two important factors affecting investment decisions for a long time. However, problems outside financial aspects started to rise with the financial system becoming more interconnected. Compliance procedures regarding prohibited transactions to certain countries and related money laundering activities, faster than expected climate change, effects of production on climate change's pace, and glass ceiling towards women and minorities have become more visible. More attention is being paid to non-financial issues, given the financial results they cause via financial, reputation, and regulatory risks. Faster than expected speed of climate change also greatly impacts the demand for

non-financial information. We are now living in a world that is racing towards net zero, and sustainable investment is more important than at any other time.Investors would like to see not only growth but sustainable growth. Hence, Environmental, Social, and Governance factors have become important investment decisions.In 2004, ESG's importance was first coined by IFC's Who Cares Wins 2004-08 reports (2004-2008). In these reports, the World Bank advised that ESG factors should be understood better and integrated into investment decisions to link financial markets to real-world events. With the 2008 Global Financial Crisis and especially after the COVID-19 pandemic, investors are now focusing on ESG indicators to identify financially and non financially resilient companies and countries. Investors demand clear reports and indicators to understand whether a company or a country has a solid ESG score. To respond to this rising demand, credit rating agencies and research companies constructed their own ESG indexes.

To achieve effective sustainable investment, ESG scores need to be clear in terms of calculation, and white papers should be public; ESG scores should be open and available, coherent among each other, and periodically updated. When we look at ESG score data, we see that credit rating agencies such as S$P Global, Fitch Ratings, and Moody's provide ESG scores or assessments for countries and companies. Also, Sustainalytics, MSCI, Bloomberg, Refinitiv, ISS-ESG Gateway, FTSE Russell, and CDP also provide ESG scores. Most of them provide their white papers to understand the methodology. Still, they do not provide enough information on data, and the data they use are not publicly available most of the time. Also, even though some provide access

to scores for free, one cannot access them as a database or as a time series but rather as a snapshot and only get data for firms. Most of them only offer scores if one has a membership with fees. The methodologies and scales are different for each rating agency, which makes comparison difficult. What is more, even the biggest companies or countries could get different ESG scores even when the scale is taken into account.

These issues are raised both by market participants and academia. One vital example is that the European Union (EU) passed legislation in February 2024 on ESG rating activities that enforces rating agencies to share what they assess and how they assess transparently. The World Bank has opened its free Sovereign ESG Data Portal. One strand of the ESG literature emphasizes the divergence in the ESG scores (Kotsantonis & Serafeim,(2019); Dimson et al.(2020); Berg et al. (2022); Agrawal et al. (2023)). These papers show the disagreements between data providers, different results with different statistical methods, and data inconsistencies. One subgroup of this strand calls for a reevaluation of sovereign ESG score methodologies (Gratcheva & Gurhy (2024)). All these papers also point out that ESG metrics provide insight for investors. This part of the literature supports my study of formulating a simple and free ESG score, given that few papers study sovereign ESG data formulation. The other part of the literature studies the ESG scores and how the ESG scores are affected by other variables (Jiang et al. (2022),(2024); Salzmann (2023)).However, the study of what affects ESG scores only includes company ESG scores.

I build an ESG score for a set of countries, both advanced and emerging, using only publicly available data provided by the World Bank Sovereign ESG Data Portal.

Jiang et al., in their 2022 and 2024 papers, use the same data to construct an ESG index. However, when the data is closely examined, we see that not all countries have continuous data for the given period, and many emerging and underdeveloped countries suffer from large data gaps. This leads to breakages in ESG score calculations, even for major economies. So, the indicators with more complete and balanced data are chosen for this study. Secondly, Jiang et al. (2022) suggest that drivers of ESG could be the subject of future research. I also look at whether macroeconomic variables have significant effects on the Environment, Social and Governance pillars of ESG and the ESG score itself. I use principal component analysis (PCA) to create Environment, Social and Governance, and ESG scores. I choose PCA because using the first component of PCA captures the main global drivers of these individual pillars. To understand the determinants, I first run Least Absolute Shrinkage and Selection Operator (LASSO) regression, which is a machine learning regression analysis, to decide which variables to choose for each pillar's model, and then I estimate panel regression with country and time-fixed effects to check for the macroeconomic determinants of ESG scores.

The World Bank Sovereign ESG Data Portal allows for ESG score building for free, but aggregation methods are only "Minimum, Average, Median and Maximum". In the future, there could be an option to use custom weights. I also build an ESG score using this website, using the same indicators I use for PCA, but in World Bank scoring, I use peer group income adjustment and average aggregation method. The rankings of the two scores I build for 2020 is not the same but similar. I run the same regression for both scores and show that there are differences even with the same data when the

method is not the same. The differences highlight the need for a unique method to construct ESG scores.

For individual score pillars, except for Environment, higher score is better. But for ease of understanding, graphs and comments are made similar to other pillars. For the Environment Pillar, I find that government spending and investment have a negative relationship, meaning they hurt the environmental score. While unemployment has a positive relationship with the Environment, increasing the environmental score, the urban population has a negative relationship. For the Social Pillar, industrial production, government spending, and urban population have a negative relationship. When the share of the service sector in GDP increases, the Social score also increases. For the Governance Pillar, industrial production has a positive relationship, though it is statistically insignificant. Unemployment and urban population have a negative relationship. After constructing individual pillars via PCA, I again construct the overall ESG score using the PCA method. For the ESG score, industrial production, government spending, and government debt have a negative relationship. Budget balance, share of services, and self-employment have a positive relationship. The results show that production hurts the ESG score, and there is a trade-off between growth and sustainability.

This paper contributes to the literature in several ways. Feeding from previous literature, this paper creates a free sovereign ESG score for major advanced and emerging markets with publicly available data. Also, as the World Bank (2021) notes, sovereign ESG needs to be studied more empirically. This paper will add to existing literature on sovereign ESG studies by looking at the relationships of macroeconomic

variables of the sovereign ESG scores. This will be helpful for literature given the small number of studies looking at the drivers of ESG and which macroeconomic variables have a relationship with ESG.

2.2 Data

The data in this paper divides into two categories. The first category is Environmental, Social and Governance indicators data and second category is macroeconomic variables to be used as explanatory variables of ESG. To get a series without data breaks and high quality data, the sample starts from 1999. Before this date, especially emerging markets had economic crises, and data collection processes were challenging. Moreover, ESG data has significant breaks even for developed countries before this date. Macroeconomic data are available until 2024, but ESG data are generally available until 2020. Due to data limitations, the data set is set to 1999-2020.

The countries are chosen according to data availability. A set of advanced and emerging countries are taken and classified according to the World Bank ESG Data Portal classification. The list of countries is provided in the Appendix Table 2.7.

2.2.1 Variables of Environment,Social and Governance Pillars

To build ESG scores, together with Environment,Social and Governance pillars, separate ESG indicators are needed. The World Bank has a free data portal for environmental, social and governance indicators for sovereigns available at

https://esgdata.worldbank.org/?lang=en, The World Bank Sovereign ESG Data

Portal. At this portal, there are 135 indicators for ESG for 211 and for 62 years on a yearly basis. This is the database that is free with most of the indicators and the longest data set. However, the data is not complete. There are significant data breaks, not only in the far past but also in recent dates, for both emerging and advanced countries. Given the limitations, I had to choose the indicators rather than taking all of them for the ESG score. The indicators I use are as follows, separated according to pillar:

Environmental Indicators	**Category**
CO2 emissions (metric tons per capita)	Emissions & pollution
Agricultural land (% of land area)	Food Security
Renewable electricity output (% of total)	Energy use & security
Nitrous oxide emissions (metric tons of CO2 equivalent per capita)	Emissions& pollution
Methane emissions (metric tons of CO2 equivalent per capita)	Emissions& pollution
Adjusted savings: natural resources depletion (% of GNI)	Natural capital endowment and management
Land Surface Temperature	Environment
Level of water stress	Environment
Annual freshwater withdrawals, total (% of internal resources)	Natural capital endowment and management

Social Indicators	**Category**
People using safely managed sanitation services (% of population)	Access to Services
School enrollment, primary (% gross)	Education & skills
Prevalence of undernourishment (% of population)	Health & Nutrition
Labor force participation rate, total	Employment
Life expectancy at birth, total (years)	Demography
Access to clean fuels and technologies for cooking (% of population)	Access to Services
Access to electricity (% of population)	Access to Services

Governance Indicators	**Category**
Regulatory Quality: Estimate	Government Effectiveness
Control of Corruption: Estimate	Stability & Rule of Law
Individuals using the Internet (% of population)	Economic Environment
Political Stability and Absence of Violence/Terrorism: Estimate	Stability & Rule of Law
Patent applications, residents)	Innovation
Proportion of seats held by women in national parliaments (%)	Gender
Rule of Law: Estimate	Stability & Rule of Law
Voice and Accountability: Estimate	Human Rights

Table 2.1: Variables for E,S and G Pillars

2.2.2 Control Variables

A set of macroeconomic variables are used to estimate the determinants of ESG Score. The list of control variables and their explanations are provided in the Appendix Table 2.8. The data is retrieved from Reuters Eikon Datastream, which uses IMF, BIS, the World Bank and national central banks and statistics offices as a source.

2.3 Methodology

2.3.1 ESG Score Derivation with Principal Component Analysis

To build ESG scores for countries, I first build Environment, Social and Governance pillars of the score. I take the variables listed in Table 2.1 and combine these variables according to their pillar by using principal component analysis (PCA), for all countries separately. The first factor load in the PCA analysis is taken into account as the common/global drivers of these variables. Thereby, excluding idiosyncratic drivers of country scores in order to get more comparable scores between countries.

After building three pillars, I use LASSO regression to see which macroeconomic variables could be used to analyse their effects on ESG pillars. LASSO models select potential covariates from a set of control variables. For LASSO, I use double selection linear regression, which avoids overfitting since LASSO selects relevant control variables. I choose the macroeconomic variables to use for each pillar determined by LASSO regression. Using these control variables, I analyze which macroeconomic variables have a relation with these pillars separately. For this, I estimate panel regression

with country and time fixed effects and Driscoll-Kraay standard errors. Pesaran's test of cross-sectional independence shows that models have cross-sectional dependence in error terms. Therefore, I use Driscoll-Kraay estimator which is robust to these problem. This estimator is also robust to heteroskedasticity, and autocorrelation in error terms(De Hoyos, Sarafidis, 2006):

$$Environment_{it} = \beta X_{it} + \alpha_t + u_i + e_{it}$$

$$Social_{it} = \beta X_{it} + \alpha_t + u_i + e_{it}$$

$$Governance_{it} = \beta X_{it} + \alpha_t + u_i + e_{it}$$

$$ESG_{it} = \beta X_{it} + \alpha_t + u_i + e_{it}$$

where α_t and u_i are unit and time fixed effects, respectively. Y_{it} and X_{it} represent the observed outcome and explanatory variables for unit i, at time t. Finally, e is the error term.

I combine Environment, Social and Governance scores with PCA to get ESG score for countries. After getting ESG score, I estimate which control variables to choose and panel regressions similarly.

2.3.2 ESG Score Derivation with The World Bank Sovereign ESG Data Portal ESG Score Builder Tool

The World Bank allows for free estimation of ESG scores online via its ESG Score Builder tool in Sovereign ESG Data Portal. I take the same variables I use to construct a PCA-combined ESG score. The tool allows for income adjustment, so I use peer group income adjustment in order to reduce the bias caused by different income

levels. There are "Minimum, Average, Median and Maximum" aggregation methods and I choose "Average". I use "Average" method due to breaks in the data set. After construction of ESG scores for each country, estimated the same panel regressions I use for PCA-combined ESG score and check relationships of macroeconomic variables and the score.

2.4 Empirical Results

2.4.1 Three Pillars: Environment, Social and Governance

2.4.1.1 Environment

I build the Environment Pillar (E) by combining Environment Pillar variables in Table 2.1 with PCA for 1999-2020. Environment pillar built in a way that increase in this pillar actually a negative situation for environment. But for ease of understanding, I reversed it for Figure 2.1. So, in Figure 2.1, higher the Environmental Score, better the nature and related issues are.

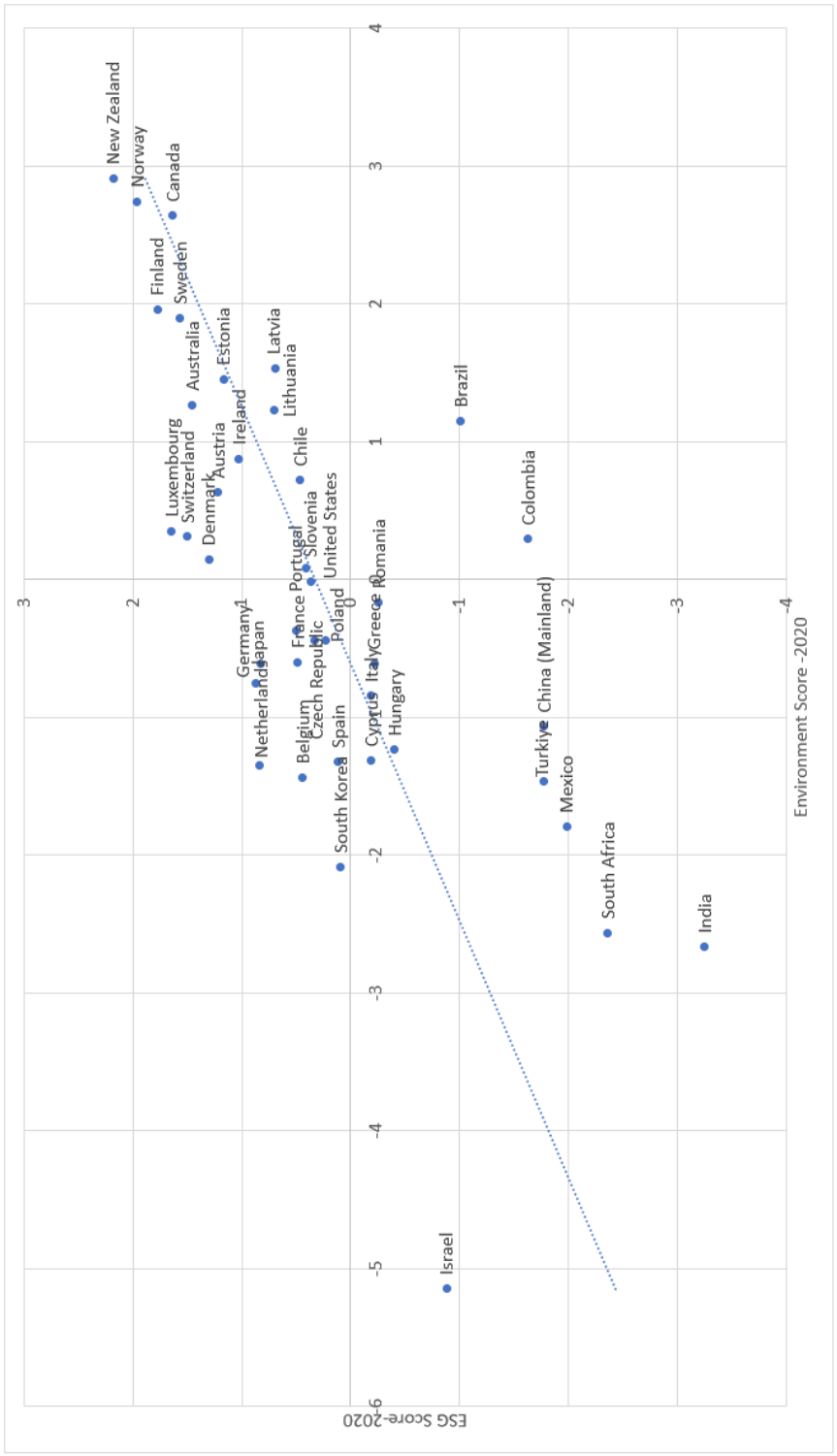

Figure 2.1: Environment Pillar and ESG Score,2020

From Figure 2.1, we can see that developed countries have higher environmental scores than emerging countries for 2020. Israel has the lowest environmental score, which could be explained by the water stress in the area and high per capita CO2 emission. Türkiye, Mexico, China, South Africa and India also have low scores on Environment. This could be due to production related emissions and natural damage. China has one of the highest CO2 emissions in the world which could be due to high production. Türkiye has limited water resources. India also suffers from limited water resources and also air and water pollution. Mexico and South Africa suffer from deforestation and air pollution. All these problems lead to lower score of environment for these countries.

After building the E pillar, I use LASSO regression with all control variables to decide which control variables to use for panel estimation.

After LASSO regression, I run panel regression with Driscoll-Kraay standard errors with chosen control variables. Results are given in Table 2.2 (Please note that in Table 2.2 Environment Pillar is not reversed, so an increase will adversely affect the Environment). According to Table 2.2, increase in imports positively related to the Environment pillar, again implying that when you do not produce in country and choose to buy from other countries, environment is positively affected. On the other hand, investment and government spending have a negative relationship with Environment pillar. Urban population increase also pressures Environment pillar. The ratio of people who are self-employed has a positive relationship with Environment pillar. What is interesting is that the labor participation rate and budget balance increase are positively

related to Environment pillar, these indicators are generally positively related with production so I would have expected to see negative relationship of these variables with Environment pillar. But this result is not new to literature, Achuo et al. (2023), find labor force participation enhances environmental quality and there is a negative relationship between greenhouse gas emissions and labor force participation. Real stock market growth is also positively related to Environment pillar. Paramati et al. (2018) find that stock market indicators negatively affects CO2 emissions in developed countries and increases CO2 in emerging countries.

Control Variable	Environment Pillar
Industrial Production YoY	0.003 (0.002)
Age Dependency Old	0.018** (0.008)
Budget Balance/GDP	0.002 *** (0.006)
Government Debt/GDP	0.0004 (0.0006)
Government Expenditure/GDP	0.046 *** (0.004)
Immigration	0.002 (0.002)
Imports/GDP	0.003 (0.002)
Fixed Investment/GDP	0.009*** (0.002)
Labor Force Participation	0.01*** (0.005)
REER	0.0001 (0.0005)
Self Employment	0.008 ** (0.004)
Service/GDP	0.003 (0.009)
Real Stock Market Index YoY	-0.001 *** (0.0004)
Total Reserves/GDP	-0.002 (0.0005)
Unemployment	0.0019 (0.006)
Urban Population YoY	0.03** (0.01)
N of obs	972
N of groups	48
within R^2	0.26
Prob	0.000

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$, country, time fixed effects.

Table 2.2: Environment Pillar and Macroeconomic Variables

2.4.1.2 Social

I build the Social Pillar (S) by combining Social Pillar variables in Table 2.1 with PCA for 1999-2020. When Social pillar increases, it means social score is getting better.

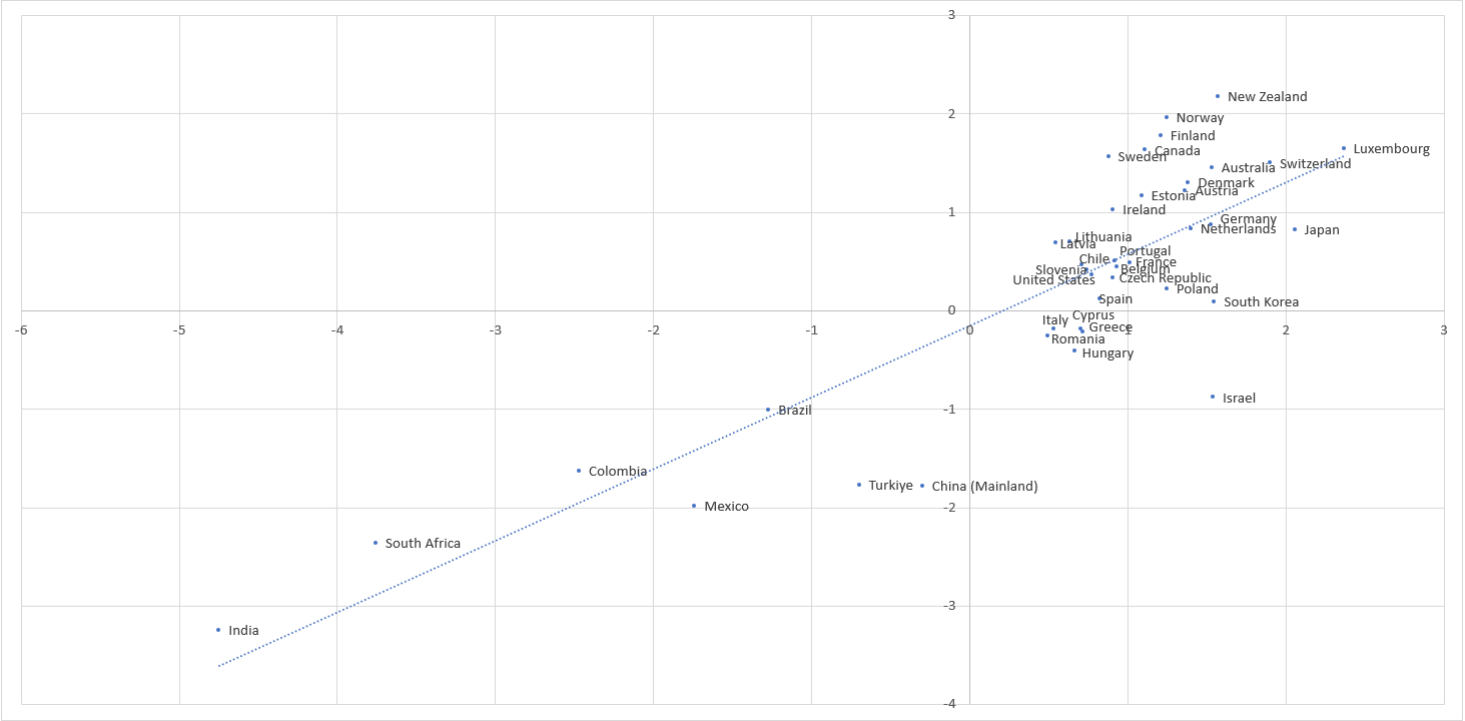

Figure 2.2: Social Pillar and ESG Score,2020

From Figure 2.2, we could see that developed countries have higher social scores than emerging countries for 2020, as in the environmental scores. India has the lowest social score, which could be due to caste system and its effects on daily life. Another reason could be crowded population and difficult access to nourishment. Türkiye, China, Brazil, Mexico, Colombia and South Africa have negative social scores. Even though these countries' data do not seem to signify a problem in social metrics, other countries' metrics surpass these countries and emerging countries fail to achieve the standards of developed countries in Social pillar.

After building the Social pillar, I use LASSO regression with all control variables to decide which control variables to use for panel estimation.

After LASSO regression, I run panel regression with Driscoll-Kraay standard errors with chosen control variables. Results are given in Table 2.3. According to Table 2.3, Social pillar has a negative relationship with industrial production and positive relationship with increase in people working in services sector. This may suggest that industrial production hurts both environmental and social development of countries. Regardless, countries with higher GDP and industrial production have better scores for these pillars. We could conclude that developed countries produce their goods and services together with minimizing harm to environment and being efficient in meeting basic needs of the population. Both birth rate and death rate have negative relationship with the Social score, birth rate increase implying the population increase and unmet contraception needs and death rate increase implying unmet health and sanitary conditions. Population increase has a negative relationship with Social score, limiting the

scarce resources per capita. Increase in real stock market index and government spending have negative relationship with S score, implying these variables increase resources but not in a way that they are shared equally. Increase in vulnerable employment also negatively relates to Social score, which is in line with expectations.

Control Variable	**Social Pillar**
Industrial Production YoY	-0.014** (0.006)
Age Dependency Old	-0.03 (0.01)
Age Dependency Young	-0.07 *** (0.007)
Budget Balance/GDP	0.01 (0.006)
Birth Rate	-0.05 ** (0.02)
Death Rate	-0.2 *** (0.02)
Government Expenditure/GDP	-0.08 *** (0.01)
Imports/GDP	-0.0001 (0.002)
Fixed Investment/GDP	0.004 (0.004)
Service/GDP	0.02*** (0.006)
Real Stock Market Index YoY	-0.002 ** (0.001)
Urban Population YoY	-0.09 * (0.05)
Vulnerable Employment	0.04*** (0.01)
N of obs	828
N of groups	46
within R^2	0.69
Prob	0.000

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$, country, time fixed effects.

Table 2.3: Social Pillar and Macroeconomic Variables

2.4.1.3 Governance

I build the Governance Pillar (G) by combining variables in Table 2.1 under Governance Pillar with PCA for 1999-2020. When G pillar increases, it means it is getting better.

From Figure 2.3, we could see that developed countries have higher governance scores than emerging countries for 2020, as in the environmental and social scores. Comparing all three figures (2.1,2.2,2.3), Brazil, Colombia, China, Türkiye, Mexico, India and South Africa get the lowest scores for three pillars. All these countries are upper or lower middle income level countries but generally have high GDP growth. These countries may catch developed countries after enough capital accumulation.

After building the G pillar, I use LASSO regression with all control variables to decide which control variables to use for panel estimation. After LASSO regression, I run panel regression with Driscoll-Kraay standard errors with chosen control variables. Results are given in Table 2.4. According to Table 2.4, contrast to Environment and Social, Governance score has a positive relationship with industrial production, even though not statistically significant. Increase in unemployment and urban population has a negative related while increase in immigration positively related with Governance score. Increase in dependent population above age 64 and death rate negatively relates to Governance score. Nominal effective exchange rate (NEER) and policy rate increases lead to increase in governance score. Baker et al. (2022) find that countries with better performing currencies have high ESG ratings. That solidifies my finding of NEER.

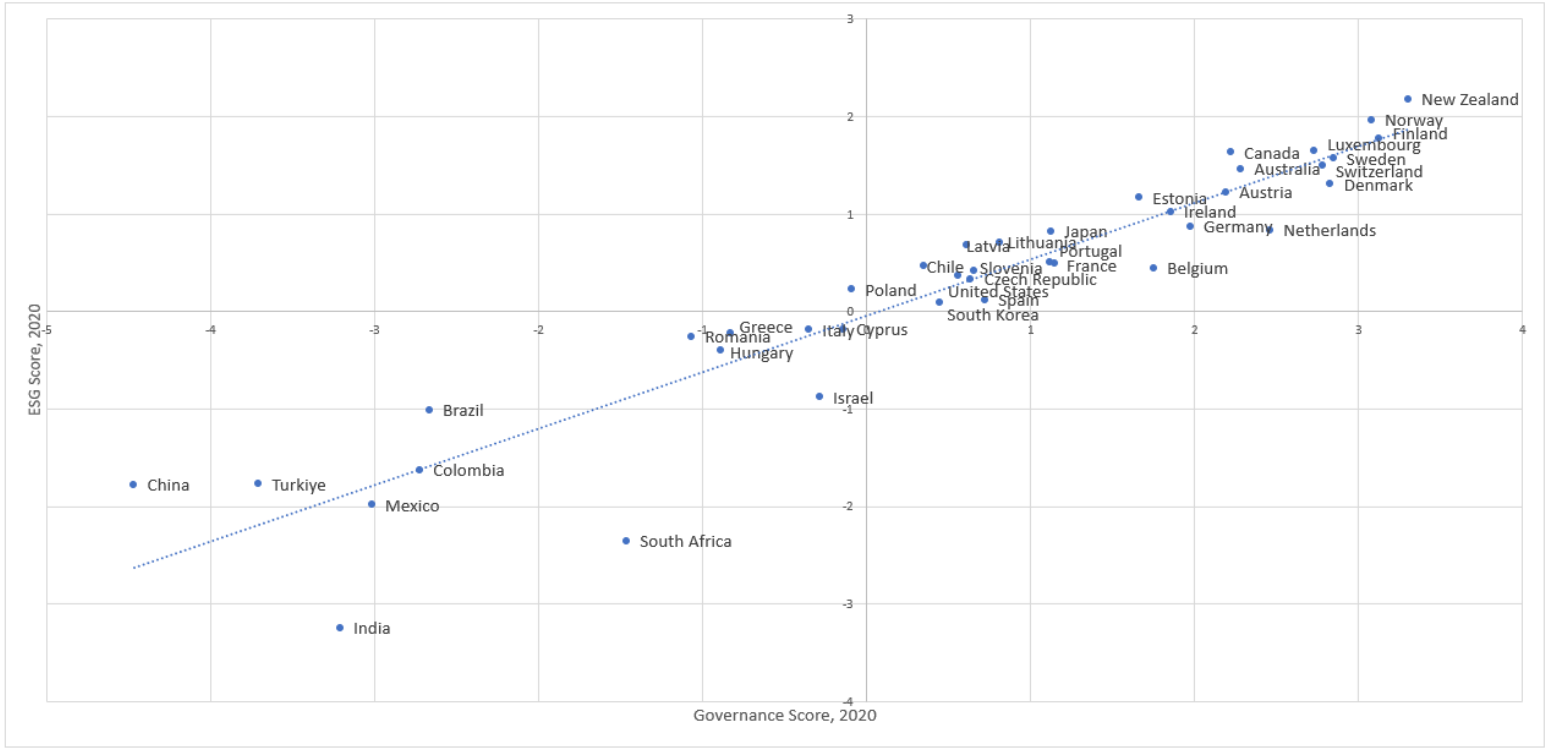

Figure 2.3: Governance Pillar and ESG Score,2020

Control Variable	**Governance Pillar**
Industrial Production YoY	0.0015
	(0.004)
Age Dependency Old	-0.03***
	(0.008)
Age Dependency Young	0.01
	(0.01)
Budget Balance/GDP	-0.006
	(0.01)
Real Credit YoY	0.004**
	(0.002)
Death Rate	-0.07 ***
	(0.03)
Government Expenditure/GDP	0.02
	(0.02)
Immigration	0.01**
	(0.006)
Fixed Investment/GDP	-0.003
	(0.003)
Real M2 YoY	0.001
	(0.002)
NEER	0.0001*
	(0.00009)
Policy Rate	0.02***
	(0.004)
Self Employment	-0.005
	(0.005)
Service/GDP	0.01
	(0.02)
Unemployment	-0.06***
	(0.009)
Urban Population YoY	-0.1***
	(0.04)
N of obs	728
N of groups	38
within R^2	0.46
Prob	0.000

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$, country, time fixed effects.

Table 2.4: Governance Pillar and Macroeconomic Variables

2.4.2 ESG Score-PCA Derived

Using PCA, I combine Environment, Social and Governance to derive the ESG Score. When the ESG Score is higher, the better it is. There is no score for the countries whose one or more pillars are missing due to missing values in indicators.

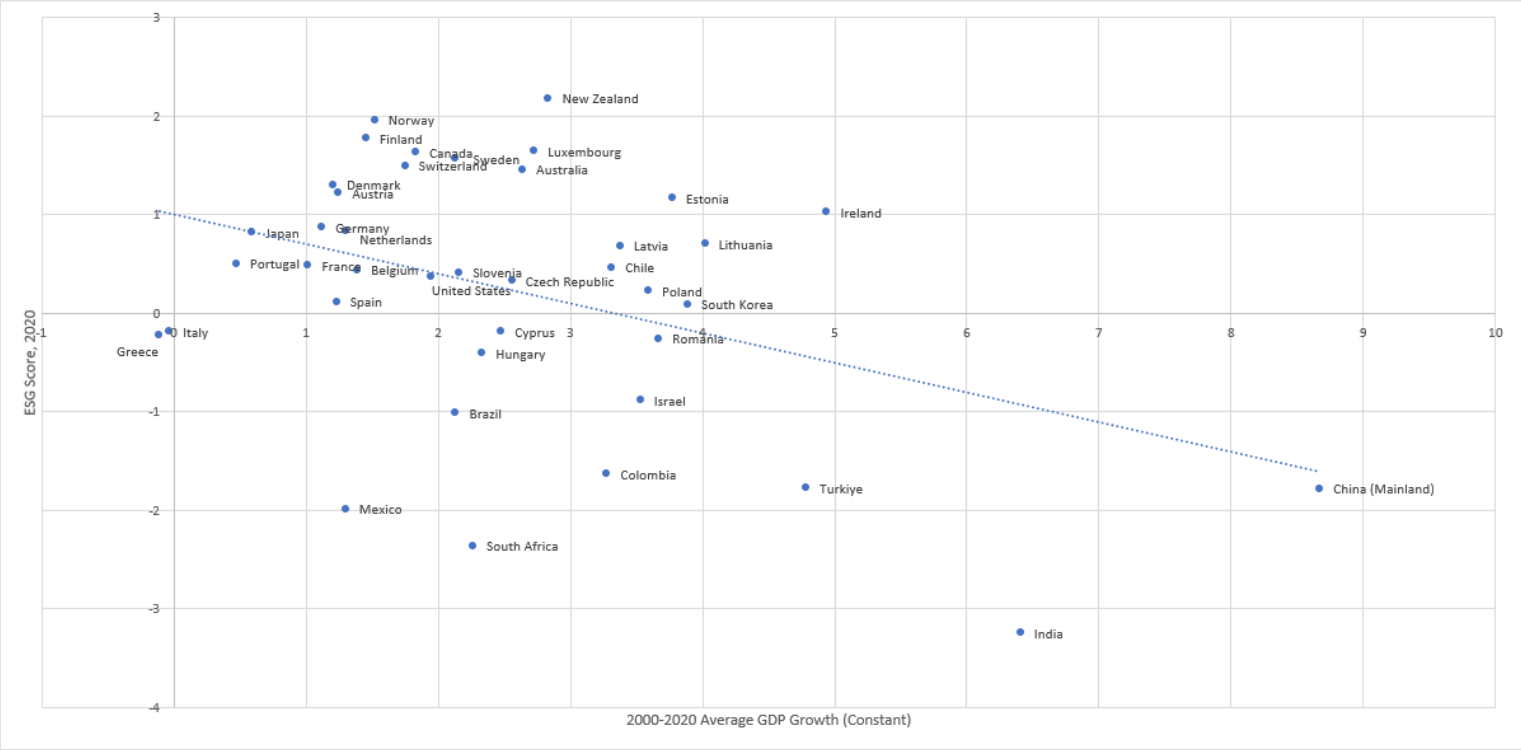

Figure 2.4: ESG Score 2020 vs. 1999-2020 Average GDP Growth

From Figure 2.4, we can see that developed countries have higher ESG scores than emerging countries, as in all pillars. Figure shows that emerging countries have higher average GDP growth but their 2020 ESG scores are lower. This implies that emerging countries are growing economically, even faster than their developed counterparts, but in terms of non-financial standards, they lack behind.

After building the ESG score, I use LASSO regression with all control variables to decide which control variables to use for panel estimation.

After LASSO regression, I run panel regression with Driscoll-Kraay standard errors with chosen control variables. Results are given in Table 2.5. According to Table 2.5, industrial production has a negative relationship with the overall ESG score, which could imply that industrial production harms nature and social standards. Increase in dependency of the people over age 64 to the working population has a negative relationship with ESG Score. Both government spending and investment (not significant) have a negative relationship with the ESG Score, implying that increase in GDP is not beneficial for non-financial aspects of development. Birth rate also has a negative relationship with ESG Score, implying decrease in resources for everyone's share, unmet contraception needs, decrease in agricultural and forest lands, increase in water stress. Self-employment and increase in employment in the services sector positively related to the ESG Score, implying better working conditions might benefit the ESG Scores. An increase in stock exchange and total reserves, which might have a positive effect on GDP, negatively related to the ESG Score. Vulnerable employment has a negative relationship with the ESG Score, which is in line with expectations.

Control Variable	**ESG Score**
Industrial Production YoY	-0.006*** (0.002)
Age Dependency Old	-0.01*** (0.005)
Budget Balance/GDP	0.008*** (0.003)
Birth Rate	-0.06*** (0.01)
Government Debt/GDP	-0.002*** (0.0005)
Government Expenditure/GDP	-0.05*** (0.007)
Immigration	0.004 (0.002)
Fixed Investment/GDP	-0.001 (0.002)
Real M2 YoY	0.001 (0.001)
Self Employment	0.04** (0.02)
Service/GDP	0.02** (0.007)
Real Stock Market Index YoY	-0.001 *** (0.0004)
Total Reserves/GDP	-0.001* (0.0004)
Urban Population YoY	-0.02 (0.03)
Vulnerable Employment	- 0.06** (0.02)
N of obs	734
N of groups	45
within R^2	0.68
Prob	0.000

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$, country, time fixed effects.

Table 2.5: ESG Scores and Macroeconomic Variables

Yearly score development for all 49 countries are given in Figure 2.5. Some countries sometimes have separate Environment, Social or Governance scores but not enough data for ESG Score. This includes developed countries like Iceland and upper middle income countries like Brazil.

Figure 2.5: ESG Scores: 1999-2020

From Figure 2.5, we could see that advanced countries already have high ESG scores and have some have rather stable scores. Since 2020 was year of global pandemic, we could see some decreases in ESG scores in most of the countries but looking at 2020 ESG scores are better to see how a sovereign handles a big crisis and how strong is their fundamental structure, because crisis like COVID19 actually shows the strength and agility of countries.

Latvia, Lithuania, Poland, Portugal, Slovakia and Slovenia are increasing their ESG scores closer to their European counterparts. Emerging countries like China, India, South Africa and Colombia also show an increasing trend.

2.4.3 ESG Score-Derived from The World Bank ESG Builder Tool

As mentioned above, The World Bank Sovereign ESG Data Portal also has an ESG Builder Tool which allows for choosing countries, indicators, time and aggregation methods. I choose same countries, same indicators I use for PCA score building and same sample period. I choose income adjustment according to countries' pairs to reduce income bias and average for indicator aggregation method. That is why, I do not expect two ESG scores to be same. Figure 2.6 shows the ESG scores of 2020 built with the tool (WB_ESG from now on) and average GDP growth at the time period.

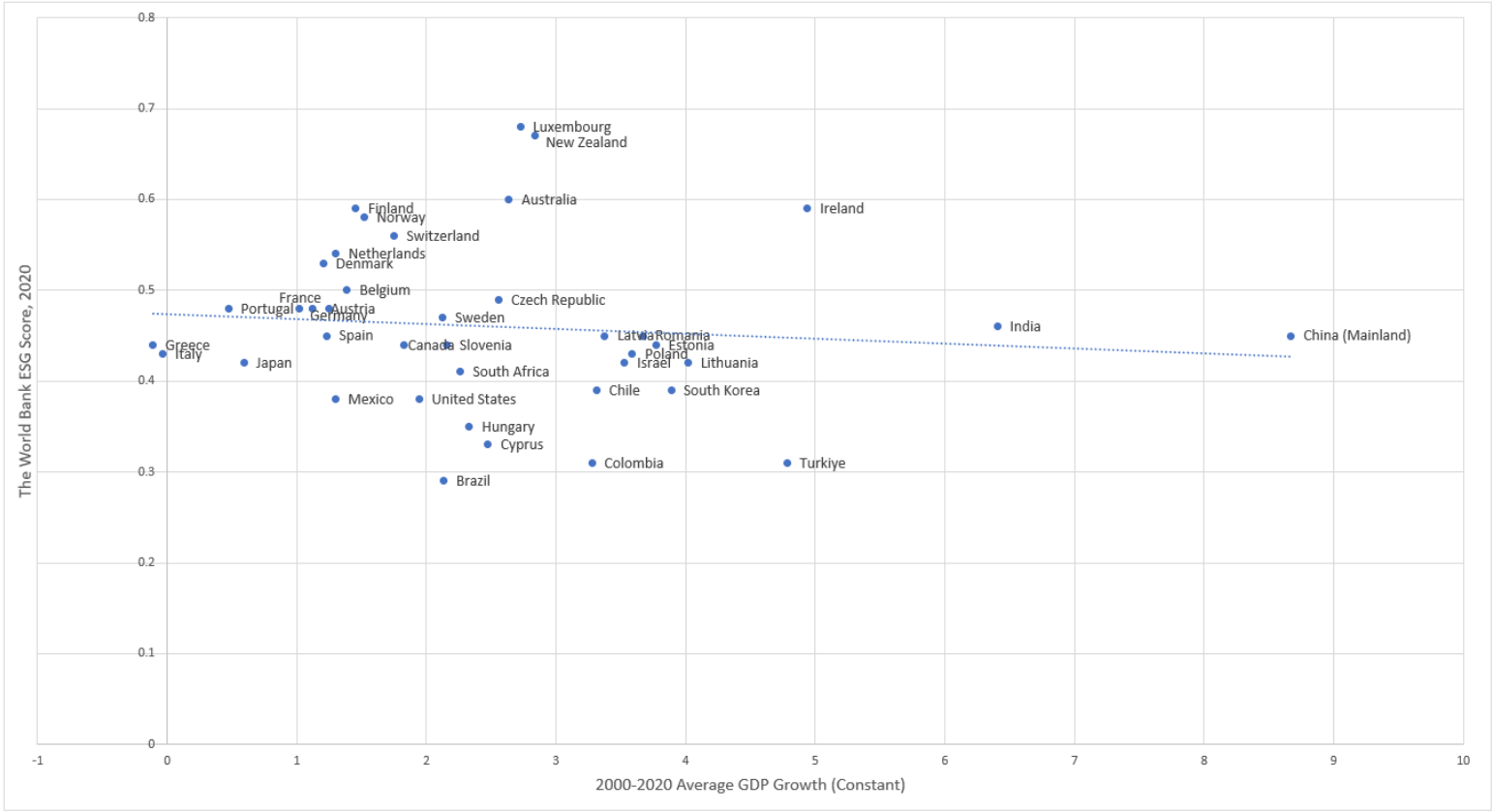

Figure 2.6: WB_ESG Score 2020 vs 1999-2020 Average GDP Growth

From Figure 2.6, we could see that there is again a negative relationship between GDP growth and ESG score even with income adjustment. Biggest difference is seen in India. The ESG Score I build for India shows it is one of the lowest scores but ESG Builder Tool gives India significantly a higher score.

I run panel regression with Driscoll-Kraay standard errors with same control variables chosen for PCA built ESG. Results are given in Table 2.6. According to Table 2.6,industrial production and vulnerable employment decrease the WB_ESG score while self employment, urban population, government spending and total reserves increase the WB_ESG score. The biggest difference is the government spending and total reserves. These indicators had negative effect on ESG score I build with PCA and reasoning was quite simple, these variables have positive effect on production, which does not help ESG score. This time, these indicators have positive effect on the score. The other variables do not have a significant effect on the score, which shows that without a unique method to ESG score calculation, every score produced by different institutions could lead to different results.

Yearly score development for all 49 countries are given in Figure 2.7. The ESG Builder Tool allows for selecting the years and countries even if there is no data, so this figure shows all the countries. The scores are not as smooth as PCA, but general development is similar:

Control Variable	**WB_ESG Score**
Industrial Production YoY	-0.001***
	(0.0004)
Age Dependency Old	0.004***
	(0.001)
Budget Balance/GDP	-0.0007
	(0.0008)
Birth Rate	-0.002
	(0.002)
Government Debt/GDP	-0.0001
	(0.0001)
Government Expenditure/GDP	0.003**
	(0.001)
Immigration	0.001
	(0.001)
Fixed Investment/GDP	0.001
	(0.0004)
Real M2 YoY	0.0001
	(0.0002)
Self Employment	0.02 ***
	(0.01)
Service/GDP	-0.0003
	(0.001)
Real Stock Market Index YoY	-0.0001
	(0.0001)
Total Reserves/GDP	0.0003**
	(0.0001)
Urban Population YoY	0.02**
	(0.007)
Vulnerable Employment	- 0.02***
	(0.005)
N of obs	1054
N of groups	49
within R^2	0.22
Prob	0.000

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$, country, time fixed effects.

Table 2.6: WB_ESG Scores and Macroeconomic Variables

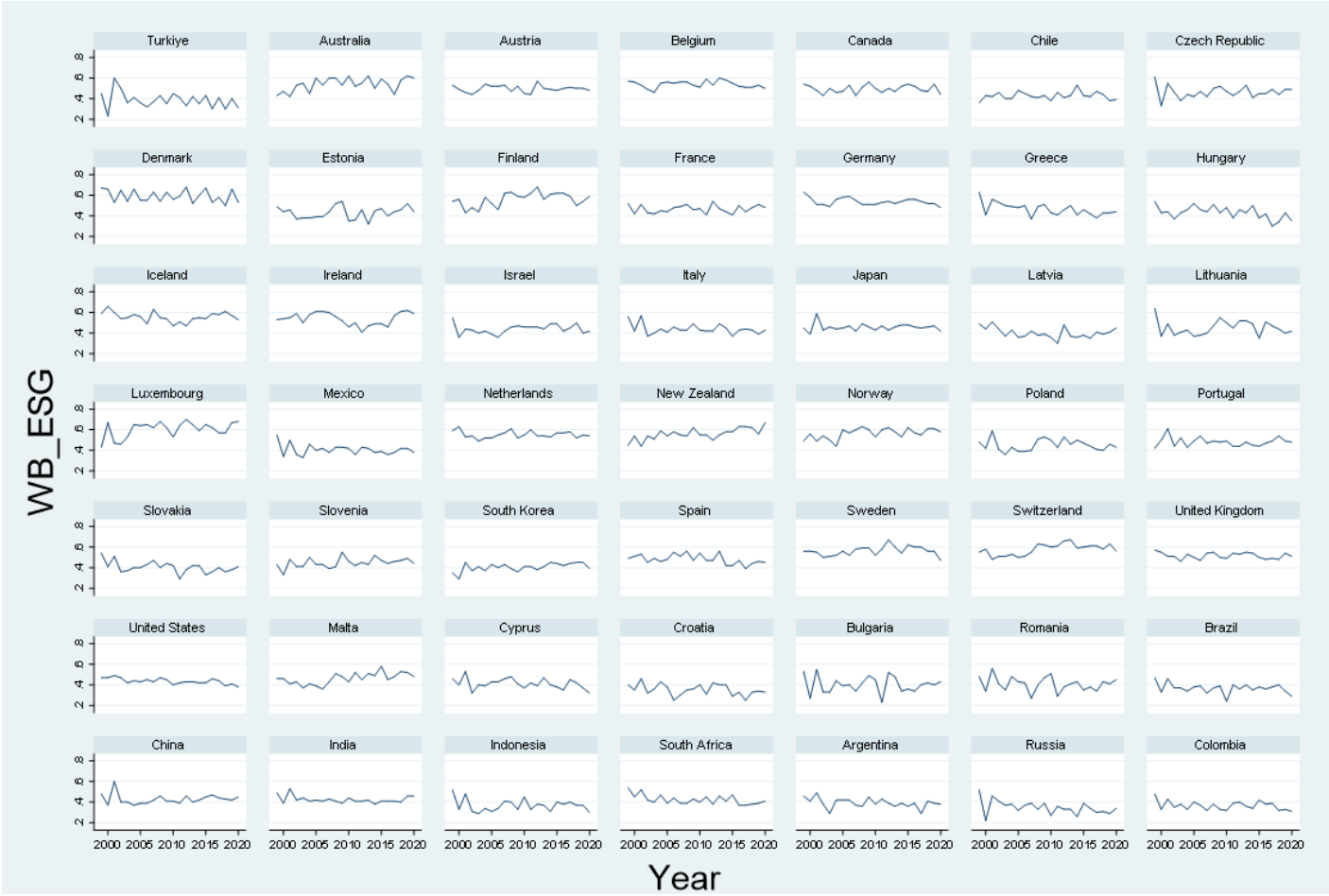

Figure 2.7: WB_ESG Scores: 1999-2020

2.5 Conclusion

This study aims to build an ESG score using publicly available tools and simple methods. It also gives information about a free database and a free tool to build ESG score. The findings show that industrial production has a negative relationship with overall ESG score, Environment and Social pillar but has a positive relationship with Governance pillar. Emerging markets seem to lag behind developed countries . To close the gap, emerging economies could make use of policies regarding environmental harm avoidance during production processes, better mechanisms to allow resources allocate efficiently and adequately among all population and sound regulatory frameworks with emphasis on human rights. Economic growth with a humane and environmental friendly process could be possible with new developments in technology and solid rules with solid management.

Population growth is another aspect that countries should be working on. Advanced countries have lower rates of birth while emerging markets have higher rates. Population is increasing more rapidly than resources which can be a bigger problem in coming years. Unmet contraception needs and anti-abortion laws passing throughout the world can lead to unintended problems in the future.

Better working conditions have a positive relationship with ESG scores. Services sector has better working conditions than other sectors and rise of employment in this sector positively relates to the ESG scores. The conditions in other sectors could be improved where possible so everyone could enjoy humane environment at work.

Without unique or similar calculation methods, it is difficult to construct comparable ESG scores across countries. International entities such as EU are working on getting transparency on scores, data and methodology. This could lead to better estimations and better information sharing. Another problem is data gaps. Even for advanced economies there are serious gaps in the data that is available for free. This study might be considered as a as a stepping stone for further research. If the literature reaches a globally accepted consensus in calculating ESG scores, further research might be conducted on how countries might improve through public policies and how significant are the effects of these policies on these scores.

2.6 Appendix

Country	Climate Profile	Income Classification
Argentina	Arid	Upper Middle Income
Australia	Arid	High Income
Austria	Cold	High Income
Belgium	Temperate	High Income
Brazil	Tropical	Upper Middle Income
Bulgaria	Cold	Upper Middle Income
Canada	Cold	High Income
Chile	Mixed	High Income
China (Mainland)	Mixed	Upper Middle Income
Colombia	Tropical	Upper Middle Income
Croatia	Cold	High Income
Cyprus	Temperate	High Income
Czech Republic	Cold	High Income
Denmark	Cold	High Income
Estonia	Cold	High Income
Finland	Cold	High Income
France	Temperate	High Income
Germany	Cold	High Income
Greece	Temperate	High Income
Hungary	Cold	High Income
Iceland	Polar	High Income
India	Mixed	Lower Middle Income
Indonesia	Tropical	Upper Middle Income
Ireland	Temperate	High Income
Israel	Arid	High Income
Italy	Temperate	High Income
Japan	Cold	High Income
Latvia	Cold	High Income
Lithuania	Cold	High Income
Luxembourg	Temperate	High Income
Malta	Temperate	High Income
Mexico	Arid	Upper Middle Income
Netherlands	Temperate	High Income
New Zealand	Temperate	High Income
Norway	Cold	High Income
Poland	Cold	High Income
Portugal	Temperate	High Income
Romania	Cold	High Income
Russia	Cold	Upper Middle Income
Slovakia	Cold	High Income
Slovenia	Cold	High Income
South Africa	Arid	Upper Middle Income
South Korea	Cold	High Income
Spain	Temperate	High Income
Sweden	Cold	High Income
Switzerland	Cold	High Income
Türkiye	Mixed	Upper Middle Income
United Kingdom	Temperate	High Income
United States	Mixed	High Income

|Source: The World Bank|

Table 2.7: Country List

Table 2.8: Control Variables for ESG Score Determinants

Variable	Explanation
Policy Rate	Central bank policy rate, average of period (%)
CPI	Consumer price index
CB Asset/GDPs	Ratio of central bank assets to GDP
Inflation	Inflation, average of period (%)
GDP YoY	Annual % change in GDP (constant prices)
Unemployment	Unemployment rate (% of total labor force)
Industrial Production	Yearly change on CPI (%)
Industrial Production YoY	Annual % change in industrial production index
Government Debt/GDP	Government debt as of GDP (%)
Budget Balance/GDP	Government budget balance as of GDP (%)
REER	Real effective exchange rate, cpi-based
NEER	Nominal effective exchange rate, cpi-based
Current GDP	GDP at current prices (in billions LC)
Current GDP Per Capita	GDP/Population (in thousands US $), current prices
Real GDP	GDP at constant 2015 prices (in billions US$)
Government Expenditure	Government consumption in GDP at constant 2015 prices (in billions US $)
Private Consumption	Private consumption in GDP at constant 2015 prices (in billions US $)
Fixed Investment	Fixed investment in GDP at constant 2015 prices (in billions US $)
Exports	Exports (goods & services) in GDP at constant 2015 prices (in billions US $)
Imports	Imports (goods & services) in GDP at constant 2015 prices (in billions US $)
Real GDP Per Capita	GDP/Population (in thousands US $), constant 2015 prices
Government Expenditure/GDP	Government consumption as of real GDP (%)
Private Consumption/GDP	Private consumption as of real GDP (%)
Fixed Investment/GDP	Fixed investment as of real GDP (%)
Exports/GDP	Exports (goods & services) as of real GDP (%)
Imports/GDP	Imports (goods & services) as of real GDP (%)
Trade Openness/GDP	Exports plus imports (goods & services) as of real GDP (%)
Trade Balance/GDP	Exports minus imports (goods & services) as of real GDP (%)
Population	Number of people in a country (in millions)
Population YoY	Annual change in population (%)
Working Population	Number of people in a country between ages 15-64 (in millions)
Employment	Total employment (in Millions)
Labor Force Participation	Total employment as a share of the working age population (%)

Continued on next page

Table 2.8 – continued from previous page

Variable	Explanation
Labor Production	Real GDP divided by total employment
Labor Production Growth	Log difference between GDP and employment
M2	M2 money supply (in billions LC)
Real M2	M2 money supply (in billions LC) divided by cpi (normalized to 100 at 1999)
M2 YoY	Annual change in M2 money supply (%)
Real M2 YoY	Annual change in real M2 money supply (%)
M2/GDP	M2 money supply as of GDP (%)
Stock Market Index	Main stock market index
Real Stock Market Index	Main stock market index divided by cpi (normalized to 100 at 2005)
Stock Market Index YoY	Annual change in stock market index (%)
Real Stock Market Index YoY	Annual change in real stock market index (%)
Credit/GDP	Credit to private sector in GDP (%)
Credit/YoY	Annual change in credit to private sector (%)
Real Credit/YoY	Annual change in credit to private sector divided by cpi (%)
FDI Inflows/GDP	FDI inflows/GDP
FDI outflows/GDP	FDI outflows/GDP
Net FDI/GDP	Net FDI/GDP
Net Portfolio/GDP	Portfolio Investment, net (BoP, current US$) divided by current GDP
Equity/GDP	Portfolio Investment, equity (BoP, current US$) divided by current GDP
Bonds/GDP	Portfolio Investment, bonds (BoP, current US$) divided by current GDP
VIX	Volatility Index, average of period
Brent Oil	Brent oil prices, average of period (in US $)
WTI Index	WTI oil prices, average of period (in US $)
Service Sector Value Added	Share of service sector value added in GVA (%)
Industry Sector Value Added	Share of industry sector value added in GVA (%)
Current Account Balance /GDP	Current account balance as of GDP (%)
Service/GDP	Share of service sector in GDP (%)
Industry/GDP	Share of industry sector in GDP (%)
Total Reserves	Total reserves (includes gold, current billions US$)
Total Reserves/GDP	Total reserves divided by GDP (%)
Urban Population	Share of people who live in urban areas (%)
Urban Population YoY	Annual change in urban population (%)
Birth Rate	Birth rate, crude (per 1,000 people)
Death Rate	Death rate, crude (per 1,000 people)
Immigration	The change in population plus deaths minus births (per 1,000 people)

Continued on next page

Table 2.8 – continued from previous page

Variable	Explanation
Net migration	Net migration (thousands of people)
Net migration/Population	Net migration divided by population (per 1,000 people)
Dependents	Dependents younger than 15 (young) or older than 64 (old)
Age dependency	Ratio of dependents to the working-age population
Age dependency Old	Ratio of old dependents to the working-age population
Age Dependency Young	Ratio of young dependents to the working-age population
Self Employment	Self-employed (% of total employment)
Vulnerable employment	Vulnerable employment (% of total employment)
TFP	TFP at constant national prices (2017=1)
Welfare-relevant TFP	Welfare-relevant TFP at constant national prices (2017=1)
Human Capital Index	Human capital index, based on years of schooling and returns to education
Corruption Control	Corruption control index, percentile rank

Table 2.8 Control Variables for ESG Score Determinants

Chapter 3

Effects of Kahramanmaras Earthquakes on Turkish Economy, A Synthetic Control Approach

3.1 Introduction

On February 6th, 2023, two enormous earthquakes hit Türkiye with Mw 7.7 and 7.6, affecting 11 provinces. The provinces account for 9.8 percent of the GDP and 13.3 percent of employment, according to 2021 data. According to the World Bank (2023), earthquakes caused Türkiye 34.2 billion USD in direct physical damages. The total burden of the earthquake is estimated at around 103.6 billion USD (SBB,2023).

This paper aims to look at the effects of these earthquakes on the Turkish economy using the synthetic control method, which is used to evaluate the effect of a treatment or intervention to compare untreated units with treated units. A synthetic

version of the treated unit is formed by taking untreated units similar to the treated unit before the treatment. After the synthetic variable is formed, the treated and untreated unit is compared to see whether the treatment significantly affects the variable.

I take a set of advanced and emerging countries that did not have a significant earthquake (in terms of deaths and cost) to form a synthetic Türkiye and compare these on the date of the earthquake. I use both quarterly and yearly date to form synthetic Türkiye. After calculating the treatment effects based on real and synthetic Türkiye, I have also run root mean square error and placebo tests for robustness purposes.

My studies have led to one result: the earthquakes do not have a significant effect on Turkish GDP. Given the magnitude of the earthquakes, this result is not expected, but there can be several reasons for this. The central bank's policies have been loose for almost five years at the time of the earthquake. Before the earthquake, fiscal policies were already loose to reduce the effects of the pandemic. The real GDP and inflation were already high when the earthquake happened. This environment continued after the earthquake. This could be why the earthquakes have no visible effect on GDP. Moreover, there has not not been enough time after the earthquake to better assess the output related effects of the disaster.

This paper contributes to the literature on several fronts. First, there is a growing literature on synthetic control methods, and my paper contributes to this literature by using SCM to identify effects of a treatment. Moreover, there is no paper on Turkish earthquakes with quarterly data and this extended dataset to my knowledge. Secondly, most disaster papers only look at the total cost of the disasters at time zero

and do not evaluate how they affect the economy. My paper contributes to the disaster literature by looking at disasters' effects on GDP. In addition, this paper not only shows that the earthquakes in Kahramanmaraş are not effective treatments for GDP but also shows there could be other treatments for GDP through the time of study and opens room for new studies.

3.2 Literature Review

This paper makes use of SCM to evaluate the effects of a disaster. The first strand of literature uses SCM to identify whether an event has a treatment effect on an outcome. This strand of literature starts with Abadie and Gardeazabal (2003). In this part of the literature, papers study one region or country with a possible treatment effect. They take similar countries to the country with the treatment effect in terms of social and economic indicators and create a donor pool. The critical point is that they only choose donors who do not have the same treatment in the sample period. After the selection of the donor pool, using SCM, they give weights to donors and variables with the aim of minimizing the error and creating a pre-treatment duplicate of the treated unit (Abadie & Gardeazabal, (2003); Abadie et al., (2010); Abadie et al. (2015)). I use the SCM methodology outlined in these papers.

The other strand of the literature uses the SCM methodology provided by Abadie et al. (2003,2015) and evaluate the effects of disasters. Coffman and Noy (2011), Noy et al. (2015), and Farzanegan and Fischer (2023) study the impacts of

hurricanes and earthquakes on affected countries/islands. This paper becomes part of this literature with my evaluation of the effects of the Kahramanmaraş earthquakes on Turkish GDP. In this part of the literature, there is no study, to my knowledge, that looks at the impact of these earthquakes with quarterly and yearly data with this long sample period. This paper contributes to disaster studies that use SCM.

The third strand of the literature uses the SCM methodology, but this time to evaluate one-time political or discovery shocks. Müller et al. (2019), Suwanprasert (2023), and Gilchrist et al. (2023) study events such as Brexit, military coups, or oil discovery to evaluate how these one-time events affect the economy. My paper's results also contribute to this strand of the literature since even though the earthquakes are insignificant, the extraordinary expansionary monetary policy of 2020 and political tension that led to currency volatility in 2018 are effective treatments that set Türkiye apart from other countries in terms of GDP.

Next section gives brief summaries of the aforementioned papers.

3.2.1 Brief Summary of SCM Literature

Synthetic Control Method was first used by Abadie and Gardeazabal (2003), where they checked for the effect of conflicts happening in Basque and their effects on the Basque economy by taking other cities in Spain as a synthetic variable. They find that the Basque region's per capita GDP declined 10 percent compared to the synthetic region. They used a weighted combination of other Spanish regions to find a synthetic region similar to Basque before the conflicts to calculate how the GDP per capita would

move if there were no conflicts. The gap between the synthetic region's GDP growth and the Basque region's growth shows the effect of conflicts on GDP per capita.

Another paper using the synthetic control method is Abadie et al. (2010); the authors compare the effects of a tobacco control program named Proposition 99 in California with states that do not have this control. In order to form the synthetic California, authors constructed the donor pool. Since Massachusetts, Arizona, Oregon, and Florida introduced tobacco control during the examined period, they were excluded from the donor pool. Also, the state raising cigarette taxes was excluded from the donor pool. If these states were not excluded from the donor pool, then the effect of the tobacco control could not be evaluated since these states also have similar controls. As a result, 38 states were used to form synthetic California. When the per capita cigarette sales trend is compared between California and synthetic California, California decreases sales after the proposition. However, before the proposition, synthetic California and California have similar consumption. This concludes that Proposition 99 effectively controlled the decrease in per capita cigarette consumption.

Abadie et al. (2015) estimate the effects of German reunification by constructing a synthetic control for West Germany. The authors use data from developed economies from 1960-2003. Using yearly data, they construct synthetic West Germany and find that, on average, per capita GDP was reduced by about 1600 USD per year during 1990-2003.

Coffman and Noy (2011) estimate the effects of Hurricane Iniki on the Hawaiian island Kauai economy using the synthetic control method. Given that the other

Hawaiian islands are unaffected by the hurricane, the authors use other counties as a control group. After the comparison, the authors conclude that Hurricane Iniki affected Kauai Island's economy, and even with transfers to the county, personal income and private sector jobs are comparably lower.

Noy et al. (2015) estimate the effects of the Kobe earthquake in 1995 with a synthetic control method. The authors used all Japanese cities not directly or indirectly affected by the earthquake. After comparison, the authors conclude that the population and average income level in Kobe decreased after the earthquake.

Müller et al. (2019) study Brexit by synthetic control using ratios of consumption, investment, exports, imports to GDP, labor productivity growth, and employment share using developed countries and some emerging European countries. Comparing deviations from output, authors conclude that the cumulative loss of Brexit is 55 billion pounds.

Gilchrist et al. (2023) provide a good summary of the literature review and examine the effects of oil discovery in the 1920s in Venezuela. Using data from 1870 to 2016 to construct synthetic control for Venezuela, the authors conclude that the discovery of oil resulted in a significant but temporary deviation of growth in Venezuela from the 1920s to 1970.

Farzanegan and Fischer (2023) estimate the effects of the 2003 Bam Earthquake in Iran using nighttime light data to proxy economic activity and synthetic control methods. They estimate that economic activity in all countries significantly increased due to the government contribution.

In their paper, Lucke and Rehfeldt (2023) use expropriations of foreign oil and gas industries in South America as a treatment to analyze their effects on FDI using SCM. The results were inconclusive, but strong adverse effects were found in some countries.

Suwanprasert (2023) concludes that the Thailand coup did not have significant economic effects by using SCM.

My paper is relevant to the SCM strand of the literature since I use the same methodology for Synthetic Control Method with these papers. This study contributes to literature where disasters or one time big events are analyzed with SCM. For Kahramanmaraş earthquakes, to my knowledge, there is no study with quarterly data yet. I contribute to literature with a quarterly long time series analysis. After evaluating effects of earthquakes, I conclude that there is no visible effect from the disaster at this point of time. This result could be due to reconstruction of capital and increase in both government spending and investments after the earthquake.

3.3 Data and Methodology

3.3.1 Data

For this study, I use real GDP (normalized) as the variable of interest. I evaluate the effects of earthquake on GDP and I follow Abadie et al.(2015) and Müller et al. (2019) for the variable selection for SCM. Variables and their explanations are provided in the Appendix Table 3.5.

All economic variables data for this study is retrieved from from Reuters Eikon Datastream and Bloomberg, which use IMF, BIS, the World Bank and national central banks and statistics offices as a source.

One study obstacle is that since earthquakes happened in 2023, data after the earthquake is limited. The sample period covers 2000Q1- 2023Q4. That is why the long-term effect of earthquakes is not part of this study.

In order to omit the countries that have a big earthquake with costs similar to Türkiye earthquakes, the list of earthquakes is checked from the U.S. Geological Survey and European-Mediterranean Seismological Centre. China in 2008 (total cost was 3,22% of 2008 nominal GDP) and Japan in 2011 (total cost was 5,78% of 2011 nominal GDP had big earthquakes and were omitted from the data set.[1]

3.3.2 Methodology

To see how economic variables of Türkiye would behave if 2023 earthquakes did not happen, I use SCM. With SCM, I am able to build a synthetic version of Türkiye from the countries with similar economic behaviour, the "donor pool", but do not have the treatment, in this paper the treatment is the earthquakes. To be able to see pure effects of earthquakes, I need to choose countries that do not have significant earthquake through the observation period. Comparing Türkiye and synthetic Türkiye, I will be able to see if earthquakes have a significant effect on the Turkish economy.

Abadie (2003) first used SCM and then became a tool for comparison in social

[1]When China and Japan are included in the study, their weights are calculated as zero.

sciences. With SCM, it is possible to compare the effects of a policy on economics by using other variables that are not treated. While using SCM, I used a sample of $J+1$ units in countries where $j = 1$ is Türkiye, treated unit, and $j = 2.....J+1$ are the untreated control units. A total of 49 countries are used with the quarterly data. I try to get balanced panel data, so I set my dates as 2000Q1 to 2023Q3, T (96) time periods. Another reason for this is that Türkiye had another big earthquake in 1999 that is why I start the sample from 2000.

To form a synthetic Türkiye, I need to weigh the other countries. $W = (w_2, ..., w_j + 1)$, a $(J+1)$ vector of weights for control countries. W^* will be the optimal weight vector. The weights will add up to 1 and will be non-negative.

For Türkiye's pre-earthquake predictors, X_1, a $(kx1)$ vector, and for other countries pre-earthquake predictors, I use X_0, a (kxJ) matrix. The optimal weight vector W^* then could be defined as:

$W^* = argmin_W$ [X_1-X_0 W]'v[X_1-X_0 W] (1)

where v is the weight of predictors to minimize the above equation. Optimal $v^* = argmin_{v \in V}$ [Z_1-Z_0 $W^*(v)$]'[Z_1-Z_0 $W^*(v)$].

where Z_1 is a (T_0x1) vector of pre-earthquake economic variable for Türkiye and Z_0 is a (T_0xJ) matrix of pre-earthquake economic variable for the donor pool.

Also, I would like to mention that $v^* = 1$, and optimal weights for the synthetic control $W^* = W(v^*)$.

The outcome of interest is Y_1 a (T_1x1) vector of post-earthquake economic variables for Türkiye and Y_0 a (T_1xJ) matrix of post-earthquake economic variables for

the donor pool. The treatment effect of the earthquake Y_1-Y_1^*, where $Y_1^* = W^* Y_0$.

For SCM, literature mostly uses jointly optimization of weights of predictors and donors to minimize the pre-treatment period mean squared prediction error of the synthetic control, including this paper, but there is no formal formulation of jointly optimization of the predictor weights and the donor weights (Malo et al., p.2,2023). Kuosmanen et al. (2020) states that SCM problem is actually and NP-hard bilevel optimization problem.

3.4 Empirical Results

3.4.1 Synthetic Control for Türkiye GDP with Quarterly Data

In order to estimate the effects of the February earthquakes on the Turkish economy, the first step is to build a synthetic Türkiye, technical steps are given in the Methodology part. For 51 countries, constant GDP, private consumption, investment, government spending, exports, and imports data complied. Also, following the articles mentioned in the literature review that study Brexit and German reunification, labor productivity growth and participation were added to the data set. CPI, budget balance, current account balance to GDP ratios, sectoral shares, and policy rate with trade openness are also added to synthetic Türkiye.

A total of 51 countries were added to the study due to quarterly data limitations. Of those 51 countries, Japan and China were removed due to big earthquakes during the sample period.

The donor pool: Australia, Austria, Belgium, Brazil, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovakia, Spain, South Africa, South Korea, Sweden, Switzerland, United Kingdom, United States, Bulgaria, Argentina, Algeria, Croatia, Hong Kong, Malaysia, Philippines, Singapore, Taiwan, Thailand, Egypt, Mozambique, Nigeria, Tanzania, Tunisia.

According to the country weight tables, only a few of the countries are taken to the synthetic Türkiye. All countries with weights and country numbers are provided in the Appendix.

Country	**Weights**	**Country Number**
India	0.428	15
United States	0.257	34
Australia	0.221	2
Slovakia	0.048	27
Nigeria	0.023	47
Romania	0.010	25
Ireland	0.010	17
Tunisia	0.002	49

Table 3.1: Country Weights for Quarterly Data

Almost half of the weight is in India, which is interesting given the inflation rate of Türkiye. According to the table, India, the US, Australia, Slovakia, Nigeria, Romania, Ireland, and Tunisia are used to build synthetic Türkiye. That is why I also check the variable weights:

Most of the weight comes from GDP itself, while all variables except for inflation are used for synthetic Türkiye. While GDP and components of GDP and terms of

Variable	Weights
GDP	0.233
Private Consumption/GDP	0.056
Government Expenditure/GDP	0.083
Investment/GDP	0.049
Exports/GDP	0.071
Imports/GDP	0.074
Labor Participation	0.004
Labor Production Growth	0.062
Inflation	0
Trade Openness /GDP	0.073
Trade Balance/GDP	0.007
Industry Share	0.077
Current Account/GDP	0.051
Terms of Trade	0.16
Budget Deficit/GDP	0.001

Table 3.2: Variable Weights for Quarterly Data

trade have higher weights, budget balance, and trade balance do not have high weights in synthetic control.

When synthetic Türkiye and Türkiye compared in terms of economic variables, it is not possible to see a significant effect of earthquakes on economic variables.

When constant normalized GDP for Türkiye is compared with synthetic Türkiye, earthquakes in February 2023 have no significant effect on this variable. The Figure 3.1 shows that the 2023 earthquakes are ineffective treatments on constant normalized GDP, but we see that in 2008-2009 and 2018-2019, there are breaks from synthetic Türkiye. These dates correspond to the Global Financial Crisis and the 2018 currency crash of the Turkish Lira. According to the Figure 3.1, these events could be better treatments for Türkiye GDP. The gaps in 2008 and 2018 are negative gaps. As Figure 3.1 shows, there is a positive gap after 2020, which can be explained by the loose monetary policy

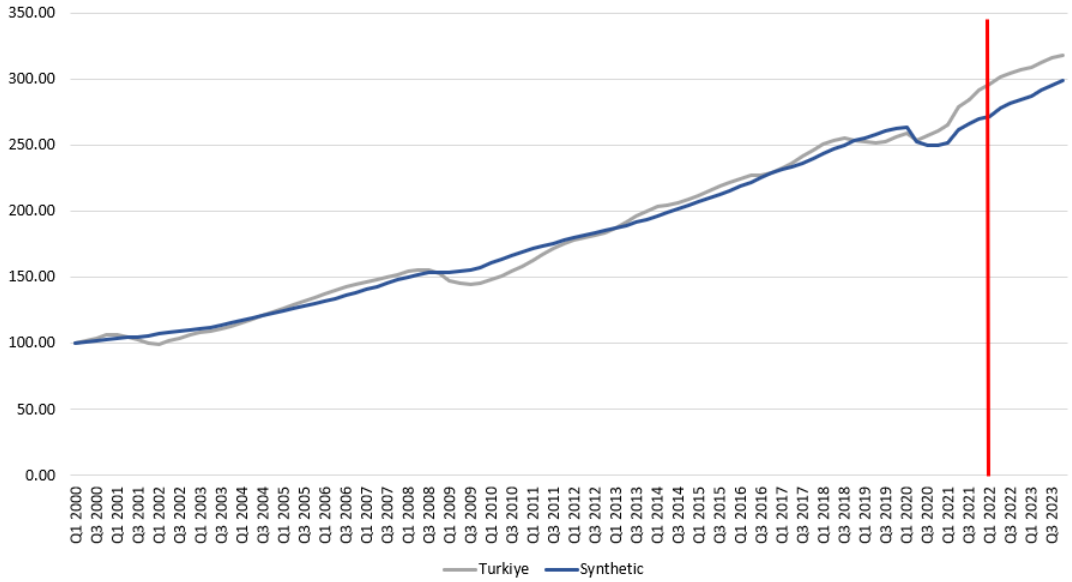

Figure 3.1: Quarterly Real GDP for Türkiye and Synthetic Türkiye

after the COVID19 pandemic.

3.4.2 Synthetic Control for Türkiye with Yearly Data

The synthetic control with quarterly data shows that there is no significant effect of earthquakes on GDP. I replicate the study with yearly data. I can increase the number of countries in the donor pool with annual data.

With annual data, the donor pool is now: Albania, Algeria, Argentina, Australia, Austria, Azerbaijan, Bangladesh, Belgium, Bolivia, Brazil, Bulgaria, Canada, Chile, Colombia, Croatia, South Cyprus, Czech Republic, Denmark, Egypt, Estonia, Ethiopia, Finland, France, Germany, Ghana, Greece, Hong Kong, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Ivory Coast / Cote d'Ivoire, Jordan, Kazakhstan, Kenya, Latvia, Libya, Lithuania, Luxembourg, Malaysia, Malta, Mexico, Morocco,

Mozambique, Namibia, Netherlands, New Zealand, Nigeria, Norway, Pakistan, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Senegal, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Vietnam. The donor pool now has 80 countries. The country numbers are given in the Appendix.

The countries taken to form synthetic control are as follows:

Country	**Weights**	**Country Number**
Argentina	0.432	4
Ethiopia	0.266	22
United States	0.198	79
Australia	0.066	5
Luxembourg	0.032	43
Mozambique	0.006	48

Table 3.3: Country Weights for Yearly Data

Different from quarterly data, now most of the weight is from Argentina, which makes more sense given the similarities between the two economies. According to quarterly and yearly data tables, Türkiye could only be replicated by considering advanced and emerging countries.

With yearly data, even though inflation is taken into synthetic control, this time, labor participation is not taken. The weights are not similar to quarterly data.

Figure 3.2 shows that the February 2023 earthquakes are ineffective on GDP. Again, the 2008 Global Financial Crisis and the 2018 currency crisis are likely treatments for the Turkish GDP rather than the earthquakes. Also, the expansionary monetary

Variable	Weights
GDP	0.078
Private Consumption/GDP	0.006
Government Expenditure/GDP	0.088
Investment/GDP	0.012
Exports/GDP	0.087
Imports/GDP	0.069
Labor Participation	0
Labor Production Growth	0.066
Inflation	0 .017
Trade Openness/GDP	0.111
Trade Balance/GDP	0.152
Industry Share	0.09
Current Account/GDP	0.071
Terms of Trade	0.079
Budget Deficit/GDP	0.073

Table 3.4: Variable Weights for Yearly Data

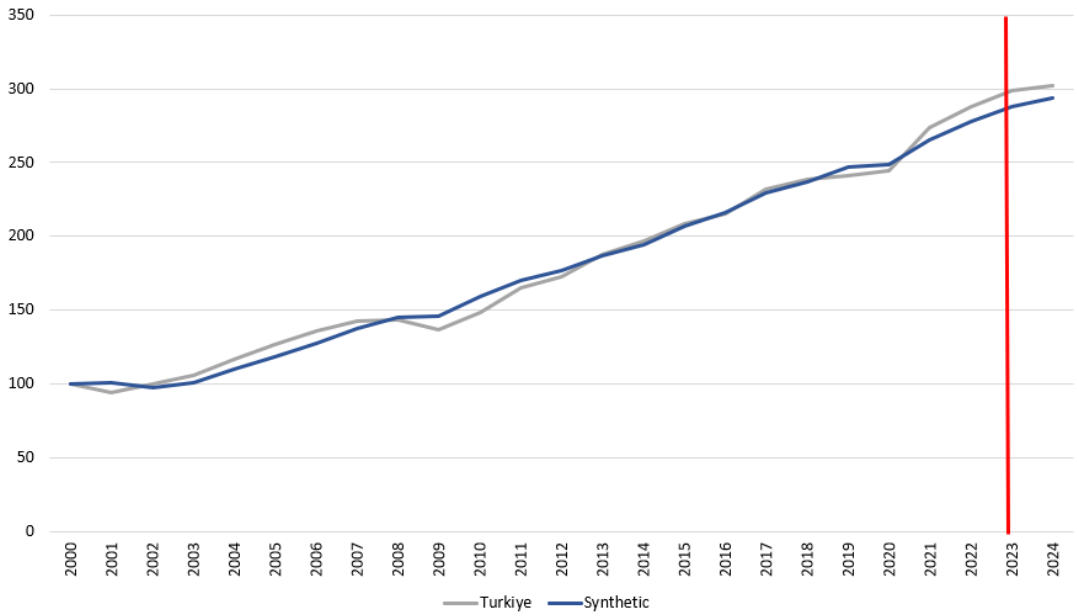

Figure 3.2: Yearly Real GDP Türkiye and Synthetic Türkiye

policy after the COVID19 can be the reason for positive gap between Türkiye and synthetic Türkiye after 2020.

3.5 Root Mean Square Error Results

I calculate the RMSE for quarterly and yearly data. The formula for RMSE is the following formula:

$$\text{RMSE} = \sqrt{\frac{\sum_{i=0}^{N-1}(y_i - \hat{y}_i)^2}{N}}$$

For quarterly data, the RMSE is 2.72 and yearly data has an RMSE of 0.506, which is very close to a range of 0.2-0.5 for an accurate model. We could, therefore, conclude that the yearly model is better than the quarterly model in explaining Türkiye's GDP and earthquakes' effects on GDP.

When I run RMSE for all countries in the sample to do the placebo test to see whether the earthquakes are significantly influential on Türkiye's GDP and has a significant treatment effect. If Türkiye has the highest RMSE after the calculations (the country number of Türkiye is 1 for the yearly and quarterly models), earthquakes are significant treatments. If not, I understand earthquakes are not a significant treatment for the Turkish GDP.

According to the RMSE of the quarterly model, Figure 3.3 shows that Türkiye's (country 1) RMSE is smaller than the RMSE for countries like Ireland (17) and Finland (10), so it is safe to conclude that earthquakes do not have a significant effect on Turkish GDP.

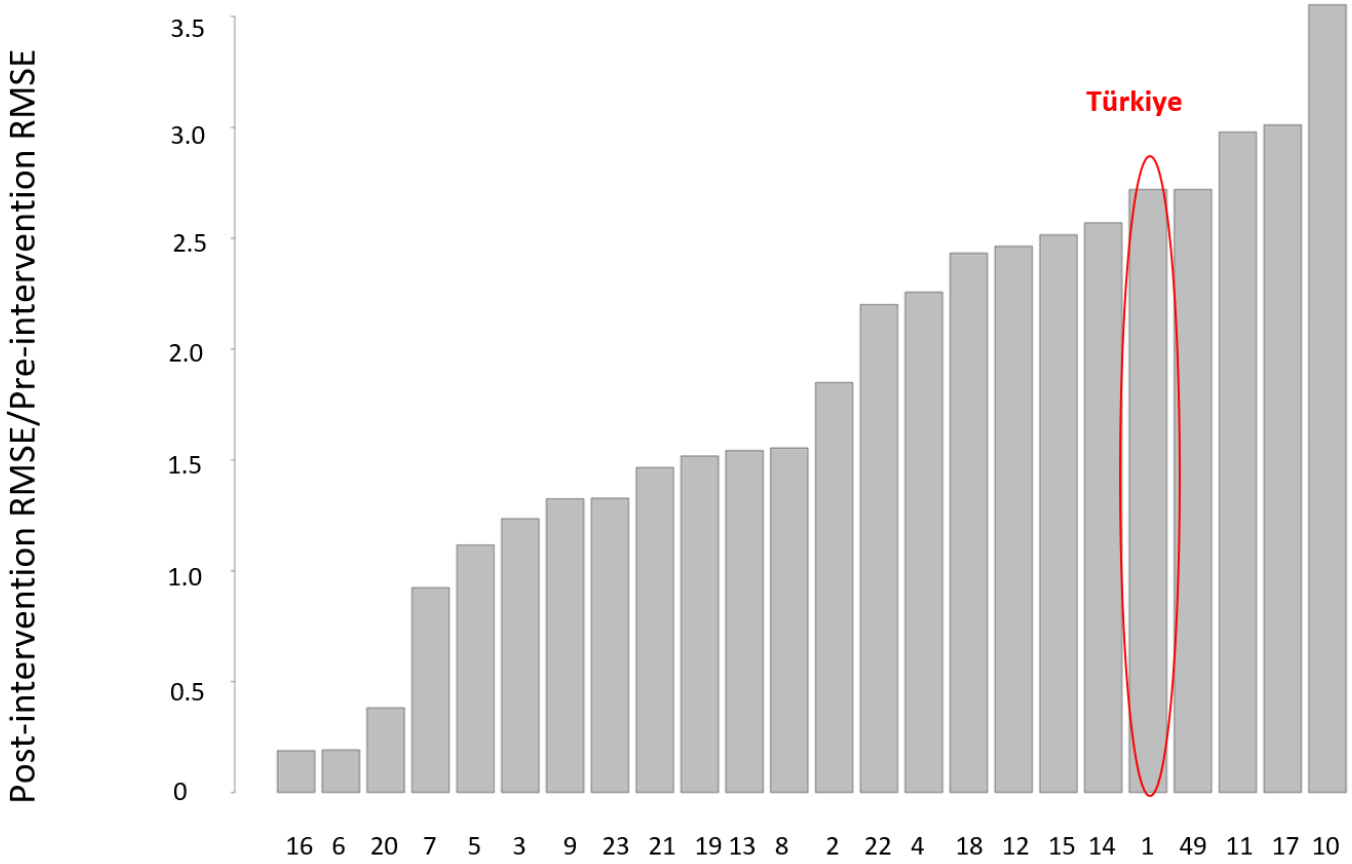

Figure 3.3: Quarterly RMSE

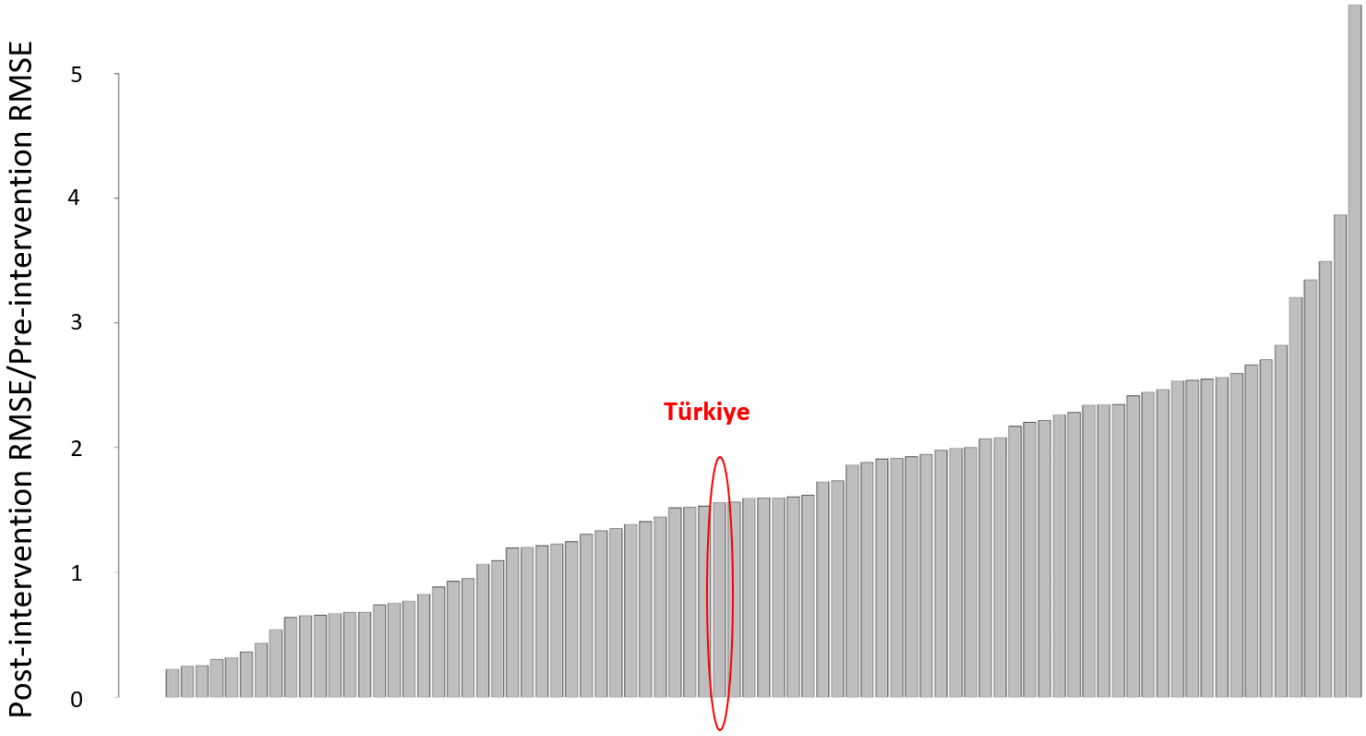

Figure 3.4: Yearly RMSE

According to the RMSE of the yearly model, Figure 3.4 shows that Türkiye's (country 1) RMSE is smaller than the RMSE for half of the countries, for example countries like Bangladesh(8) and South Africa (66), so it is safe to conclude that earthquakes do not have a significant effect on Turkish GDP, given Türkiye's RMSE is smaller than some countries.

According to several placebo tests, 2008 GFC and 2018 currency shocks are seem to better treatments for Türkiye than the earthquake, which also shows the earthquake does not have a treatment effect on Turkish GDP. Also, the expansionary monetary policy during 2020 is a better treatment effect than earthquakes.

3.6 Conclusion

In this study, I aim to understand whether the earthquakes that happened in Kahramanmaras, Türkiye, in February 2023 treated Turkish GDP. This might be due to the extremely expansionary monetary policy stance before and after the disaster. As a matter of fact, we saw the effects of this policy in inflation rather than the output. Even though the output level is not affected inflation increased to 60-70% levels after the earthquake. These earthquakes are one of the most costly disasters in history, and they are expected to affect the Turkish GDP due to the earthquake's magnitude. However, according to the synthetic control method analysis in this paper, earthquakes have no significant effect on the Turkish GDP. Still, the Global Financial Crisis of 2008 and the 2018 currency crisis could be treatments for Turkish GDP.

The RMSE tests also show that quarterly and yearly models have lower RMSE than the countries that do not have the treatment effect, the earthquake during the sample period, which means that earthquakes are not effective on Turkish GDP.

This unexpected result could have some possible explanations. First, the currency crash in 2018 led to fiscal and monetary policy changes. Also, the pandemic in 2020 led to a fiscal easing worldwide, and Türkiye is no exception. Turkish real and nominal GDP started to increase along with inflation. Also, the policy rate decreased during 2018-2022, and easy access to loans increased private consumption, asset accumulation, and inflation. Right after the earthquake, the central government, international organizations, and the public raised help, and the real GDP rates of Türkiye, even though 11 cities were affected by the earthquake, did not fall. Another reason could be that the cities affected were not a big part of GDP, which could be another reason why the synthetic control method did not affect GDP.

This paper concludes that earthquakes have no effect on Turkish GDP but points out that there could be other treatments in the study timeline. Also, the data after the earthquake is rather limited, so this study could be replicated with more data in the future to see whether any effects could be evaluated.

3.7 Appendix

Appendix provides information on the variables and countries used in SCM.

Table 3.5 lists the variables that are used to create synthetic Türkiye.

Table 3.6 lists the countries that are used to create synthetic Türkiye with quarterly data.

Table 3.7 lists the countries that are used to create synthetic Türkiye with yearly data.

Variable	Explanation
GDP	Gross Domestic Product (2015 constant prices, billions, USD, SA)
GDP, Government	Gross Domestic Product, Government consumption (2015 constant prices, billions, USD, SA)
GDP, Private	Gross Domestic Product, Private consumption (2015 constant prices, billions, USD, SA)
GDP, Investment	Gross Domestic Product, Fixed investment (2015 constant prices, billions, USD, SA)
GDP, Exports	Gross Domestic Product, Exports of goods & services (2015 constant prices, billions, SA)
GDP, Imports	Gross Domestic Product, Imports of goods & services (2015 constant prices, billions, SA)
Trade balance/GDP	Exports minus imports of GDP, goods & services (%)
Trade openness/GDP	Exports plus imports of GDP, goods & services (%)
Inflation rate	Yearly change on CPI (%)
Consumer price index (CPI)	Consumer price index
REER	Real effective exchange rate, CPI-based (index)
NEER	Nominal effective exchange rate, CPI-based (index)
Population	Population (millions of people)
Active population	Active population, 15-64 years old (millions of people)
Employment	Employed persons (millions of people)
Labor participation	Employment/Labor force (%)
GDP per capita	GDP/Population (thousands, USD)
Labor productivity	GDP/Employment
Labor productivity growth	Log difference between GDP and employment
EPU index	Economic policy uncertainty index
Policy rate	Central bank main policy rate (%)
Government debt/GDP	Public debt as of GDP (%)
Budget balance/GDP	Government budget balance as of GDP (%)
ToT	Terms of trade (as exports prices divided by import prices)
Unemployment	Unemployed persons as a percentage of the labor force (%)
Industry/GDP	Industry share as a percentage of the GDP(%)

Table 3.5: Variables for Synthetic Control Method

Country	Number	Country	Number
Türkiye	1	Australia	2
Austria	3	Belgium	4
Brazil	5	Canada	6
Chile	7	Czech Republic	8
Denmark	9	Finland	10
France	11	Germany	12
Greece	13	Hungary	14
India	15	Indonesia	16
Ireland	17	Italy	18
Mexico	19	Netherlands	20
New Zealand	21	Norway	22
Poland	23	Portugal	24
Romania	25	Russia	26
Slovakia	27	Spain	28
South Africa	29	South Korea	30
Sweden	31	Switzerland	32
United Kingdom	33	United States	34
Bulgaria	35	Argentina	36
Algeria	37	Croatia	38
Hong Kong	39	Malaysia	40
Philippines	41	Singapore	42
Taiwan	43	Thailand	44
Egypt	45	Mozambique	46
Nigeria	47	Tanzania	48
Tunisia	49		

Table 3.6: Country List for Quarterly Data

Country	Number	Country	Number
Türkiye	1	Albania	2
Algeria	3	Argentina	4
Australia	5	Austria	6
Azerbaijan	7	Bangladesh	8
Belgium	9	Bolivia	10
Brazil	11	Bulgaria	12
Canada	13	Chile	14
Colombia	15	Croatia	16
Cyprus	17	Czech Republic	18
Denmark	19	Egypt	20
Estonia	21	Ethiopia	22
Finland	23	France	24
Germany	25	Ghana	26
Greece	27	Hong Kong	28
Hungary	29	India	30
Indonesia	31	Iran	32
Ireland	33	Israel	34
Italy	35	Ivory Coast	36
Jordan	37	Kazakhstan	38
Kenya	39	Latvia	40
Libya	41	Lithuania	42
Luxembourg	43	Malaysia	44
Malta	45	Mexico	46
Morocco	47	Mozambique	48
Namibia	49	Netherlands	50
New Zealand	51	Nigeria	52
Norway	53	Pakistan	54
Peru	55	Philippines	56
Poland	57	Portugal	58
Qatar	59	Romania	60
Russia	61	Senegal	62
Singapore	63	Slovakia	64
Slovenia	65	South Africa	66
South Korea	67	Spain	68
Sweden	69	Switzerland	70
Taiwan	71	Tanzania	72
Thailand	73	Trinidad and Tobago	74
Tunisia	75	Ukraine	76
United Arab Emirates	77	United Kingdom	78
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Table 3.7: Country List for Yearly Data

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