**THREE ESSAYS IN APPLIED MACROECONOMICS:**

**A QUASI-EXPERIMENTAL APPROACH**

**Doktora Tezi**

**Aymar Berenger Ismael NANA**

**Eskişehir 2022**

# THREE ESSAYS IN APPLIED MACROECONOMICS: A QUASI-EXPERIMENTAL APPROACH

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# JÜRİ VE ENSTİTÜ ONAYI

# FINAL APPROVAL FOR THESIS

# ÖZET

# UYGULAMALI MAKROEKONOMİ ÜZERİNE MAKALELER: YARI DENEYSEL BİR YAKLAŞIM

**İktisat Anabilim Dalı**

**Anadolu Üniversitesi, Sosyal Bilimler Enstitüsü, Mart 2022**

**Danışman: Doç. Dr. İsmail Onur BAYCAN**

Bu tez, üç farklı uygulamalı makroekonomik çalışma üzerindeki araştırmaları birleştirmektedir. Hem gelişmiş hem de gelişmekte olan ekonomi grupları için Eğilim Puanı Eşleştirme (PSM) yaklaşımını kullanılmıştır. En yakın komşu eşleştirme, radyan, katmanlaştırma ve kernel eşleştirme olmak üzere dört eşleştirme yöntemlerini kullanarak Ortalama İşlem Etkisini (ATE) ve İşlenenler Üzerindeki Ortalama İşlem Etkisini (ATT) tahmin etmek için eşleştirme sonuçlarını araştırılmıştır. Sonuçlarımız belirli politika çıkarımlarını istatistiksel olarak anlamlı ve sağlam (robust) olarak ortaya koymaktadır.

İlk makale, Enflasyon Hedefleme (IT) politikasının gelişmiş ve gelişmekte olan ekonomiler için iç ve dış kamu borcu üzerindeki etkisini incelemektedir. Sonuçlar, enflasyon hedeflemesi politikasının dış kamu borcunu hem gelişmiş hem de gelişmekte olan ekonomiler için azalttığını istatistiksel olarak anlamlı ve sağlam (robust) şekilde ortaya koyar. Ayrıca enflasyon hedeflemesi uygulanmasının gelişmekte olan ekonomilerde iç kamu borcunu azalttığı istatistiksel olarak anlamlı şekilde ortaya konulur. Başka bir deyişle, yarı deneysel eğilim skoru eşleştirme analizleri yoluyla, enflasyon hedefleme rejimini benimsemeyen ülkelerin eğer enflasyon hedeflemesini benimsemiş olsalardı kamu dış borçlarının gelişmiş ve gelişmekte olan ülke gurupları için daha düşük olacağı ve bunun yanında iç kamu borcunun da gelişmekte olan ekonomiler için daha az olacağı bulgusuna istatistiksel olarak anlamlı şekilde varılır.

İkinci makale, yolsuzluğun ekonomik büyümedeki rolüne yeni bir bakış açısı sunmaktadır. Yolsuzluğun ekonomik büyüme üzerindeki etkisinin nicel tahminlerini verir. Sağlam ve istatistiksel olarak anlamlı sonuçlarımıza göre, ekonomik büyüme ve enflasyon hedeflemesi politikası, düşük yolsuzluğun olduğu ülkelerle negatif ilişkilidir. Ayrıca, düşük düzeyde yolsuzluğa sahip bir ülke olmak ekonomik büyümeyi önemli ölçüde artırırken, düşük düzeyde yolsuzluğa sahip bir ülke olmak, gelişmekte olan pazarlardan oluşan örneğimizde IT politikasını benimseme olasılığını istatistiksel olarak anlamlı şekilde önemli ölçüde artırmaktadır. Başka bir deyişle, yolsuzluğun yüksek olduğu ülkelerde yolsuzluk düzeyi düşük

olsaydı, bu ülkelerin ekonomik büyümelerinin ve IT'yi benimseme olasılıklarının istatistiksel olarak anlamlı olarak daha yüksek olacağı gösterilmiştir.

Üçüncü makalenin arkasındaki ana fikir petrol ihracatçılarının organizasyonu ile ilgilidir. OPEC+ üye ülkeleri için petrol işletmesinden elde edilen gelirler bazı üye ülkelerde makroekonomik performansı iyileştirmektedir. Sonuçlarımız OPEC+ üye ülkesi olmanın, tam örneklem ve 2008 öncesi dönem için ekonomik büyümeyi istatistiksel olarak anlamlı ve sağlam (robust) biçimde artırdığını ortaya koymaktadır. Diğer bir deyişle, OPEC+ üyesi olmayan petrol üreticisi ülkelerin eğer örgüte üye olmuş olsalardı ekonomik büyümelerinin istatistiksel olarak anlamlı biçimde daha yüksek olacağı ortaya konmuştur.

**Anahtar kelimeler:** Eğilim Skoru Eşleştirmesi, Enflasyon hedeflemesi, Ekonomik büyüme, Yolsuzluk, OPEC+, Petrol.

# ABSTRACT

# THREE ESSAYS IN APPLIED MACROECONOMICS: A QUASI-EXPERIMENTAL APPROACH

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This thesis combines research on three different applied macroeconomic essays. We use the Propensity Score Matching (PSM) approach for the advanced and developing economies groups. We investigate the matching results to estimate the Average Treatment Effect (ATE) and Average Treatment Effect on the Treated (ATT) by employing different matching methods of nearest-neighbor, radius, stratification, and kernel matching. Our results are robust and statistically significantly reveal specific policy implications.

The first study examines the impact of adopting the Inflation Targeting (IT) policy on internal and external public debt for advanced and developing economies. Our results are robust and significantly reveal that adopting the inflation targeting policy reduces external public debt both for developed and developing economies. Moreover, on average, the adoption of inflation targeting policy leads to a statistically significant reduction of internal public debt for developing economies. In other words, the quasi-experimental analysis implies that if non-inflation targeting countries had adopted the inflation targeting policy, their external debts would have been statistically significantly lower both for advanced and developing economies while their internal debts would have been statistically significantly lower for developing economies.

The second study provides a new perspective on the role of corruption in economic growth. It gives quantitative estimates of the effect of corruption on economic growth. Based on our robust and statistically significant results, economic growth and the inflation targeting policy negatively correlate with the low-corrupt countries. Moreover, being a low corrupt country significantly increases economic growth, and being a low corrupt country significantly increases the probability of adopting IT policy in our sample of emerging markets. To put it another way, we show that if high corrupt countries had a low level of corruption, their

economic growth and the probability of adopting IT would have been statistically significantly higher.

The main idea behind the third paper concerns the organization of oil exporters. Indeed, the revenues from oil exploitation for OPEC+ member countries have improved macroeconomic performance in some member countries. Our robust statistically significant results show that, on average, being an OPEC+ member increases the economic growth for the full sample and the period before 2008. In other words, we document that if non-OPEC+ oil producer countries had been the organization's members, their economic growth would have been statistically significantly higher.

**Keywords:** Propensity Score Matching, Inflation targeting, Economic growth, Corruption, OPEC+, Oil.

# ETİK İLKE VE KURALLARA UYGUNLUK BEYANNAMESİ

Bu tezin bana ait, özgün bir çalışma olduğunu; çalışmamın hazırlık, veri toplama, analiz ve bilgilerin sunumu olmak üzere tüm aşamalarında bilimsel etik ilke ve kurallara uygun davrandığımı; bu çalışma kapsamında elde edilen tüm veri ve bilgiler için kaynak gösterdiğimi ve bu kaynaklara kaynakçada yer verdiğimi; bu çalışmanın Anadolu Üniversitesi tarafından kullanılan "bilimsel intihal tespit programı"yla tarandığını ve hiçbir şekilde "intihal içermediğini" beyan ederim. Herhangi bir zamanda, çalışmamla ilgili yaptığım bu beyana aykırı bir durumun saptanması durumunda, ortaya çıkacak tüm ahlaki ve hukuki sonuçları kabul ettiğimi bildiririm.

Aymar Berenger Ismael NANA

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I hereby truthfully declare that this thesis is an original work prepared by me; that I have behaved in accordance with the scientific ethical principles and rules throughout the stages of preparation, data collection, analysis and presentation of my work; that I have cited the sources of all the data and information that could be obtained within the scope of this study, and included these sources in the references section; and that this study has been scanned for plagiarism with "scientific plagiarism detection program" used by Anadolu University, and that "it does not have any plagiarism" whatsoever. I also declare that, if a case contrary to my declaration is detected in my work at any time, I hereby express my consent to all the ethical and legal consequences that are involved.

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# ESSAY 1 THE IMPACT OF INFLATION TARGETING ON PUBLIC DEBT: AN EVIDENCE FROM PROPENSITY SCORE MATCHING APPROACH

# INTRODUCTION

The economic globalization of the countries in the world led to an increase in commercial exchanges. It also allowed countries that did not have sufficient resources to look for international loans to finance their growing needs for financing. However, this source of funding for countries is not without consequences. Several countries in debt have found it difficult to pay their due.

Developing countries, as many industrialized countries have done in the past, import capital to accelerate growth. Nowadays, debt most often takes the form of government borrowing from the public. In addition, commercial banks, international institutions (Regional Development Banks, IMF, World Bank, and institutions), or other countries can make loans.

In some countries, public debt has prioritized public budget allocations, leaving paltry resources available for development expenditure. One witnessed in the 1980s a debt crisis that emerged in Latin America, especially when, in 1982, Mexico could not pay its debt; this situation subsequently heckled the balance payment from several countries, including that of oil-importing countries. However, the mid-1990s marked a turning point in the public debt of developing countries. Whereas the external and internal public debt was equal in 1998, ten years later, the public debt towards the national agents represents almost three times the public debt due to external creditors. This dizzying progress affects all countries in the South, although this trend is less pronounced in the poorest countries of sub-Saharan Africa. More recently, the financial crisis that erupted in 2007, and the economic depression that followed, have caused a deterioration in the public finances of many countries. As a result, public debt ratios observed recently in some countries, especially those in the Euro area, have reached levels never seen before.

Developing countries are highly dependent on external funding. As debt increased at a slower pace in 2018 compared to the record year of 2017, the burden continues to grow. According to the recent data from the World Bank Group (2019), these countries' total outstanding external debt reached $ 78 trillion, up 5.3%[1]. The increase is more marked - 12% - for short-term debt, which weighs 2.2 trillion.

Based on the Institute of International Finance (IIF) report, in 2019, falling interest rates fuelled the debt of the emerging market in the first quarter. As a result, that debt reached a record amount of nearly $ 70 trillion, more than twice their gross domestic product (GDP). As

[1]International Debt Statistics 2020

a result, the public debt of non-financial companies, financial institutions, and households in all emerging countries reached 69.1 trillion dollars (61.240 billion euros) or 216% of GDP, against 68.9 trillion a year earlier. The debt ratio, which relates the stock of debt to GDP, grew fastest in Chile, South Korea, Brazil, South Africa, Pakistan, and China in the space of a year, according to IIF data. In the same period, within developed countries, the increase in indebtedness in the first quarter was mainly due to countries which increased by 1,000 billion dollars. Finland, Canada, and Japan recorded the most significant increase in their year-over-year debt ratio. At the same time, some Eurozone countries such as the Netherlands, Portugal, and Ireland continued their debt reduction efforts.

High debt can impact the effectiveness of the monetary policy regardless of the level of development in the country. When the exchange rate is under pressure, a high debt level (mainly denominated in foreign currencies) can result in delicate arbitration for the monetary authorities: to limit the depreciation of the money and exit from rising interest rates, and contain the financing costs. Central banks can indirectly influence public debt, mainly through their communication (private or public). Institutional monetary policy arrangements, such as targeting inflation with operational independence from central banks, could discipline fiscal policy, curb debt accumulation, and reduce inflationary pressures.

Initially, the inflation targeting policy was part of the monetary rules centered on the operational instrument's interest rate. Since then, the issue of inflation-production arbitrage has arisen with new approaches: the optimal smoothing of the interest rate, the nature of targeting, the time dimension of the rule, etc. On the nature of targeting, Svensson (1999) proposes price level targeting because it presents a definite advantage (free lunch) in inflation variability. Price level targeting means a policy that reacts systematically to changes in price level relative to the target path to avoid long-term price level drift. Similarly, inflation targeting is a policy that responds systematically to shifts in the inflation rate from the target rate, which implies the possibility of long-term price drift.

As we can notice, the 2020 crisis result in a sharp increase in all countries' public debt and deficit. However, public debt often exceeded 100%, sometimes 200%, of GDP in periods of war and fell significantly in post-war periods, marked by high inflation (but also strong growth in GDP volume). Based on such historical examples, this study revolves around a guiding question: *Did the countries adopting inflation targeting as monetary policy face a change in their public debt?*

The experience of some countries with inflation targeting forms the basis for this article. It proposes to provide preliminary responses to candidate countries to adopt targeting to manage their public debt better. This study shows the potential impact of adopting IT policy on the different types of public debt (internal and external) in the group of advanced economies and developing economies (emerging market + least developed countries). First, we propose an analysis based on descriptive statistics of the inflation and public debt series (internal and external). Secondly, we complete our study with a Propensity Score Matching (PSM) approach. Finally, to better define the contours of our research, we examine whether or not:

- Inflation targeting is favorable to a reduction in internal public debt in general and in the different countries (advanced and developing economies) ;
- Inflation targeting is favorable to reducing external public debt in general and in different countries (advanced and developing economies).

After presenting the objective of our study on inflation targeting and public debt, the rest of this paper is organized as follows. Section two discusses the review of existing literature. Section three provides details about the data, methodology, and empirical strategy employed to analyze the impact of IT on public debt. Section four presents the empirical results. Finally, section five concludes.

## 1.1. INFLATION TARGETING: A SOLUTION FOR MONETARY POLICY?

This part of the study will focus on the presentation of the IT policy by giving explanations and details about the policy.

### 1.1.1. Overview

Price stability is a priority for the authorities in macroeconomic management. Indeed, in the context of permanent price growth, knowing that incomes evolve only very little, an economic and social crisis is inevitable. Moreover, theoretical analyses have made it possible to identify monetary policy as an instrument to combat price developments. Therefore, the monetary policy of a country or zone should serve the outcome of that country or area.

The global economy experienced many upheavals in the 20th century. As a result, monetary policy underwent immense changes until the end of the 1990s, going from direct control of interest rates and monetary aggregates to regulating money using interest rates. This development is part of the objective of price stability assigned to monetary policy to ensure the appropriate conduct of this policy. However, according to Spiegel (2007), absolute stability,

not price stability, is ultimately the most crucial goal for attracting investors and achieving sustainable development. Thus, excessive or exclusive attention to price stability can negatively impact growth.

According to the idea of Fischer, S. (2001), exchange rate regimes fixed or pegged to other currencies have been a factor in all the major financial crises that have hit the foreign exchange markets of emerging markets in recent years like Mexico in 1994, 1997 for South Korea, Thailand, and Indonesia, Russia and Brazil in 1998, Turkey and Argentina in 2000 and again Turkey in 2001. Their experiences have made it clear that combining a free movement of capital, a fixed exchange rate, and an independent monetary policy is impossible[2]. Krüger (2004) states that fixed exchange rates pose high risks in the event of changes in the capital market. As proof, all attempts to ensure exchange rate parity on the part of the monetary authorities of Argentina and Mexico after the economic collapse and hyperinflation have failed. To remedy these other crises, two monetary policies, the principle of which is based on the nominal anchoring of intermediate variables such as the exchange rate (fixed or flexible) and monetary aggregates (M1, M2, or M3), have been adopted by many countries. These include the targeting policy for monetary aggregates and the targeting policy for the exchange rate. However, these economic policies have failed to keep inflation under control in the long term. A failure is attributed to their actions' lack of credibility and degree of discretion.

With the repeated failures of these two monetary policies, the need for a change in the implementation of monetary policy was strongly felt. As a result, many economies have adopted a new inflation-targeting policy. First, it was assumed for the first time by New Zealand in February 1990, then by many central banks such as Sweden, Canada, Chile, England, etc. (see Table 1). However, this policy has no theoretical basis. In other words, this policy started without an underlying theory.

[2]Mundell's (1962) Impossible trinity

**Table 1**: *List of countries across the world that have adopted IT irrespective of their income level*

| Country | IT adoption date | IT rate at the time of adoption | Country | IT adoption date | IT rate at the time of adoption |
|---|---|---|---|---|---|
| New Zealand | 1990 | 1 - 3 | Philippines | 2002 | 4+ / -1 |
| Canada | 1991 | 2+ / -1 | Guatemala | 2005 | 5+ / -1 |
| U.K | 1992 | 2 (point Target) | Indonesia | 2005 | 5+ / -1 |
| Australia | 1993 | 2 - 3 | Romania | 2005 | 3+ / -1 |
| Sweden | 1993 | 2 (point target) | Serbia | 2006 | 4 – 8 |
| Czech Republic | 1997 | 3+ / -1 | Turkey | 2006 | 5.5+ / -2 |
| Israel | 1997 | 2+ / -1 | Armenia | 2006 | 4.5+ / -1.5 |
| Poland | 1998 | 2.5 / -1 | Ghana | 2007 | 8.5+ / -2 |
| Brazil | 1999 | 4.5+ / -2 | Uruguay[1] | 2007 | 3 – 7 |
| Chile | 1999 | 3+ / -1 | Albania | 2009 | 3+ / -1 |
| Colombia | 1999 | 2 - 4 | Georgia | 2009 | 3 |
| South Africa | 2000 | 3 - 6 | Paraguay | 2011 | 4.5 |
| Thailand | 2000 | 0.5 - 3 | Uganda | 2011 | 5 |
| Hungary | 2001 | 3+ / -1 | Dominican Republic | 2012 | 3 – 5 |
| Mexico | 2001 | 3+ / -1 | Japan | 2013 | 2 |
| Iceland | 2001 | 2.5+ / -1.5 | Moldova | 2013 | 3.5 - 6.5 |
| Korea, Republic of | 2001 | 3+ / -1 | India | 2015 | 2 – 6 |
| Norway | 2001 | 2.5+ / -1 | Kazakhistan | 2015 | 4 |
| Peru | 2002 | 2+ / -1 | Russia | 2015 | 4 |

Sources: Roger 2010; Hammond 2011; and IMF staff calculations. Note: Countries are classified as inflation targeters based on the IMF Annual Report on Exchange Arrangement and Exchange Restrictions (AREAER) database.

### 1.1.2. Definition of inflation targeting

Economists such as Leiderman & Svensson (1995), Bernanke & Mishkin (1997), Svensson (1997, 1999, 2002), Bernanke et al. (1999), Cottarelli and Giannini (1997), Mishkin (2000), Greenspan (2001), King (2005), Angeriz and Arestis (2007) are considered to be the founders of the inflation targeting theory. There is no universal definition for this monetary regime, but several. For Bernanke and Mishkin (1997), IT policy is perceived as a new system for monetary policy analysis that consists of an official announcement of a target interval for one or more horizons.

Also, there is a multidimensional definition adopted by economists Masson, Savastano, and Sharma (1997), Eichengreen (2002), Mishkin (2000). According to this definition, the inflation target is a monetary policy approach that revolves around five (05) characteristics:

i. the public announcement of a numerical inflation target in the medium term;
ii. establishment of an institutional engagement to price stability as the main objective of monetary policy, to which the other goals are subordinate;
iii. the use of an information strategy focusing on several variables in addition to the exchange rate or monetary aggregates to decide on the instruments of monetary policy;
iv. increasing the level of transparency through communication with the public on the action plan, decisions, and objectives of the monetary authorities;
v. increasing the responsibility of the central bank to meet its inflation targets.

Among so many divergences in the reflection around this monetary policy, this last definition is the most exhaustive.

### 1.1.3. Prerequisites and implementation of inflation targeting

Like any monetary regime, the inflation targeting policy has several rules that set its objectives. First, the explicit purpose of monetary policy remains price stability. Nevertheless, the central bank's banking institution must not derogate from achieving its other goals such as economic growth, the strength of the exchange rate, or the level of employment in favor of its inflation objective. Indeed, the central bank must interact with its inflation target with its other targets while respecting several institutional and structural prerequisites.

*a)* ***Institutional prerequisites***

At the institutional level, independence, communication, and transparency are the critical factors for the success of an inflation-targeting policy (Roger and Stone, 2005).

- Indeed, the central bank must have operational independence to decide on monetary instruments, the orientation of monetary policy, administrative and financial autonomy. In other words, it must achieve its objectives without political intervention.
- Transparency, which ensures the credibility of the central bank, must regularly communicate its strategies and decisions to the public, since as emphasized by Croce & Khan (2000), "*Monetary policy is most effective when the markets understand the objectives and the link between these objectives and the measures put in place. in action*".

### *b) Structural prerequisites*

Besides the institutional prerequisites, the central bank must have a structural base developed to support independence, transparency, and communication.

- Advanced technical infrastructures: the central bank must have the means necessary to implement the decisions taken and establish more reliable forecasts;
- A stable economic structure;
- A healthy financial system.

### *c) Implementation of inflation targeting*

The main idea sought when applying inflation targeting is price stability. However, price stability can be interpreted in two ways, namely:

(i) price stability interpreted as a stationary price level with a slight variance; in this case, it is the price level targeting policy;

(ii) price stability, characterized by stable and low inflation; in this case, it is the inflation targeting policy[3].

It poses the problem of choosing the variable to target by the central bank. Studies by some economists have shown that the choice is based on arbitrage between output variability and short-term inflation. The Consumer Price Index (CPI), constructed from the average price level of goods and services consumed by households, is used as the official measure for the chosen target. This index allows greater ease of communication on the part of the central bank with the public. However, it suffers in particular from a bias in calculating the inflation index in developed and emerging economies; it does not necessarily reflect the increase in the cost of living; this is the Boskin effect[4]. Such reasons may distort the calculation of the real value of the CPI and may bias the price of goods and services.

The implementation of IT requires a detailed analysis of the model of the economy considered. It should consider several elements such as the transmission mechanisms of monetary policy, a precise definition of inflation, a clear target value or range[5]. Three forms of inflation targeting are identified by Stone (2003):

[3]Jihène Bousrih. L'adoption de la politique de ciblage de l'inflation dans les marchés émergents : apport théorique et validation empirique. Economies et finances. Université Rennes 1, 2011. Français. tel-00646573

[4]The "Boskin effect", from the name of the American commission which showed in 1996 that the price indices used to measure inflation tended to overvalue it, by underestimating the substitution towards cheaper circuits, and the product innovation.

[5]The most commonly used terminology are: a target point refers to a single quantitative number (for example: 3%), a target point with a band represents a number +/- an interval (for example: 3% +/- 1%) and finally a target band refers to an interval (for example: 3% to 4%).

- *Eclectic inflation targeting:* concerns central banks that have met with success within the framework of this strategy, but they are heterogeneous according to the nature of their monetary policy concerning the definition of price stability and the operations of monetary policy.
- *Full-fledged inflation targeting:* concerns central banks that have committed themselves to an inflation target. Emerging countries are mostly those that apply this rigorous version of inflation targeting;
- *Inflation targeting lite:* concerns central banks that announce the inflation target but, due to their low credibility, which does not make a clear and explicit commitment favoring the target.

These different forms cited above share a point which is the desire to control inflation and stabilize production in a context of pure or impure exchange rate flexibility. Thus, Freedman and Laxton (2009) stipulated that implementing IT in developing countries would involve abandoning the fixed exchange rate or respecting the maintenance of two anchor points. While for developed countries, inflation targeting remains the only mechanism available for monetary policy, especially with the loss of the exchange rate anchor (end of the Bretton Woods regime) and in circumstances where the monetary base is unstable (failure of the "k%[6]" rule).

In the next section, we will present the effects of the adoption of the inflation targeting policy on the economic performance of the countries which have chosen this policy.

## 1.2. INFLATION TARGETING POLICY AND MACROECONOMIC PERFORMANCE

Empirical studies by Bernanke et al. (1999), Neumann & Von Hagen (2002) on the effects of adopting IT agree on the positive contribution of this monetary policy in facilitating the economic situation of countries that target inflation.

However, this result is not unanimous among researchers who question Ball & Sheridan (2003). This divergence can be interpreted as IT being adopted for the duration. So, the effects of this policy could be concluded with precision. The impact of this policy on certain macroeconomic variables are highlighted as follows:

[6]Friedman proposed a fixed monetary rule, called the Friedman k-percent rule, where the money supply would be calculated by known macroeconomic and financial factors, targeting a specific level or range of inflation.

### 1.2.1. Economic growth

Figure 1 below illustrates the evolution of average economic growth[7] for the countries that have adopted the IT policy (see the list in appendix 1) for the periods before and after adoption. There is an increase in growth in the two groups of countries, namely advanced and developing economies. However, for advanced economies, economic growth evolved almost similarly between the two periods (pre and post-inflation targeting). In the other economies (developing countries and emerging markets), the improvement in growth between the pre-IT and post-IT are markedly more significant and more visible. Thus, based on these statistics, it appears that the adoption of inflation targeting is vital for economic growth, especially in other economies.

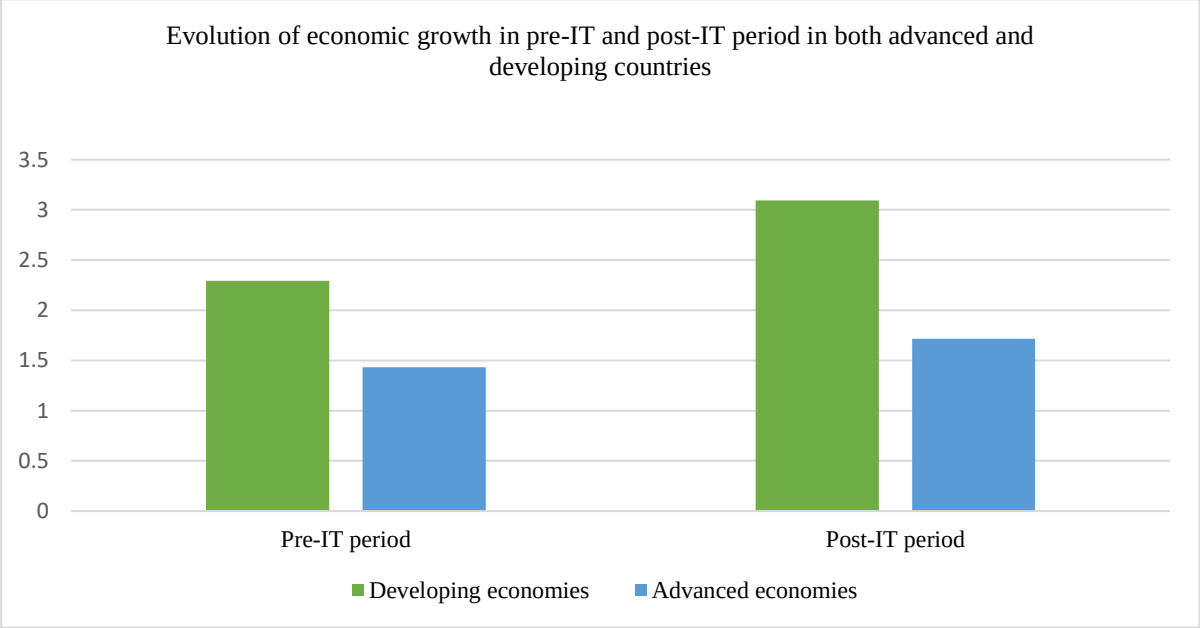


**Figure 1**: Evolution of economic growth (pre-IT and post-IT period)

### 1.2.2. Foreign Direct Investment

In Figure 2 below, which illustrates the evolution of average foreign direct investment for countries that have adopted the IT policy before and after adoption, one notes that from the pre-IT period to the post-IT period, the volume of FDI almost doubled in the two groups of countries. That makes it possible to draw a reasonably positive conclusion on the effect of adopting IT on the FDI.

[7]GDP per capita(% of annual growth) has been used as economic growth variable.

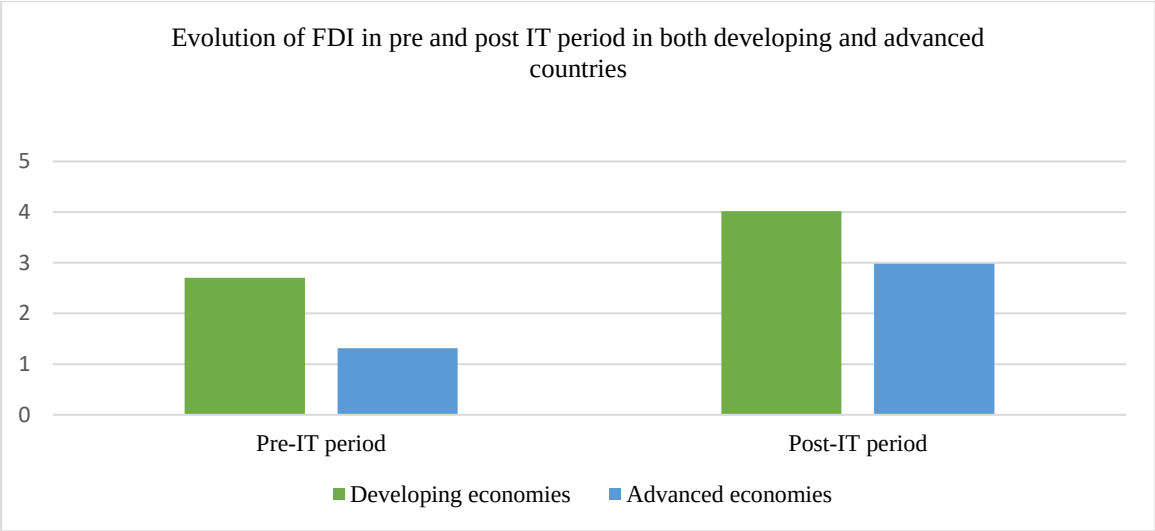


**Figure 2**: Evolution of FDI in pre and post IT period

### 1.2.3. Unemployment

Based on the results in Figure 3, we see a drop in the unemployment rate of around 1.45% on the side of developing countries from the pre-inflation targeting period to that of post-inflation targeting. However, the fall is slightly larger in advanced countries by around 2.73% going from pre-IT to post-IT. Thus, the adoption of the monetary IT policy positively affects the fight against unemployment in the two groups of countries.

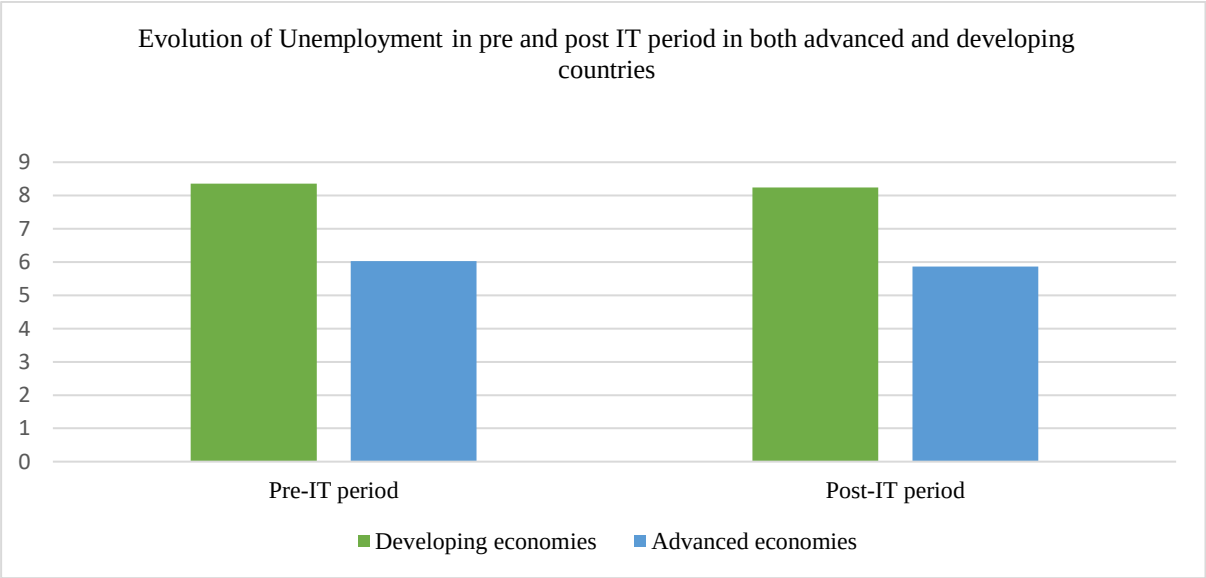


**Figure 3**: Evolution of Unemployment in pre and post IT period

From the outset, the adoption of IT monetary policy seems to positively affect the various macroeconomic variables, specifically for developing countries whose post-IT change is more extraordinary. However, such results lead us to wonder if such a monetary policy would have the exact expectations throughout the economy.

Thus, it is known that whatever the crisis (economic, health, war, etc.), it leads to a sharp increase in the public deficit and debt worldwide. Sometimes, public debt exceeds 100% and even 200% of GDP during wartime and drops significantly in post-war periods due to high inflation. Based on such examples, some economists argue that inflation may be the best solution for reducing public debt and, at the same time, avoiding fiscal consolidation policies. Thus, our study focuses on the assertion made by these economists and presents the impact of the targeting policy on public debt, whether domestic or external.

### 1.3. LITERATURE REVIEW

It is common to hear that "inflation reduces the debt." That is one of the reasons why some argue that higher inflation would have positive repercussions on the economy in the context of excessive indebtedness of the countries.

According to Akitoby et al. (2014), higher inflation is likely to decrease public debt through three channels. First, governments can capture more resources through monetary creation and seigniorage receipts. Second, inflation erodes the real value of the debt. However, the effectiveness of this channel depends on the maturity of the debt, its denomination in foreign currencies, and the reaction of interest rates to the acceleration of inflation. Indeed, the central bank is likely to raise its key rates to preserve price stability. Also, inflation has prompted private agents to demand higher interest rates on new issues of government securities. Third, inflation affects the primary balance if the tax is progressive, and the tax brackets are not indexed to inflation[8]. Finally, an acceleration of inflation would facilitate deleveraging in the public sector and private agents. That situation would accelerate the recovery of economic activity, thus increasing tax revenues. In this case, as Blanchard et al. (2010) and more recently Ball (2013) suggested, an increase in inflation targets would reduce the risk that economies would fall into a liquidity trap or, if necessary, would increase their chances of getting out. Hilscher et al. (2014) corroborate in the same direction and highlight that higher inflation leads to the higher real value of public debt stock. To do this, they employ a method focused primarily on the ex-ante perspective of the budget constraint, a set of plausible counterfactuals, and some detailed debt information. Their study shows that in the United States of America, the impacts of an increase in inflation on the budgetary burden are reasonable. Almost half of the debt could be erased in ten years by combining high inflation at a crackdown.

[8]http://www.blog-illusio.com/article-alimenter-l-inflation-pour-reduire-la-dette-publique-123903503.html

Akitoby & al. (2014) have studied the effect of inflation on the public debt to GDP ratio of G7 countries. Their simulations suggest that if inflation remained low around zero for five years, the net debt to GDP ratio would increase by an average of 5% points at the end of the period. Conversely, if inflation were to stay at 6% for five years, the net debt to GDP ratio will fall on average by 11 to 14 percent. Accelerating inflation would effectively decrease the public debt burden. It would be more effective if the central banks did not tighten monetary policy.

A low and stable price level with high growth is one of the main economic objectives of most governments in the world. Unfortunately, to promote economic growth, some countries, more specifically developing countries, often have to go into debt to finance the budget deficits. Nguyen (2015) focuses on the impacts of public debt on inflation in developing economies in Asia from 1990 to 2012. His study shows that public debt has a positive effect on inflation, which implies that in these countries, the fiscal policy with an inflated level of the public debt to finance the budget deficits is inflationary. The study of the relationship between inflation and public debt on three continents, conducted by Van Bon (2015), is accordant with the whole sample. That means that public debt has a markedly positive impact on inflation, while inflation is significant and negatively impacts public debt. This result is partly in agreement with that of Harmon (2012). The latter carried out a study on the impact of public debt on GDP growth, inflation, and the interest rate in Kenya between 1996 and 2011. After using simple linear regression models, it appears that there is a low positive relationship between public debt and inflation. In contrast, the relationship is negative for GDP growth, interest rates, and public debt. By using a VEC model estimated by the Johansen approach, Nastansky et al. (2014) showed, through his study with quarterly data for Germany for the period 1991-2010, that the level of public debt positively impacts on consumer prices index, meaning that public debt statically causes inflation and vice versa.

With empirical study, other authors, such as Taghavi (2000), examined the assumption that public debt has potentially negative effects on inflation, growth, and investment in the major European economies. After using the auto-regressing vector and hybrid co-integration models, the results suggest that debt appears to be inflationary in the long run. However, its impact on short-term inflation is unclear, while debt has a negative and significant effect on investment and ambiguous effects on growth.

For some people, the increase in public debt would lead to inflation for the highly indebted countries. Sargent and Wallace (1981) expressed this view agrees with Kwon et al. (2006). Indeed, they conducted an empirical study on the relationship between inflation and

public debt with panel data concerning 71 countries from 1963-2004 using the OLS regression estimate and the VAR model. The results show that in indebted developing countries, the relationship is strong and weak in other developing countries, but it does not exist for developed economies. However, in the case of an inflexible exchange rate regime, this relationship becomes weak.

The dynamic interaction of debt and budget deficits with economic variables such as the interest rate, inflation, output, and the trade gap has been the subject of some studies. That is the case for Kannan and Singh (2007), who applied the 2 SLS simulation technique from 1971-2006, found that debt and public budget deficits have a negative effect on all the macroeconomic variables considered in the medium and long term. The interest rate plays a capital role in public accounts and public debt. Considering it as an essential variable for analyzing the impacts of public debt and fiscal deficits on the interest rates in Nigeria, Obi & Nurudeen (2009) concluded that deficits and public debt positively impact the interest rates. However, the study on the macroeconomic impacts of the public debt in the United States carried out by Wheeler (1999) shows that public debt has a negative sign and significant effect on interest rates, the prices level, and production.

Few empirical studies provide results on the linkage between domestic debt and inflationary effects. Bildirici and Ersin (2007), in an empirical study, show that there is a weak link between internal debt and inflationary effects. The relationship between domestic debt and inflation for nine countries during 1980-2004 shows that in countries experiencing inflation, the inflationary process was high, fueled by rising domestic debt costs. In the least developed countries, inflation is perceived as a critical problem. Thus, according to Ahmad et al. (2012), internal debt and domestic debt services improve the price level in Pakistan; in other words, they have a significantly positive impact on the price level.

## 1.4. DATA AND METHODOLOGY

This section presents the data used to realize the estimations in the first subsection. The methodology employed to examine the impacts of inflation targeting on macroeconomic variables is provided in the second subsection.

### 1.4.1. DATA

This study uses the PSM approach to examine the impact of adopting IT on internal and external public debt. Our sample consists of two economies (advanced and developing[9]) for 46 countries. The treatment group in our study consists of 22 that combine advanced and developing economies that have adopted the IT framework by the end of 2015. The control group consists of 24 countries that do not target inflation (See the list of countries in appendices 1 and 2). Due to the availability of the data, we specify that our data are annual and start from 1990 to 2019. The choice of the year 1990 is because it corresponds, on the one hand, to the date of the first adoption of IT by New Zealand. On the other hand, according to some economists, the stability of the inflation observed in these countries is due instead to economic conditions and not to the inflation targeting observed from the nineties (Cecchetti and Ehrmann, 1999; Dueker and Fisher, 1996).

Some papers have highlighted two starting dates, namely default and conservative inflation targeting, according to the literature. In other words, the two dates are differentiated by the fact that the first, which is "informal or soft" inflation targeting (Vega & Winkelried, 2005), is the date officially declared by the central banks as the date of adoption. On the other hand, the second date, "full-fledged or formal" IT, is considered by academics as the data from which central banks began to meet the criteria required to be classified as inflation targeting. Therefore, in this study, we exclusively used the data issued by the central banks.

Our outcome variable, public debt, is disaggregated into domestic public debt and external public debt. However, obtaining data from these two variables makes this study somewhat exceptional since it remains challenging to collect. Thus, in this study, we use the outstanding international public debt securities to GDP (%) as the variable for external public debt and the outstanding domestic public debt securities to GDP (%) as that of the domestic public debt.

Table 2 shows the variables used for this study. The various macroeconomic data on which our study relates mainly come from the following different databases: IMF database, World Bank Development Indicator (WDI), Bank for International Settlements (BIS), the Chinn-Ito Index.

[9]We notice that in this group we combined developing and emerging countries

**Table 2**: *List of variables*

| Variable | Definition | Source |
|---|---|---|
| External public debt | The amount of international public debt securities (outstanding) is a share of GDP. It covers long-term bonds and notes and money market instruments placed on international markets. | BIS |
| Domestic/Internal public debt | Amount of domestic public debt securities (outstanding) issued in domestic markets as a share of GDP. It covers long-term bonds and notes, treasury bills, commercial paper, and other short-term notes. | BIS |
| FDI | net inflows (% of GDP). Foreign direct investment is the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. | WDI |
| Inflation | The average consumer price index (CPI). The rate of inflation is the percent change in the average CPI | WEO (IMF) |
| Current account | Current account balance (% of GDP) = government current account balance as a percentage of the GDP | WDI |
| Gross Domestic Product per capita | GDP per capita (constant 2010 US$) | WDI |
| Financial development | Domestic credit provided by the financial sector (% of GDP). It includes all credit to various sectors on a gross basis, except credit to the central government, which is net. The financial sector includes monetary authorities, deposit money banks, and other financial corporations where data are available (including corporations that do not accept transferable deposits but do incur such liabilities as time and savings deposits). | WDI |
| Financial openness[10] | The Chinn-Ito index (*KAOPEN*) measures a country's degree of capital account openness. *KAOPEN* is based on the binary dummy variables | The Chinn-Ito Index |

Source: The Chinn-Ito Index, WDI, WEO (IMF), BIS.

### 1.4.2. METHODOLOGY

This study is examined in two stages. The first stage consists of conducting a statistical analysis of the internal and external public debt evolution in the countries that have adopted it. To do this, one present in separate tables the average and the average of the standard deviation of inflation and of the various public debts over time intervals, namely: 1) over the entire period of study (1990-2019), 2) the pre-targeting period (from 1990 to the date of adoption of each

[10]Chinn, Menzie D. and Hiro Ito (2006). "What Matters for Financial Development? Capital Controls, Institutions, and Interactions," *Journal of Development Economics*, Volume 81, Issue 1, Pages 163-192 (October).

country), 3) the post-targeting period (from the date of adoption to 2019). Secondly, the study differs by using a wide variety of non-parametric PSM techniques to eliminate the problems that often arise in studies with traditional linear regression methods (Baycan, 2016).

- First, due to the randomized valuation feature of the method, there is no problem of selection bias that is frequently encountered in traditional linear time or panel data models.
- Secondly, a specific functional form is not required for this method. Therefore, the results are not affected by omitted variable bias.
- Third, another advantage of the propensity score matching approach is that it does not generate extrapolation outside of the common support.
- Fourth, the estimator does not need a monotonic transformation as it is non-parametric.
- Finally, alternative models that use an instrumental variable enable us to reach the results without being exposed to errors and deficiencies caused by choosing the correct instrumental variable.

Estimated propensity scores are made using one or a combination of four main methods to adjust. (1) Stratification, (2) Matching, (3) Medium variable / Regression setting, and (4) Weighting.

While the number of variables observed increases, they will face the problem of dimensionality in matching these features. Initial studies assessed the changes and matched the observations by basing them on a single variable vector or hosting the variables. It is simple to map a few common variables using two dummy variables. However, estimating the average treatment effect will be complex as the number of variables increases.

The average treatment effect on the treated (ATT) of inflation targeting refers to the following:

$$ATT = E(Y_{i1}|IT_i = 1) - E(Y_{i0}|IT_i = 1) \quad (1.1)$$

with $IT_i$ is a dummy indicator showing whether the countries adopt IT policy or not. If the country $i$ adopts an IT policy, IT value takes 1 and 0 if not. Thus, $(Y_{i0}|IT_i = 1)$ equals the counterfactual outcome that change in external or internal public debt would have occurred if the country $i$ had not conducted IT and ( $Y_{i1}|IT_i$=1) gives the value of change in external or internal public debt if country $i$ has implemented IT. Therefore, equation (1.1) demonstrates that the ATT unit shows the difference between the outcome obtained after the adopted IT policy and the possible result that the value would have reached if it had never been adopted IT policy. However, although the first term in this equation is observable, the second term in the

ATT is impossible to observe, which is problematic. After a policy regime change, no knowledge regarding the inflation rate would be apparent if the country did not decide to choose the policy. On the contrary, when the decision to change the political regime is non-random, and the treatment allocation is made randomly, the problem disappears. According to the results on the decision of countries to switch to an inflation-targeting regime, the process of policy regime changes is non-random. The choice of this regime is also influenced by the institutional infrastructures and the economic characteristics of these countries. Therefore, there is a link between the observable variables and the impact of the outcome variable called the "self-selection" problem. The propensity score matching method solves this self-selection problem on observables.

The propensity score matching approach shares similar observed characteristics between non-inflationary targeters and inflation targeters. This statement leads to matching treated and untreated units practically and compares the differences between the average external and domestic public debt change in a counterfactual way.

Then, based on the conditional independence: $Y_0 \perp IT|.X$ and $Y_1 \perp IT|.X$. From this assumption, we can rewrite the equation (1) as:

$$ATT = E[Y_{i1}|IT_i = 1, X_i] - E[Y_{i0}\lfloor IT_i = 0, X_i] \quad (1.2)$$

with $(Y_{i1}|IT_i = 1, X_i)$ refers to the average external and internal public debt in the $i^{th}$ country that changed after the adoption of the regime under conditions $X_i$. The term $[Y_{i0}|IT_i = 0, X_i]$ indicates the average external and internal public debt in the $i^{th}$ country that maintained its monetary policy under the same conditions $X_i$. For the latter term $E[Y_{i1}|IT_i = 1, X_i]$, we substitute $[Y_{i0}|IT_i = 0, X_i]$, which ensures all the parameters in our equation consist of observables.

The problem of dimensionality that arises from the increased number of observed covariates finds a solution in propensity scores between the matching of untreated and treated units on their propensity scores (Rosenbaum and Rubin, 1988).

$$P(X_i) = Pr[IT = 1|X_i] \quad (1.3)$$

Estimating the propensity score that takes the value between 0 and 1 denotes the probability function. Based on the same assumption, equation (1.2) conditional on a propensity score can be rewritten as:

$$ATT = E[Y_{i1}|IT = 1, P(X_i)] - E[Y_{i0}\lfloor IT_i = 0, P(X_i)] \quad (1.4)$$

Common support assumption at evaluation PSM method guarantees to overcome biased ATT estimation. The common support necessary condition indicates equation as:

$$0 < P(X_i) = \Pr(|D_i = 1|X_i) < 1 \quad (1.5)$$

After providing the common support condition, ATT indicates the mean difference in external and internal public debt over the common support, adequately weighted by the propensity score distribution of all economies in the data set.

The Average Treatment Effect (ATE) quantifies the difference in mean (average) scores between the treatment group and the control group that did not receive the treatment. In a randomized trial (i.e., an experimental study), the average treatment effect can be estimated from a sample using a comparison of the average results for the treated and untreated units. The nature of treatment or outcome is relatively unimportant in estimating the ATE -i.e., for the estimation of the ATE, treatment must be applied to some units and not to others. However, this treatment's nature is not related to the estimation of ATE.

The effect of the treatment for individual $i$ is as follows: $y_1(i) - y_0(i) = \beta(i)$. In this general case, this effect differs from one individual to another. The ATE is given by:

$$ATE = \frac{1}{N}\sum_i (y_1(i) - y_0(i)) \quad (1.6)$$

with the summation takes place over all N individuals from the overall population, $y_1(i)$ represents the numerical value of the outcome variable for $i$ if the individual received the treatment, and $y_0(i)$ represents the numerical value of the outcome variable for individual $i$ if the individual did not receive the treatment.

The ATE on the treated unit shows the difference between the result obtained after the treatment and the possible outcome the unit would have achieved if it had never been processed. In the specific case of our study, the ATE shows the country's different economic performances before and after adopting the inflation targeting policy. Several matching algorithms improve the quality of the results drawn from the propensity score estimates in the existing literature. As pointed out by Lucotte (2012), the evaluation of the treatment effect through an estimated propensity score is employed by different matching methods that use different approaches:

(i) *Nearest neighbor matching* consists of matching each treated unit with one or more untreated units that are closest according to the propensity score. The more the number of neighbors, the more we get knowledge by reducing the variance. However, a drop in quality by using the matching algorithms is possible;

(ii) *Radius matching*: in case the nearest neighbor remains far away, estimation from nearest neighbor matching cannot yield accurate ATT results. The radius matching estimator addresses this problem by imposing a maximum propensity score distance threshold. This estimator allows each processed observation to be matched with unprocessed observations and with estimated propensity scores that fall within a specified radius.

(iii) *Kernel matching*: Kernel matching considers the weighted averages of all economies. This method is different from the two previous ones, which construct a counterfactual matching from a few processed observations. This approach consists of matching the treated units to all the control units using different weights proportional to the proximity of the control units. In our study, we use Epanechnikov kernel matching methods.

(iv) *Stratification matching:* this approach consists of partitioning the common support of the propensity score into a set of intervals. According to Caliendo and Kopeinig (2008), the measure depends on the average difference within each interval of inflation rates between the observations of inflation targeters and non-inflationary targeters.

Concerning control variables, they refer to those that increase the probability of transition to the inflation targeting regime and further determine the external and internal public debt. By performing several preliminary regressions, only the specifications for which the balancing property is satisfied are retained to examine the effect of ITers on the reduction of the external and internal public debt of developing, emerging, and advanced economies.

## 1.5. EMPIRICAL RESULTS

This section discusses the effectiveness of the IT policy. First, we document a descriptive statistical analysis between inflation and public debt (internal and external) in the first subsection. Then, we reveal the analysis by employing the PSM methodology in the following subsections.

### 1.5.1. Descriptive statistical analysis

As part of this statistical analysis, we analyze inflation data and internal and external public debt between the pre-inflation targeting and inflation-targeting periods. Our study covers a total of 22 countries that have adopted inflation targeting, including ten advanced economies and 12 developing economies. Tables 3 and 4 show the inflation statistics for advanced and developing economies adopting inflation targeting policy. For example, Table 3 shows that all countries in advanced economies except Japan have experienced a significant drop in their

inflation after adopting the IT policy. Thus, the average inflation of countries with advanced economies with inflation targeting goes from 5.938% during the pre-IT period to 2.054% during the post-IT period.

Furthermore, this drop-in inflation is accompanied by a drop in its volatility, measured by the standard deviation. This average volatility goes from 2.44 during the pre-IT period to 1.311 during the post-IT period. Such results show the significant change in the inflation dynamics between the periods before and after the IT policy. The results document that controlling the volatility contributes to a better economic performance in these countries.

Table 4 below presents the inflation and volatility statistics for the developing economies consisting of emerging markets and the least developed countries practicing inflation targeting. According to the results, we see that the level of inflation for some countries is too high before the IT period (Brazil: 936.4%; Peru: 673.72%; Poland: 103.66%; Russia: 137.38%; and Turkey: 60.53%) while during the post-policy adoption period inflation is lower and remains stable (the highest rate in this category is 9.54% in Turkey). Indeed, the average inflation during the pre-IT was 167.620% against 4.984% during the post-IT period, a considerable drop of about 97.02%. Moreover, this drop is accompanied by a significant decline in volatility in these countries from 323.1 to 2.488. In summary, considering all the samples, the levels of inflation and volatility are higher for the pre-IT period than for the post-IT period. The next step in this work is to assess the effect of IT policy on public debt. In other words, it is a question of determining the internal and external public debt situation in the countries whose monetary policy targets inflation. In recent years, debt has become a matter of concern again, not only because of the macroeconomic impact it could have on economic performance but also because of the possible adverse effects on the conduct of monetary policy.

**Table 3**: *Inflation in advanced economies (1990-2019)*

| | Total Period | | Pre-IT | | Post-IT | |
|---|---|---|---|---|---|---|
| | Mean | s.d | Mean | s.d | Mean | s.d |
| Australia | 2.596 | 1.403 | 3.833 | 3.134 | 2.459 | 1.116 |
| Canada | 2.016 | 1.083 | 4.8 | - | 1.789 | 0.666 |
| Czech Rep. | 3.133 | 2.801 | 11.554 | 4.172 | 2.886 | 2.584 |
| Israel | 4.760 | 5.428 | 13.228 | 3.446 | 2.182 | 2.416 |
| Japan* | 0.483 | 1.152 | 0.378 | 1.209 | 0.828 | 0.937 |
| South Korea | 3.526 | 2.298 | 5.418 | 2.539 | 2.431 | 1.213 |
| New Zealand | 2.126 | 1.280 | - | - | 2.126 | 1.280 |
| Norway | 2.223 | 0.888 | 2.518 | 0.807 | 2.052 | 0.909 |
| Sweden | 1.950 | 1.617 | 4.466 | 3.859 | 1.670 | 0.979 |
| United Kingdom | 2.460 | 1.630 | 7.250 | 0.353 | 2.117 | 1.014 |
| **Mean** | **2.527** | **1.958** | **5.938** | **2.440** | **2.054** | **1.311** |

**Table 4**: *Inflation in developing economies (1990-2019)*

| | Total Period | | Pre-IT | | Post-IT | |
|---|---|---|---|---|---|---|
| | Mean | s.d | Mean | s.d | Mean | s.d |
| Brazil | 285.310 | 728.009 | 936.400 | 1113.521 | 6.271 | 2.546 |
| Colombia | 10.710 | 8.972 | 23.4 | 4.3792 | 5.2714 | 2.355 |
| Hungary | 10.276 | 9.727 | 21.054 | 7.797 | 4.036 | 2.564 |
| Indonesia | 9.233 | 9.978 | 12.360 | 13.290 | 6.106 | 2.947 |
| Mexico | 9.856 | 9.309 | 19.409 | 9.545 | 4.326 | 0.977 |
| Peru | 271.090 | 1363.914 | 673.725 | 2146.994 | 2.677 | 1.249 |
| Philippines | 5.886 | 3.828 | 8.675 | 4.137 | 4.027 | 2.184 |
| Poland | 29.976 | 106.205 | 103.662 | 195.544 | 3.181 | 3.178 |
| Russia | 115.603 | 321.137 | 137.380 | 348.777 | 6.720 | 5.143 |
| South Africa | 7.043 | 3.240 | 9.890 | 3.432 | 5.620 | 2.013 |
| Thailand | 3.010 | 2.295 | 4.960 | 2.047 | 2.035 | 1.748 |
| Turkey | 36.736 | 32.729 | 60.531 | 27.736 | 9.542 | 2.954 |
| **Mean** | **66.227** | **216.612** | **167.620** | **323.100** | **4.984** | **2.488** |

Tables 5 and 6 show the average external public debt statistics and volatility for advanced and developing economies, respectively. In Table 5, we observe that the level of the external public debt of these advanced economies which adopted inflation targeting was 4.018% during the pre-inflation targeting period and decreased to 3.081% during the inflation targeting period, i.e., a significant decrease in the external public debt to the height of 23.33%.

The same result is observed in Table 6 (external public debt for developing economies) with a decrease in external public debt from 6.662% during the pre-inflation targeting period to 5.016% during the post-IT period, i.e., a reduction of 24.77%. Thus, we find no significant differences between the two groups of countries before and after the adoption of IT in terms of external public debt.

Regarding the volatility of external public debt, we find that under the inflation targeting regime, there has been an increase from 0.389 to 1.623. That implies that debt has become more volatile in advanced economies during the post-IT period (Table 5). Furthermore, as for advanced economies, we notice a slight increase in volatility (2.03 to 2.04) in developing economies, implying more volatility after adopting IT (Table 6).

**Table 5**: *External public debt in advanced economies (1990-2019)*

| | Total Period | | Pre-IT | | Post-IT | |
|---|---|---|---|---|---|---|
| | Mean | s.d | Mean | s.d | Mean | s.d |
| Australia | 1.582 | 1.279 | 3.411 | 0.181 | 1.301 | 1.130 |
| Canada | 10.044 | 3.607 | 15.245 | - | 9.865 | 3.532 |
| Czech Rep. | 2.759 | 2.580 | 0.525 | 0.058 | 3.439 | 2.589 |
| Israel | 3.302 | 1.553 | 1.459 | 0.283 | 3.862 | 1.323 |
| Japan* | 0.090 | 0.034 | 0.078 | 0.027 | 0.127 | 0.026 |
| South Korea | 2.556 | 2.202 | 2.527 | 1.461 | 2.573 | 2.574 |
| New Zealand | 0.731 | 0.186 | - | - | 0.731 | 0.186 |
| Norway | 0.441 | 1.093 | 1.576 | 0.984 | -0.874 | 0.379 |
| Sweden | 9.472 | 3.999 | 11.015 | 0.114 | 9.301 | 4.187 |
| United Kingdom | 0.472 | 0.296 | 0.330 | 0.007 | 0.482 | 0.304 |
| **Mean** | **3.145** | **1.683** | **4.018** | **0.389** | **3.081** | **1.623** |

Regarding the volatility of external public debt, we find that under the inflation targeting regime, there has been an increase from 0.389 to 1.623. That implies that debt has become more volatile in advanced economy countries during the post-IT period (Table 5). Furthermore, as for countries with advanced economies, we notice a slight increase in volatility (2.034 to 2.045) in developing economies, implying more volatility after adopting IT (Table 6).

**Table 6**: *External public debt in developing economies (1990-2019)*

| | Total Period | | Pre-IT | | Post-IT | |
|---|---|---|---|---|---|---|
| | Mean | s.d | Mean | s.d | Mean | s.d |
| Brazil | 5.646 | 3.163 | 4.645 | 3.056 | 7.984 | 2.031 |
| Colombia | 7.342 | 2.399 | 8.267 | 2.055 | 5.184 | 1.683 |
| Hungary | 13.518 | 6.247 | 14.701 | 4.302 | 11.178 | 8.387 |
| Indonesia | 1.590 | 2.844 | 3.815 | 2.102 | -0.634 | 1.316 |
| Mexico | 5.922 | 2.011 | 5.084 | 1.097 | 9.109 | 1.349 |
| Peru | 8.318 | 1.256 | 8.794 | 1.357 | 7.531 | 0.435 |
| Philippines | 11.810 | 3.143 | 12.912 | 3.225 | 10.155 | 2.140 |
| Poland | 7.571 | 4.431 | 9.277 | 3.935 | 2.880 | 0.764 |
| Russia | 4.632 | 3.439 | 2.156 | 0.576 | 5.127 | 3.564 |
| South Africa | 2.911 | 1.174 | 3.520 | 0.943 | 1.691 | 0.291 |
| Thailand | 1.073 | 0.929 | 0.663 | 0.816 | 1.893 | 0.503 |
| Turkey | 5.931 | 1.217 | 6.441 | 0.975 | 5.485 | 1.260 |
| **Mean** | **6.355** | **2.688** | **6.662** | **2.034** | **5.016** | **2.045** |

Then there is the analysis of the internal public debt in Tables 7 and 8. Table 7 shows statistics about advanced economies that the average of the domestic public debt, which was 47.747% during the pre-IT period, decreased to 34.15% during the inflation-targeting period. This decrease in domestic public debt is also observed in the developing economies in our sample shown in Table 8 that have adopted IT (25.217% pre-IT versus 15.962% post-IT). The volatility of the domestic public debt of countries with advanced economies is less volatile (pre-IT 9.604 against post-IT 7.884) and that of countries of developing economies that are less volatile after adopting IT (pre-IT 6.061 versus 4.124 post-IT). One could conclude that the adoption of IT causes a significant decrease in the volatility of the domestic public debt of countries with advanced economies; in other words, inflation targeting policy reduces the uncertainty of inflation.

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**Table 7**: *Internal public debt in advanced economies (1990-2019)*

| | Total Period | | Pre-IT | | Post-IT | |
|---|---|---|---|---|---|---|
| | Mean | s.d | Mean | s.d | Mean | s.d |
| Australia | 27.039 | 17.445 | 30.506 | 16.084 | 4.503 | 2.237 |
| Canada | 59.576 | 6.296 | 59.629 | 6.40 | 58.029 | - |
| Czech Rep. | 20.683 | 7.630 | 23.662 | 6.016 | 10.894 | 1.708 |
| Israel | 37.421 | 6.303 | 39.467 | 5.749 | 30.699 | 1.434 |
| Japan* | 123.589 | 56.435 | 189.041 | 14.877 | 103.668 | 48.579 |
| South Korea | 21.347 | 12.708 | 29.062 | 8.625 | 8.020 | 5.098 |
| New Zealand | 17.367 | 11.120 | 17.367 | 11.120 | - | - |
| Norway | 16.190 | 3.404 | 16.968 | 3.885 | 14.845 | 1.732 |
| Sweden | 36.970 | 13.361 | 34.756 | 12.167 | 56.899 | 1.476 |
| United Kingdom | 35.869 | 11.583 | 37.018 | 11.116 | 19.792 | 0.812 |
| **Mean** | **39.605** | **14.628** | **47.747** | **9.604** | **34.150** | **7.884** |

**Table 8**: *Internal public debt in other economies (1990-2019)*

| | Total Period | | Pre-IT | | Post-IT | |
|---|---|---|---|---|---|---|
| | Mean | s.d | Mean | s.d | Mean | s.d |
| Brazil | 47.764 | 17.959 | 56.964 | 12.876 | 26.298 | 3.757 |
| Colombia | 19.631 | 7.229 | 23.703 | 4.059 | 10.129 | 1.773 |
| Hungary | 39.376 | 11.294 | 46.213 | 8.047 | 27.567 | 3.336 |
| Indonesia | 12.397 | 6.351 | 11.698 | 2.581 | 13.096 | 8.723 |
| Mexico | 15.522 | 10.124 | 21.852 | 6.471 | 4.587 | 3.768 |
| Peru | 3.590 | 4.599 | 6.165 | 3.490 | -0.667 | 1.993 |
| Philippines | 28.412 | 4.423 | 29.92 | 4.619 | 26.149 | 3.046 |
| Poland | 30.471 | 13.790 | 36.723 | 10.238 | 13.278 | 3.559 |
| Russia | 5.257 | 2.352 | 7.156 | 1.623 | 4.877 | 2.311 |
| South Africa | 34.24 | 6.693 | 33.877 | 7.536 | 34.967 | 4.856 |
| Thailand | 17.531 | 9.840 | 23.599 | 4.832 | 5.394 | 4.151 |
| Turkey | 23.186 | 8.635 | 22.458 | 6.393 | 23.824 | 10.383 |
| **Mean** | **23.557** | **7.787** | **25.217** | **6.061** | **15.962** | **4.124** |

### 1.5.2. Analysis with the Propensity Score Matching (PSM)

This section examines the Average Treatment Effect on the Treated (ATT) and the Average Treatment Effect (ATE) on the lagged inflation rate, GDP per capita, current account of balance, trade, financial openness, financial development (proxied by domestic credit to the

private sector), and FDI. The following section concerns the empirical estimation of the propensity scores to external and internal public debt outcome variables. We present results employing several matching technics to examine the effect of IT policy on external and internal public debt for both groups of countries. Before going any further on the estimation of the PSM, we first point out a descriptive statistic of the independent and dependent variables used in this study.

**Table 9**: *Descriptive statistics from 1990 to 2019*

| **Variable** | **Advanced economies** | | | | | **Developing economies** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Obs** | **Mean** | **Std. Dev** | **Min** | **Max** | **Obs** | **Mean** | **Std. Dev** | **Min** | **Max** |
| Extpubdebt | 840 | 5.11 | 6.51 | -6.65 | 31.66 | 570 | 9.14 | 14.83 | -4.13 | 97.63 |
| Intpubdebt | 840 | 39.90 | 29.74 | -11.77 | 215.02 | 570 | 25.16 | 21.07 | -4.325 | 105.39 |
| GDPP | 840 | 1.71 | 2.72 | -11.40 | 23.94 | 570 | 2.812 | 4.674 | -27.56 | 43.37 |
| CPI l1 | 839 | 3.70 | 20.82 | -4.48 | 552.08 | 569 | 30.185 | 182.31 | -3.75 | 2947.73 |
| FDI | 840 | 5.58 | 11.82 | -43.46 | 198.07 | 570 | 3.292 | 5.054 | -48.28 | 54.86 |
| Trade | 840 | 59.37 | 343.57 | -7946.71 | 3616.1 | 570 | 55.44 | 404.18 | -2353.49 | 9110.44 |
| Curac | 840 | 1.14 | 6.29 | -23.72 | 25.92 | 570 | -1.921 | 6.22 | -26.12 | 17.47 |
| Kaopen | 840 | 1.90 | 0.86 | -1.21 | 2.385 | 570 | -0.028 | 1.19 | -1.92 | 2.33 |
| Domcredit | 840 | 110.5 | 4692 | 0.18 | 253.26 | 570 | 54.19 | 40.51 | 3.29 | 166.50 |

Table 9 presents the descriptive statistics of the variables employed for this study while considering the two groups of countries: Advanced and developing economies. It appears that the advanced economies, unlike the developing ones, obtain high averages as results on most of the variables, except the external public debt and the GDP per capita, where developing economies acquire high averages.

#### *1.5.2.1. Estimation of Propensity scores*

To have a control group and a reasonably comparable treatment group, it is essential to first sort the observations according to their estimated propensity scores (PS). Then, isolate countries in the control group that estimated PS is lower than the lowest score in the group treated (Persson 2001). We estimate the propensity score using the probit model, where IT is the binary and dependent variables. The binary variable takes 0 if a country does not operate under the IT policy in a given year and 1 if it operates under the IT policy.

**Table 10**: *Propensity scores for both external and domestic public debt*

| Variable | Advanced economies | | Developing economies | |
|---|---|---|---|---|
| | **Coef.** | **Prob** | **Coef.** | **Prob** |
| **GDPP** | 0.02<br>(0.01) | 0.252 | -0.03**<br>(0.01) | 0.019 |
| **CPI_l1** | -0.03*<br>(0.019) | 0.091 | 0.0009<br>(0.001) | 0.282 |
| **FDI** | -0.04***<br>(0.007) | 0.000 | -0.02*<br>(0.01) | 0.058 |
| **Trade** | -0.0002**<br>(0.0001) | 0.029 | -0.00009<br>(0.0001) | 0.471 |
| **Curac** | -0.003<br>(0.008) | 0.671 | 0.01**<br>(0.009) | 0.038 |
| **Kaopen** | -0.16***<br>(0.06) | 0.008 | 0.08*<br>(0.05) | 0.097 |
| **Domcredit** | 0.0001<br>(0.001) | 0.860 | -0.005***<br>(0.001) | 0.000 |
| **Cons** | 0.20<br>(0.16) | 0.217 | 0.68***<br>(0.08) | 0.000 |
| **N. of obs** | **839** | | **570** | |

Note: Standard errors in parenthesis. ***, **, and *, indicate the significance level of 1%, 5%, and 10%, respectively.

Table 10 reports the probit estimation of the propensity scores in advanced economies and developing economies, based on the starting date (see appendix 1). In the advanced economies group, the negative sign of the lag-inflation is in accordance with the coefficient in Lin and Ye (2007, 2009), Ball and Sheridan (2004), De Mendonça and e Souza (2012). We find that the past inflation in developing economies is not significant and had a positive sign. The current account balance is negative and not significant for advanced economies but has a positive sign and is significant for developing economies. Foreign direct investment inflows are negative but significant for advanced and developing economies, contrasting to a positive coefficient in Vasileva (2018). Financial openness is significant for both groups but remains negatively correlated with the probability of adopting IT in advanced economies and positively in developing economies. The real GDP per capita growth rate is significant. It negatively correlates with IT adoption by developing economies, while it is not significant in advanced economies and has a positive sign. The trade openness variable is negative for both types of economies. Still, it remains significant only for advanced economies, meaning that adopting IT policy leads to more trade activities abroad for these countries. Financial development has a negative sign and is significant only for developing economies.

According to their propensity score ranges, Figures 4 and 5 represent the numerical densities of adopting inflation targeting countries and non-inflation targeting countries. The vertical section indicates the number of countries in these Figures, while the horizontal section

in the chart indicates the density distribution of the propensity scores. The red blocks in the upper part of the horizontal line indicate the density distribution of the propensity scores for country group that adopted IT. The blue blocks show the density distribution of the propensity scores for countries that did not adopt IT. Figures 4 and 5 indicate that propensity scores are overlapped, and common support is provided.

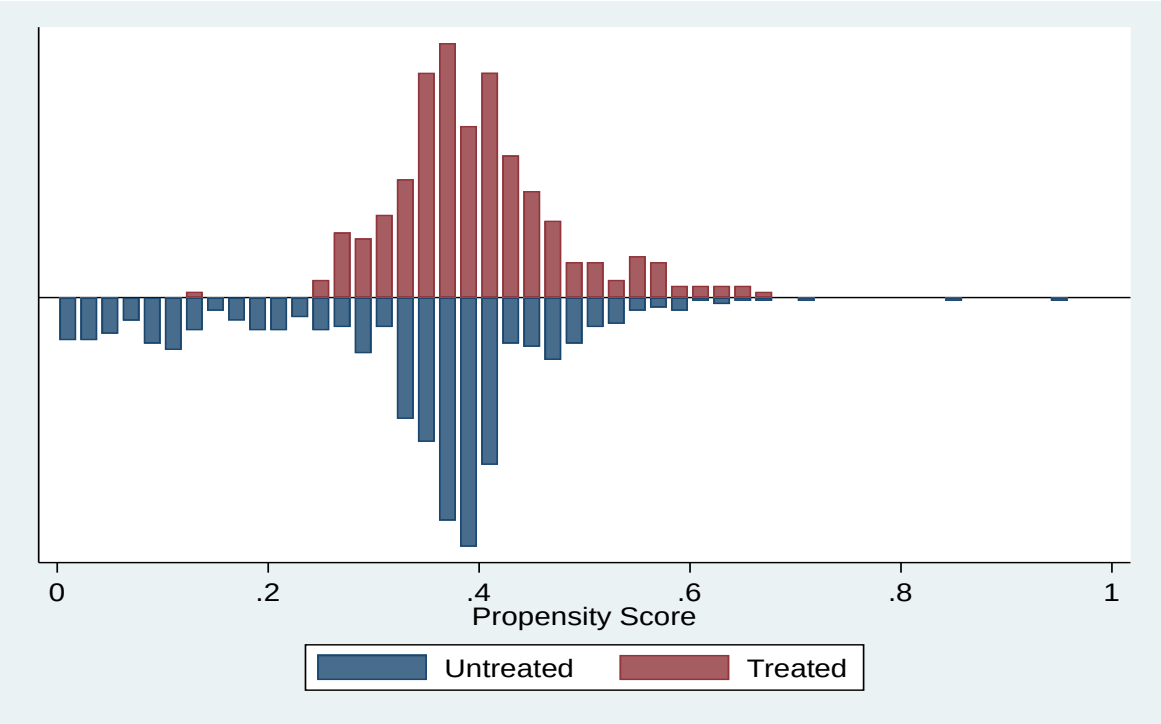


**Figure 4**: Propensity score for advanced economies

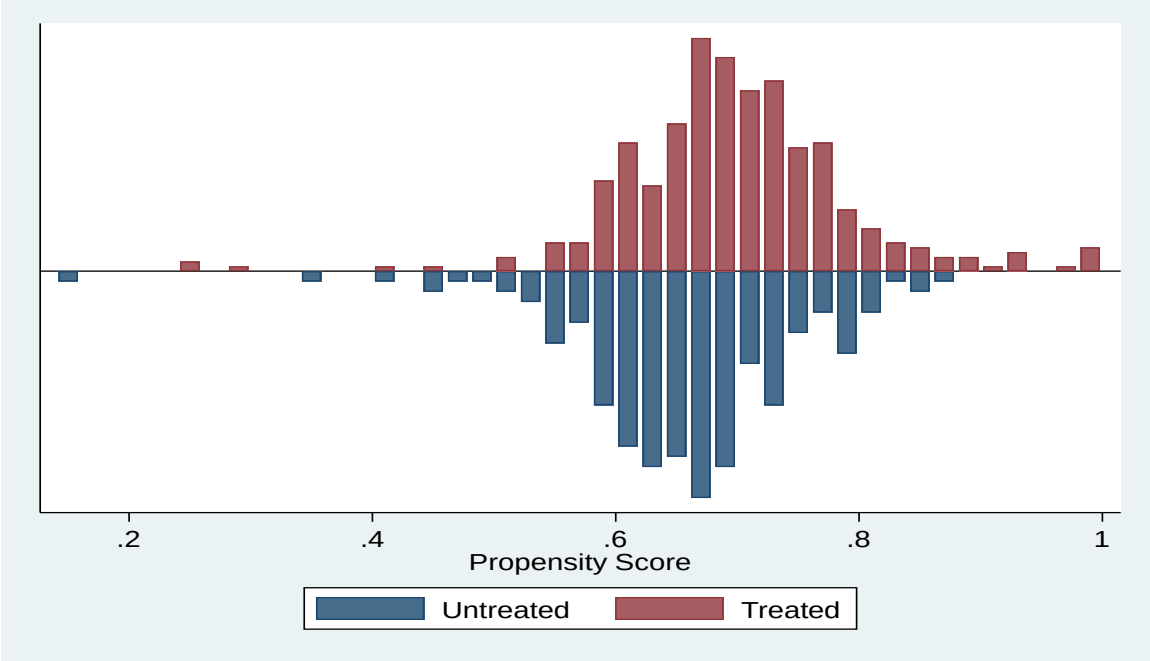


**Figure 5**: Propensity score for developing economies

#### *1.5.2.2. Results from matching the effect of IT on internal and external public debt*

In this part of the study, we reveal the matching results by employing different matching techniques such as Radius matching, Nearest-Neighbor Matching, Stratification Matching, and Kernel Matching. Tables 11 and 12 represent the treatment effect's impact on the external and internal public debt in advanced and developing economies.

Firstly, we analyzed the impact of the adoption of IT on external public debt for advanced and developing economies. According to Table 11, all the coefficients in the two groups of countries are negative, and this negative effect is statistically significant for all of the matching techniques used for advanced and developing economies. On average, the magnitude of the estimated ATT concerning the external public debt ranges from -4.22 (nearest-neighbor matching, n=1) to -3.7 (kernel matching) percent in the group of advanced economies and ranges from -10.5 (stratification matching) to -7.51 (radius matching, r=0.01) percent in the group of developing economies. There is robust evidence that the adoption of the IT policy has quantitatively essential and statistically significant impacts on reducing external public debts. On average, the decrease is at least 3.7 percent than non-IT advanced counterparts and at least 7.5 percent compared to non-IT developing counterparts. In other words, if non-IT advanced economies had preferred an inflation-targeting framework, their external public debt would have been, on average, at least 3.7 percent lower. Additionally, the results reveal that if non-inflation targeting developing countries had adopted an inflation targeting regime, their external public debt would have decreased by 7.5 points.

**Table 11**: *Estimates of ATT of the external public debt*

| | Matching | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| External public debt | Nearest neighbor matching | | | Radius matching | | | Kernel matching | Stratification matching |
| | n=1 | n=2 | n=3 | r=0.01 | r=0.03 | r=0.05 | | |
| Advanced economies | -4.22*** (0.79) | -3.85*** (0.63) | -3.98*** (0.63) | -3.99*** (0.48) | -3.86*** (0.46) | -3.69*** (0.48) | -3.75*** (0.37) | -3.82*** (0.50) |
| Developing economies | -8.01*** (2.91) | -8.02*** (2.78) | -8.38*** (2.59) | -7.51*** (0.71) | -8.59*** (0.54) | -8.29*** (4.43) | -8.56*** (0.23) | -10.5*** (1.76) |

Note: The bootstrapped standard errors with 100 replications in parenthesis. ***, **, and *, indicate the significance level of 1%, 5%, and 10%, respectively.

Table 12 concerns the internal public debt and identifies that none of the coefficients is significant for any of the matching methods for the advanced economies. This means that the internal or domestic debt of the inflation targeting in the group of advanced economies is insignificant after adopting the policy. On the other hand, in developing economies, the

adoption of IT decreases internal debt. Indeed, as we can see in Table 12, each test showed a negative sign and significant coefficient of the internal debt meaning that the inflation targeting has a negative effect on the internal debt of this group of countries that decided to adopt inflation targeting. On average, the magnitude of the estimated ATT concerning internal public debt ranges from -6.86 (stratification matching) to -5.01 (nearest-neighbor matching, n=1) percent. In other words, the results show that if inflation targeter developing economies had not adopted the IT policy, internal public debt would have been at least 5.01 percent higher.

**Table 12**: *Estimates of the ATT of the internal or domestic public debt*

| | Matching | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Internal public debt | Nearest neighbor matching | | | Radius matching | | | Kernel matching | Stratification matching |
| | n=1 | n=2 | n=3 | r=0.01 | r=0.03 | r=0.05 | | |
| Advanced economies | 1.09 (3.19) | -0.28 (3.06) | -0.46 (3.20) | -0.55 (2.63) | -1.62 (2.71) | -2.03 (2.57) | -1.85 (2.59) | -1.41 (2.67) |
| Developing economies | -5.01** (2.57) | -5.85** (2.96) | -6.02** (2.57) | -5.94*** (2.31) | -5.85*** (1.87) | -6.37*** (1.99) | -6.13*** (1.90) | -6.86*** (2.24) |

Note: The bootstrapped standard errors with 100 replications in parenthesis. ***, **, and *, indicate the significance level of 1%, 5%, and 10%, respectively.

#### *1.5.2.3. Results from matching the effect of IT on external and internal public debt: using ATE*

Tables 13 and 14 provide robust matching results for the IT policy based on the advanced and developing economies. The estimated ATE on our sample from the matching methods (nearest neighbor, radius, and kernel) is negative and statistically significant for developing economies. Focussing on external and internal public debt, IT lowers the external and internal public debt for developing economies. Again, the results are negative and statistically significant for advanced economies, with the external public debt non-significant for internal public debt. On average, the magnitude of the estimated ATE concerning the external public debt ranges from -4.06 (nearest-neighbor matching, n=2) to -3.34 (radius matching, r=0.01) percent in the advanced economies and ranges from -8.57 (nearest-neighbor matching, n=2) to -6.63 (radius matching, r=0.01) percent in developing economies. In other words, the adoption of IT significantly reduces external public debt both for developed and developing economies. Moreover, on average, the adoption of IT creates a significant reduction of internal public debt for developing economies. On average, the magnitude of the estimated ATE concerning internal public debt ranges from -4.44 (nearest-neighbor matching, n=2) to -2.73 (nearest-neighbor matching, n=1) percent.

**Table 13**: *Estimates of the ATE of the external public debt*

| | Matching | | | | | | |
|---|---|---|---|---|---|---|---|
| External public debt | Nearest neighbor matching | | | Radius matching | | | Kernel matching |
| | n=1 | n=2 | n=3 | r=0.01 | r=0.03 | r=0.05 | |
| Advanced economies | -3.41*** (0.87) | -4.06*** (0.82) | -3.95*** (0.71) | -3.34*** (0.80) | -3.37*** (0.74) | -3.41*** (0.79) | -3.56*** (0.41) |
| Developing economies | -6.85*** (2.95) | -7.80*** (2.85) | -8.57*** (2.52) | -6.63*** (2.51) | -6.90*** (2.65) | -6.85*** (2.41) | -7.33*** (1.52) |

Note: The bootstrapped standard errors with 100 replications in parenthesis. ***, **, and *, indicate the significance level of 1%, 5%, and 10%, respectively.

**Table 14**: *Estimates of the ATE of the internal or domestic public debt*

| | Matching | | | | | | |
|---|---|---|---|---|---|---|---|
| Internal public debt | Nearest neighbor matching | | | Radius matching | | | Kernel matching |
| | n=1 | n=2 | n=3 | r=0.01 | r=0.03 | r=0.05 | |
| Advanced economies | -3.32 (3.52) | -2.09 (3.84) | -2.74 (3.26) | -2.85 (3.65) | -3.1 (3.63) | -3.32 (3.02) | -0.85 (2.66) |
| Developing economies | -2.73* (2.88) | -4.44* (2.65) | -4.36* (2.36) | -3.19* (2.75) | -2.90* (2.87) | -2.73* (3.04) | -6.43* (1.89) |

Note: The bootstrapped standard errors with 100 replications in parenthesis. ***, **, and *, indicate the significance level of 1%, 5%, and 10%, respectively.

We find that adopting an inflation-targeting regime reveals lower levels of external public debt in developing and advanced economies. In the case of external public debt, inflation targeting results in lower external public debt, and these results are statistically and economically significant for developing and advanced economies. Concerning internal public debt, the findings suggest debt reduction through the adoption of the inflation targeting regime in developing economies.

The results report that the control group in the group of advanced and developing economies may follow the monetary policy adopted by the inflation-targeting countries, especially for countries where the public debt is a drag on their economic development.

# CONCLUSION

IT is a relatively new monetary strategy for most countries. However, since its inception in the 1990s, there has been an increase in the number of adherents to this monetary policy to such an extent that inflation targeting is considered to be the cornerstone of the new monetary system (Rose, 2007). Various articles on inflation targeting support this monetary policy through its remarkable performance.

The method implemented in this study is propensity score matching, which is the most suitable methodology to solve the self-selection problem to evaluate the counterfactual analysis of inflation targeting. The decision to adopt inflation targeting is not random, resulting in biased and overestimated results when using linear econometric techniques. Thus, this study's propensity score matching method performs various analyses while addressing self-selection bias. The evaluation process of the inflation targeting regime takes place in several stages. First, probit regression calculates propensity scores between each treatment and control individuals. Next, we visually analyze the density distribution with the resulting common support plot of the estimated propensity score in the untreated and treated units. Finally, the last step consists of estimating the treatment's average effect on the treated and that of the average effect of the treatment to evaluate the role of an inflation targeting regime. Four different matching methods are employed in the study: nearest-neighbor matching, radius, kernel, and stratification matching approaches. This research examines the effects of this monetary policy on internal and external public debts both in the groups of advanced and developing economies.

The countries that adopted IT achieved lower and less volatile inflation rates than in later periods based on the results. IT thus contributes to a large extent to maintaining price stability. So, besides price stability, the firm commitment to keeping inflation low has also helped anchor inflation expectations around the target value.

Also, advanced economies' average external public debt equals 3.14%, with an average volatility of 1.68, while that of developing economies is 6.35%, with an average volatility of 2.68. The domestic public debt seems similar to that of the external public debt, with an average of 39.60% and a volatility of 14.62 advanced economies against 23.55% and a volatility of 7.78 for the developing economies. Therefore, this monetary regime is suitable for sustainable internal and external public debt.

The results from the propensity score matching analysis results reveal that both of the employed methods of ATT and ATE present similar coefficient signs and degree of significance. Based on the results of ATT, two groups of countries are examined. On average,

we find a decrease in their internal and external public debt, except for the analysis with the internal debt of advanced economies, where despite the inflation targeting policy, the results did not have a significant effect. On average, the magnitude of the estimated ATT concerning the external public debt ranges from -4.22 (nearest-neighbor matching, n=1) to -3.7 (kernel matching) percent in the group of advanced economies and ranges from -10.5 (stratification matching) to -7.51 (radius matching, r=0.01) percent in the group of developing economies. There is strong and robust evidence that the adoption of the IT policy has quantitatively essential and statistically significant impacts on reducing external public debts on average by at least 3.7 percent than non-IT advanced counterparts and by at least 7.5 percent compared to non-IT developing counterparts. In other words, if non-IT advanced economies had preferred an inflation-targeting framework, their external public debt would have been, on average, at least 3.7 percent lower. Additionally, the results reveal that if non-inflation targeting developing countries had adopted an inflation targeting regime, their external public debt would have decreased by 7.5 points. On average, the magnitude of the estimated ATT concerning internal public debt ranges from -6.86 (stratification matching) to -5.01 (nearest-neighbor matching, n=1) percent. To put it another way, the results show that if inflation targeter developing economies had not adopted the IT policy, internal public debt would have been at least 5.01 percent higher.

According to the results, the IT regime helps reduce external public debt for advanced and developing economies and reduces internal public debt. In other words, the interpretation of the results of ATE method reveals that, on average, the magnitude of the estimated ATE concerning the external public debt ranges from -4.06 (nearest-neighbor matching, n=2) to -3.34 (radius matching, r=0.01) percent in the advanced economies and ranges from -8.57 (nearest-neighbor matching, n=2) to -6.63 (radius matching, r=0.01) percent in developing economies. That is, the adoption of IT significantly reduces external public debt both for developed and developing economies. Moreover, on average, the adoption of IT creates a significant reduction of internal public debt for developing economies. On average, the magnitude of the estimated ATE concerning internal public debt ranges from -4.44 (nearest-neighbor matching, n=2) to -2.73 (nearest-neighbor matching, n=1) percent. In short, the results are robust and show that employing the ATE for matching also reveals that if non-inflation targeting countries had adopted inflation targeting, their external public debts would statistically significantly have been lower both for the advanced and developing economies and their internal public debts would statistically significantly have been lower for the group of developing economies.

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# APPENDICES

Appendix 1: Inflation targeting countries

| **Countries** | **Starting date** | **Countries** | **Starting date** |
|---|---|---|---|
| Australia | 1993 | New Zealand | 1990 |
| Brazil | 1999 | Norway | 2001 |
| Canada | 1991 | Peru | 2002 |
| Colombia | 1999 | Philippines | 2002 |
| Czech Republic | 1997 | Poland | 1998 |
| Hungary | 2001 | Russia | 2015 |
| Indonesia | 2005 | South Africa | 2000 |
| Israel | 1997 | Sweden | 1993 |
| Japan | 2013 | Thailand | 2000 |
| Korea, Republic of | 2001 | Turkey | 2006 |
| Mexico | 2001 | United Kingdom | 1992 |

Sources: Hammod 2011, Roger 2010

Appendix 2: List of control group countries

| | |
|---|---|
| Argentina | Ireland |
| Austria | Italy |
| Belgium | Lebanon |
| China | Malaysia |
| Croatia | Netherlands |
| Cyprus | Pakistan |
| Denmark | Portugal |
| Finland | Singapore |
| France | Slovenia |
| Germany | Spain |
| Greece | Switzerland |
| Hong-Kong | United States of America |

# ESSAY 2

# INFLUENCE OF CORRUPTION IN THE ECONOMY: A PROPENSITY SCORE APPROACH

# INTRODUCTION

Nowadays, numerous countries are engaged in a development strategy; however, some face important difficulties due to an impressive level of corruption. Therefore, to increase development effectiveness, these countries need a better understanding of corruption analysis, particularly its implications on economic growth. Indeed, corruption creates a significant obstacle to economic growth, good governance, and fundamental freedoms.

Corruption occurs on economic, administrative, and political grounds. It can worsen in countries where laws and compliance with regulations are not rigorously observed. Thus, the professionalism and independence of the public sector can lose their rigors, and civil society lacks the means to put pressure on the public authorities.

According to a 2018 Transparency International (TI) publication, the Corruption Perception Index (CPI) reveals that the crisis in democracy around the world can be traced to the chronic inability of most countries to control corruption effectively. The same publication shows that the African continent is the region of the world where corruption is the highest, especially in authoritarian regimes. Democracy once eroded by corruption produces a vicious circle and infiltrates democratic institutions, which becomes ineffective in measuring corruption. In some countries, where democracy is well-established, corrupt practices are difficult and riskier for their actors. The problems of transparency, governance, and public accountability have severely handicapped economic, social and human development, constituting barriers to investment and reducing the country's capacity to optimize the use of its resources and further improve the living conditions of citizens.

The process of globalization requires the reduction of trade barriers, and the ensuing free movement of people, goods, and capital has helped to provide new means and new incentives for corruption worldwide, with a devastating effect on emerging economies. As developing countries take an increasing share in the global economy, multinationals can threaten the integrity of global markets, weaken governance, and foster corruption in developing countries by paying bribes in international transactions.

Economists now admit that corruption, ranging from bribery and extortion to patronage, can have disastrous effects on struggling economies. In poor economies, the problem arises at the social and developmental levels. Due to corruption, many countries in transition suffer from tax and customs revenue losses. Contraband, black-market transactions, and falsified accounting encourage tax evasion. Weak governance and economic backwardness may explain

the extent of corruption (Kaufmann et al., 2005). However, it would be wrong to think that the poorest countries are the most corrupt and the richest are the most uncorrupt. Developing countries are not the only ones affected by corruption. For example, Botswana or Cape Verde score better than Italy or Greece. According to the OECD[11] (2014), almost one in two foreign bribery cases indeed involves "public officials from countries with a high human development index," in other words, from developed countries.

Corruption weakens the ability of the state to do its job. The authorities may be tempted to favor projects that pay bribes to the detriment of those that create economic and social value. It isn't good either for growth or the economic outlook. It damages equity and justice because the poor is the one who suffers most from the reduction in social spending and the money invested in sustainable development. It also harms economic stability because the decrease in tax revenue, combined with the costly use of public funds, is a toxic mixture that quickly degenerates into uncontrollable deficits. Indeed, corruption induces losses of tax revenue: it causes or facilitates tax evasion, fraud, non-payment of taxes by the wealthiest / most connected and generates the growth of the informal economy. The lack of public revenue leads to the reduction of social programs (to the detriment of the most disadvantaged classes) and the maintenance of the poor quality/quantity of public services. Investment in human capital is then weakened (education at a discount, poor health facilities, diplomas purchased, etc.). At the same time, corruption often diverts talents from productive activities towards more lucrative activities.

The most widespread debates among the population on corruption generally concern the implications of this phenomenon on development and collective well-being. Therefore, several market players and different civil society players regularly oppose the real impact of bribes and other illicit practices on economic activity. The intensity and relevance of this debate have not escaped the attention of economic research, which has devoted much attention in particular to the impacts of corruption on economic growth, and in general, on economic development.

Nowadays, corruption has become a concern for all countries without exception. It is often considered one of the reasons for the poor functioning of economic activities in some countries. However, all countries are not corrupted at the same level. According to the different studies, corruption level is high in developing countries and low in developed countries. Therefore, establishing a clear and precise diagnosis of the nature of the relationship between

[11]Organization for Economic Cooperation and Development

economic growth and corruption concerning the level of corruption. To do this, we try to analyze the impact of corruption on economic development.

The investigation of this analysis has been the subject of several studies and continues to arouse the interest of researchers. However, in our research, we will be focusing on using an estimation method different from that already used.

Thus, the objectives sought in this study are: first to examine the treatment effect of the level of corruption on economic growth, second to study the treatment effect of the level of corruption on inflation targeting policy. The originality of this study lies in the use of the PSM method. Indeed, to our knowledge, the relationship between corruption and growth has not yet been investigated employing this methodology.

This study will proceed as follows: the first section of this second essay concerns the approach and evolution of corruption. The second section considers the literature review. The data and the methodology are discussed in the third section. The empirical results are documented in section four. Section five concludes.

## 2.1. APPROACHES AND EVOLUTION OF CORRUPTION

This first section is divided into two main subsections. The first subsection documents the definitions and concepts concerning the notion of "corruption." The concepts corresponding to the concept of corruption will be discussed first. The second subsection highlights the evolution of corruption and its impact on the economy.

### 2.1.1. Definitions and concepts of corruption

Corruption encompasses the misuse of authority and power linked to the public service and the power an individual holds by a given position he deals with in public life. Several different definitions, formulated by various specialists in the subject, have been proposed. However, according to the 2019 Corruption Perception Index (CPI) report, an impressive number of countries show little or no signs of improvement in the fight against corruption. The dominant perception about corruption is, therefore, a growing phenomenon. Therefore, understanding corruption is a challenge for several reasons.

TI defines corruption as the abuse of private or public power to satisfy special interests. At the same time, the World Bank Group (WBG) definition places the public sector at the center of the phenomenon.

For development agencies, corruption is defined as misusing public power for private ends. Also, described as "the misappropriation of public power for private gain" (Klitgaard, 1988; Bardhan, 1997; Gray and Kaufman, 1998; Rose-Ackerman, 1999; Lambsdorff, 2007), corruption is a multifaceted concept with several reasons and consequences (Aidt, 2003).

Corruption is, above all, a problem of governance, which leads to the failure of institutions and the inability to manage society based on a system of social, legal, political, and economic checks and balances. It can concern all kinds of people using a decision-making power, whether a politician, an executive of a private company, a civil servant, a trade unionist, a teacher, an arbitrator or an athlete, a doctor or the entity in which they belong. Also, corruption can be seen as the misuse of state property by a public servant for personal gain (Alesina and Weder, 2002). The act of corruption can be initiated either by a state official or by a public service user. Lui (1996) clarifies that state ownership can take the form of an import license, a passport, a regulatory provision, the award of public contracts, tax services, etc. This approach to corruption is shared by Mishra (2005), who believes that corruption is a phenomenon that is an integral part of the human person.

Based on the most recent definitions of corruption, we see two distinct facts: the illicit use of delegated power and the pursuit of private gain. Indeed, for the World Bank, corruption is the act of using one's position as head of public service for one's benefit. It occurs when the person directly responsible for a modification of this structure obtains in return a personal advantage, monetary or not, from the beneficiaries. However, it is difficult to find a complete and common definition of corruption. No description satisfies its different practices and forms in each country and over time.

Besides the plurality of definitions, there are typologies of corruption. Thus, we can cite, for example:

- ***Petty corruption and Grand corruption***

What Chand and Moene (1999) qualify as petty corruption refers to bribes or advantages given to a public official to obtain the application or non-application of regulation within the framework of public service. According to the IMF in 2017, the cost of bribes paid each year globally is between $ 1.5 trillion to $ 2000 billion, almost 2% of global GDP. Grand corruption, for its part, can be understood as the creation, application, or manipulation of regulations by high-level institutional actors, to capture private income from collective wealth transfers (Krueger, 1974).

- ***Legislative corruption***

It is the responsibility of parliamentarians and relates to the biased process of creating or amending laws. In other words, more comprehensively, political corruption concerns any form of corruption originating from a politician, elected, or appointed (Delavallade, 2007).

- ***Active and passive corruption***

There would be a distinction between proposing corruption and accepting corruption for judicial institutions. Thus, more broadly, the OECD defines active corruption as the fact of making, at any time, indirectly or directly offers, donations, promises, gifts or benefits of any kind, to obtain from a person in charge of a function, a mandate, or a mission, that he refrains from performing or performs an act of his function, its mandate or mission, or facilitated by its function, mandate or mission. In this sense, passive corruption is claiming and receiving these different advantages.

- ***Domestic and Foreign corruption***

According to Montigny (2006), national corruption concerns corrupt transactions between residents of the same state, while foreign corruption brings together a corrupter and a bribe located in different countries. By the late 1990s, most of the export of bribes fell to rich, OECD member countries. According to Montigny (2006), it was possible to regularize bribes in foreign markets through national regulations. Like France, tax authorities could declare cases as "extraordinary costs" sales and were tax-deductible.

According to Anjara (2018), the notion of corruption remains subjective. Indeed, we can differentiate between active corruption, which consists of offering service or money to a person holding power in exchange for undue advantage. In contrast, passive corruption consists of accepting this money or service offered or requested. Furthermore, Celentani and Ganuza (2002) have carried out studies that show that corruption also exists in the form of exchange, a favor or ease in the public service, or a privilege against a monetary bribe or another mutual favor.

### 2.1.2. The microeconomic approach of corruption, according to Becker (1968)

From an economic point of view, corruption gets its specificities from the interweaving of two contracts with divergent objectives. Defined by Jacquemet (2014), corruption is an illegal agreement, or corruption pact, binding an agent to a corrupter and intended to organize the misuse of discretionary power. The agent inherits this discretionary power from a delegation contract concluded with a principal.

According to the approach initiated by Becker (1968), there is illegal behavior on an agent as soon as the value of honesty exceeds that of illegality. The fixed salary "w" received from the principal and the agent's preference for honesty, "θ," which represent the set of non-monetary profits associated with legal behavior (good conscience or esteem of those around them) are among others the determinants of the value of honesty. In matters of corruption, the profit of illegality on the agent's side consists of receiving a bribe, noted "a." Suppose he is unable to control the agent's behavior through wage incentives. In that case, the principal can implement a monitoring mechanism, whereby the illegality is revealed to him with a probability "p." Thus, the agent in question undergoes a sanction that is assimilated to a definitive termination of the contract in the simplest form of the model. This situation results in the loss for the agent of the salary and obtains his external wage, "$w_0$".

By taking the founding model of Becker & Stigler (1974), we see that these hypotheses correspond to it. Indeed, an agent decides to be corrupted if the value of corruption exceeds that of honesty, meaning that: $\theta + w < (1-p)(w+a) + pw_0$ :

$$\theta + p(w - w_0) < (1-p)a \tag{2.1}$$

Given the density of types within the agent population, this condition characterizes the weight of corrupt agents, "y", as a function of the principal decisions:

$$y = P[\theta < (1-p)a - p(w - w_0)] = G[\theta^*] \tag{2.2}$$

Where $\theta^*$represents the level of preferences for honesty at which agents refrain from practicing corruption and $\theta^* = (1-p)a - p(w - w_0)$.

From the results in this section, the level of bribery is exogenous. With such an assumption, the comparative statics of the weight of corrupt agents make it possible to evaluate the effectiveness of the instruments to fight against corruption. The spread of corruption within the organization is indeed shown to decrease in the probability of detection as in the relative salary: $y = y[p, (w - w_0)]$.

From this result emanates an extensive literature, analyzing the capacity of control (p) and incentives (w - $w_0$) to deter corruption. In addition, the arbitration condition that determines the agent's decision is all the more "paramount" as the preference for honesty, θ, is strong.

### 2.1.3. The situation of corruption in the world

As for the embezzlement of public funds represents some 2,600 billion dollars or more than 5% of world GDP. The annual cost of corruption within the European Union, published in

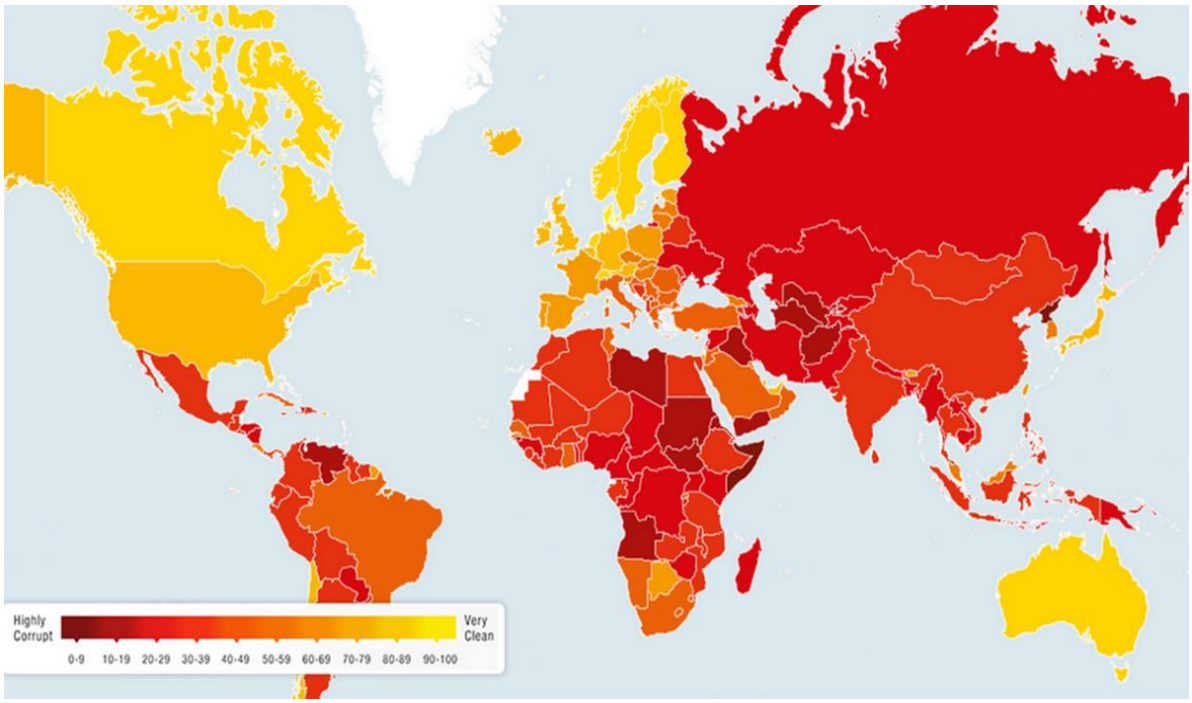
a report by the European Parliament in 2016, is in the range of 179 and 990 billion euros, or 6.3% of European GDP. The cost of corruption in public procurement is estimated at 5 billion euros per year. The most affected countries are Croatia, Cyprus, Lithuania, Romania, and Poland.

As Daniel Kaufmann explained: “We know that in countries where corruption is endemic, embezzlement can be a severe problem. For example, if we limit ourselves to the highest authorities of the countries, the organization TI estimates that former president Suharto of Indonesia stole between 15 and 35 billion dollars. Ferdinand Marcos in the Philippines, Abacha in Nigeria, and Mobutu in former Zaire have embezzled around $ 5 billion [12]”. According to the UN, corruption leads to "less prosperity, less respect for rights, fewer services and fewer, fewer jobs."

Transparency International has just published its annual report on corruption in the world. The latter assesses the level of corruption perceived in the public sector in 180 countries, on a scale of zero (highly corrupt) to 100 (very virtuous). Last year, 2/3 of the countries surveyed scored below 50, and the average score was only 43 out of 100, which underscores that corruption remains an endemic problem around the world.

As noticed in Graph 1, the world map is almost covered by the red color representing the perception of the highly corrupt countries, and the more it is yellow, the more it is close to being a clean country.

[12]Daniel Kaufmann, former director of the governance program of the World Bank, in a note published in 2013




**Graph 1:** Situation of corruption (2019)

Source: Transparency International

Also, figure 6 represents the different levels of perception of corruption in the different regions of the world.

According to the figure, the Western Europe and European Union countries are well-performing for the all period. Indeed, this part of the world records the best results in corruption, with an average score of 66. This result is achieved thanks to certain countries such as Denmark (88) and 85 for Sweden, Finland, and Switzerland. However, countries like Hungary, Romania, and Bulgaria end up with 44 each.

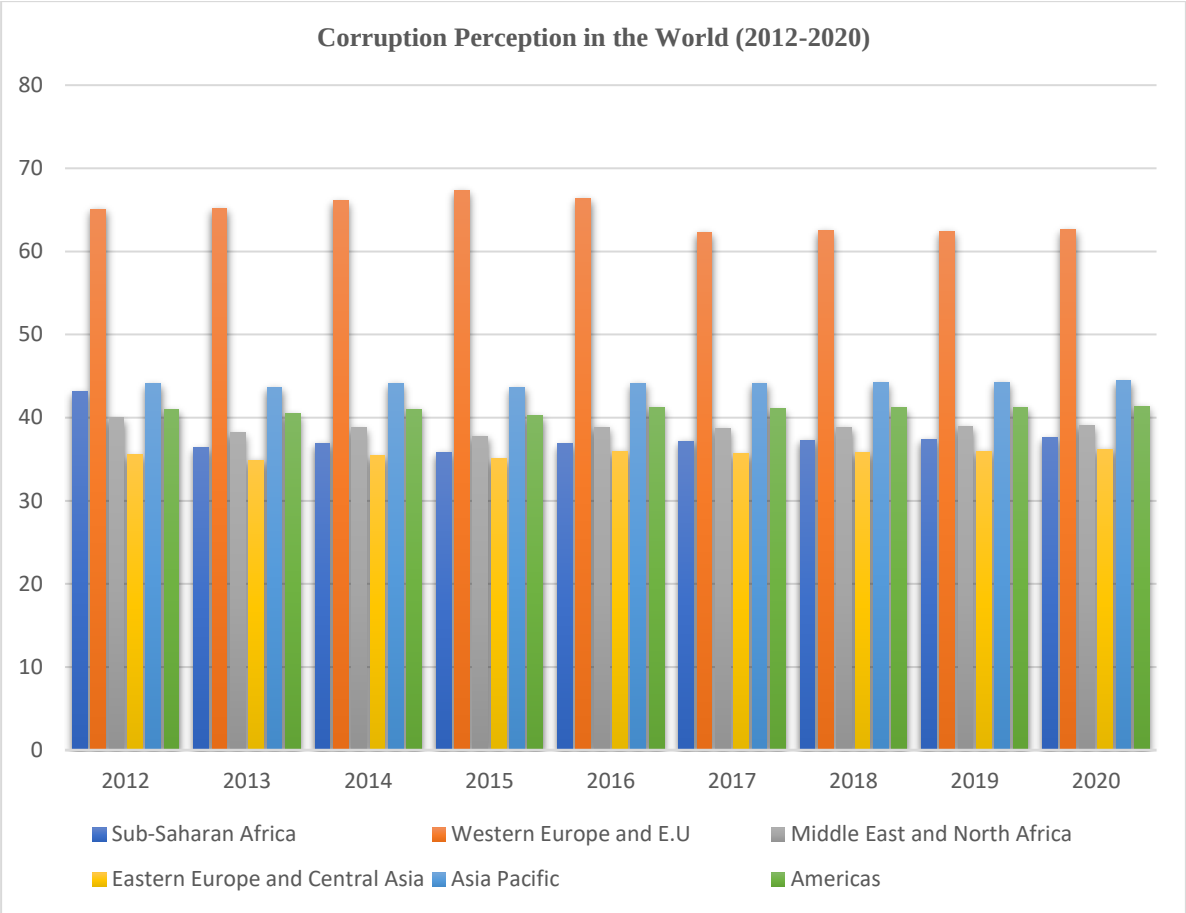



**Figure 6**: Corruption perception

Despite a score below the general average in the Asia-Pacific region, New Zealand is among the countries with a strong performance in the world with a score of 88. Recall that the region's average is 45, with countries like North Korea and Afghanistan scoring 18 and 19, respectively.

The Americas region has for the 5th consecutive time an average score of 43 in 2020. This low score represents the level of corruption and mismanagement of funds. Only Uruguay and Canada are the best performers in this group, with 71 and 77 respectively, while the "bad guys" are Venezuela, Haiti, and Nicaragua with a score of 15, 18, and 22 respectively.

The second worst performing region after sub-Saharan Africa is Eastern Europe and Central Asia, with an average of 36.

Sub-Saharan Africa is no slouch when it comes to corruption. Indeed, as shown in Figure 6, this region is, on average, the least efficient with a score of 32. However, this region is guided by good performances of countries like Seychelles with 66, Botswana and Cabo Verde with 60 and 58 respectively. On the other hand, South Sudan and Somalia lag behind each with 12 as an average score, and Sudan, which is doing with 16.

In general, we can see that except for the European Union and the region of Western Europe, all the other regions have an average of less than 50/100. That shows how corruption is a universal phenomenon.

## 2.2. LITERATURE REVIEW

In this section, we first explore the theoretical literature and then cite the various works that have had to analyze the dependence between purely institutional variables and economic growth.

### 2.2.1. Theoretical literature

In a microeconomic approach, the pioneering work attempted to model the rationality of corrupt behavior. A large part of contemporary corruption models is then based on the theory of Akerloff's agency (1970) and his ability to explain the biases resulting from the information asymmetry in the relations of delegation of power within organizations.

In the same sense as this theory, Jacquemet (2005), following a contractual approach, will propose a model analyzing corruption as an interweaving of two contracts with contradictory motivations. Moreover, Becker (1976), by examining the problem of utility maximization posed by corruption, proposes a formalization of the economic reasoning of an economic agent in the face of corruption. This model, known as the economic calculation of corruption, highlights the determinants of refusing or accepting corruption.

Banfield (1975) is the first to use the agency model to explain corruption in public organizations. Considering the particular case of a delegation of power within a public administration, the principal-agent-client model explains the inefficiency of particular public administrations by the information asymmetry, which prevails in the relations between the three actors of the model.

Some studies have looked at the effects of corruption on economic activity as measured by economic growth. On the theoretical level, relevant works have following different approaches, formalized the effect of corruption according to the theory of endogenous growth (Ehrlich and Lui, 1999; Blackburn et al., 2002; Mothadi and Roe; 2003) or within different neoclassical-inspired growth models (Schleifer and Vishny, 1993; Banerjee, 1997; and Acemoglu & Verdier, 2000). These approaches highlight the potential barriers of corruption on the classic growth factors that are exogenous technical progress and savings and on the

endogenous growth engines that are the improvement of private capital through the externalities of public spending or improving human capital through learning and education.

Thanks to Klitgaard (1988) study on the conditions for the occurrence of corruption at the country level, the understanding of the phenomenon of corruption at a macroeconomic level has been initiated. With econometric advances, this approach will thus be fueled more by empirical work, making it possible to identify the sources of corruption revealing themselves through the experiences of the world's various economies. Therefore, a study on corruption cannot be done without understanding the main microeconomic models, the determinants they highlight, and the sources of corruption emerging from empirical work carried out in different countries.

### 2.2.2. Empirical literature

Several empirical studies on the correlation between corruption and economic growth have been carried out in recent years. Indeed, corruption can impact economic growth through its effect, either on the composition of public expenditure or on human capital or investment formation.

The first works relating to corruption in economics go back to authors such as Klitgaard (1988), Rose-Ackernam (1989). However, the first empirical evaluation on the question dates back to the study of Mauro (1995). This author highlights the harmful nature of corruption on growth and investment. The purpose of his research is to identify the mechanisms through which corruption can impact economic growth and quantify the degrees of these effects. To reach this goal, he analyzes a database developed by "Business International"[13] on a set of countries which includes 70 economies during the period (1980-1983). This database is formed by indices of corruption, bureaucracy (red-tape) of the efficiency of the judicial system, and the degree of political stability.

The relationship between corruption and economic growth has been at the center of much scientific research. Collier (2000) states that corruption can allow, for example, unprofitable companies (on the verge of bankruptcy) to continue to exist and to benefit from government subsidies. Such practices render a large part of public spending inefficient. The author then concludes that a high level of corruption obstructs economic growth through spending. This relationship is evident in many countries in Europe and Asia.

[13]Business International based on questions filled in by its local correspondents and whose value is between 0 (high level of corruption) and 10 (high level of probity).

Seka (2005) assesses the effect of corruption on the growth and accumulation of human capital. He proves that corruption negatively affects human capital accumulation and constitutes a brake on economic growth.

Davoodi and Tanzi (1997) empirically show a significant negative correlation between public revenue and corruption, making it more difficult for governments to finance their public spending. That is seen as an indirect negative effect of corruption on infrastructure via reducing State resources. However, it also happens more directly that corruption, especially political corruption, distorts public spending. Tanzi and Davoodi (2001) show that such distortions artificially increase infrastructure spending, very often without the said infrastructure meeting an expressed need, thus creating a waste of public resources. That can often explain the large amounts of investment projects, typically involving more rents diverted and more opportunities to get bribes than operating expenses. That brings Davoodi and Tanzi (1997) to conclude from an empirical study that the quality of public infrastructure is called into question because of corruption. The higher the public investment, the greater the negative effects of corruption on infrastructure productivity. However, Ades and Tella (1999) show in their study that this thesis does not hold in some geographic regions. Indeed, they show that companies consolidate their competitiveness on the market and derive income from rent situations in an environment of high corruption.

Foreign direct investment and corruption have also been the subject of several studies. Indeed, in one study, Wei (1997) concluded that an increase in the CPI by a single point reduces the inflow of foreign direct investment by about 11 percent. Another study by Wei (1997) shows that the unpredictability of corruption also has a negative effect on FDI. Finally, according to Baliamoune-Lutz and Ndikumana (2007), corruption has a negative and significant effect on domestic investment. The reluctance of private investment stems from the fact that corruption drives up the costs of doing business while increasing uncertainty about expected returns on capital.

Researchers consider inequality and poverty as corruption determinants. Indeed, Mukherjee et al. (2002), for their part, find a negative correlation between corruption and the Gini index in that the more corruption increases, the less egalitarian the economy is. Likewise, Gymiah-Brempong (2002) finds the same conclusion for African countries.

Other empirical studies have targeted a particular type of corruption resulting in tax evasion within the economy—for example, the presence of corrupt tax officials. Indeed, they

have a discretionary power that they can abuse in return for certain advantages by their powers. The results obtained by Barreto and Alm (2003), who are interested in the structure of taxes in a corrupt environment, suggest that the optimal tax policy should focus more on taxes on consumption than on taxes on income. Along these lines, Imam and Jacobs (2007) show that some taxes such as tariffs are more affected by corruption. It is important to notice that fiscal policies are rather peculiar in developed countries than in developing countries (Gordon and Li, 2009). Indeed, developed countries not only derive their fiscal resources from taxes on income but also on consumption. In contrast, they rely more on taxes on consumption than on income in developing countries.

Mukherjee et al. (2002) state that the level of health and education of populations are generally the result of the quality and quantity of expenditure in the health and education system. Thus, the analysis of the effect of corruption on training human capital can be considered through its effect on education and health spending.

Despite the intentional finding that corruption can be harmful to growth, some studies by some authors claim that corruption can be beneficial for the economy. Indeed, according to Lui (1974), corruption may be a desirable action since it saves time for those seeking public services and may encourage corrupt officials to be more efficient and to take decisions more quickly. Moreover, in an environment of corruption, the corrupt earn more than they should have, which prompts them to produce more, thus increasing the marginal productivity of their labor input. Thus, the bribe paid constitutes a guarantee of effectiveness (Beck and Maher (1986)).

Corruption can also be a source of efficiency in removing rigidities imposed by the State that hinder investment. Similarly, Leff (1964) argues that corruption avoids administrative rigidities and “greases” the bureaucracy's functioning.

The literature on corruption within the tax administration sometimes presents corruption as an exemplary act that would improve the behavior of officials in terms of fiscal discipline. Indeed, corruption is beneficial to the economy because it is the basis of mechanisms to encourage the work of tax officials (Mookherjee, 1997). However, some authors such as Fjeldstad and Tungodden (2003) point out a limit to this reasoning because the flip side is that, when there are incentive mechanisms for tax collectors, it can lead them to increase the income amount of bribe for not reporting tax fraud. According to Chen (2003), tax evasion would push

the state to apply a higher tax rate than it would have been without tax evasion. Such action aims to compensate for the loss of revenue associated with the escape to ensure public services.

The interest of this research is the most significant number has been to determine whether this relationship (economic growth and corruption) has a negative or virtuous character. In this regard, many theories and empirical studies are highlighted, leading to a divide between the proponents of the theory of positive corruption for economic growth and the advocates of the negative effects of corruption.

## 2.3. METHODOLOGY & DATA

In this section, we first present the methodology used in this study. To our knowledge, this methodology is employed for the first time to analyze the relationship between corruption and economic growth. Next, we explain the data used in the study according to the vast literature.

### 2.3.1. METHODOLOGY

The propensity score refers to the probability of being exhibited to treatment according to a set of observable characteristics. This method is widely used in quasi-experimental research in economics. PSM refers to matching individuals from the control and treated groups with similar propensity score values and excludes unmatched individuals. Matching methods attempt to match each treated individual with one or more untreated individuals whose observable attributes are as similar as possible.

#### *2.3.1.1. The Propensity Score*

The objective of our analysis is to determine the relationships between the level of corruption and different macroeconomic indicators. This study uses the Propensity Score Matching method, which is popular for causally estimating the effect of exposure on an outcome using observational data (non-randomized data). The propensity score methods are particularly useful in the case of a relatively rare binary outcome. In this case, it might be difficult to fit in the traditional way for several adjustment variables within an exposure-outcome model (Baycan, 2016).

Assessing the effect of corruption on economic growth requires assuming the level of growth that would have been observed if countries were less corrupt. However, since we cannot observe (because the corruption variable here is qualitative and is considered a perception) each

country's level of economic growth in the case where these countries were less corrupt, the establishment of the occasional effect becomes an inference problem with the missing data.

For more precision, let $C_{i1}$ and $C_{i0}$ denote the level of growth of country *i* (variable result or response) conditional on the absence and presence of treatment (corruption), respectively. $D_i$ is a participation variable that identifies whether the country is one of the "treated" countries, that is, if the country is less corrupt ($D_i$ = 1) or more ($D_i$ = 0).

$$\Delta_i = C_{i1} - C_{i0} \tag{2.3}$$

The observed economic growth for country i is given by: $C_{i=}C_{i0} + D_i(C_{i1} - C_{i0})$, with only one possibility of observation of $C_{i0}$ and $C_{i1}$ at any given time. We are interested in estimating all the individuals treated. The most common parameter in the evaluation literature is referred to as the effect of the treatment on the treated:

$$E[(C_{i1} - C_{i0}|D_i = 1), X_i]. \tag{2.4}$$

The problem of evaluation in social experiments is, in principle, solved by random assignment to participation. That guarantees that the potential results are independent of the attribution mechanisms. Then,

$$E[(C_{i0}|D_i = 1), X_i] = E[(C_{i0}|D_i = 0), X_i] \tag{2.5}$$

However, the finding is that in the case of observational studies, attribution is not random. Indeed, it results in either a selection made by a program manager, from an individual self-sorting or both. The fundamental assumption in the matching is the conditional independence assumption, which states that the treatment attribution ($D_i$), conditional on the attributes ($X_i$), is independent of the level of growth ($C_{i0}$, $C_{i1}$). It corresponds to:

$$(C_{i0}; C_{i1}) \perp \ D_i|X_i \tag{2.6}$$

Where ⊥ represents independence.

That means that, given $X_i$, one can use the growth level of non-participants to approximate the (counterfactual) growth level of participants who did not participate. Thus, the matching consists in finding, for each observation treated, a set of untreated statements with the same realization of $X_i$.

In practical implementation, a problem arises when the vector $X_i$ is highly dimensional and contains continuous variables. To solve this problem, Rosenbaum and Rubin (1983) show that the propensity score $P(X_i) = \Pr(D_i = 1|X_i)$ is sufficient to balance the $X_i$ covariates between the processing and the control units.

Thus, if the conditional independence assumption is conditional on $X_i$, it will also be conditional on the propensity score,

$$(C_{i0}; C_{i1}) \perp \ D_i | P(X_i) \tag{2.7}$$

For empirical content, the matching also requires:

$$0 < P(X_i) = \Pr(D_i = 1 | X_i) < 1 \tag{2.8}$$

The matching technique eliminates two of the three sources of selection bias that Heckman et al. (1998) identified. These are, among other things, the bias that results from having different $X_i$ distributions on their common support, and that from having different $X_i$ ranges for the treated and control samples. The matching hypotheses exclude the remaining one; it is about the differences in the unobservable between the groups. Based on the matching hypotheses, the effect of the treatment on the treaty is as follows:

$$\sum_{i \in D=1} n_i (Y_{i1} - \sum_{j \in D=0} N_{ij} Y_{j0}) \tag{2.9}$$

With $Y_{j0}$ and $Y_{i1}$ representing a generic result, for the comparison and treatment groups, respectively; $n_i$ representing the adequate weight for the final processed sample; $N_{ij}$ controls the weight placed on each comparison observation j for individual i.

#### *2.3.1.2. Matching*

The most natural estimator is the average effect of the measure on those who benefited from it, i.e., the treatment effect on the treated (Average Treatment effect on the Treated or ATT in the following). Formally, it is written:

$$\Delta^{ATT} = E(C_{i1} - C_{i0} | D_i = 1) \tag{2.10}$$

Beyond the measure's effect on the beneficiaries alone, one wonders what the effect of this measure would be if it were extended to the entire population. It is then a question of estimating the average effect of the treatment on the whole of the population (Average Treatment Effect), or formally:

$$\Delta^{ATE} = E(C_{i1} - C_{i0}) \tag{2.11}$$

A multitude of different matching schemes is possible. A proximity criterion, a neighborhood, and the selection of a suitable weighting function are defined for each scheme to associate the set of unprocessed observations with each participant. The objective of the matching is to build a control group compared to the treated group to allow an unbiased estimate of the effect of the treatment on the treated individuals, controlling for selection bias (Smith & Todd, 2001; Dehejia & Wahba, 2002; Imbens, 2004; Dehejia, 2005; Abadie & Imbens, 2005;

Caliendo & Kopeinig, 2008). Consequently, there are different match estimators, the main ones presented below.

*a) The Nearest Neighbor Matching*

That is the most widely used matching method. A participant from the treated group is matched with a participant from the control group based on the closest propensity score. However, Nearest Neighbor Matching is not always efficient, especially when the Nearest Neighbor is far from the treated individual to be matched. Disparate individuals can then be matched. Therefore, from a practical point of view, it is advisable to order the data randomly before matching.

*b) The Caliper (or Radius) matching*

A participant in the control group is matched with a participant in the treated group based on the closest propensity score, subject to a certain maximum distance, the caliper. Treated individuals for which the untreated Nearest Neighbor does not belong to the defined region are excluded from the analysis. The caliper is at the analyst's discretion; therefore, there is no method for determining the "reasonable" level of tolerance to choose. The smaller the caliper, the more similar the matched individuals will be, but the number of unmatched individuals will increase. It is generally recommended to test different versions of the caliper and conduct sensitivity analyses according to the different sizes of the caliper.

*c) The Kernel Matching*

The kernel matching approach uses a weighted average of all untreated observations to construct the counterfactual match for each treated observation.

### 2.3.2. DATA

The data used in this study are all secondary sources, mainly from the World Bank's annual publication (WDI). The data used is annual data for 46 countries covering 1995-2019. We need to recall that this study uses the propensity score matching with a sample of emerging countries[14]. Corruption, a qualitative variable, is arduous to measure because of its nature. This difficulty prevents giving a precise classification of countries according to their relative degree of corruption. Indeed, there are several measures of corruption.

[14]Combination of developing and emerging countries.

#### *2.3.2.1. The Politiqua Risk Services index*

The group "International Country Risk Guide" (ICRG), since 1982, published the estimated level of the economic, political, and financial risk of classification for 140 countries based on the evolution of the experts. The Politiqua Risk Services (ICRG) index ranges from 0 (most corrupt) to 6 (less corrupt). According to the group, senior government officials demand illegal payments in bribes, especially in the public sector.

#### *2.3.2.2. The Corruption Perception Index from Transparency International*

Since 1995, this non-governmental organization has used the CPI, which varies between 0 (more corrupt) and 10 (very honest). The CPI defines corruption as the abuse of public office for enrichment and focuses its attention on corruption in the public sector.

#### *2.3.2.3. The International Business Corruption Perception Index*

This international trade organization produces several institutional indices. Its index (BI) indicates the degree of business transactions involving corruption and doubtful payments and is based on the development of experts, not investigations. The BI adopts the same methodology used by the TI in the country rankings.

#### *2.3.2.4. Corruption Control according to the World Governance Indicators*

Kaufmann, Kraay, and Mastruzzi (2005) developed corruption control as an institutional (governance) indicator with more sources than other TI or Politiqua Risk Services indices. This one-year World Bank indicator is constructed solely from data collected during the year in question. At the same time, the TI index uses data from previous years. One of the peculiarities of this index is that it uses data measuring both the incidence of corruption in general and petty corruption or even control of the state.

In our study, it is the latter measure of corruption that is used. Indeed, as stated above, this indicator ranks countries on a scale from -2.5 (very corrupted) to 2.5 (not less corrupted). However, it should be noted that in the context of our research, we carried out an average over the entire period studied to classify each country (either corrupted or not very corrupted). Then, the country with an average value from 0 to 2.5 is considered not very corrupt, while the country with an average value from -2.5 to less than 0 is considered very corrupt. Since the corruption control is the binary variable, the treated group will take the value 1 and 0 if not.

The other variables used are the logarithm of GDP per capita, Foreign direct investment (FDI), domestic investment (Gross fixed capital formation), the level of government

consumption (GGFCE), Unemployment, and Trade. In addition, inflation targeting has been used as a dummy variable. The list of countries included in the dataset can be found in Appendix 1.

Table 15 below is a summary of the different variables that are used for this study. Recall that many countries have been removed due to the unavailability of the data.

**Table 15**: *Summary of the measures of the variables used in this estimate*

| Variables | Description | Sources |
|---|---|---|
| Control of Corruption (CC) | Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including petty and grand forms of corruption and "capture" of the state by elites and private interests. Estimate gives the country's score on the aggregate indicator, in units of standard normal distribution, i.e., ranging from approximately -2.5 to 2.5. | World Governance Indicator (WGI) |
| FDI | Foreign direct investment net inflows (% of GDP). Foreign direct investment is the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. | WDI |
| Real Gross Domestic Product per capita (GDPP) | Log of real GDP per capita in constant U.S. dollar. | WDI |
| Gross fixed capital formation (GFCF) | Gross fixed capital formation (% GDP) includes land improvements (fences, ditches, drains, and so on); machinery, plant, and equipment purchases; and the construction of railways, roads, and the like, including offices, schools, hospitals, private residential dwellings, and commercial and industrial buildings. | WDI |
| Unemployment | The unemployment rate refers to the share of the labor force out of work but available and looking for a job. | WDI |
| GGFCE | General Government Final Consumption Expenditure | WDI |
| Inflation targeters (IT) | Used as a dummy variable. Taking value if the country adopted IT policy and 0 if not. | Author |
| Trade | Trade represents the sum of exports and imports of goods and services measured as a share of gross domestic product. | WDI |
| Gini | Gini index. Data are based on primary household survey data obtained from government statistical agencies and World Bank country departments. In this study, Gini represents poverty. | WDI |

Source: WGI, WDI, Author

## 2.4. EMPIRICAL RESULTS

This section presents the different results obtained before and after estimating the PSM. The first subsection shows the characteristics of the other variables used through the results of the descriptive statistics. Then, the second subsection is about the estimate of the PSM with economic growth as the dependent variable. Finally, the last subsection concerns estimating the propensity score matching with inflation targeting policy as the dependent variable.

### 2.4.1. Descriptive statistics

The descriptive statistics of the variables considered for this study are presented below. According to the results, most macroeconomic indicators are better. Indeed, some variables such as foreign direct investment and final consumption expenditure of the general government are better on average. In addition, the value of the GDPP variable is on average higher in emerging countries, which reflects the dynamics of these countries, which generally have the highest growth values.

**Table 16**: *Descriptive statistics*

| | Emerging countries | | | | |
|---|---|---|---|---|---|
| Variable | Obs | Mean | Std. Dev. | Min | Max |
| TREAT | 1,325 | 0.245 | 0.43 | 0 | 1 |
| lnGDPP | 1,325 | 4.371 | 14.846 | -14.379 | 280.131 |
| GGFCE | 1,325 | 13.145 | 5.477 | -14.268 | 30.069 |
| GFCF | 1,325 | 23.129 | 8.284 | 2.781 | 69.672 |
| Gini | 1,325 | 37.983 | 13.702 | 1.933 | 67.85 |
| Trade | 1,325 | 66.707 | 32.264 | 15.635 | 168.24 |
| Unemployment | 1,325 | 18.42 | 32.078 | 0.398 | 169.491 |
| FDI | 1,325 | 652.485 | 378.474 | 1 | 1311 |
| IT | 1,325 | 0.433 | 0.495 | 0 | 1 |

### 2.4.2. Estimates of propensity score matching (with economic growth as dependant variable)

This section is divided into four subsections. First, we present the results of the propensity score. Second, we examine the matching results using the ATT method. Third, we provide the results for the matching using the ATE method. Fourth, we use sensitivity analysis for the robustness check.

The propensity score is estimated using a probit model to decide which variables should be included in this model.

$Pr$(low corrupted=1) = $f$ (GFCF, Unemployment, FDI, GGFCE, Trade, Gini) (5)

In equation 5, low corrupted refers to a binary treatment indicator. The probit model is used for this estimation. The variable corruption control (CC) is employed as the binary

variable, taking the value 1 if a country is considered low corrupted and 0 if the country is highly corrupted[15]. GDPP represents the dependent variable.

#### *2.4.2.1. Propensity Score results for economic growth*

Table 17 presents the propensity score ratio according to the probit regression results; in other words, it demonstrates the probable outcomes of being a low corrupt country. Our results from the propensity score analysis show that being a country with a low level of corruption is not random. The conditional probability of a low corrupt country is significantly affected by FDI, domestic investment (GFCF), Unemployment, Gini, GGFCE, and Trade.

The FDI is positively correlated with the low level of corruption. This should be because, in a certain threshold of corruption in emerging countries, it eases the flux of foreign investment in a case of rigid administration. Generally speaking, empirical research finds a negative effect of corruption on international trade. Our findings show a positive correlation between Trade and corruption, meaning that the higher the tariff and/or non-tariff barriers in these countries, the more corruption would appear as a means that could facilitate trade since they would contribute to overcoming these obstacles. The level of domestic investment positively correlates with corruption, meaning that corruption might "grease the wheel," as some studies show (Wedeman, 1997; Huang, 2016). In other words, corruption might make it easier to create and do business in countries with excessive bureaucracy and regulations. The income inequality represented in this study by the Gini index shows a positive sign. Such a result can be explained by the fact that the countries with low-income inequality are probably less corrupted. Gupta and al. (1998) state that high corruption may lead to increased poverty in the same vein. The coefficient calculated for unemployment is positive and significant, showing that countries with low unemployment tend to be less corrupt.

With corruption at the state level, limits are placed on the government to carry out the budget and spend money for current consumption. According to Table 17, the corruption perception index has a statistically significant positive relationship with final consumption expenditure (GGFCE).

[15]Recall that we used the average of the corruption control variable for each country, and if the average is below (negative sign and up to -2.5) zero, then the country is considered as corrupt and if the average is above (positive sign and up to 2.5) zero, it is a low corrupt country.

**Table 17**: *Propensity scores results*

| Variable | Emerging countries | |
|---|---|---|
| | **Coef.** | **Prob** |
| **GFCF** | 0.04***<br>(0.005) | 0.000 |
| **GGFCE** | 0.05***<br>(0.01) | 0.000 |
| **Gini** | 0.01**<br>(0.004) | 0.008 |
| **FDI** | 0.0006***<br>(0.0001) | 0.000 |
| **Unemployment** | 0.04***<br>(0.003) | 0.000 |
| **Trade** | 0.003*<br>(0.001) | 0.046 |
| **_cons** | -4.49***<br>(0.32) | 0.000 |
| **N. of obs** | **1325** | |

Note: Standard errors in parenthesis; *, **, and *** indicate the significance level of 10%, 5%, and 1%, respectively

Figure 7 shows the numerical densities of low corrupt and high corrupt countries according to their propensity score ranges. In the Figures below, the horizontal section indicates the propensity score range, while the vertical section indicates the number of countries. The red blocks in the upper part of the horizontal line indicate the density distribution of the propensity scores for the country group of low levels of corruption. The blue blocks represent the density distribution of the propensity scores for high corrupt countries. The Figure indicates that propensity scores are overlapped, and common support is provided.

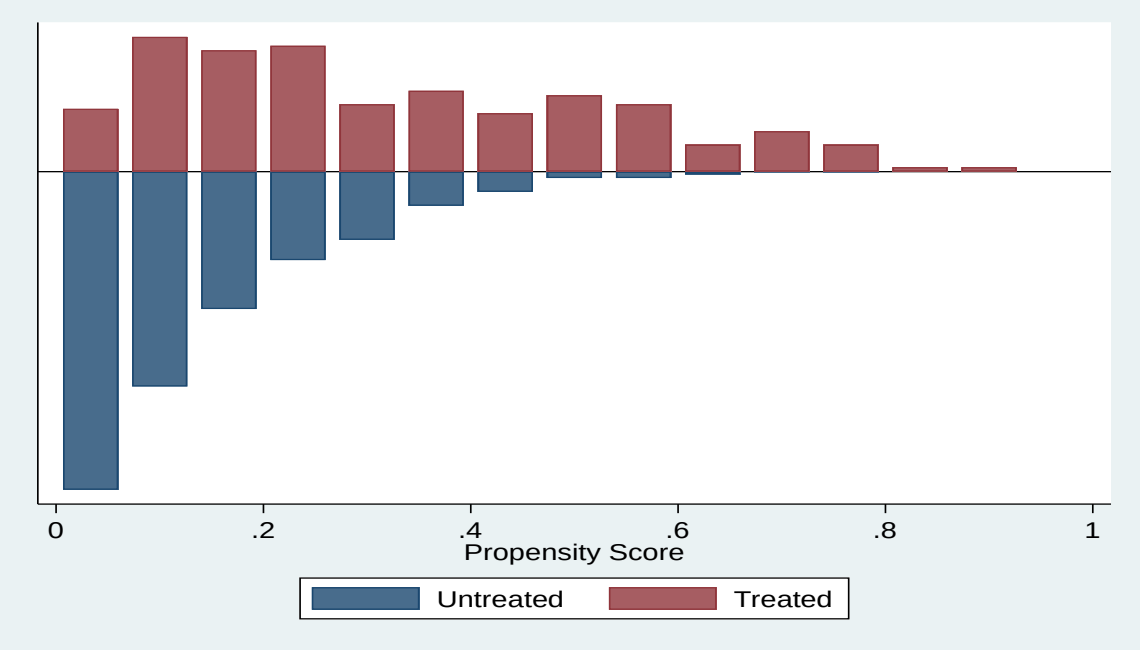



**Figure 7**: Common Support Graph for Emerging Countries

#### *2.4.2.2. ATT Matching results*

Table 18 presents the matching results of the treatment effect's impact on economic growth, according to the different matching estimator techniques (Radius matching, Nearest-Neighbor matching, and Kernel matching). Based on the results, the impact of the ATT on economic growth is negative and is statistically significant for all of the matching techniques. The applied matching analysis shows that a low corrupt country leads to economic growth with a negative relationship. Tanzi (1998), Zhao et al. (2003), and Aidt (2003) have supported that corruption is negatively correlated to economic growth. On average, the amplitude of the estimated ATT on economic growth ranges from -0.23 (radius matching, r=0.01) to -0.15 (Kernel matching) percent. There is robust evidence that being low corrupt countries have quantitative and statistically significant effects on increasing economic growth. In other words, if low corrupt countries were highly corrupt, their economic growth would have been, on average, at least 0.15 percent lower.

**Table 18**: *ATT Matching results*

| | Emerging countries | | | | | | |
|---|---|---|---|---|---|---|---|
| Matching techniques | Nearest neighbor matching | | | Radius matching | | | Kernel matching |
| | n=3 | n=4 | n=5 | r=0.01 | r=0.02 | r=0.05 | |
| r(att) | -0.18*<br>(0.10) | -0.20*<br>(0.10) | -0.21**<br>(0.09) | -0.23**<br>(0.08) | -0.17*<br>(0.10) | -0.15*<br>(0.08) | -0.15*<br>(0.08) |

Note: The bootstrapped standard errors with 100 replications in parenthesis; *, **, and *** indicate the significance level of 10%, 5%, and 1%, respectively

Figure 8 shows the numerical densities of low corrupt and high corrupt countries according to their propensity score ranges. In the Figures below, the horizontal section indicates the propensity score range, while the vertical section indicates the number of countries. The red blocks in the upper part of the horizontal line indicate the density distribution of the propensity scores for the country group of low levels of corruption. The blue blocks represent the density distribution of the propensity scores for high corrupt countries. Figure 8 indicates that propensity scores are overlapped, and common support is provided.

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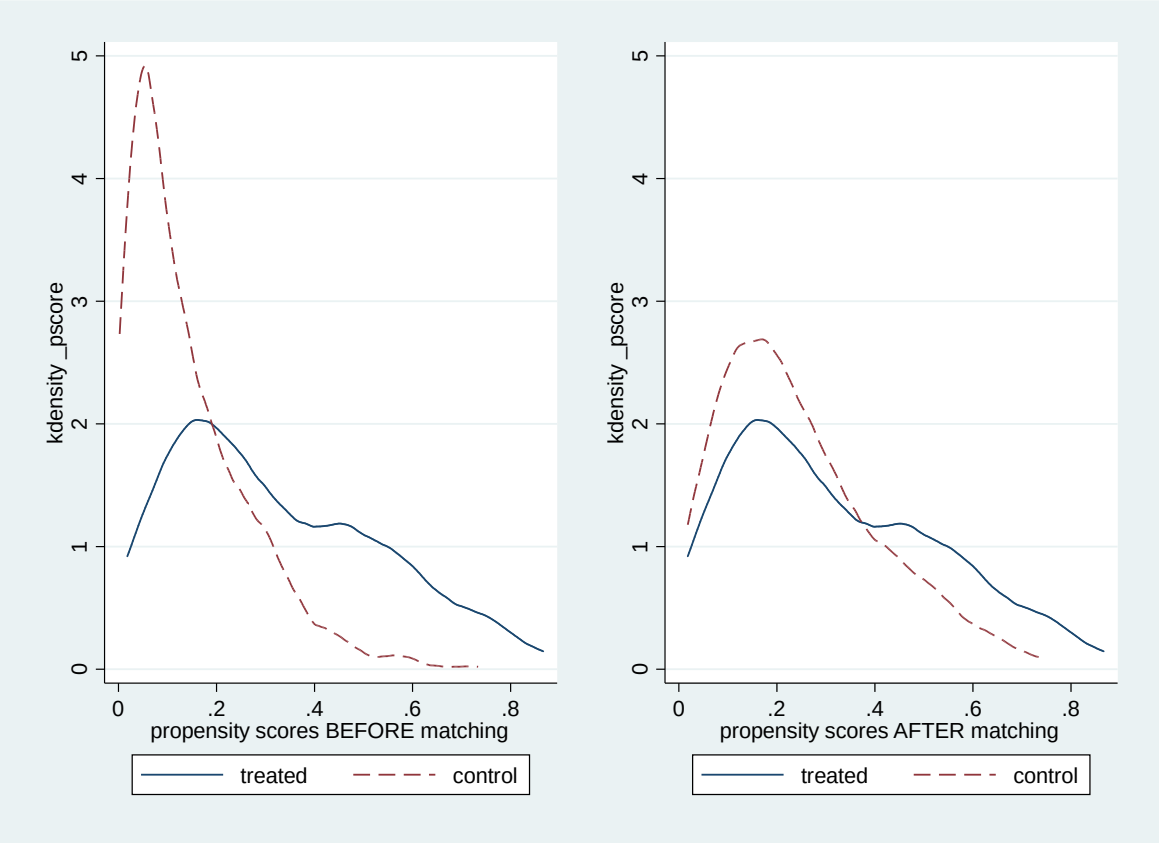


**Figure 8**: Results for the Emerging Countries

#### *2.4.2.3. ATE matching results*

Table 19 provides robust matching results of the estimated ATE according to the different matching estimator techniques. The estimated ATE on our sample from the different matching methods (Nearest neighbor matching, Radius matching, and Kernel matching) is negative and statistically significant. On average, the magnitude of the estimated ATE concerning the economic growth ranges from -0.24 (Radius matching, r=0.01) to -0.16 (Kernel matching) percent. In other words, being a low corrupt country significantly increases economic growth in our sample of emerging markets. More precisely, if high corrupt countries had a low level of corruption, their economic growth would have been 0.16 percent higher.

**Table 19**: *ATE matching results*

| | Emerging countries | | | | | | |
|---|---|---|---|---|---|---|---|
| Matching techniques | Nearest neighbor matching | | | Radius matching | | | Kernel matching |
| | n=3 | n=4 | n=5 | r=0.01 | r=0.03 | r=0.05 | |
| r(ate) | -0.21*** (0.1) | -0.20*** (0.08) | -0.21* (0.1) | -0.24* (0.12) | -0.19* (0.10) | -0.19** (0.11) | -0.16*** (0.08) |

Note The bootstrapped standard errors with 100 replications in parenthesis. *, **, and *** indicate the significance level of 10%, 5%, and 1%, respectively

### 2.4.3. Estimates of propensity score matching (with dummy inflation targeting - IT as dependent variable)

The previous section presented the results for economic growth as a dependent variable. It is known in the scientific community that corruption is linked to inflation. Several studies have been carried out for this purpose. We analyze the relationship between the level of corruption and the choice of adopting the IT policy.

#### *2.4.3.1. Propensity scores result for Inflation Targeting*

The observation is quickly made that in Table 20, the results do not differ from those in Table 20, except the presence of the logarithm of GDP per capita variable that is statistically significant and negatively correlated to the low level of corruption (low corrupt countries). This result is robust since the same result is observed in the previous point. The value of the coefficients of other variables differs from the one in Table 17. Still, the signs remain the same and are all significant; hence unnecessary for us to interpret not repeat ourselves.

**Table 20**: *Propensity scores results (with IT as dependent variable)*

| Variable | Emerging countries | |
|---|---|---|
| | **Coef.** | **Prob** |
| **lnGDPP** | -0.14*<br>(0.06) | 0.035 |
| **GFCF** | 0.04***<br>(0.007) | 0.000 |
| **GGFCE** | 0.07***<br>(0.01) | 0.000 |
| **Gini** | 0.01**<br>(0.006) | 0.048 |
| **FDI** | 0.0007***<br>(0.0001) | 0.000 |
| **Unemployment** | 0.04***<br>(.004) | 0.000 |
| **Trade** | 0.006*<br>(0.002) | 0.056 |
| **Cons** | -4.51***<br>(0.49) | 0.000 |
| **N. of obs** | **1107** | |

Note: Standard errors in parenthesis. *, **, and *** indicate the significance level of 10%, 5%, and 1%, respectively.

Figure 9 shows the numerical densities of low corrupt and high corrupt countries according to their propensity score ranges. In the Figures below, the horizontal section indicates the propensity score range, while the vertical section indicates the number of countries. The red blocks in the upper part of the horizontal line indicate the density distribution of the propensity scores for the country group of low levels of corruption. The blue blocks represent the density

distribution of the propensity scores for high corrupt countries. The Figure indicates that propensity scores are overlapped, and common support is provided.

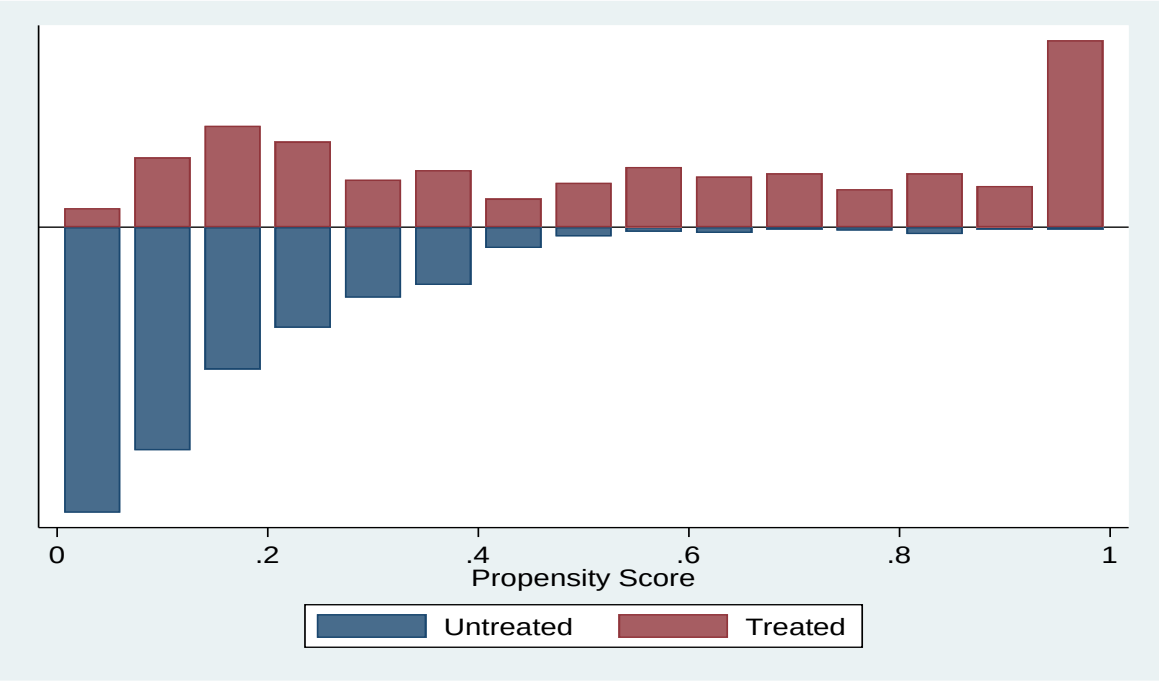


**Figure 9**: Common Support Graph for Emerging Countries

#### *2.4.3.2. ATT Matching Results*

After considering different matching estimators, the impact of the treatment effect on the inflation targeting policy has negative coefficients. Based on the results in Table 21, the impact of the ATT on adopting IT is negative. It is statistically significant for all matching techniques of Radius matching, Nearest-Neighbor matching, and Kernel matching. We then obtain an inverted U-shaped relationship between corruption and inflation by asserting that inflation is a negative growth function. The applied matching analysis shows that a low corrupt country increases the probability of IT policy adoption. On average, the amplitude of the estimated ATT on adopting IT policy ranges from -0.18 (nearest-neighbor matching, n=3) to -0.06 (Kernel matching) percent. There is robust evidence that low corrupt countries have quantitative and statistically significant effects on increasing the probability of adopting IT policy. In other words, if low corrupt countries were highly corrupt, the probability of adopting IT policy would have been, on average, at least 0.06 percent lower.

**Table 21**: *ATT Matching results*

| | Emerging countries | | | | | | |
|---|---|---|---|---|---|---|---|
| Matching techniques | Nearest neighbor matching | | | Radius matching | | | Kernel matching |
| | n=1 | n=2 | n=3 | r=0.01 | r=0.02 | r=0.03 | |
| r(att) | -0.16*** (0.053) | -0.17*** (0.052) | -0.18*** (0.049) | -0.15*** (0.044) | -0.14*** (0.039) | -0.11** (0.046) | -0.06* (0.092) |

Note: The bootstrapped standard errors with 100 replications in parenthesis. *, **, and *** indicate the significance level of 10%, 5%, and 1%, respectively

Figure 10 shows the numerical densities of low corrupt and high corrupt countries according to their propensity score ranges. In the Figures below, the horizontal section indicates the propensity score range, while the vertical section indicates the number of countries. The red blocks in the upper part of the horizontal line indicate the density distribution of the propensity scores for the country group of low levels of corruption. The blue blocks represent the density distribution of the propensity scores for high corrupt countries. Figure 10 indicates that propensity scores are overlapped, and common support is provided.

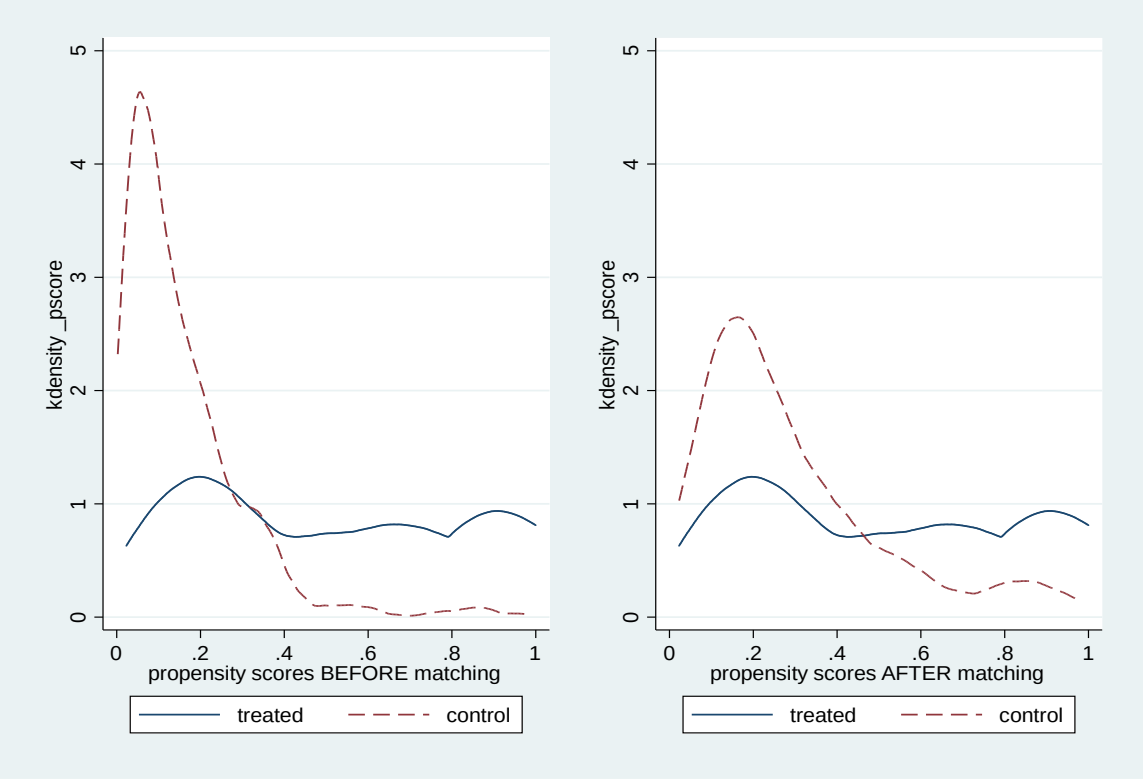


**Figure 10**: Results for the Emerging countries

#### *2.4.3.3. ATE Matching Results*

Table 22 provides robust matching results of the estimated ATE according to the different matching estimator techniques of Nearest-neighbor matching, Radius matching, and Kernel

matching. Again, the coefficients are negative and statistically significant. On average, the magnitude of the estimated ATE concerning the probability of adopting IT policy ranges from -0.18 (nearest-neighbor matching, n=3) to -0.02 (radius matching, r=0.01) percent. In other words, being a low corrupt country significantly increases the probability of adopting IT policy in our sample of emerging markets. More precisely, if high corrupt countries were low corrupted, the probability of adopting IT would have been 0.18 percent higher.

**Table 22:** ***ATE matching results***

| | Emerging countries | | | | | | |
|---|---|---|---|---|---|---|---|
| Matching techniques | Nearest neighbor matching | | | Radius matching | | | Kernel matching |
| | n=1 | n=2 | n=3 | r=0.01 | r=0.03 | r=0.05 | |
| r(ate) | 0.02<br>(0.106) | -0.17***<br>(0.057) | -0.18***<br>(0.048) | -0.02***<br>(0.082) | -0.16***<br>(0.085) | -0.16**<br>(0.08) | -0.16***<br>(0.048) |

Note: The bootstrapped standard errors with 100 replications in parenthesis. *, **, and *** indicate the significance level of 10%, 5%, and 1%, respectively

In this section, we have tried to validate the assumptions made empirically. To affirm or invalidate these hypotheses, we have resorted to propensity matching. The results obtained agree with the hypothesis that low corrupt countries negatively correlate with economic growth. Therefore, higher economic growth is of tremendous importance for emerging economies. The second hypothesis is also confirmed, meaning that countries with a low level of corruption have a negative relationship with the policy of adopting inflation targeting. Indeed, countries with low corruption levels have a higher probability of implementing inflation-targeting policy.

### 2.4.4. Sensitivity Analysis

In this section, the "Rosenbaum Bounds" test is performed to verify the possible effect of "hidden bias." This test re-estimates the average treatment effect and indicates the effectiveness of the unobservable variables. The bias stems from the existence of pre-existing unmeasured characteristics that affect the level of corruption and economic growth and the likelihood of adopting inflation targeting. For our study, sensitivity analysis of Rosenbaum bounds helps us test for the existence of a "hidden bias problem" (Rosenbaum, 2002). The results show that emerging countries generate robust evidence for insensitivity to unobserved heterogeneity. Table 23 and Table 24 report the Rosenbaum bounds for economic growth and adoption of IT in emerging countries, respectively.

**Table 23**: *Rosenbaum bounds for economic growth on emerging countries*

| Gamma | sig+ | sig- | t-hat + | t-hat - | CI+ | CI- |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1.28 | 1.28 | 1.23 | 1.33 |
| 1.5 | 0 | 0 | 1.13 | 1.43 | 1.08 | 1.47 |
| 2 | 0 | 0 | 1.02 | 1.52 | 0.96 | 1.57 |
| 2.5 | 0 | 0 | 0.93 | 1.59 | 0.86 | 1.64 |
| 3 | 0 | 0 | 0.85 | 1.65 | 0.79 | 1.70 |

Note: gamma - log odds of differential assignment due to unobserved factors; sig+ - upper bound significance level; sig- - lower bound significance level; t-hat+ - upper bound Hodges-Lehmann point estimate; t-hat- - lower bound Hodges-Lehmann point estimate; CI+ - upper bound confidence interval (a= .95); CI- - lower bound confidence interval (a= .95).

**Table 24:** *Rosenbaum bounds for IT on emerging countries*

| Gamma | sig+ | sig- | t-hat + | t-hat - | CI+ | CI- |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 |
| 1.5 | 0 | 0 | 0.5 | 0.5 | 0.5 | 0.5 |
| 2 | 0 | 0 | 0.5 | 0.5 | -4.1e-07 | 0.5 |
| 2.5 | 0 | 0 | -4.1e-07 | 0.5 | -4.1e-07 | 0.5 |
| 3 | 0 | 0 | -4.1e-07 | 0.5 | -4.1e-07 | 0.5 |

Note: gamma - log odds of differential assignment due to unobserved factors; sig+ - upper bound significance level; sig- - lower bound significance level; t-hat+ - upper bound Hodges-Lehmann point estimate; t-hat- - lower bound Hodges-Lehmann point estimate; CI+ - upper bound confidence interval (a= .95); CI- - lower bound confidence interval (a= .95).

According to the results from both Tables, the p-value of sig+ (the upper bound significance level) remains 0 between Γ=1 and Γ=3; that demonstrates no evidence of heterogeneity. Furthermore, it means that the results are not susceptible to hidden biases. Therefore, we conclude that the results in Tables 23 and 24 are robust to the existence of unmeasured variables.

# CONCLUSION

Many researchers agree that corruption is considered one of the reasons for poor economic performance in several countries. Its undesirable impact on economic development has been the subject of numerous theoretical and empirical studies. According to the Berlin-based NGO Transparency International, corruption sabotages economic growth and sustainable development that could free millions of people from the poverty trap.

This study investigates the potential effects of corruption on economic growth and the adoption of IT policy in emerging economies. In addition, we examine the treatment effects of corruption on economic growth and adopt the inflation targeting policy for 1995-2019 in emerging economies. This study utilizes the propensity score matching method, the best-fitted methodology for solving the self-selection problem to evaluate the counterfactual analysis of our binary variable. In cases where the preference is not random, estimation results with linear econometric techniques lead to biased, overestimated results. Therefore, the propensity score matching method is employed in this study to run the analyses while dealing with the self-selection bias.

The evaluation process takes place in many steps. First, we calculate the propensity scores between each treatment and control individuals through the probit regression. Then, we analyze the density distribution with the resulting common support plot of the estimated propensity score in the untreated and treated units. Lastly, we estimate the treatment's average effect on the treated and that of the average effect of the treatment to evaluate the impact of being a low corrupt country on economic growth and adopting the IT policy. We employ the matching methods of Nearest-Neighbor, Radius, and kernel matching approaches.

Based on the results, the impact of the ATT on economic growth is negative and is statistically significant for all of the matching techniques. The applied matching analysis shows that a low corrupt country leads to economic growth with a negative relationship. On average, the amplitude of the estimated ATT on economic growth ranges from -0.23 (radius matching, r=0.01) to -0.15 (Kernel matching) percent. On the other hand, there is robust evidence that low corrupt countries have quantitative and statistically significant effects on increasing economic growth. In other words, if low corrupt countries were highly corrupt, their economic growth would have been, on average, at least 0.15 percent lower. This result agrees with the hypothesis that low-corrupt countries negatively affect economic growth. That implies that countries with low levels of corruption tend to have high economic growth. The estimated ATE is also negative

and statistically significant. On average, the magnitude of the estimated ATE concerning the economic growth ranges from -0.24 (radius matching, r=0.01) to -0.16 (Kernel matching) percent. In other words, being a low corrupt country significantly increases economic growth in our sample of emerging markets. More precisely, if high corrupt countries had a low level of corruption, their economic growth would have been 0.16 percent higher.

After considering different matching estimators, the ATT results that concern the impact of the adoption of inflation targeting on the level of corruption in emerging countries have negative coefficients. Based on the results, the impact of the ATT on adopting IT is negative. It is statistically significant for all matching techniques (Radius matching, Nearest-Neighbor matching, and Kernel matching). The applied matching analysis shows that being a low corrupt country increases the probability of adopting the IT policy. On average, the amplitude of the estimated ATT on adopting IT policy ranges from -0.18 (nearest-neighbor matching, n=3) to -0.06 (Kernel matching) percent. There is robust evidence that low corrupt countries have quantitative and statistically significant effects on increasing the probability of adopting IT policy. In other words, if low corrupt countries were highly corrupt, the probability of adopting IT policy would have been, on average, at least 0.06 percent lower. According to the results from the ATE matching, the coefficients are negative and statistically significant. ATE results also document that low corrupt countries negatively correlate with the inflation targeting policy. On average, the magnitude of the estimated ATE concerning the probability of adopting IT policy ranges from -0.18 (nearest-neighbor matching, n=3) to -0.02 (radius matching, r=0.01) percent. In other words, being a low corrupt country significantly increases the probability of adopting IT policy in our sample of emerging markets. More precisely, if high corrupt countries were low corrupted, the probability of adopting IT would have been 0.18 percent higher.

Results of this study strongly assure that the effect of a low level of corruption on economic growth and IT policy adoption is substantial and statistically significant, whatever the matching technique used. That would indicate that having a low level of corruption is beneficial for emerging economies since it has permitted increased economic growth and facilitated the adoption of IT policy.

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# APPENDIX

Appendix 1: Emerging countries (with the developing countries)

| |
|---|
| Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Belarus, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cameroon, Cabo Verde, Chile, China, Colombia, Costa Rica, Dominican Republic, Ecuador, Egypt, El Salvador, Georgia, Honduras, Hungary, Indonesia, Iran, Kazakhstan, Kyrgyz Republic, Mexico, Moldova, Pakistan, Paraguay, Peru, Poland, Romania, Russia, Thailand, Turkey, Ukraine, Uruguay, Venezuela. |

# ESSAY 3

# DOES IT ECONOMICALLY WORTH BEING A MEMBER OF OPEC+?

# INTRODUCTION

Oil, also called crude oil (or crude), is among the most valuable commodities on the planet's markets. By constituting just over 1/3 of the world's energy reserves, oil is vital for many nations and industries. The price of oil, ordinarily high, fluctuates from day to day depending on various factors such as demand and supply, the world economy, environmental problems, wars, or other dynamics in the buying or producing countries.

Over the past decades, the global demand for petroleum products has grown. This increase in global fuel consumption is because of increased urbanization, population growth, and accelerated economic development in highly populated countries like India and China. Indeed, the growing populations of industrialized urban centers consume more energy and demand more petroleum products. As a result, daily world demand for crude oil has increased steadily, rising from around 60 million barrels in the mid-1990s, rising 1.17% over the previous year to more than 88 million barrels in 2008 / day[16]. According to the IEA[17], the entire world consumed around 98 million barrels of oil per day in 2019, and estimates are 89.6 million barrels per day (BPD) by the end of 2020.

The economic growth of industrialized countries, like that of developing countries, has significantly increased their energy consumption. Therefore, without the risk of compromising ourselves, we could link the degree of development to the level of energy consumption. Indeed, this energy source has enabled most producing countries to accelerate the development of industries. Moreover, if oil is refined locally, these countries can considerably increase their revenues by exporting finished products automatically high prices.

Some oil-producing and exporting countries have allied to create OPEC[18], pursue a common price policy, and use this product as a pressure weapon by limiting the quantities exported to their adversaries. OPEC is a cartel of oil-producing countries created on September 14, 1960, at the Baghdad conference, amid heightened competition between oil companies and intense downward pressure on the oil's price. Its objective is to regulate the production and the price of oil through a concerted policy of its members. In 1973, these oil-producing and exporting countries decided to increase the price of crude. The consequences of these increases in oil prices have been numerous: slower growth in the world, acceleration of inflation, disruption of the balance of payments, and development of new and renewable energies. Sixty

[16]United States Energy Information Administration
[17]International Energy Agency
[18]Organization of the Petroleum Exporting Countries

years after its creation and when it was believed to be subject to internal disagreements, which threatened to lose it, OPEC has just reaffirmed the decisive role it could play in the world oil market in times of collapsing prices.

Countries seeking membership in the Organization of the Petroleum Exporting Countries must display "substantial net crude oil exports" and "fundamentally similar interests" to current members. Applicants must also obtain a three-quarters endorsement from all founding countries. For a long time, most academic research on the Organization of the Petroleum Exporting Countries has focused on its reserves, production, price monopoly, the impact of OPEC quotas, or oil prices on the world petroleum market. (Griffin and Xiong (1997); Wirl and Kujundzic (2004); Kaufmann et al., (2004); Noguera and Pecchecnino (2007); Dees et al., (2007); Lin and Tamvakis (2010); Griffin and Teece (2016); Loutia and al., (2016)). On this question, there are a few studies that look at the question of what advantage an oil-producing country might have in being a member of OPEC. For example, Noguera and Pecchecnino (2007), in their study, show two economic objectives to be a member of OPEC: a macroeconomic objective (to improve the economic development of its members), and a microeconomic objective (to control the volatility of the oil market).

Even though the revenues from oil exploitation for OPEC member countries have improved macroeconomic performance in some member countries, there is no consensus on its effectiveness. In addition, the various financial, oil, and even health crises open the debate on its effectiveness. Indeed, there is a problem in estimating the impact of OPEC membership, and the latter is the difficulty of estimating counterfactuals for member countries of the organization. Therefore, we consider the research question: What would have been the macroeconomic outcome in these countries if they had not joined?

Our objective in this study is to know whether joining the organization of oil exporters is economically beneficial for oil-producing countries. To achieve this objective, we investigate whether:

- Membership of the OPEC+ positively influences the economic growth of member countries over the entire period studied;
- The impact of OPEC+ membership on the economic growth is the same over the pre and post 2008 oil shock period.

Indeed, it would have been easier to calculate the difference in averages between member countries and non-member countries of OPEC if the decision to join this organization was random. However, this is not the case, and therefore a problem of self-selection arises because

the decision to join OPEC is not random. In particular, the issue of self-selection will be caused by a systematic correlation between specific covariates and the choice of member countries, which will result in biased estimates.

The rest of our study is as follows: the first section concerns the literature review. Then, section two documents the methodology and presentation of the data used. Finally, section three investigates the empirical results.

## 3.1.LITERATURE REVIEW

Oil has been the most "conflict-causing" product in the world economy since the start of the 20th century. Yet, indispensable to development, growth, and trade, it is the most coveted raw material in the world. In this first point, we will first focus on the main operators in the oil market, including OPEC, then enumerate the various crises that the oil sector has experienced, and finally end with the empirical literature.

### 3.1.1. The main contributors in the oil market

Access to oil is one of the major challenges of international economic policy, all the more so since the Middle East region has the largest reserve. Multinational companies (the majors and others), OPEC, consumer countries, and the International Energy Agency are the main operators in the oil market. Besides defending its interests, each group seeks to maintain market equilibrium to regulate it in a constantly changing geopolitical, economic, and technological context.

#### *3.1.1.1. International companies*

The discovery in 1901 of the vast oil fields in Texas caused a rush for black gold which led to the birth of two other large companies: Gulf Oil Corporation (Gulf) and Texas Company (Texaco).

From the beginning to the present day, most of today's major oil companies have a common ancestor: Standard Oil, created in the 19th century by Rockefeller. After helping to regulate market growth by defining quality standards, marketing channels, and prices, it extended its hold on the downstream side of the oil chain. Then, however, the anti-trust law split up into 33 companies, some known under Exxon, Mobil or Chevron, Amoco, Conoco. Other companies appeared in parallel: Shell and Royal Dutch, which joined forces, B.P, and European national companies like Total, ELF, ENI, or Petrofina. Over the years, successive mergers and acquisitions have given birth to new groups.

Nicknamed the "Super-Majors" or "Big Oil," these international companies emerged in the 90s due to mergers. These are in particular: Total SA; Chevron Corporation, resulting from the Chevron and Texaco merger; Royal Dutch Shell, resulting from the Shell and Royal Dutch merger; ExxonMobil, born from the union between Exxon and Mobil; BP, born from the merger between British Petroleum and Amoco. These operations had many objectives: improving their geographic coverage, financial profitability, and return on investment.

**Table 25**: *Supermajor oil companies and their revenue in 2020*

| Company | Revenue in US billion |
|---|---|
| Royal Dutch Shell | 263.1 |
| BP | 230.7 |
| ExxonMobil | 213.9 |
| Total | 146.1 |
| Chevron | 115 |

Source: GlobalData (2020)

Despite their economic weight, the super-majors control only nearly 5% of the world's oil reserves. Moreover, most of these reserves are owned by national companies[19] such as Saudi Aramco.

#### *3.1.1.2. IEA and consumer countries*

Created in 1974 at the initiative of Henry Kissinger during the oil crisis of 1973/1974, the IEA is an autonomous inter-governmental organization dependent on the OECD. The primary mission of the IEA was to help member countries coordinate a collective response to severe disruptions in oil supplies by releasing oil stocks into the market. By uniting their action, the consuming countries were concerned with: ensuring the security of oil supplies on which transport depends almost entirely; promoting the diversification of import sources; to keeping prices at a reasonable level. Today, the action of the IEA focuses on four areas:

- Energy security: promoting diversity, efficiency, and flexibility in all energy sectors;
- Economic development: ensuring a stable supply of energy for member countries and promoting free trade areas to foster economic growth and eradicate energy poverty;

[19]Rapport annuel (2016) de BP

- Environmental awareness: raise awareness at the international level of existing options to curb climate change;
- Involvement at the global level: acting in concert with non-member countries, particularly the main energy consumers and producers, to find solutions to environmental problems and common energy.

***a) Member countries***

To date, it brings together 30 member countries[20], most of the oil importers. It ensures that their energy security is maintained by coordinating their respective energy policies. These countries are among others Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, The Netherlands, Turkey, United Kingdom, and the United States of America. In addition, the Agency also has associated countries like Brazil, China, India, Indonesia, Morocco, Singapore, South Africa, and Thailand.

***b) Description of operation***

The IEA consists of a Governing Council, which brings together senior energy officials from different member countries, and meets periodically. In addition, a secretariat made up of energy specialists, under the supervision of an Executive Director, is on duty, and the Board of Directors handles appointing the Executive Director.

The IEA publishes annual reports and monthly global oil demand forecasts but does not deal with renewable energies; it only allocates 2% of its budget. Nor is it concerned with nuclear fission issues that it leaves to the IAEA[21]. Following the damage caused by Hurricane Katrina, the IEA had coordinated the activities of the Member Countries to guarantee a continuous oil supply by drawing in particular from the reserves of the United States, Germany, and France.

Consumer countries consume more oil, and among these major consumers, there are many producing countries. In 2019, for example, growth in oil consumption was driven by China (680,000 BPD)[22] and other emerging economies. We can cite among others besides China countries such as Japan, the United States, Germany, Russia, South Korea, India, Brazil, Canada, Mexico, Italy, France, the United Kingdom.

[20]https://www.iea.org/countries
[21]International Atomic Energy Agency
[22]BP Statistical Review of World Energy 2020

#### *3.1.1.3. The Organization of Petroleum Exporting Countries (OPEC)*

Previously, international oil companies had absolute control over oil production in Venezuela, Iran, Kuwait, and Saudi Arabia. Thus, the companies in question dominated the market they wielded as they wished because they could put the oil of one nation in competition with that of another. Moreover, international companies could still change prices without prior consultation with the governments of oil-owning countries. Usually, these changes are harmful to export countries without always benefiting consumers. All this in addition to the fall of crude prices. Therefore, in the context of the emancipation of the colonized countries, the producing countries' revenues precipitated the establishment of the Petroleum Exporting Countries (OPEC) in 1960. OPEC is, therefore, an alliance imposed by necessity.

The objective was first to counterbalance the big international companies' power and stabilize the price of crude. However, it takes care to rationalize production, to adapt it to the needs of effective demand, a normal and fair principle of any healthy production regime. The objectives are not limited to there. OPEC also fights for the increase of the profits of the member countries, whose needs are growing as a result of the increase of the population, and which always require more money to buy from the developed countries ever more expensive goods.

The headquarters of the Organization of the Petroleum Exporting Countries is based in Vienna (Austria) and houses the services of the only permanent body, the general secretariat, the executive body responsible for implementing the conference's resolutions, or the decisions of the board of directors.

***a) Member countries***

This intergovernmental organization was founded at the end of the Baghdad conference on September 14, 1960, by Saudi Arabia, Kuwait, Iran, Iraq, and Venezuela. The five countries will then be joined between 1961 and 2018 by other producing countries, namely:

❖ **Africa**

- Libya: member since 1962. A tremendous exploration potential not exploited due to the conflict affecting this country;
- Algeria: member since 1969. The first country to have nationalized the production of hydrocarbons;
- Nigeria: member since 1971;

- Gabon: member since 1975, left the organization in 1995 and joined it again in July 2016;
- Angola: member since 2007;
- Equatorial Guinea: a country that joined OPEC in May 2017;
- Congo: last member country to join the organization (in summer 2018);

❖ **South America**

- Ecuador was a member of OPEC between 1973 and 1992 and again between 2007 and January 2020.

❖ **Middle East**

- Qatar: member since 1961; but terminated its membership on January 1, 2019;
- the United Arab Emirates: member since 1967.

❖ **Asia Pacific**

- Indonesia: member since 1962, then left in 2009 to reintegrate the organization in January 2016. But at the 171st meeting of the OPEC Conference on November 30, 2016, it decided once again to suspend its membership.

That implies that the Organization currently has 13 member countries: Algeria, Angola, Congo, Equatorial Guinea, Gabon, Iran, Iraq, Kuwait, Libya, Nigeria, Saudi Arabia, United Arab Emirates, and Venezuela. According to article 7 of the OPEC statute of 2012, they are considered founding members of OPEC. This is because these countries took part in the first Conference held in Baghdad and signed the initial agreement establishing OPEC. In paragraph B of the same article, the organization's members are the founding members and the countries that have had their application for membership accepted by the conference. Thus, to join the organization, paragraph C of Article 7 states that any candidate country must have a substantial net export of crude oil and share the same essentially similar interests as those of Member Countries to apply for the Council. After, the country will integrate the organization only if it is accepted by the majority of ¾ of the members and the simultaneous vote of the founding members. Countries that do not meet these conditions above may nevertheless be admitted as associate members under the same conditions of acceptance[23].

[23]Note that to be admitted as an associate member, the country would have to have similar interests and objectives to those of the member countries. The readmission of a country as a member having left the organization will be done taking into account article 7, paragraph C.

OPEC members coordinate policies on oil production, prices, and related issues at biannual and special meetings of the OPEC Conference. The Board of Governors, responsible for managing the organization, convening the Conference, and establishing the annual budget, includes representatives appointed by each member country; its president is elected for a one-year term by the Conference. In addition, OPEC has a Secretariat headed by a Secretary-General whom the Conference appoints for a three-year term; it includes research and energy studies divisions.

***b) Operation of OPEC***

If oil prices appear to be determined by the competitive game, OPEC nevertheless can influence the market. Since 1982, OPEC has had a system of regulation of production and the selling price using a total amount of production (slightly over 30 million barrels of crude per day). This production volume is defined according to the reserves of member countries. It is adjusted according to the needs of consumer countries (the system of production quotas per member country was adopted in 2011). As a result, OPEC is sometimes presented as a cartel of producers despite internal dissensions.

Each producer enjoys a certain degree of freedom in declaring their reservations. Thus, the reserves of the countries of OPEC, which hold a large share of the world's conventional oil, are assessed by the member countries themselves through their national companies. For example, in Saudi Arabia, the Saudi Aramco company identifies the reserves available in the territory. It alone is empowered to conduct investigations.

***c) Oil price***

❖ Oil price structure

The peculiarities of the oil market make it complicated to forecast oil prices, which are subject to strategic decisions rather than economic mechanisms. Indeed, if the market mechanisms (spot market and a forward market) today govern crude oil prices, the supply regulation methods, put in place by OPEC, remain the central element of their training. This evolution of price formation mechanisms, similar to that experienced by other raw materials, has led some to assert that oil was now a raw material, a commodity, whose market structure would tend towards a model of pure and perfect competition.

However, the prices on the oil market are far from equating to the marginal cost of the last unit produced. That is because the regulation of supply by OPEC countries remains a central

element in price formation. Today, the price level is determined by the anticipations of the effects of its action on a few reference markets.

To simplify oil trading, trading focuses on a select restricted range of benchmark crude. Each production region has its kind of benchmarks, such as West Texas Intermediate (WTI) in Brent in Europe, North America, and Africa, and Dubai Fateh in the Persian Gulf (Asia). Increases or reductions determine the prices of other crude compared to the benchmark crude. Fluctuations in oil prices directly impact household budgets and consumption in developed countries. They also affect, in varying proportions, the price of all goods and services since all are produced using, at least indirectly, petroleum.

OPEC operates a quantification instrument allowing it to set a reference price from the prices of fifteen crude oils (one per member country) with different qualities reflecting the main crude exports of member countries (for example, the "Arab Light "from Saudi Arabia): OPEC Basket Price (ORB) (see Figure 11 below).

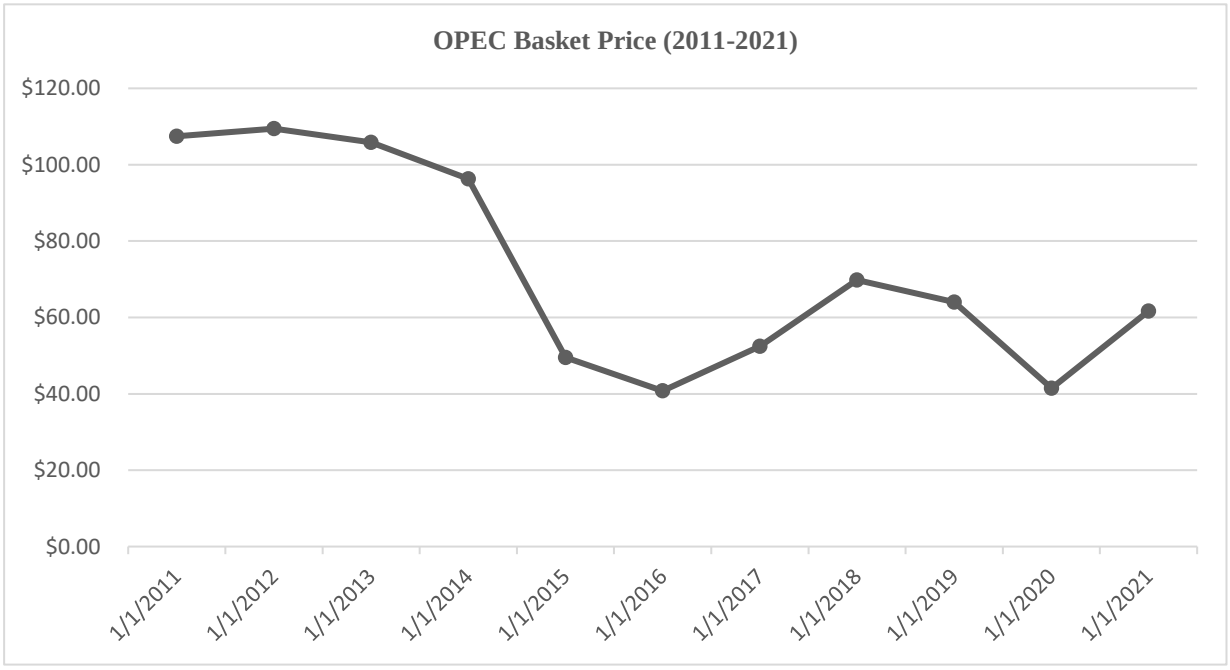



**Figure 11**: OPEC Basket Price (2011-2021)
Source: OPEC

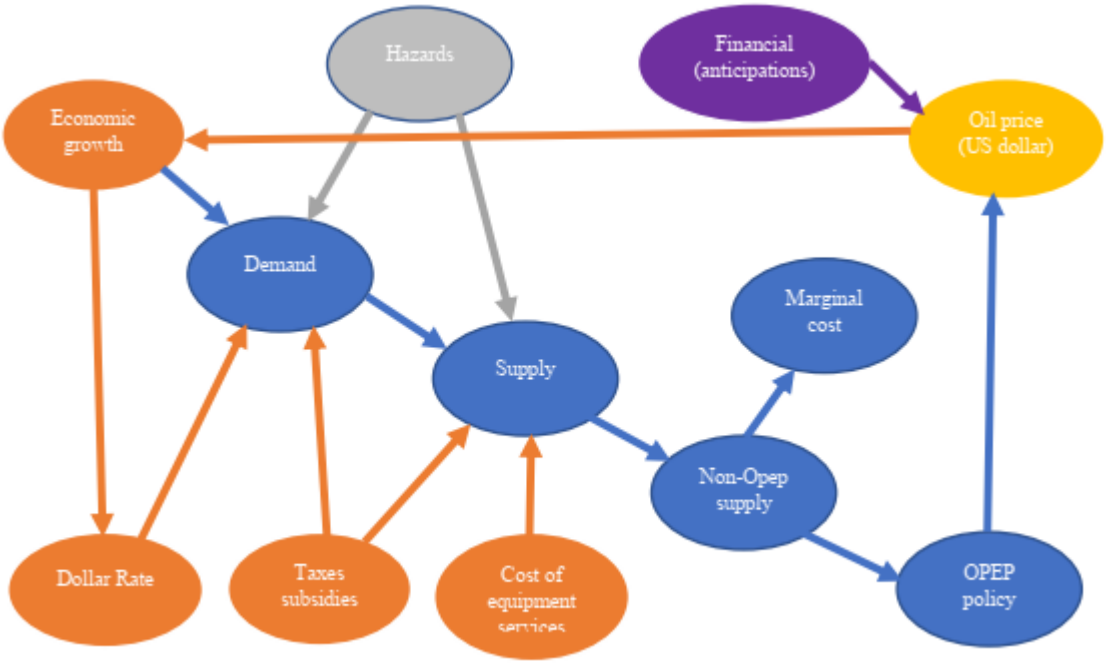
Figure 11 shows that between January 2012 and January 2016, the average price of oil within this basket fell 62.75% or $ 109.45 to reach $ 40.76. Since January 2021, it has reached $ 61.65 / b[24]. Fluctuations in the dollar price, the transaction currency of oil, affect the

[24]www.opec.org

functioning of this regulatory system. The purchasing power of producing countries decreases when the dollar rate falls and vice versa.

- ❖ Determinants of the price of oil

The graph below shows all the delicacy of the formation of the price of crude. The economic context, various meteorological and geopolitical hazards, the supply-demand balance of the oil market, and financial expectations are the main determinants of the price.




**Graph 2**: Determinants of the price of oil

**Note: Orange color:** economic context; **Blue color**: Market supply/demand balance; **Grey color**: Weather or geopolitical hazards; **Purple color**: financial anticipations. Source: French Institute of Petroleum (IFP)

Influenced by the price of crude, economic growth remains the dominant part of this puzzle. It determines the evolution of demand, which will define the supply adjustment policy of OPEC member countries). To limit the drops and sometimes the too significant increases, OPEC must adjust its production to the market since the supply of non-OPEC is always at its maximum. However, the maximum production cost of non-OPEC will define the floor below which these production costs would no longer be covered. That states that the highest oil price describes it, not the average price.

Apart from economic growth, the price of crude, the oil market, other factors can act directly or indirectly on the price. For example, this is the case of the dollar rate, which is an important parameter since it will, depending on its value, more or less strongly reflect the

increase in oil expressed in other currencies. Also, hazards of geopolitical nature (the Middle East in particular) or climatic (temperature, hurricanes, etc.), the level of taxes on the final price or at the level of production, possible inflation on costs (services and equipment) will be likely to modify the market balance.

The drop in crude oil prices observed since July 2014 has been helped by excess production over demand. This fall in prices has led to the initiation of various market rebalancing mechanisms, in particular acceleration in demand and a drop in investment in production projects. However, the degraded economic context, which weighed on demand, the resistance of non-OPEC production, and the increase in production in OPEC member countries favored maintaining a surplus situation throughout 2015.

### *d) The main oil crises*

The history of petroleum dates back to 1859 in Pennsylvania. This new raw material that springs from the ground quickly becomes essential (Chautards, 2007). Its exploitation (extraction and refining) makes it possible to generate huge profits; it is a real income (Mongrenier and Reithmann, 2012). The prices of a barrel of crude oil have undergone considerable changes over the decades, especially during the global crisis (1971, 1979, or 2008).

- 1973: the first oil shock

In October 1973, the Yom Kippur War between a coalition of Arab countries and Israel led by Syria and Egypt triggered the first oil shock: the main producers of the Persian Gulf decided to increase the price of a barrel of oil by 70% in response to the support of some Western countries for Israel. OPEC is organizing an oil embargo against countries that support Israel and cutting production by 25%. In December 1973, two months after the start of the war, the average increase in the price of a barrel reached 130%. After 1973, under OPEC control, oil prices stabilized upwards at around $ 10 per barrel.

- 1979: the second oil shock

In the late 1970s, the political situation in the Middle East became tense again because of the revolutionary agitations in Iran. To guard against possible disturbances, oil companies in consuming countries increase their demand from producing countries to build up stocks. The Iranian revolution broke out in late 1978 and ended on January 11, 1979, with the fall of the Shah. That is the starting point of the oil shock. The deterioration of relations between Iran and

Iraq led to a war from 1980 to 1988. The price of a barrel then exceeded 35 $. This oil shock will drag the world into an economic crisis until 1982.

- 2008: the third oil shock

If the oil shocks of 1973 and 1979 had a lasting impact on world production, that of 2008, which some observers refer to as "the third oil shock in history," above all saw the price of a barrel of oil break a record of 145 dollars (Artus et al., 2010). OPEC, which occasionally injected oil drawn from their reserves, then lost its ability to regulate prices. The 2008 "oil shock" is different from the previous two: (1) it was not due to a supply crisis caused by geopolitical instabilities, but to increased demand; (2) it is spread over several years (2003-2008), unlike the one-off shocks of 1973 and 1979. The increase of oil price has the magnitude of previous shocks but not their concentration over time.

Each of the previous shocks has coincided with profound changes in the world economy and the oil market.

The year 2014 was an oil counter-shock, with a drop of more than 50% in the price of black gold. This date indeed marks a turning point in OPEC policy. Between 2014 and 2016, at the instigation of Saudi Arabia, the OPEC countries tacitly encouraged a situation of abundant supply to keep prices low and squeeze out some non-conventional American production. However, the offensive strategy vis-à-vis US shale oil has not borne fruit, and the sharp drop in prices has largely damaged Saudi public finances. As a result, at the end of 2016, OPEC signed an agreement with eleven non-member countries (including Russia) to reduce the overall oil supply on the markets and thus push up prices.

The agreement concluded at the end of 2016 with other non-OPEC producers (“OPEP +”), which has since been extended several times, once again specifies production ceilings for each member country of the organization. "OPEC +" refers to 23 oil-producing countries: the 13 member countries of OPEC and ten other producers, including Russia. In addition, the ten other producer countries united in OPEC + but not members of OPEC are still in production: Russia, Kazakhstan, Mexico, Oman, Azerbaijan, Malaysia, Bahrain, Brunei, Sudan, and South Sudan.

In Table 26, Russia and Saudi Arabia are the groups of other countries united in OPEC + lead oil production. (See Table below).

**Table 26**: *2019 oil production in OPEC countries and the ten other producing countries united in OPEC +*

| OPEP countries | | Other countries united in OPEC + | |
|---|---|---|---|
| Saudi Arabia | 4.8 Mb/d | Rusia | 11.5 Mb/d[25] |
| U.A.E | 4 Mb/d | Mexico | 1.9 Mb/d |
| Iran | 3.5 Mb/d | Kazakhstan | 1.9 Mb/d |
| Kuwait | 3 Mb/d | Oman | 1 Mb/d |
| Nigeria | 2 Mb/d | Azerbaijan | 0.8 Mb/d |
| Libya | 1.2 Mb/d | Malaysia | 0.7 Mb/d |
| Algeria | 1.5 Mb/d | Bahrain | 0.2 Mb/d |
| Angola | 1.4 Mb/d | Brunei | 0.1 Mb/d |
| Venezuela | 0.9 Mb/d | Sudan | 0.1 Mb/d |
| Congo | 0.3 Mb/d | South Sudan | 0.1 Mb/d |
| Gabon | 0.2 Mb/d | | |
| Equatorial Guinea | 0.2 Mb/d | | |
| | | | |

Sources: **BP** Statistical Review of World Energy 2020

Note that the ten other producer countries united in OPEC + are not members of OPEC. However, these countries have regularly been meeting since 2016 to support oil prices by pooling their efforts to reduce production. As a result, according to the IEA, they accounted for nearly 51% of global oil production in 2020.

At the close of the 15th OPEC and non-OPEC ministerial meeting in April 2021[26], 3 OPEC countries are exempt from an effort to reduce their production: Iran, Libya, and Venezuela, as for the 20 other countries within OPEC +, they have pledged to limit their cumulative production of crude oil to 37.3 MMb / d in May 2021, or nearly 15% less than their "reference production" (October 2018 level, except for Saudi Arabia and Russia, countries for which “benchmark” production is set at 11 Mb / d).

[25]According to BP Statistical Review of World Energy 2020 this amount represented 12.1% of world oil production in 2019

[26]15th OPEC and non-OPEC Ministerial Meeting concludes, OPEP, 1er avril 2021.

### 3.1.2. Empirical literature review

Most studies concerning OPEC focus on the monopoly aspect of price, quantity produced and reserves, the effects of the various OPEC quotas on the world oil market (see Griffin and Xiong 1997, Dees et al., (2007); Lin and Tamvakis (2010); Griffin and Teece (2016); Loutia and al., (2016)). Others also test the organization's behavior and influence on the oil market and prices (see James 1999, Noguera & Pecchecnino, 2006).

Farhan Al-Farhan (2003) states that OPEC as an international trade organization happens to be a good illustration of an alternative international political economy not controlled by the West and whose bargaining power remains unchallenged. Considered by some as a Cartel and as an intergovernmental organization by others, the statute of OPEC defines it as an international organization to influence and ensure the maintenance of oil price through the control of production levels. At the same time, it generates income, which should serve to meet its members' social and economic development needs. Indeed, many academics call OPEC a cartel, but this point of view is increasingly contested. For example, MacAvoy (1982) argues that a conscientious model can be adequately used to explain the long-term trend in oil prices. Also, other supporters of the target income model, such as Cremer and Salehi-Isfahani (1980) & Teece (1982), support that what happened in the 1970s, namely the cuts in production and the rise in prices of oil, was not attributable to collusive behavior but rather to the fact that exporting countries had a revenue target for internal investment purposes.

Noguera & Pecchecnino (2007) state in their study that it would be advantageous for all oil-exporting countries to join the OPEC cartel if and only if the oil market's volatility is low. Indeed, when the organization was founded (in the 1960s), most major oil exporters joined it experienced high growth rates. That is the case of Venezuela, which experienced growth above 5% between 1945 and 1973. However, this was close to zero just after the oil market's volatility became a major concern for producing countries from 1978. With the oil market's volatility, which is rife, the non-oil sectors in the OPEC countries are neglected due to OPEC's frantic pursuit of profits. In addition, it only has one tool to achieve two different goals.

The oil-producing countries' organization can be considered one of the international organizations with a long history and an impact on the energy and supply market in the world. In addition, all OPEC member countries are developing countries and know how it is beneficial for these countries to be part of it. As a result, all the oil revenues derived from this sector are essential for economic development. Furthermore, Morrison (2004) points out that most of

these countries have a high dependence on oil. Therefore this sector must function well to maintain the current standard of living and ensure the future.

These oil-rich countries sometimes underperform compared to other developing economies. That is often explained by the fact that investments allocated to the oil sector remain low in several OPEC member countries. Cordesman (1999) argues that many oil countries lack resources to develop their gas and oil reserves. Also, there is the fact that their economies have high rates of population growth and strong dependence on oil revenues. Some researchers such as Eastwood & Venables (1982), Gylfason (2001), Rodriguez & Sachs (1999), Sachs and Warner (2001), Auty (2001), and Stevens (2003), believe that the economic decline experienced by some OPEC member countries is empirically abnormal and go further by calling them victims of the resource curse. The reasons given are income volatility, government mismanagement, trade drop, corruption, Dutch disease, etc. Others prefer to blame the cartel because, according to them, OPEC has the means to adjust supply to keep (nominal) oil prices targeted to maximize profits from oil activities, which should ensure a steady flow of revenues derived from oil, i.e., macroeconomic stability.

The international oil market is distinctive from others. The decision to join OPEC is made by countries that consider macroeconomic considerations, namely stabilization and development, and not by big oil companies (Noguera & Pecchecnino, 2007). They state two economic goals of being a member of OPEC. One goal is macroeconomic - which is to promote economic development, and the second is microeconomic - achieves low volatility in the oil market for member countries.

Despite its crucial role in the global energy market, many agree that OPEC's influence has declined considerably since the 1970s. OPEC influences the economies of its member countries through the need to ensure regular income and a return on capital, as mentioned in the OPEC statute[27]. That should help promote economic growth. According to statistical data from the last 30 years of several measures, it appears that OPEC member countries have experienced economic and social progress to varying degrees (Khusanjanova, 2011).

[27]OPEC statue article 1 to 2

## 3.2. METHODOLOGY AND DATA

For this study, we employ the PSM methodology to analyze whether joining the organization of oil exporters is economically beneficial for oil-producing countries. First, the PSM method is described in detail with the different matching methods. The second subsection concerns the data used for the study.

### 3.2.1. METHODOLOGY

Several studies have been carried out on the macroeconomic impact of oil price volatility due to actions taken by OPEC + and its member countries. However, when it comes to the effects of membership in this conglomerate on member countries, only the study by Khusanjanova (2011) has been identified. In her research, Khusanjanova analyzed the role of OPEC in the development of member countries. Our study examines the macroeconomic impact of membership in OPEC + by estimating the causal effect of this membership while using a non-random propensity score matching approach.

We first estimate the score for the propensity of joining OPEC + to reduce dimensionality and resolve the non-chance of the covariates. Then the score is used to estimate the effects of the treatment. Thus, the countries selected for treatment are the member countries of OPEC +, and the control countries are the non-member countries but oil exporters. The potential outcomes for each country *i,* are assumed to be $(Y_{0i}, Y_{1i})$ which corresponds to the control and treatment groups, respectively. Let $U_i = 1$ the country joins OPEC + and $U_i = 0$ for a non-OPEC + member country; let *x* be a set of observed covariates. Thus, our parameter is the average effect of the treatment on the treaty (ATT), which is defined as follows:

$$\tau_{att} = E[(Y_1 - Y_0|U = 1)] \quad (3.1)$$

According to Holland (1986), there is a fundamental problem with this causal inference, which is that we cannot observe $Y_{0i}$ $et$ $Y_{1i}$ for each country $i$ and place, and instead, we only observe $Y_{0i}$ ou $Y_{1i}$ (not both). For more precision, the result can be as follows:

$$Y_i = U_i Y_{1i} + (1 - U_i) Y_{0i} \quad (3.2)$$

The next step will be to recover equation (1) using the result observed in equation (3.2). To do this, we plan to use the PSM approach. Let $\theta(x)$ be the propensity score defining the conditional probability of joining OPEC + given the observed covariates.

$$\theta(x) = P(U = 1|x) \quad (3.3)$$

Where P (.) represents the conditional probability, Rosenbaum and Rubin (1983) developed two conditions, namely:

- $E(Y_0|x, U) = E(Y_0|x)$
- $\theta(x) < 1$ for all *x. (overlap)*

These conditions allow us to obtain the result below:

$$E(Y|x, U = 1) - E(Y|x, U = 0) = E(Y_0|x, U = 1) - E(Y_0|x, U = 0) + E(Y_1 - Y_0|x, U = 1)$$

$$= E(Y_1 - Y_0|x, U = 1)$$

From this one, we can write:

$$\tau_{att} = E[E(Y_1 - Y_0|x, U = 1)] = E[E(Y|x, U = 1) - (E(Y|x, U = 0)|U = 1)]$$

Or

$$\tau_{att} = E[E(Y|\theta(x), U = 1) - E(Y|x, U = 0)|U = 1] \quad (3.4)$$

Our approach consists of two steps. The first step is to estimate the propensity score, and the second step is to estimate the ATT while integrating the estimated propensity score. First, the propensity score is estimated using a logistic regression model (logit) where the logistic regression is written:

$$\theta(x) = \frac{e^{x\beta}}{1 + e^{x\beta}}$$

Where $\beta$ represents the parameters.

After estimating the propensity scores, we use them to match OPEC + members and non-members. Using this approach has a twofold advantage:

- It allows to reduce the dimensionality that allows a better match based on a single score as opposed to several covariates;
- It allows OPEC + members and non-members to be selected while keeping the same distribution of covariates observed after generating a homogeneous matched set.

In principle, the selection bias is corrected in the new sample. Thus, from the estimated propensity scores $\hat{\theta}(x)$, we estimate the ATT and the ATE.

Indeed, beyond the effect of the ATT, one wonders what the effect of this measure would be if it were extended to the entire population. It is then a question of estimating the average effect of the treatment on the whole of the population (Averaged Treatment Effect), or formally:

$$\Delta^{ATE} = E(Y_{i1} - Y_{i0}) \tag{3.5}$$

The ATE on the treated unit shows the difference between the result obtained after the treatment and the possible outcome the unit would have achieved if it had never been processed. In the specific case of our study, the ATE shows the country's different economic performances before and after adopting the inflation targeting policy. This effect is likely to depend on the economic characteristics of the different groups of countries.

Literature employs different matching algorithms to increase the quality of impact analysis. Furthermore, different matching approaches use different assignments at evaluation treatment effect through estimated propensity score (Lucotte, 2012). In this study, we document four PSM approaches commonly used in the literature:

(i) The first one is the nearest-neighbor matching estimator. We employ one-to-one matching with no replacement (n=1), three nearest-neighbor matching (n=3), and five nearest-neighbor matching (n=5). An increased number of neighbors allows us to get more information through decreasing variance. However, matching estimations may produce reduced quality, and this is because using poorer matches on average may also raise biased results.

(ii) In the cases when the closest neighbor is far away, estimates from nearest-neighbor matching cannot document accurate results. The radius matching estimator deals with this problem by imposing a maximum propensity score distance threshold. To reduce problems sourced by increased variance because of decreased matching, we use three calipers; a wide radius (r=0.05), a medium radius (r=0.03), and a tight radius (r=0.01).

(iii) Contrary to neighbor and radius matching methods, kernel matching considers weighted averages of all economies by building up counterfactual matching as benefited from a few treated observations. The kernel matching approach uses a weighted average of all untreated observations to construct the counterfactual match for each treated observation. Each non-ITers observation has a weight that depends on the distance from the ITers observation aspect of the propensity score.

(iv) Stratification matching consists of partitioning the common support of the propensity score into a set of intervals. Measurement depends on the mean difference within

each interval in inflation rates between ITers and non-ITers observations (Caliendo and Kopeinig,2008).

### 3.2.2. DATA

OPEC + designates a group of 23 oil-producing countries: the 13 member countries of OPEC and ten other producers, including Russia, Kazakhstan, Azerbaijan, Mexico, Bahrain, Brunei, Oman, Malaysia, Sudan, and South Sudan. In this study, OPEC + countries include 20 countries, 11 of them from OPEC plus 9 new members, make up the treated group, and 43 other exporting countries that are not part of OPEC + form the control group. We note the exclusion of OPEC+ in this sample due to their repetitive membership and withdrawal, such as Gabon, Ecuador, and Indonesia, and countries that have recently joined the organization: Equatorial Guinea and Congo, respectively in 2017 and 2018.

Tables 27 and 28 below list the countries of the treated group and the control group, respectively, and the dates of joining OPEC +.

**Table 27**: *List of the group of countries treated*

| Treated countries (OPEC) | Date | Treated countries (9 New countries) | Date |
|---|---|---|---|
| Algeria | 1969 | Azerbaïdjan | 2016 |
| Angola | 2007 | Bahrain | 2016 |
| Iran | 1960 | Brunei | 2016 |
| Iraq | 1960 | Kazakhstan | 2016 |
| Kuwait | 1960 | Malaysia | 2016 |
| Libya | 1962 | Oman | 2016 |
| Nigeria | 1971 | Mexico | 2016 |
| Qatar | 1961 | Russia | 2016 |
| Saudi Arabia | 1960 | Sudan | 2016 |
| U.A.E | 1967 | | |
| Venezuela | 1960 | | |

**Table 28***: List of non-treated countries*

| Control group | | | |
|---|---|---|---|
| Albania | Colombia | Mongolia | Singapore |
| Argentina | Cote d'Ivoire | New Zealand | Syrian Arab |
| Barbados | Czech Republic | Pakistan | Thailand |
| Belarus | Egypt | Papua New Guinea | Timor-Leste |
| Belize | Georgia | Peru | Trinidad&Tobago |
| Bolivia | Ghana | Philippines | Tunisia |
| Brazil | Guatemala | Poland | Ukraina |
| Cameroon | Hungary | R.D.C | Uzbekistan |
| Chad | Lithuania | Romania | Vietnam |
| Chile | Macedonia | Senegal | Yemen |
| China | Mauritania | Serbia | |

As explained in the previous sections, OPEC was created by five countries in the 1960s and was then joined by other countries until June 2016 with the creation of OPEC +. To examine whether there is a difference in the effect of OPEC + on early adopters[28] and countries overall[29], we consider two treated groups. For lack of data for several countries, we compare the results before and after the 2008 oil shock following the financial crisis. Thus, we compare three sampling periods: the total sample, which contains data from 1990 to 2019, a period from 1990 to 2008 (before the crisis), and from 2009 to 2019 (post-crisis). The data collected is on an annual basis.

We made sure that the untreated group and the treatment group were comparable for the reliability of the results. To do so, the criterion for selecting the countries of the untreated group is that the countries with advanced economies producing petroleum are excluded from our sample.

This study estimates the effects of treatment of OPEC + membership on member countries. To achieve this, we examine the impact on a selection of macroeconomic variables, including inflation, GDP growth, Trade openness, investment measured by gross fixed capital formation, current account, domestic credit, unemployment, FDI, and Real interest rate.

[28]here we will consider the member countries from 1960-2015, that is to say before the creation of OPEC +
[29]OPEC+

There are two steps to estimating the treatment effect: the first is to estimate the propensity scores through the probit regression model. The second step consists of matching the observations by taking into account the estimated propensity scores and estimating the average effects of the treatment.

The table below represents the variables used, expected signs, and origin.

**Table 29:** *Definition and sources of all the variables*

| Variables | Description | Sources |
|---|---|---|
| GDP growth | The annual percentage growth rate of GDP | WDI |
| Inflation | The average consumer price index (CPI). The rate of inflation is the percent change in the average CPI | WDI |
| Current account | Current account balance (% of GDP)=government current account balance as a percentage of the GDP | WDI |
| Domestic credit | Domestic credit provided by the financial sector (% of GDP). It includes all credit to various sectors on a gross basis, except credit to the central government, which is net. The financial sector includes monetary authorities, deposit money banks, and other financial corporations where data are available (including corporations that do not accept transferable deposits but incur such liabilities as time and savings deposits). | WDI |
| Unemployment | The unemployment rate refers to the share of the labor force out of work but available and looking for work. | WDI |
| Investment | Gross fixed capital formation (% GDP) includes land improvements (fences, ditches, drains, and so on); machinery, plant, and equipment purchases; and the construction of railways, roads, and the like, including offices, schools, hospitals, private residential dwellings, and commercial and industrial buildings. | WDI |
| Interest rate | Real interest rate concerns the lending interest rate adjusted for inflation as measured by the GDP deflator. | IMF/IFS |
| Trade openness | Trade represents the sum of exports and imports of goods and services measured as a share of gross domestic product. | WDI |
| FDI | Foreign direct investment net inflows (% of GDP). FDI is the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than the investor. | WDI |

Source: WDI, IMF/IFS

## 3.3. EMPIRICAL RESULTS

This section presents the results of different tests implemented using the appropriate model for each. The first subsection concern the results of the propensity score for the entire sample and the Pre/Post 2008 financial crisis. And the second subsection concerns the matching analyses with different matching methods.

First, it is important to know the statistical description of the variables. Table 30 presents descriptive statistics of the variables considered for OPEC + member countries and non-OPEC + countries. Concerning the results, OPEC + member countries perform better with investment, economic growth, current account, and trade than the organization's non-member countries. The maximum inflation value of OPEC + member countries that reaches 2740.2 belongs to Venezuela in 2016, which explains part of the higher average inflation value for OPEC + members compared to non-member countries.

**Table 30**: *Descriptive statistics*

| Variables | OPEC+ countries | | | | | Non-OPEC+ countries | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Full sample | Obs | Mean | Std. Dev. | Min | Max | Obs | Mean | Std. Dev. | Min | Max |
| Inflation | 600 | 103.0 | 187.7 | -0.77 | 2740.2 | 1,290 | 74.75 | 43.77 | -2.7 | 281.6 |
| Investment | 600 | 22.94 | 8.63 | 0 | 57.71 | 1,289 | 21.83 | 8.91 | -33.7 | 93.54 |
| Unemployment | 600 | 7.24 | 5.76 | 0.08 | 31.84 | 1,289 | 7.76 | 5.90 | 0.39 | 37.25 |
| GDP growth | 600 | 4.3 | 9.69 | -64.0 | 123.1 | 1,290 | 3.55 | 4.95 | -44.9 | 33.62 |
| Current account | 600 | 7.04 | 18.56 | -240.5 | 65.27 | 1,290 | 0.57 | 22.12 | -43.7 | 311.7 |
| Domestic credit | 600 | 38.59 | 34.16 | 0.10 | 176.27 | 1,290 | 39.78 | 33.18 | 0.11 | 164.6 |
| Trade openness | 600 | 83.38 | 42.01 | 0.02 | 220.4 | 1,290 | 79.92 | 57.14 | -9.1 | 437.3 |
| Real interest | 600 | 2.43 | 15.69 | -93.51 | 61.88 | 1,290 | 15.06 | 57.49 | -91.7 | 619.7 |
| FDI | 600 | 3.24 | 5.81 | -6.36 | 55.07 | 1,290 | 3.86 | 5.44 | -41.0 | 54.6 |
| Pre-2008 | | | | | | | | | | |
| Inflation | 209 | 57.3 | 33.77 | -0.77 | 207.1 | 988 | 52.99 | 28.30 | $4.1^{-10}$ | 101.0 |
| Investment | 209 | 22.82 | 9.65 | 0 | 53.12 | 988 | 21.61 | 8.81 | -33.7 | 93.54 |
| Unemployment | 209 | 8.31 | 7.35 | 0.31 | 31.84 | 988 | 7.79 | 5.97 | 0.39 | 37.25 |
| GDP growth rate | 209 | 6.18 | 10.5 | -64.04 | 57.81 | 988 | 3.74 | 5.77 | -44.9 | 34.46 |
| Current account | 209 | 9.48 | 22.26 | -240.5 | 44.62 | 988 | 1.71 | 21.41 | -30.6 | 311.7 |
| Domestic credit | 209 | 33.12 | 38.79 | 0.10 | 176.27 | 988 | 35.60 | 29.64 | 0.11 | 158.5 |
| Trade openness | 209 | 74.37 | 35.58 | 0.02 | 178.59 | 988 | 78.91 | 55.98 | -9.17 | 437.3 |
| Real interest | 209 | -1.75 | 17.39 | -93.51 | 36.64 | 988 | 12.93 | 52.73 | -91.7 | 619.7 |
| FDI | 209 | 2.20 | 4.16 | -3.52 | 40.16 | 988 | 4.18 | 5.77 | -5.28 | 55.07 |
| Post-2008 | | | | | | | | | | |
| Inflation | 220 | 181.5 | 291.4 | 78.01 | 2740.2 | 473 | 114.17 | 37.59 | -2.7 | 281.6 |
| Investment | 220 | 23.60 | 7.91 | 1.16 | 48.86 | 473 | 22.44 | 8.85 | -26.2 | 76.5 |
| Unemployment | 220 | 6.79 | 4.88 | 0.082 | 19.06 | 473 | 7.28 | 5.24 | 0.48 | 32.02 |
| GDP growth | 220 | 2.94 | 10.34 | -62.07 | 123.13 | 473 | 3.24 | 3.92 | -27.9 | 17.29 |
| Current account | 220 | 6.59 | 13.34 | -46.26 | 45.45 | 473 | -0.35 | 22.61 | -43.7 | 238.3 |
| Domestic credit | 220 | 44.38 | 29.82 | 3.77 | 123.1 | 473 | 47.81 | 38.03 | 3.72 | 164.6 |
| Trade openness | 220 | 83.58 | 38.56 | 19.1 | 191.87 | 473 | 87.16 | 57.41 | -6.71 | 379.0 |
| Real interest | 220 | 6.003 | 15.43 | -58.15 | 61.88 | 473 | 15.12 | 57.52 | -33.5 | 423.6 |
| FDI | 220 | 1.95 | 2.74 | -6.36 | 12.54 | 473 | 4.03 | 6.35 | -41.0 | 54.64 |

### 3.3.1. Results of the Propensity Scores

As part of the propensity score estimation, we used a probit model, and the results are presented in Table 31.

**Table 31**: *Estimation of the Propensity Score*

| | **Propensity Score** | | |
|---|---|---|---|
| | Full sample | Pre-2008 | Post-2008 |
| Inflation | 0.002***<br>(0.000) | 0.005***<br>(0.002) | 0.005***<br>(0.000) |
| Investment | 0.007*<br>(0.051) | 0.01**<br>(0.024) | 0.01**<br>(0.044) |
| Unemployment | -0.01*<br>(0.055) | 0.004<br>(0.514) | -0.01*<br>(0.089) |
| Current account | 0.005***<br>(0.000) | 0.005***<br>(0.001) | 0.006***<br>(0.008) |
| Domestic credit | -0.002**<br>(0.026) | -0.001<br>(0.340) | -0.001<br>(0.316) |
| Trade openness | 0.0002<br>(0.706) | -0.002*<br>(0.080) | 0.001<br>(0.256) |
| Real interest | -0.011***<br>(0.000) | -0.01***<br>(0.000) | -0.004*<br>(0.053) |
| FDI | -0.01<br>(0.081)* | -0.06***<br>(0.000) | -0.04***<br>(0.000) |
| Constant | -0.63***<br>(0.000) | -1.10***<br>(0.000) | -1.25***<br>(0.000) |
| **Nb. Of obs** | **1887** | **1195** | **693** |
| **Pseudo $R^2$** | **0.0551** | **0.0941** | **0.1052** |

Note: Standard errors in parenthesis; *** p<0.05, ** p<0.05, * p<0.10

The analysis of the propensity score results clearly shows that for the period 1990-2019, the decision to join OPEC+ is not random. The conditional probability of joining the organization appears to be driven significantly by inflation, investment, unemployment rate, current account, domestic credit, real interest rate, and FDI. Such results suggest that an oil-producing country with a higher level of investment has a greater propensity to join OPEC +. The estimated coefficient of inflation and current account balance are both positive and statistically significant, implying that countries with higher inflation and exporting countries are more likely to join the organization, respectively. The unemployment, domestic credit, interest rate, and foreign direct investment coefficients also show a negative and statistically significant relationship. These variables suggest that a higher gap is associated with a lower probability of joining OPEC +. For the two sub-samples (Pre and Post-crisis of 2008), the propensity score of the different variables is approximately similar. For example, one notes that the coefficients of the variables inflation, investment, current account are positive and significant, while the real interest rate and FDI are negative and significant. The unemployment propensity score before the 2008 crisis is statistically insignificant, unlike the post-crisis period, which is statistically significant and negative. Also, trade has a negative coefficient and is significant for the pre-crisis period that is different from the whole sample and the post-crisis period.

Figures 12, 13, and 14 show the numerical densities of OPEC+ member countries and non-OPEC+ members according to their propensity score ranges. In the Figures below, the horizontal section indicates the propensity score range, while the vertical section indicates the number of countries. The red blocks in the upper part of the horizontal line indicate the density distribution of the propensity scores for the country group of OPEC+ members, and the blue blocks represent the density distribution of the propensity scores for non-OPEC+ member countries. Figures indicate that propensity scores are overlapped, and common support is provided.

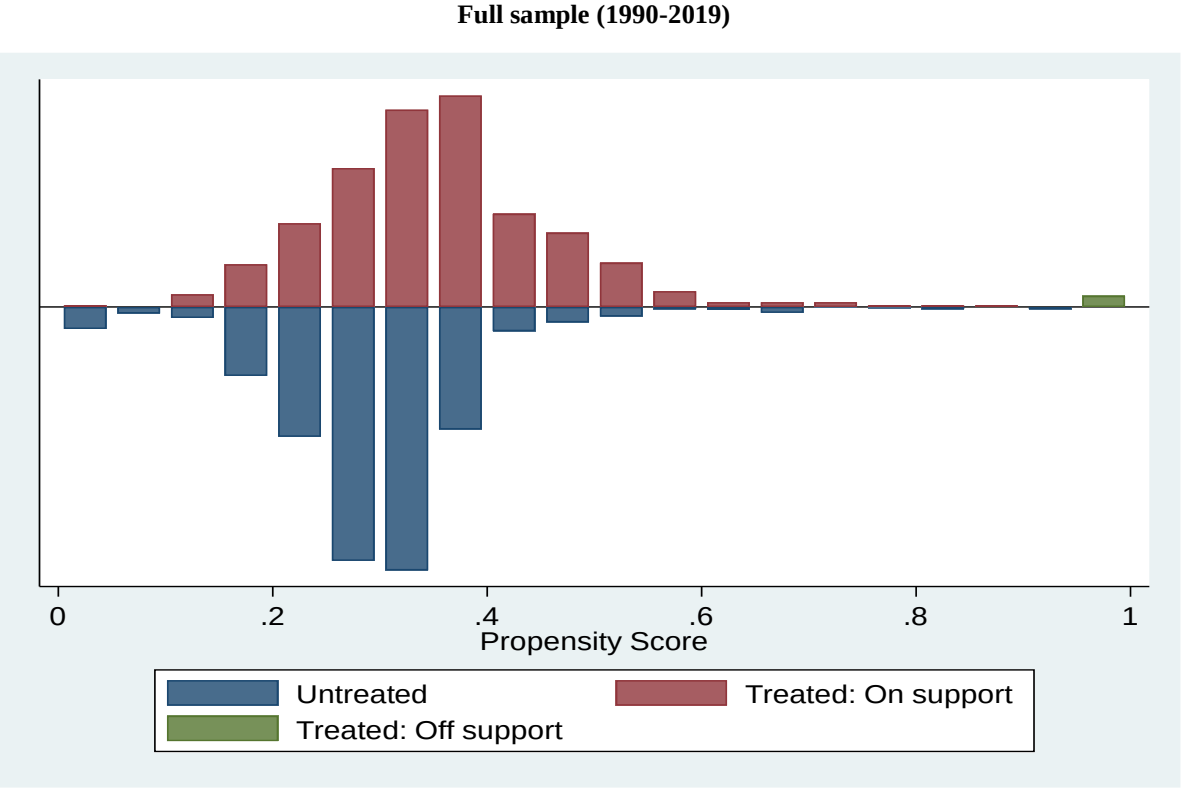



**Figure 12**: Propensity score matching for the total sample

**Pre-2008**

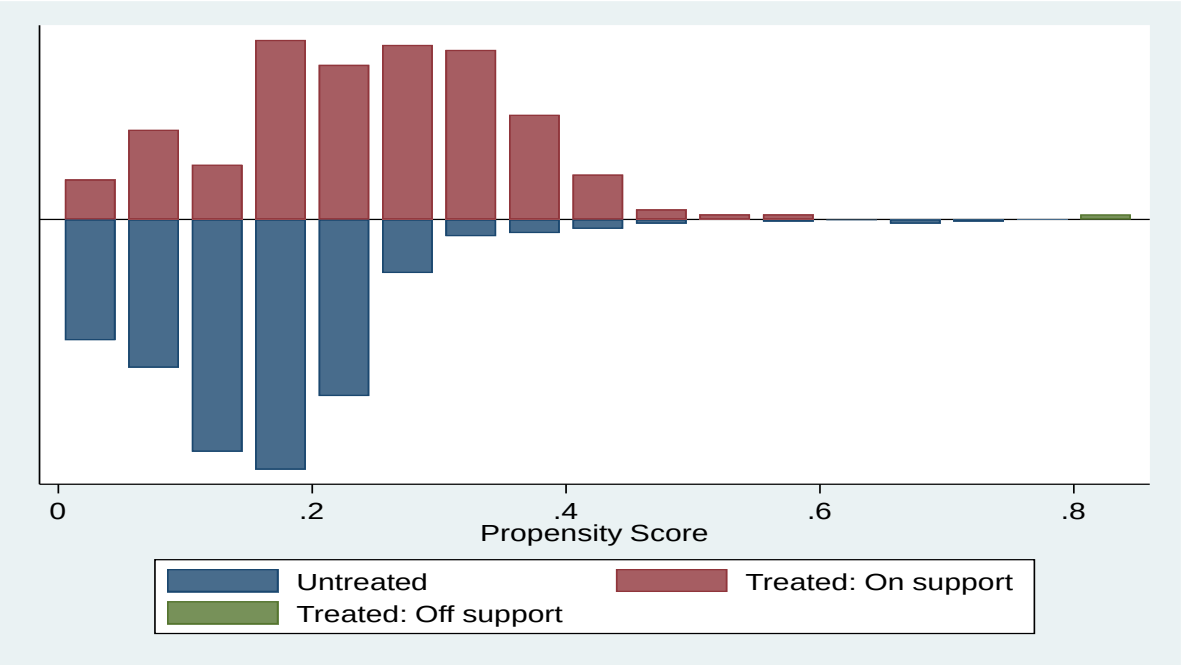



**Figure 13**:Propensity score results pre-2008

**Post-2008**

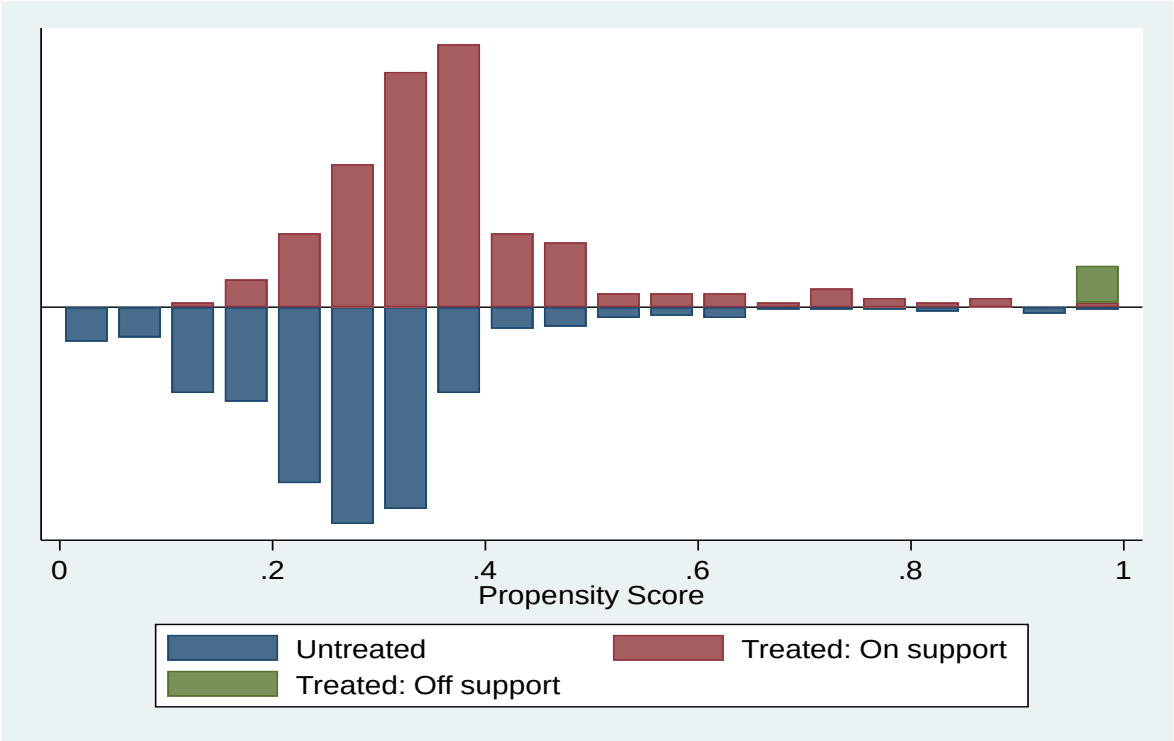



**Figure 14**: Propensity score results post-2008

The next section estimates the ATT of joining OPEC + on economic growth based on the propensity score results.

### 3.3.2. Results of the PSM

In this section, we use the results of the first step, i.e., the propensity score, to estimate the treatment effects. Firstly, we present the results of the matching using the ATT method, and second, the matching results using ATE methods.

#### *3.3.2.1. ATT matching results*

Table 32 presents the ATTs results using the matching methods: Nearest-Neighbor Matching, Kernel Matching, Radius Matching, and Stratification Matching. The results of the propensity score matching in the case of the full sample show that being a member of OPEC + leads to an improvement of specific macroeconomic aggregates in general and economic growth in particular compared to non-member countries. Indeed, according to Table 32, the coefficients are all positive and statistically significant irrespective of the matching technique used for the full sample. On average, the magnitude of the estimated ATT concerning being an OPEC+ member ranges from 0.91 (nearest-neighbor matching, n=5) to 1.02 (stratification matching) percentage point for the full sample. Therefore, joining OPEC+ has positive and statistically significant impacts on increasing economic growth by at least 0.91 percent to a maximum of 1.02 percent compared to non-OPEC+ counterparts.

The ATT results for the two subsamples are different from each other. Indeed, in the period preceding the 2008 crisis, the results are similar to the full sample period. The coefficients of the different matching methods are statistically significant with a positive sign. Indeed, on average, being an OPEC+ member increases the economic growth by at least 2.55 percent according to the nearest-neighbor matching (n=3) to a maximum of 2.82 percent according to the stratification matching.

**Table 32:** *Estimates of the ATT of joining OPEC+ on economic growth*

| | **Full sample (1990-2019)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| OPEC+ | Nearest neighbor matching | | | Radius matching | | | Kernel matching | Stratification matching |
| | n=2 | n=3 | n=5 | r=0.01 | r=0.03 | r=0.05 | | |
| r(att) | 0.95* (0.54) | 0.96* (0.52) | 0.91* (0.47) | 0.92* (0.52) | 0.99** (0.46) | 0.92** (0.39) | 0.95* (0.51) | 1.02** (0.48) |
| | **Pre-2008** | | | | | | | |
| OPEC+ | Nearest neighbor matching | | | Radius matching | | | Kernel matching | Stratification matching |
| | n=2 | n=3 | n=5 | r=0.01 | r=0.03 | r=0.05 | | |
| r(att) | 2.56** (1.01) | 2.55*** (0.90) | 2.61*** (0.93) | 2.64*** (0.94) | 2.64*** (0.842) | 2.65*** (0.844) | 2.65*** (0.99) | 2.82*** (0.92) |
| | **Post-2008** | | | | | | | |
| OPEC+ | Nearest neighbor matching | | | Radius matching | | | Kernel matching | Stratification matching |
| | n=2 | n=3 | n=5 | r=0.01 | r=0.03 | r=0.05 | | |
| r(att) | -0.44 (0.76) | -0.51 (0.84) | -0.53 (0.80) | -0.22 (0.88) | -0.62 (0.70) | -0.62 (0.84) | -0.62 (0.82) | -0.68 (0.80) |

Note: The bootstrapped standard errors with 100 replications in parenthesis. *** p<0.05, ** p<0.05, * p<0.10

Unlike the period before 2008, that after 2008 is showing different results. Indeed, the coefficients have negative signs and are not significant.

#### *3.3.2.2. ATE matching results*

Table 33 presents the ATE using the estimates of the propensity score. The matching of propensity scores in the case of the full sample shows that being a member of OPEC + improves specific macroeconomic aggregates in general and in economic growth for the whole sample period compared to non-member countries. Indeed, it appears that the coefficients are all positive and statistically significant irrespective of the matching technique used for the full sample. On average, the magnitude of the estimated ATE concerning being an OPEC+ member ranges from 0.65 percent according to the kernel matching to 0.96 percent according to the nearest-neighbor matching (n=3) for the full sample. Therefore being an OPEC+ member increases the economic growth from 0.65 to 0.96 percent, which means that being an OPEC+ member seems to have positive and statistically significant effects on increasing economic growth. In other words, if non-OPEC+ members had been members of the organization, the percentage of increasing their economic growth would have been ranged between 0.65 to 0.96 percent more.

The ATE results for the two subsamples are different from each other. Indeed, in the period preceding the 2008 crisis, the results are similar to the full sample period. Moreover, the coefficients of the different matching methods are statistically significant with a positive sign. Indeed, being an OPEC+ member increases economic growth in a range from 2.61 to 3.06 percent according to radius matching (r=0.01) and stratification matching, respectively. However, for the period post-crisis, the coefficients are negative and not significant.

**Table 33**: *ATE matching results*

| | **Full sample (1990-2019)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| OPEC+ | Nearest neighbor matching | | | Radius matching | | | Kernel matching | Stratification matching |
| | n=1 | n=3 | n=5 | r=0.01 | r=0.03 | r=0.05 | | |
| r(ate) | 0.76* (0.62) | 0.96* (0.50) | 0.91* (0.52) | 0.87* (0.58) | 0.87* (0.56) | 0.85* (0.39) | 0.65* (0.45) | 0.94** (0.48) |
| | **Pre-2008** | | | | | | | |
| OPEC+ | Nearest neighbor matching | | | Radius matching | | | Kernel matching | Stratification matching |
| | n=1 | n=3 | n=5 | r=0.01 | r=0.03 | r=0.05 | | |
| r(ate) | 2.64*** (1.21) | 3.06*** (1.26) | 3.06** (1.04) | 2.61** (1.12) | 2.65*** (1.07) | 2.64*** (1.25) | 2.70*** (0.95) | 3.04*** (0.98) |
| | **Post-2008** | | | | | | | |
| OPEC+ | Nearest neighbor matching | | | Radius matching | | | Kernel matching | Stratification matching |
| | n=1 | n=3 | n=5 | r=0.01 | r=0.03 | r=0.05 | | |
| r(ate) | -0.33 (0.78) | -0.51 (0.80) | -0.53 (0.85) | -0.05 (0.89) | -0.30 (0.87) | -0.33 (0.83) | -0.49 (0.65) | -0.61 (0.77) |

Note: The bootstrapped standard errors with 100 replications in parenthesis. *** p<0.05, ** p<0.05, * p<0.10

To sum up, the results above partly reflect that most countries whose economy is based mainly on oil exploitation have witnessed the significant impact of the financial crisis on the oil market and a countershock with a decrease of more than 50% of the price of black gold in 2014. That led these countries to adopt a policy of declining production, which is not without consequences on the GDP growth, which fell considerably during and after the crisis in member countries.

### 3.3.3. Sensitivity analysis of treatment effects

For this study, Rosenbaum bounds are used for sensitivity analysis. This method measures the logarithmic probability of being assigned to the treatment group due to unobserved factors using the sensitivity parameter gamma (Γ) (Rosenbaum, 2002). In the absence of selection bias due to unobserved factors, the random assignment of treatments in the experimental data corresponds to Gamma = 1.

**Table 34**: *Rosenbaum bounds for economic growth on OPEC+ countries*

| Gamma | sig+ | sig- | t-hat + | t-hat - | CI+ | CI- |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 3.91499 | 3.91499 | 3.73971 | 4.09079 |
| 1.5 | 0 | 0 | 3.22421 | 4.59462 | 3.03632 | 4.77457 |
| 2 | 0 | 0 | 2.71468 | 5.08035 | 2.50807 | 5.27263 |
| 2.5 | 0 | 0 | 2.3004 | 5.46229 | 2.07471 | 5.66615 |
| 3 | 0 | 0 | 1.94941 | 5.77799 | 1.70045 | 5.99687 |

Note: gamma - log odds of differential assignment due to unobserved factors; sig+ - upper bound significance level; sig- - lower bound significance level; t-hat+ - upper bound Hodges-Lehmann point estimate; t-hat- - lower bound Hodges-Lehmann point estimate; CI+ - upper bound confidence interval (a= .95); CI- - lower bound confidence interval (a= .95).

Our study performed a sensitivity analysis on 8 continuous variables for economic growth on the full sample (1990-2019). Table 34 reports the results. Assuming an overestimate of the treatment effect, Rosenbaum's upper bound (sig+) is considered the relevant statistic. Thus, the result for economic growth shows that when Γ = 3, the p-value at the upper bound (sig+) remains unchanged and remains at 0. Following this, the null hypothesis of no treatment effect is rejected.

# CONCLUSION

This study aims to examine the effect of the treatment of OPEC + membership on the macroeconomic performance of member countries using a PSM analysis. The PSM model considers the self-selection problem associated with being a member of OPEC+ because the decision to join OPEC + is not a random fact. The study period runs from 1990 to 2019. Our study is examined on three samples as: the first concerns the entire period, the second concerns the period before the 2008 oil shock, and the last concerns the post-shock period of 2008.

Propensity score methods are popular methods for estimating the causal effect of an exposure on an outcome using observational data (non-randomized data). The propensity score is then used to limit a selection bias potential linked to treatment choice. In this study, the decision to join OPEC+ is not random, resulting in biased and overestimated results when using linear econometric techniques. Thus, this study's PSM method performs further analyses while addressing self-selection bias. Evaluating the impact of being an OPEC+ member on economic growth occurs in several stages. First, probit regression calculates propensity scores between each treatment and control individuals. Then, to analyze the density distribution, we use the result of the common support plot from the estimated propensity score. The last step consists of estimating the average treatment effect on all the population (ATE) and the average treatment effect on the treated (ATT) to evaluate the impact of being an OPEC+ member. For estimating the matching, nearest-neighbor matching, kernel, radius, and stratification matching approaches are employed

The propensity score matching analysis results reveal that both of the employed methods of ATT and ATE present similar degrees of significance and coefficient signs. Based on the results of the ATT, being a member of OPEC + improves certain macroeconomic aggregates in general and in economic growth for the entire sample period compared to non-member countries. On average, the magnitude of the estimated ATT concerning being an OPEC+ member ranges from 0.91 (nearest-neighbor matching, n=5) to 1.02 (stratification matching) percent for the full sample. These results show that if OPEC+ members had not joined the organization, their economic growth would have been at least 0.91 percent lower. In other words, member countries benefit from the organization.. However, for the two subsamples, we obtained different results. Indeed, considering the coefficients of the pre-crisis, we observe that all are statistically significant and positive irrespective of the matching technique. On average, being an OPEC+ member increases the economic growth by at least 2.55 percent according to the nearest-neighbor matching (n=3) to a maximum of 2.82 percent according to the

stratification matching. For the case of the post-crisis sample, unfortunately, none of the coefficients is significant and positive; in other words, it means that the economic growth of the OPEC+ members and those countries that joined after the crisis did not significantly impact their economic growth.

The propensity score matching analysis for the full sample shows that being a member of OPEC + significantly improves economic growth. The coefficients are both positive and statistically significant. On average, the magnitude of the estimated ATE concerning being an OPEC+ member ranges from 0.65 percent according to the kernel matching to 0.96 percent according to the nearest-neighbor matching (n=3) for the full sample. Therefore being an OPEC+ member increases the economic growth from 0.65 to 0.96 percent, which means that being an OPEC+ member has positive and statistically significant effects on increasing economic growth. In other words, if non-OPEC+ members had been members of the organization, the percentage of increasing their economic growth would have been ranged between 0.65 to 0.96 percent more. The ATE results for the two subsamples are different from each other. Indeed, in the period preceding the 2008 crisis, the results are similar to the entire sampling period (total sample). The coefficients of the different matching methods are statistically significant with a positive sign. Indeed, being an OPEC+ member increases economic growth in a range from 2.61 to 3.06 percent according to Radius (r=0.01) and stratification matching, respectively. We verify that the impact on the economic growth of being a member of OPEC+ is not the same over the pre and post 2008 oil shock periods.

The empirical results reveal in general that being a member of OPEC gives an economic advantage over time. Despite the various oil shocks, the existing quotas on oil production, and often non-compliance with these quotas by some members, member countries benefit from exporting oil. OPEC influences and maintains oil prices through the quota system by controlling oil production volume and generating income. These revenues obtained by members are allocated in most cases to their economic development programs and sometimes to other countries as part of their development process.

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