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ARTICLE

Two decades of pegging to the euro and economic performances in the two franc CFA zones: An empirical assessment

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Abstract

This paper separately assesses the impact of the franc CFA's fixed parity with the euro on the real GDP per capita of the WAEMU and CAEMC economic and monetary areas. Using data collected from eight and six countries respectively, and over the period 1989–2019, we use counterfactual estimation methods to estimate the average treatment effect of the currency peg on GDP per capita in two economic zones. This involves estimating the average treatment effect on the treated by directly imputing counterfactual outcomes for treated observations. Our results reveal contrasting average effects in the two zones. Compared to the counterfactual outcome, our results show contrasting effects of the reform on income in the two zones. While the reform significantly increased GDP per capita in the CAEMC zone, it had no effect on GDP per capita in the WAEMU zone compared to what would have happened otherwise. Analyzing the effects of this reform on income in terms of time trajectories also highlights converging situations between the two zones. In the long term, the average impact of reforms tends to be negatively reinforced.

Keywords: Counterfactual estimators, Franc CFA, Currency pegging, Income, WAEMU and CAEMC

JEL classification: C19; C33; E52; 58; O55; P24

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1. Introduction

The CFA franc zone, established in 1945 and comprised of two independent monetary unions managed by two different central banks, has been a long-standing monetary union with 14 member countries[1]. The adoption of the Euro posed challenges for monetary cooperation between CFA zone countries and France. Interestingly, the exchange rate against the French franc (today's euro), the pegged currency, has only ever been modified once, in 1994. As highlighted by Irving (1999), this is one of the areas most likely to be affected by the switch to the euro. However, the economic impact of introducing the euro in the CFA zone has not been adequately assessed (Coulibaly 2014).

1. Benin, Burkina Faso, Ivory Coast, Guinea-Bissau, Mali, Niger, Senegal and Togo form the West African Economic and Monetary Union (WAEMU). Cameroon, Central African Republic, Chad, Republic of Congo, Equatorial Guinea and Gabon form the Central African Economic and Monetary Community (CAEMC).

From an economic point of view, the CFA zone is an interesting case study due to the monetary stability and fixed exchange rates it has recorded for over 50 years. This is in contrast to the experiences of non-CFA sub-Saharan African countries. This stability may be primarily due to the monetary credibility provided by France's external guarantee. Furthermore, confidence in the currency's value has been maintained, even amid unfavorable economic and political developments in the region. However, despite this monetary stability, these countries do not systematically perform better in the long term in terms of growth, GDP per capita or the human development index (Senat, 2020).

While the advantages are numerous, questions remain concerning the fixed exchange rate between the CFA franc and the euro. It should be emphasised that the introduction of the euro represents a historic turning point. The monetary policy of the European Central Bank, inspired by the German Bundesbank, is significantly more rigorous than that of the Banque de France (Didier & al., 2008). The major challenge for countries in the two CFA areas lies in the overvaluation of the euro following this new pegging (Hadjmichael & Galy, 1997; Zafar, 2005).

The overvaluation of the CFA franc caused by a strong euro, is an important issue. It is likely to result in a loss of competitiveness for members of the CFA areas vis-à-vis their trading partners. This could lead to a deterioration in their current accounts and growth rates. Bolle (1997) highlights in his analysis that the countries of the CFA zone saw their competitiveness increase thanks to their pegging to the French franc, which depreciated during the 1970s. However, between 1980 and 1993, these countries lost competitiveness, which was one of the causes of the CFA franc's devaluation in 1994. During this period, the member states of the CFA zone posted economic results that fell short of expectations. This can be attributed to the overvaluation of the CFA franc, which resulted in a loss of competitiveness for the region's exports.

As Gnimassoun (2012) and Gnansounou & Verdier-Chouchane (2012) point out, the deterioration in terms of trade and the appreciation of the anchor currency over the years have led to a decline in the competitiveness of products from CFA countries on the international market. After two decades, the euro has undergone significant nominal appreciation against the US dollar (an annual average of +40% between 2002 and 2010). The real effective exchange rates of some countries have become overvalued as a result, leading to deteriorating current account deficits (Arghyrou & Chortareas, 2008). It should be noted that any nominal fluctuation in the anchor currency is reflected in an equivalent nominal fluctuation in the CFA franc. Consequently, the euro's appreciation over the years has rekindled debate about the future of the CFA franc. This concern is all the more pressing given that the monetary integration of the CFA zone has not been accompanied by significant economic integration. Intra-CFA zone trade flows are therefore relatively limited due to member states' marked specialisation in exporting raw materials. Consequently, their economies have limited capacity to absorb exogenous shocks, such as the depreciation of the euro.

Consequently, in the face of current global economic upheavals, the CFA's peg to the euro, despite conferring stability, continues to raise questions about overvaluation and competitiveness. The goal of this study is therefore to assess the impact of choosing the euro as an anchor currency on GDP per capita in the CFA franc zones. In other words, we aim to determine what the GDP per capita of the CFA zone would be if this reform had not taken place.

According to the World Bank's income classification, eight of these countries are classified as low-income, four as lower-middle-income and two as upper-middle-income. Only two countries, Gabon and the Republic of Congo, do not fall into the bottom quartile of the United Nations Development Programme's Human Development Index. Consequently, countries in the Franc zone remain among the poorest in the world. The majority of these countries suffer from slow growth and low real income. Reasons for this situation include drought, weak institutions, inadequate macroeconomic policies, adverse terms of trade, corruption, political instability and limited foreign credit.

Following France's adoption of the euro in 1999, the CFA francs were pegged to it at the same relative parity. The arrangement is based on France's external guarantee. The French Treasury provides an unlimited guarantee of convertibility between the euro and the CFA franc at a fixed rate. In return, national foreign exchange reserves are pooled, with at least 50 per cent of these pooled reserves being deposited in an 'operations account' at the French Treasury — although this is no longer the case in the WAEMU — and total foreign exchange reserves are maintained at a level exceeding 20 per cent of demand commitments. These operational accounts — one for each CFA franc zone — are accompanied by an overdraft facility that can be drawn upon in the event of foreign exchange reserve exhaustion. In effect, the French Treasury acts as a lender of last resort for foreign exchange reserves to the CFA franc zones. This arrangement also permits the free movement of capital between countries in each zone and between these countries and France.

The relevance of the CFA franc system for its member countries has been widely discussed (Guillaumont & al., 1988; Debrun., & al (2005). To evaluate the impact of pegging the CFA franc to the euro, we have applied an innovative counterfactual estimation framework for causal inference with panel data. This framework enables us to estimate the average effect of the reform on the treated group by directly imputing counterfactual outcomes for the observations in this group. Our results reveal contrasting average effects in the two zones. Compared to the counterfactual outcome, we find that the reform had contrasting effects on income in the two economic and monetary zones. While the reform significantly increased GDP per capita in the CAEMC zone, it had not boosted GDP per capita in the WAEMU zone compared to what would otherwise have happened.

This evaluation exercise should contribute to the debate on pegging the CFA to the euro, which is not consistent with the underlying economic fundamentals of the countries concerned. In other words, was it economically justified to maintain parity when the euro was introduced? Would the euro not be too strong for the CFA zone?

The remainder of the paper is structured as follows: Section 2 provides a literature review; Sections 3 and 4 presents the methodology and data, respectively; Section 5 presents the results; Section 6 discusses the robustness of the results; and Section 7 discusses the results before the conclusion.

2. Literature Review

2.1 Theoretical arguments

The fixed exchange rate between the CFA franc and the euro has been the subject of criticism for its mitigated effects on economic growth in both zones. Although one of the main objectives of pegging the CFA franc to the euro may be to reduce uncertainty and promote economic integration between France and its former African colonies, it does not enhance the countries' ability to respond to external shocks, such as fluctuations in global commodity prices, which can undermine economic growth and terms of trade (Meh & al 2025). A select body of literature focuses on the impact of exchange rate regimes on growth (Grekou 2015, Coulibaly 2014, Domac & al., 2004b; Levy-Yeyati & Sturzenegger, 2002; Bohm & Funke, 2001; Du & Zhu, 2001; Dollar, 1992; Sachs & al, 1995; Rodríguez & Rodrik, 2001; Nilsson & Nilsson, 2000; Brada & Méndez, 1988). Unlike to the relationship between exchange rate regimes and inflation, the link between exchange rate regimes and growth has attracted far less research. This is "probably because nominal variables are generally considered to be unrelated to long-term growth performance" (Levy-Yeyati & Sturzenegger, 2002, p. 2). Similarly, Goldstein (2002) asserts that the natural rate hypothesis assumes the optimum macroeconomic policy can achieve is mid-term price stability. Regarding exchange rate policy, the nominal exchange rate cannot be used to keep the unemployment rate below its natural level in the long term. Therefore, any excessive effort to stimulate the economy through expansionary monetary policy or currency devaluation will lead to higher inflation but not higher real economic growth (Barro & Gordon, 1983).

Consequently, the exchange rate (as a nominal variable) is unlikely to influence long-term economic growth. There is no conclusive theoretical proof of the impact of exchange rate targets on growth. Economic theory offers little clarity on how the exchange rate regime, particularly the exchange rate peg, affects growth. Instead, the debate focuses on its impact on investment and international trade, mainly exports. Opinions are divided. According to one viewpoint, monetary policy can be used to adjust to internal and external shocks under a flexible exchange rate regime. However, this regime is challenging for developing countries characterised by weak institutions and an underdeveloped financial market. Conversely, a fixed exchange rate regime can lead to currency crises detrimental to economic growth due to the risk of significant misalignments (Coudert & al., 2011; Dubas, 2009).

De Grauwe & Schnabl (2004) claim that output growth will be higher in the case of a peg for two reasons. Firstly, removing exchange rate risk fosters international trade and the international division of labour. Secondly, a credible peg enhances confidence, reducing the country risk premium embedded in the interest rate. Low interest rates in turn spur consumption, investment and growth. For the monetary stability of the CFA franc, the peg has been a driver of a credible monetary regime in the franc zone (Verdier-Chouchane, 2001, p. 54). Bianchi & Coulibaly (2023) present a straightforward theory in which the fear of floating emerges as an optimal policy outcome. Contrary to the Mundellian paradigm, they demonstrate that depreciation can have a contractionary effect and that allowing the exchange rate to float can expose the economy to self-fulfilling crises.

In fact, it was expected that pegging the CFA franc to the euro as part of a currency agreement with eurozone countries would have beneficial effects. According to Irving (1999), the countries within the CFA zone are expected to benefit from a stable euro. This stability is particularly important as it reduces uncertainty relating to exchange rate variability, relative price fluctuations and exports. Consequently, public revenues expressed in local currency should also be more stable. Secondly, growth rates in the CFA zone are expected to be high due to the 'hypothetical' high growth rates expected in the eurozone in the future, given the importance of trade between the two zones (Hadjimichael & Galy, 1997; Dearden, 1999). Ultimately, adopting the euro could lead to increased capital flows from European countries due to greater financial integration.

However, since the mid-1990s, trade between the countries of the CFA zone and developed countries, particularly European ones, has declined significantly, rendering these advantages more tenuous. According to Ehrhart & Jacolin (2012), the eurozone's share of exports from the CFA zone has halved over the past 20 years, falling from 50% to 25%. Since its introduction a few years ago, the euro has seen a significant increase in its nominal effective exchange rate (NEER), rising by 30% between 2002 and 2009. This raises pertinent questions about the impact of the transition to the euro on real and nominal exchange rates, competitiveness and growth in the CFA zone.

Considering that economic theory provides no clear basis for the relationship between exchange rate targets and economic growth, the focus turns to empirical evidence. However, the few published empirical studies have produced contrasting results.

2.2 Some empirical evidence

Overall, most empirical studies find no solid evidence of the impact of exchange rate regimes on growth. This is not an unexpected outcome, given that some authors argue that the choice of exchange rate regime is a monetary policy decision which does not affect real variables, such as long-term economic growth (see Bailliu & al., 2003; Levy-Yeyati & Sturzenegger, 2003; Rose, 2011). Nevertheless, Bailliu & al., (2003) suggest that the exchange rate regime could influence the adjustment of real variables to their long-term levels.

By analysing the experience of 25 emerging countries between 1973 and 1998 and applying two systems of regime classification, Bailliu & al., (2003) found that flexible regimes promoted higher growth when the capital market was relatively open, or to a slightly lesser extent when the domestic financial market was developed. They also reveal that a well-established monetary policy framework is more important than the type of regime itself. Ghosh & al. (1996) support this view, arguing that exchange rate regimes do not affect growth performance. They demonstrate that fixed parities are coupled with higher levels of investment and trade than floating exchange rates and lead to higher productivity growth. They also point out that a peg implies greater volatility in output and employment. Similar differences were observed by Klein & Shambaugh (2012) in a sample of 92 developed and developing countries over 20 years (1980–1999). They demonstrate that fixed exchange rates result in lower growth than flexible regimes, particularly in non-industrial countries. Conversely, Levy-Yeyati & Sturzenegger (2001) found clear effects of pegged and other regimes on growth in developing countries only, as did Bleaney & Francisco (2007). These studies demonstrate that long- and short-term fixed parities are negatively correlated with output per capita growth in non-industrial economies.

Baxter & Stockman (1989) compared economic growth during two periods: the fixed exchange rate system period and the generalised floating period, both in the United States and in four other regions. The first study concluded that exchange rate agreements had little effect on the main macroeconomic variables. The second study showed that the first fixed-rates period performed better in all respects, including per capita growth. However, neither study was accompanied by an econometric analysis that would have revealed significant cause-and-effect relationships.

Ghosh & al. (1997) conducted a descriptive analysis comparing the means and standard deviations of growth performance under different regimes in 145 IMF member countries over 30 years after 1960. They found that GDP growth was slightly higher under a floating regime (1.7% versus 1.4% under a parity regime). In both studies, Moreno (2000; 2001) also applied descriptive statistics to measure the effect of the regime on GDP growth and volatility in samples of 98 developing and East Asian countries respectively over the period 1974–1999. His work supports the view that real growth was higher under a parity regime of 1.1 and 3 respectively.

Rogoff & al. (2004) argue that fixed exchange rate regimes (pegs and intermediate agreements) can reduce inflation in developing countries without causing significant economic losses. Furthermore, they demonstrate that rigid exchange rate regimes lead to greater volatility in output growth and larger currency crises. Finally, Rose (2011) suggests that the main discrepancies in the reviewed results are probably due to the methodologies employed to evaluate the potential growth effects of different exchange rate regimes.

With regard to Sub-Saharan Africa, it is often claimed that the growth achievements of the CFA zone are worse than those of other countries. However, Tsangarides & Van den Boogaerde (2008) point out that the CFA zone achieves no higher growth rates than non-CFA African countries. Coulibaly & Davis (2013), using de jure and de facto regime classification systems and a sample of 35 Sub-Saharan African countries over the period 1985–2009, , show that membership of the CFA zone has no significant effect on growth; however, CFA zone countries enjoy growth that is 1 or 2 percentage points higher than that of non-CFA countries. Ghura & Hadjimichael (1996), when estimating unconditional growth averages for 29 sub-Saharan African countries between 1981 and 1992, show that income in the CFA zone fell by 0.91% over this period while output per capita stagnated at 0.01%. For the case of WAEMU, Nubupku (2017) indicate that the persistent overvaluation of the real effective exchange rate of the euro area over the period 1985–2014 was associated with a loss of economic growth of 0.32 percentage points, while increased volatility led to a reduction in growth of 0.86 percentage points. Furthermore, Meh al. (2025) obtained results using a panel ARDL model which reveal that pegging the CFA franc has a negative impact on economic growth.

In their recent analysis about the potential transition from CFA to ECO , Couharde et al. (2022) focused on heterogeneity between economies in terms of equilibrium exchange rates. This concept, defined as the level of exchange rates compatible with the absence of macroeconomic imbalances, allowed the authors to assess whether West African countries would benefit from the creation of the

ECO monetary union. In the remainder of their analysis, the authors address the issue of a sustainable exchange rate regime. The relevance of indexing the ECO, a fixed parity, or an intermediate solution is then assessed. The study's findings establish two homogeneous groups of economies and conclude that neither a single monetary peg nor a floating exchange rate regime offers advantages for the countries or groups of economies concerned. In summary, the results obtained from the study support the implementation of two ECOs, with one designated for each of the two identified zones. Each ECO would serve as a virtual anchor for the group under consideration, with the basket of currencies used for this purpose primarily consisting of the euro and the US dollar.

3. Methodology

This paper aims to estimate the average treatment effect (ATT) of the CFA franc's currency peg to the euro - called treatment- on the income, i. e. GDP per capita, of the two CFA franc zones: WAEMU and CAEMC. In other words, we are trying to determine what the real GDP per capita (the outcome variable) would have been in these two currency zones if this policy had not been implemented. This situation cannot be observed, of course, because the treatment has already occurred due to France's entry into the eurozone. The presented framework for counterfactual estimation and causal inference using time-series cross-sectional data estimates the ATT in the WAEMU and CAEMC zones by directly imputing the counterfactual outcomes for the observations in the treated zones (i.e. the countries that make up the WAEMU and CAEMC zones). These counterfactual outcomes reproduce the currency area's outcome over the pre-treatment period while also matching the area's actual outcome with the covariates' values. The difference in trajectories between the 'counterfactual outcome' and the 'actual outcome' after the treatment period (2001) captures the ATT.

3.1 The counterfactual estimations

To address the significant limitations of the linear two-way fixed effects (TWFE) model (Liu & al., 2024), which is widely used in the social sciences to establish causal relationships using observational time-series cross-section (TSCS) data or long panel data, Liu & al., (2024) introduce a new framework: counterfactual estimators. These offer great flexibility when dealing with TSCS data involving dichotomous processing and a general panel treatment structure.

Counterfactual estimators are obtained by imputing the counterfactuals of treated observations based on models that meet the control conditions in their construction. This counterfactual estimation framework provides three major advantages (Liu & al., 2024). Firstly, it avoids the aforementioned negative weights problem and corrects biases induced by treatment effect heterogeneity. Secondly, the same weight is assigned to each treatment effect on observations that have been treated. Secondly, it can accommodate a variety of models, some of which can potentially relax the strict exogeneity assumption typically required by conventional models. Thirdly, diagnostics and visualisation are much easier than with traditional TWFE models.

Under this framework, the estimators treat observations under the treatment condition as missing. Consequently, the estimation is made for the untreated potential outcome. Counterfactual estimations form part of Rubin's (1974) classic analysis framework, which defines the effect of public policy as the difference between the counterfactual situation and the situation observed in the treated unit.

In a context marked, on the one hand, by passionate debate between defenders and critics of the CFA and, on the other hand, by a project to create a common West African currency, which will materialise through the CFA being replaced by the ECO — the new single currency — our article seeks to provide figures through a rigorous and innovative method. Firstly, the method excludes any variable that might predict treatment. Therefore, the misalignment of the CFA, whether overvalued (Nubukpo, 2017) or not (Plane, P., & da Piedade, C. (2022), is not considered a control variable.

As we shall see below, only the determining variables highlighted in the literature that are not directly correlated with the anchoring of the CFA will be taken into account in the control variables.

In each CFA treated zone, our results could contribute to the debate on the following: (i) the costs of a possible over-evaluation of the CFA, which would favour imports; (ii) the potential benefits of the CFA Franc zone, such as providing its members with a stable currency and access to a large market; (iii) the costs of abandoning the CFA Franc zone, such as higher inflation and transaction costs. Secondly, from a technical point of view, unlike difference-in-difference or propensity score matching methods, which provide an estimate of the average treatment effect, counterfactual estimators make it possible to estimate the evolution of the effects over each post-treatment period. Thus, ATT in each CFA zone can be analysed in the short, medium and long term.

3.2 Motivating model

Following Liu & al., (2024), we can use a simple framework of counterfactual estimation for causal inference to estimate the ATT of the change in currency peg on real GDP per capita in the WAELMU and CAEMC unions. Consider a balanced panel with N units, T periods, and denote the treatment status by $D_{it}.Y_{it}(1)$ and $Y_{it}(0)$ represent a vector of outcomes variables for unit i at period t when $D_{it} = 1$ and $D_{it} = 0$, respectively. DefineX_{it} is a vector of observed covariables (not affected by the treatment), U_i the unobservable attributes, and ε_{it} the error term, independent and identically distributed (i.i.d.). The authors define: $\delta_{it} = Y_{it}(1) - Y_{it}(0)$. According to Liu & al., (2024), an ATT whose treatment status has changed at least once during the observed time window can be obtained:

$$ATT = E[\delta_{it} | D_{it} = 1]$$

where $C_i = 1$ if $\exists t, t'$ s.t $D_{it'} = 1$; otherwise, $C_i = 0$

Empirically, the average treatment effect on the treated at sth ($s > 0$) periods since the onset of the treatment can be defined as follows:

$$ATT_s = E\left[\delta_{i,t} \mid D_{i,t-s} = 0, \quad \underbrace{D_{i,t-s+1} = D_{i,t-s+2} = \ldots = D_{i,t} = 1,}_{\text{s periods}} C_i = 1\right], \quad s > 0.$$

Counterfactual estimators provide causal results for the untreated potential outcome based on three assumptions (Liu & al., 2024).

- Assumption 1 on functional form of untreated outcome: $Y_{it}(0) = f(X_{it}) + h(U_{it}) + \varepsilon_{it}$, in which $f(.)$ and $h(.)$ are known, parametric functions
- Assumption 2 of strict exogeneity defined as: $\epsilon_{it} \perp \{D_{js}, X_{js}, U\}$, for all $i, j \in 1, 2..., N$ and $s, t \in \{1, 2..., T\}$. Associated with assumption 1, his corresponds to baseline quasi-randomisation conditional on X and U.
- Assumption 3, which allows us to condition on U_{it}, stipulates that there is a low-dimensional decomposition of $h(U_{it}) : h(U_{it}) = L_{it}$, and rank $(L_{N*T}) \ll \min N, T$.

Having defined the observations under control and treatment conditions, we can use a directed acyclic graph (DAG) to illustrate the assumptions involved. According to Liu & al., (2024), the estimation strategy is as follows:

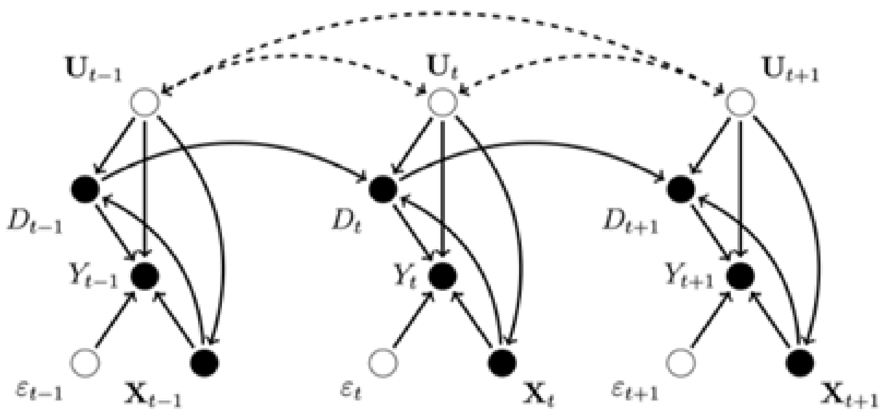


Figure 1. Directed acyclic graph (DAG) illustration

Note : Liu & al., (2024) : The above graph illustrates a DAG consistent with Assumptions 1-3. Unit indices are dropped for simplicity. Y , D, X, represent the outcome, treatment, covariates, and error term, respectively.

As the authors point out, the three novel counterfactual estimators that we will examine below are conceptually similar. This is because they follow the same identification strategy outlined above.

3.3 Presentation of the counterfactual estimators

The new framework for estimating causal effects in panel data settings admits three estimators that share a similar identification strategy (Liu & al., 2024):

- the fixed effects counterfactual (FEct) estimator is a special case of difference-in-differences (DID) estimator. Under assumptions 1-3, the FEct is an unbiased and consistent weighting estimator.
- the interactive fixed effects counterfactual (IFEct) estimator is consistent;
- the matrix completion (MC) estimator.

The FEct is an improvement on the TWFE method (Borusyak, Jaravel & Spiess, 2021; Gardner, 2021). We generally start with the simplest estimator, the FEct, and then draw the dynamic treatment effects plot, performing both visual inspection and diagnostic tests. However, according to Liu & al., (2024), this approach becomes ineffective in the presence of unobserved time-varying confounders. In this case, we apply more complex models: IFEct and MC. These models allow us to relax the strict exogeneity assumption and are more effective. The IFEct and MC models use a factor-augmented model to estimate the response surface of untreated potential outcomes. Despite the difference in how they regularise the singular values when decomposing the residual matrix, the superiority of IFEct or MC depends on context. In practice, Liu & al. (2024) recommend selecting between the two models based on their behaviour under diagnostic tests. Among the three estimators, a cross-validation procedure is executed to determine which estimator to select: FECt, IFEct or MC. After cross-validation, the mean squared prediction error for each hyperparameter is saved in e(CV), and the minimum value is saved as e(min_(mspe)).

Liu & al., (2024) highlight three main advantages. Firstly, it avoids the negative weights problem in the TWFE model, thereby correcting biases induced by treatment effect heterogeneity. Secondly, it allows for three estimators, two of which (IFect and MC) potentially relax the conventional strict exogeneity assumption. Thirdly, it facilitates diagnostics and visualisation to a much greater extent than traditional TWFE models. According to Liu & al., (2024), "*IFEct (i.e. hard imputation) performs better than MC (i.e. soft imputation) when only a small number of factors are present, each exhibiting relatively* *strong signals, while MC outperforms IFEct when a large set of weak factors exist'. In other words, MC should handle sparsely distributed factors better than parametric models such as IFEct*".

Statistically, we have a set of diagnostic tests to verify the validity of the three assumptions postulated in the counterfactual estimator settings. Firstly, a plot of dynamic treatment effects is based on counterfactual estimators. On the other hand, one statistical test (the placebo test) and two extensions (tests for no-pretend and no-carryover effects) verify the presence of potential time-varying confounders.

4. Data and sample

To estimate the ATT of experience on GDP per capita (the outcome variable) in the WAEMU and CEMAC zones, we used annual, country-level panel data, primarily from the World Bank (WDI, 2022) and the Penn World Tables (2022), covering the period from 1989 to 2019 (see Appendix A1). Each currency union (WAEMU and CEMAC) that experienced a change in the indexation of their single currency (XOF and XAF) with the effective introduction of the euro on 1 January 2002 is comprised of 30 developing countries. One of the major difficulties in these counterfactual exercises lies in identifying the control group units. In our sample, we include African countries that have the same socio-economic characteristics as the treated countries — Botswana, Cape Verde, Eswatini, Lesotho, Mauritius, Morocco, Namibia, Seychelles, Ghana, Nigeria, Tanzania, Kenya, Ethiopia, Rwanda, Sierra Leone and Uganda — but To maximise the probability of finding the best pre-treatment match with the 'counterfactual outcome', we have introduced countries outside the african continent with the same level of development as WAEMU and CAEMC (WB ranking, 2022): Bangladesh, Barbados, Bhutan, Bolivia and the Dominican Republic., Ecuador, Grenada, Laos, Oman, Panama, Saint Kitts and Nevis, and Saint Lucia. From a technical point of view, the first requirement of the control group remains unfulfilled. No control country has undergone the treatment. Empirically, these donor pool countries have been chosen to match the pretreatment socioeconomic characteristics (covariates) of the treated currency union as closely as possible during the pretreatment period. The 'counterfactual outcome' is made as similar as possible to the 'current outcome' during the pretreatment period (1989–2001). Therefore, the difference in trajectories between the two latter outcomes after treatment captures the ATT.

Following Bouvet & al (2022) and Strong (2021), our selection of the donor pool obeys three rules in order to reinforce similarity with the treated currency area. Firstly, only low- and middle-income countries are selected (see Table 1), with the exception of Nigeria, which is an emerging market. Nigeria is the leading economic and demographic power in West Africa and has a significant socio-economic effect on the WAEMU countries. This justifies its inclusion in our data, in contrast to South Africa, whose business cycle is not obviously synchronised with that of the countries in the treated pool. We therefore excluded South Africa. Secondly, we ensure that the GDP per capita of the donor country is no more than ten times higher or lower than that of the monetary zone. We have carried out a statistical analysis of the socio-economic structure of our countries. Thirdly, in accordance with the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER), our list includes countries with a currency board, a conventional peg, other managed arrangements, crawl-like arrangements, and a floating exchange rate. Notably, these countries have not experienced a financial crisis during the entire period.

The ATT on the outcome variable is assessed separately in the two currency unions. The pre-treatment period spans 13 years (1989–2001), while the post-treatment period spans 18 years (2002–2019). This long timeframe reduces the risk of bias in the marginal distribution of the marginal statistic (Ferman & Pinto, 2017; Ferman & al., 2020). Bouvet & al. (2022) emphasise that the selection of pre-treatment characteristics should include variables that can approximate the outcome path, but not anticipate the treatment effects. Otherwise, there is no strategy for selecting the covariables. To determine the ATT, we therefore control for the covariates identified in the empirical literature as affecting the outcome variable (real GDP per capita).

To increase GDP per capita, we need to either increase productivity or the global productivity factors. In other words, we need to make the production process more efficient. Real GDP per capita is therefore controlled by the capital factor, which includes gross fixed capital formation (investment as a percentage of GDP), government expenditure (as a percentage of GDP), official development assistance (ODA as a percentage of GDP), foreign development aid (FDA as a percentage of GDP), industry (as a percentage of GDP), consumption, openness and institutions. For more details, see Annex 1.

The GDP per capita trajectory depends on many factors, such as the discovery of natural resources, which can be captured here through government expenditure, as well as structural policies, governance, institutional quality and shocks experienced during the study period. Thus, we introduce characteristics and transitions of the political regime (institutions), as well as household consumption and industry added value as a percentage of GDP, and the degree of openness. Regarding the trend of the outcome variable, we introduce its lagged values as explanatory variables. While some studies include the entire pre-treatment period as covariates, this specification of synthetic control is problematic. This leaves no room for other explanatory variables (Kaul & al., 2015). Past values of the outcome variable almost exclusively determine the choice of control countries. Consequently, while the pre-treatment period is accurately predicted, future developments are not.

However, as Andersen (2023) points out, a question remains as to whether alternative specifications lead to similar synthetic control estimators. If so, the problem of specification searches becomes asymptotically irrelevant (Ferman & al., 2020). Below, we experiment with a broad set of additional growth predictors, such as inflation, manufacturing, exports, imports, schooling, rural population, tax revenue, central government, and debt. However, including them did not change our results substantially[2].

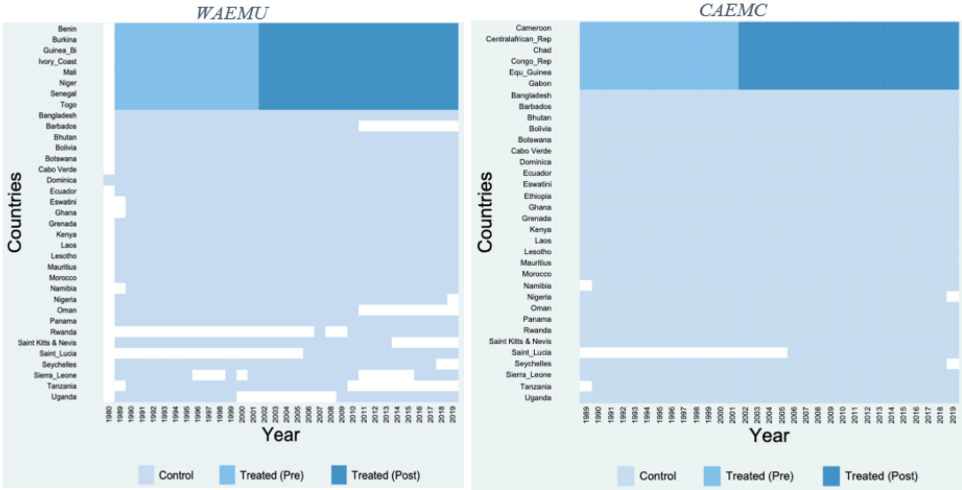
5. Results

5.1 The average effect of single currency peg change (ATT) on income

Table 1 illustrates the dichotomous treatment in the two WAEMU and CAEMC panel datasets, which have 38 and 36 units, respectively, over 31 time periods. For each unit, the treatment may switch on and off or have missing values. Table 1 shows how we calculate of the estimated treatment effect, $\hat{\delta}_{it}$, based on the timing relative to the next closest treatment.

2. Ferman et al (2020) show that appropriate conditions different specifications will lead to asymptotically equivalent synthetic control estimators

Table 1. The Dynamic Treatment Effect Plot



Note: White bands represent missing data for one or more covariates. For illustrative purposes, for Namibia only institutions and FDI are not available for 1989. In 2019, data on institutions are not available. The same is true for the Seychelles. Data on the degree of trade openness, and industry are missing for the first year, 1989. Concerning, St. Lucia, data on industry are missing for the period 1989-2005.

This diagnostic tool shows that our experiences have a general panel treatment structure (GPTS). The treatment is not staggered, nor does it involve switching back and forth; it applies to units in the same period, 2002.

This section presents the results of the ATT analysis for GDP per capita in the WAEMU and CEAMAC currency unions separately. All uncertainty estimates were obtained using a clustered bootstrap approach 1000 times at the unit level. For each analysis, we first apply the three estimators to the data and plot the estimated dynamic treatment effects (see Fig. 1a and 1b). The two experiments demonstrate that, firstly, with FEct, the pretreatment residual average consistently deviates from zero. The 'counterfactual outcome' is not sufficiently similar to the 'actual outcome', suggesting potential violations of the identifying assumptions. Conversely, the pretreatment residual averages for the other two counterfactual estimators, IFEct and MC, are consistently close to zero. Therefore, it is possible to closely reproduce the economic characteristics of each currency union before the 2002 reform without extrapolating beyond the data supporting the untreated pool. The counterfactual estimators IFEct and MC best reproduce the values of the predictors of GDP per capita in each CFA zone in the pretreatment period. We carry out the estimator selection test.

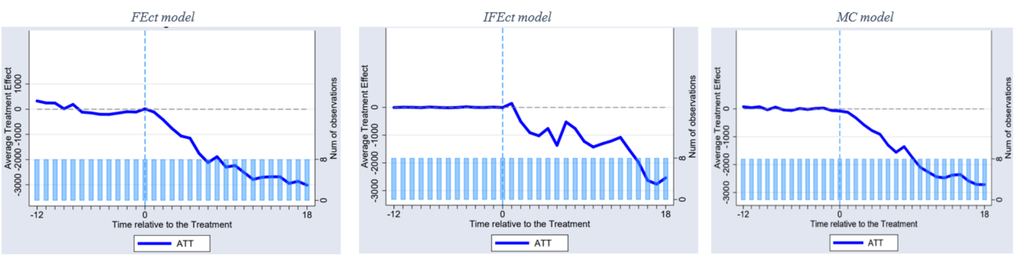


Figure 1a. Dynamic Treatment effect on GDP per capita for WAEMU

Note: The above figure shows the result from applying FEct, IFEct and MC estimator models respectively for WAEMU with 95% confidence intervals based on block bootstraps of 1,000 times. The vertical blue broken line represents the treatment, the year of the currency peg change. The blue full line represents the average treatment effects on the group of countries treated. The bar plot at the bottom of each panel illustrates the number of treated units

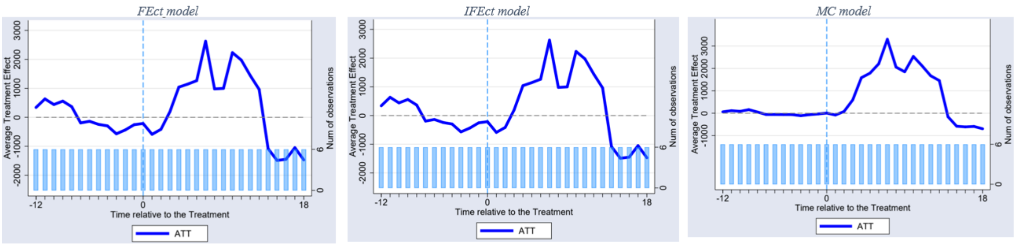


Figure 1b. Dynamic Treatment effect on GDP per capita for CAEMC

Note: The above figure shows the result from applying FEct, IFEC and MC estimator models respectively for CAEMC with 95% confidence intervals based on block bootstraps of 1,000 times. The vertical blue broken line represents the treatment, the year of the currency peg change. The blue full line represents the average treatment effects on the group of countries treated. The bar plot at the bottom of each panel illustrates the number of treated units

The choice of counterfactual estimator to retain, between IFECT and MC, is based on a goodness-of-fit criterion: the minimal mean squared prediction error (MSPE). The cross-validation procedure selects the matrix completion model with the optimal number of factors for searching: r = 0.804 and 2.018 for the WAEMU and CAEMC MC models, respectively. The estimated ATTs for the retained models are shown in Figure 2 below.

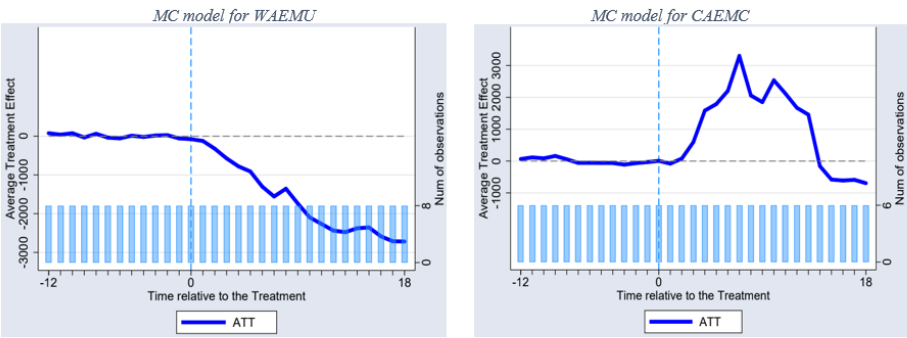


Figure 2. Dynamic treatment effect for the retained model

Before interpreting the ATTs and their short-, medium- and long-term impacts on GDP per capita in the two currency zones, we will conduct two diagnostic tests to verify the validity of the assumptions in the counterfactual estimator settings, namely the functional form, strict exogeneity and low-dimensional decomposition assumptions. See table 1 below for a summary of the tests. See Table 2 below for a summary of the tests. Moreover, these tests will enable us to ascertain whether the best counterfactual estimator has been retained through the cross-validation procedure. We apply the placebo and equivalence tests to the three estimators: FEct, IFEct and MC (see Annex 2). The decision rule for the two tests is summarised in Table 2 below.

Table 2. Diagnostic Tests Summary

	Placebo test	Testing (no) pretrend (Eqiva-lence)
	t test	F test
Null	$ATTP^p = 0$	$ATT_s = 0, \forall s \leq 0$
If Rejecting the Null	Invalidate Assumptions	Invalidate Assumptions

Note: As underlined by Liu et al., (2022), Both the t and F tests are conventional difference-in-means tests, testing against the null of no difference. "Assumptions" refers to Assumptions 1-3 as a whole. $ATTP^p$ refers to the average placebo treatment effect on the treated.

Figure 3a shows the results of the placebo test. The idea behind this diagnostic test is quite simple. We assume that the treatment starts S periods earlier than its actual onset for each unit in the treatment group, and apply the same counterfactual estimator to obtain ATT estimates for the new, advanced treatment period. This method is robust to model misspecification and immune to overfitting. This allows us to examine the significance of the estimated ATTs by checking whether they are unusual. We specify a range of pre-treatment periods as 'placebo periods' and remove observations within this range when fitting the model. We then test whether the estimated 'ATT' within this range is significantly different from zero. Under hypotheses 1–3, we would expect the magnitude of this estimated 'ATT' to be close to zero.

In the two-currency unions, with FEct and IFECT, we cannot reject the null hypothesis of a non-zero placebo effect at the 1% level (annex 2). Only with MC models is the placebo effect statistically indistinguishable from zero ($p^{MC}_{WAEMU} = 0.281$ and $p^{MC}_{CEAMC} = 0.592$) (fig. 3a). However, the placebo test can be biased, particularly when a potential time-varying confounder is cyclical or does not present itself immediately prior to the onset of treatment. Therefore, we need a more comprehensive test to detect any pre-trend.

Figure 3b illustrates the equivalence test. The placebo test often yields good results. However, when the number of observations is limited, the difference-in-means approach may be underpowered. In other words, when the number of observations is small, failing to reject the null placebo effect does not verify equivalence. To increase diagnostic robustness, we performed an equivalence test, which is essentially an improved placebo test. Therefore, as demonstrated by Liu & al., (2024), if sufficient data shows that the fake 'ATT' falls within a prespecified narrow range, this provides evidence in support of the validity of the identifying assumptions.

The results are based on the MC_WAEMU and MC_{CAEMC} models. For both models, the trend leading towards the onset of the treatment did not exceed the equivalence range. The 90% confidence intervals of the pretreatment prediction error averages are within the equivalence range and the minimum range is narrower than the equivalence range. Therefore, the MC_{WAEMU} and MC_{CAEMC} models pass the no-pretrend equivalence test. The null hypothesis is not rejected.

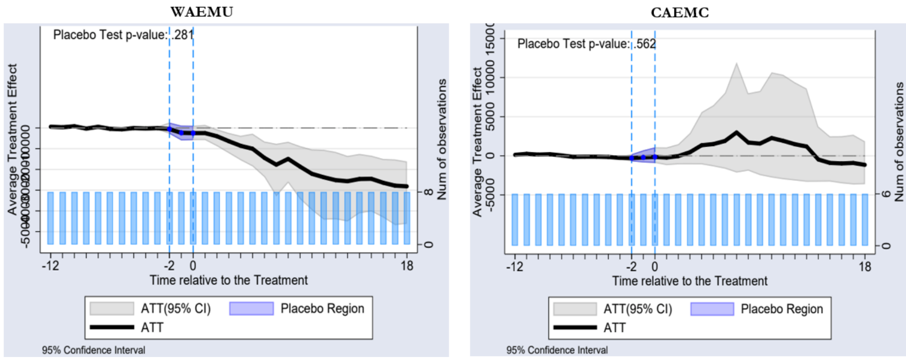
Lastly, we applied the Wald test to assess the accuracy and robustness of the models, despite Liu & al., (2024) discussing why the Wald test is not as desirable as an equivalent test. The Wald test (see Annex 3) suggests that we cannot reject the null hypothesis that the pre-treatment residual averages are close to zero over time.

he results suggest that the MC model passes all diagnostic tests. Unlike other counterfactual estimation models, the MC model enables us to verify the validity of the three identifying assumptions — functional form, strict exogeneity and low-dimensional decomposition — in a more efficient and transparent manner. Therefore, the MC model is the most suitable counterfactual estimator for estimating the average effect of a change in the currency peg (ATT) on income in the two currency unions.

As shown by our mains results (Figure 2) our estimated results suggest, while income increased in the CAEMC over the post-treatment period (2002–2019), the opposite was observed in the WAEMU zone. This is due to the adoption of the reform of the peg of the CFA franc to the euro after its introduction in 2002. In the WAEMU zone, our analysis indicates that GDP per capita decreased by \$1,704 compared to what would have been observed without the reform. This average treatment effect on income is significant in terms of the GDP per capita of most countries in the economic zone. In the second CFA franc zone (CAEMC), the reform accelerated income growth for the population. GDP per capita would have increased by an average of \$882.81 during the pretreatment period.

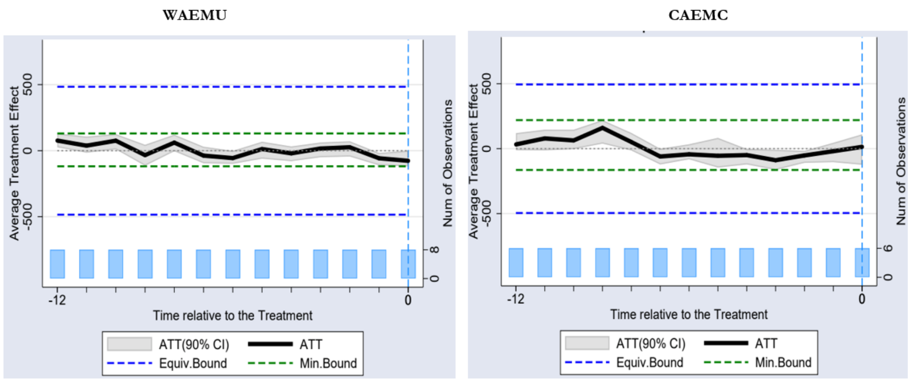
Nevertheless, it would be interesting to observe how this average effect evolves over time within the two currency unions.

Figure 3. Diagnostic tests



a) The Placebo tests

The above panel shows the results from a placebo test using the “treatment” in two pretreatment periods as a placebo. The bar plot at the bottom illustrates the number of treated units



(b) The equivalence tests

The right panel shows the results of an equivalence test for no-pretrend, in which the blue and green dashed lines mark the equivalence range and the minimum range, respectively, for CAEMC. Conversely for WAEMU

5.2 *Pegging to the euro and a lasting ATT on income*

This analysis enables us to determine whether economies have adapted to this change in favour of a strong currency, the euro. Thus, we will define three time dimensions, as summarised in Table 3.

Table 3. Average effect of treatment on GDP per capita ($ us)

Currency unions	Currency unions			
	Short term ($T < T_0 < T_0 + 6$)	Medium term ($T_0 + 5 < T < T_0 + 11$	Long term ($T > T_0 + 10$)	Total impact ($T > T_0$)
WAEMU	-542,4	-1609,13	-2490	-1704,55
CAEMC	703,1291	2195,3452	174,78	882,81

This disparity in fortunes between the two CFA zones is also evident in the long-term analysis of the impact of the reform on income. Indeed, our results suggest that the currency peg to the euro has a negative impact on GDP per capita in the WAEMU zone in the short term. This negative effect increases over time. Between the short and medium terms, as defined in Table 1, the average treatment effect on GDP per capita ranges from $-542 to -1,609$. These results demonstrate that WAEMU countries are struggling to adapt to the reform of anchoring the CFA to a hard currency. This is especially the case since, in the long term, the loss of income compared to what would have been observed without the 2002 reform is greater than the GDP per capita of most WAEMU countries. In the CAEMC area, the impact of the reform on the population's income is positive, but this tends to decline in the long term. Indeed, in the short and medium term, the reform had a significant positive effect on GDP per capita ($703 to $2,195). However, ten years after the reform, the positive impact remains at an estimated US$174.78, though this is less significant than in previous periods.

6. Robustness tests

In this section, we examine the sensitivity of our results. Firstly, we perform a sensitivity analysis test for matching estimators, as proposed by Nannicini, T. (2007). This simulates a potential confounder to assess the robustness of the estimated treatment effects with respect to deviations from the conditional independence assumption. On the other hand, we re-estimate the baseline model to construct a counterfactual for each treated CFA zone by excluding non-African countries from the control group.

Our baseline sensitivity results for matching estimators show that our ATT calculations (-$1,512 for WAEMU and $1,412 for CAEMC) (annexes 4 and 5) are close to our previously retained matrix completion (MC) FECT ATT calculations (-$1,704.55 and $882.81, respectively, for WAEMU and CAEMC). The proximity of the results is further confirmed when the standard errors are taken into account. Indeed, Sensitivity analysis for the CAEMC area has a higher standard error (522) than the WAEMU area (184).

To test the sensitivity of our baseline results (annexes 4 and 5), we simulated a 'killer' confounder. This involves simulating the impact of an unobserved variable in the error term on our results. In other words, we are testing the robustness of the baseline ATT with respect to a more 'dangerous' confounder (i.e. confounder U), which still behaves like other relevant observable variables. Therefore, we assume that we want to calculate this estimate and assess its robustness with respect to a potential confounder that behaves like an important observed covariate. For example, we could transform the balance of trade into a binary variable representing deficit and surplus countries over the period. For WAEMU, the simulated ATT is higher, but the potential confounder 'kills' the baseline estimate by only a small amount. In other words, the sensitivity analysis tells us that the existence of a confounder U that behaves like the balance of trade dummy might account for almost 0.33% of the baseline estimate ((1512 1517)/1512 = 0.033). For CEAMC, the sensitivity analysis shows that the existence of a confounder U (balance of trade dummy) doesn't account for any of the baseline estimates. Therefore, we can deduce a certain stability in our results.

In the second robustness check, in which only African countries were included in the control pool, the results for the two economic areas were fairly similar to our main baseline results (see annexes 6 and 7). Excluding non-African countries did not cause a substantial change in the gap between the two series' trends. Overall, these robustness tests confirm the potential benefits of using combinations of countries rather than a single country as a point of comparison in evaluation studies.

7. Discussion

This study contributes to the debate on the fundamental role of the exchange rate in GDP per capita growth by assessing the average impact of changing the Franc CFA peg to the euro, a hard currency, in the WAEMU and CAEMC areas. Overall, the results show that the estimated impact of the reform differs between the two economic and monetary areas, a trend that becomes more pronounced when analysed over time (short, medium and long term).

This divergence can be analysed through misalignment of the real effective exchange rate and deterioration of the terms of trade in the two zones. Following the creation of the eurozone, the pegging of the CFA to the euro has accentuated questions about the loss of export competitiveness of CFA countries and the effect of exchange rate misalignment on economic growth. As the CFA is strictly pegged to the euro, variations in the CFA exchange rate are driven by variations in the euro against the US dollar, the main currency used for trade invoicing.

We analysed the evolution of average misalignments in the two zones between 1989 and 2019, as well as the terms of trade, (Figure 4 & 5), using CEPII data (Couharde & al., 2023).

Figure 4. Misalignment means of WAEMU and CAEMC countries

Source: Authors, by CEPII data

Figure 5. Term of trade means of WAEMU and CAEMC countries

Source: Authors, by CEPII data

As with the estimated average impact of the reform, differences are also observed between the two zones in terms of misalignment and terms of trade. In the WAEMU zone, positive misalignment in the form of overvaluation of the real exchange rate was observed until 1993 (Fig. 1). This contributed to the devaluation of the CFA franc in 1994, resulting in an undervaluation of the real effective exchange rate until the introduction of the euro in 2002. The fixed peg to the euro then led to overvaluation of the real effective exchange rate for these countries, which mainly export agricultural commodities, until 2011 (annex 8). However, due to a downward trend in real exchange rate misalignment, deterioration in terms of trade has eased significantly. From 2012 onwards, a sub-period of negative misalignment followed. Nevertheless, the WAEMU has failed to capitalise on this improvement in terms of trade.

However, analysis of the CEMAC data (Fig. 1) reveals an opposite trend to that observed in the WAEMU zone. Since the devaluation in 1994, the real effective exchange rate has remained undervalued. From 2013 onwards, there has been a gradual reduction in the level of real exchange rate undervaluation. Five of the six countries in this zone (Equatorial Guinea, Gabon, Cameroon, Congo and Chad) are major oil producers. Following 12 years of deteriorating terms of trade (1989–2001), the start of our pre-treatment period in 2002 marked a clear improvement in these terms, which turned positive in 2006. A fixed peg to the euro would benefit countries whose currencies have not appreciated despite oil exports. It is also worth noting that the Central African Republic, the only non-oil-producing country in the zone, has experienced overvaluation of its real exchange rate. This has resulted in a continued deterioration of its terms of trade (annex 9).

Thus, the results regarding the impact of the CFA peg on income in the two relevant zones could be partly explained by a misalignment of the real exchange rate. In the CAEMC zone, characterised by net oil exports, the peg to the euro has helped to maintain an undervalued real exchange rate (Jehan & Irshad, 2020). In contrast, the peg to the euro has resulted in the real effective exchange rate being overvalued in the WAEMU zone, which specialises in exporting commodities, as revealed by Nubukpo's work (2015 and 2017).

8. Conclusion

The experience of the franc zone shows that the formal establishment of a fixed exchange rate regime alone does not automatically lead to an increase in economic performance across member countries more than 50 years later. However, structural differences between countries and the effect of exogenous factors such as initial structural weaknesses, external shocks, differences in initial GDP per capita and population growth rates, low human capital, under-five mortality rates, changes in terms of trade, oil revenue growth, the intensity of conflict, the type of political regime in place and the longevity of the head of state all play a role in understanding the results of the fourteen countries (see Feindouno & al., 2019; Couharde & al., 2022). Strong reforms are needed.

The central banks of the two zones should take further steps towards implementing a modern monetary policy framework. They must bring it closer to international best practice. Central banks must equip themselves fully to take advantage of globalisation and establish sustainable conditions for economic development. Monetary autonomy seems to be an even more necessary approach since 2010, when central banks began to reform. They must go further and review exchange rate policy. They could opt to peg the future ECO currency to a basket of international currencies, such as the euro, the dollar, the yen, the yuan and the pound sterling. Singapore is the clear example to follow. The ECO exchange rate could be weighted according to the main trading partners and competitors of each economic zone, and kept within a 'sliding band'. This would avoid the exchange rate volatility of a freely floating regime. However, as highlighted by the findings of Couharde & al. (2022), considering the heterogeneity of countries, it would be preferable to adopt two separate ECOS in the two zones.

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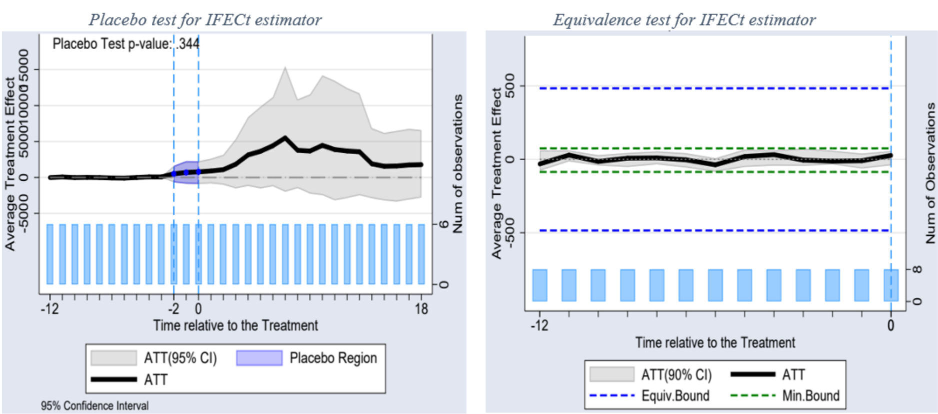
Annexes

Annex 1: Data description and sources

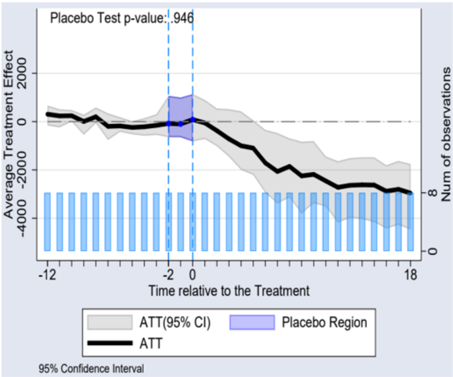
Variables	Description	Sources
Industry	As a % of GDP	WDI, PennWorld Tables
Government	Share of government consumption at current $	WDI, PennWorld Tables
Investment	Share of household consumption at current $	WDI, PennWorld Tables
Official development Assistance	Net official development assistance is disbursement flows (net of repayment of principal) that meet the DAC definition.	
Consumption	Final consumption expenditure as a % of GDP	WDI
Institutions	Political regime Characteristics and Transitions, 1980-2019, annual, cross-national, time series, and polity case formats coding democratic and autocratic “patterns of authority” and regime changes in all independent countries with total population greater than 500,000 in 2018	Polity5 for Center of Systemic Peace
Foreign development investment (FDI)	Foreign direct investment refers to direct equity investment flows into the reporting economy. It is the sum of equity, reinvestment of earnings and other capital.	WDI
Openness	Trade openness, the degree to which the nondomestic transactions (import (M) and export (X)) take place and affect the size and growth of a national economic. Calculate as (X+M)/2GDP	WDI
Per-capita GDP	Output-side real GDP at current $	WDI, PennWorld Tables

Annex 2: diagnostic tests for FEct and IFEct estimators

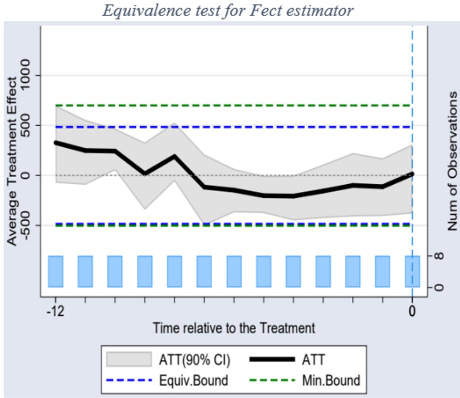


Note : WAEMU, diagnostic test

Placebo test for Fect estimator



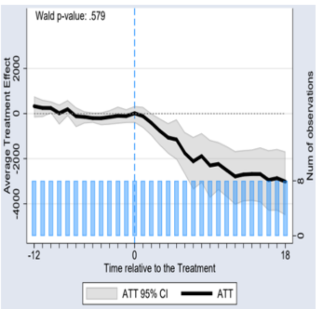
Equivalence test for Fect estimator



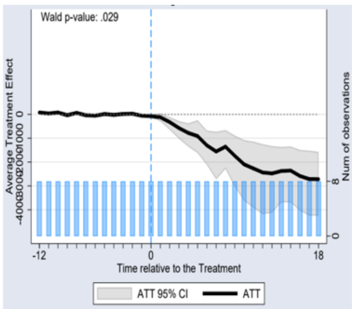
Note : CAEMC, diagnostic tests

Annex 3: Wald tests for FEct, IFect and MC

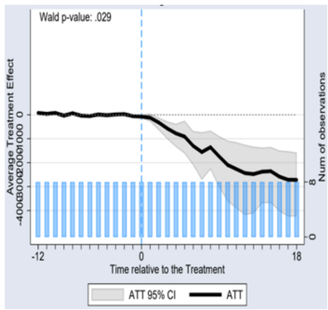
Wald test for IFEct estimator



Wald test for IFEct estimator

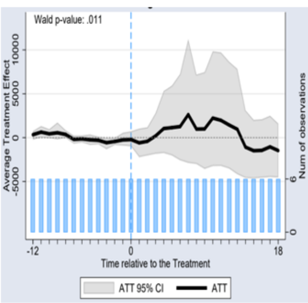


Wald test for MC estimator

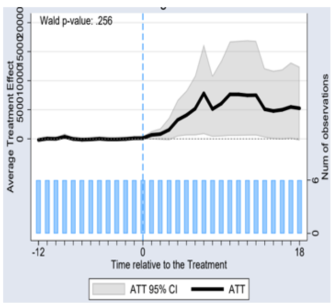


Note: WAEMU, Wald tests for three three estimators

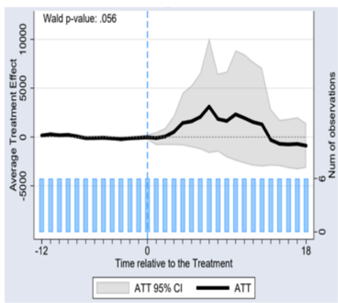
Wald test for FEct estimator



Wald test for IFEct estimator



Wald test for MC estimator



Note: CAEMC, Wald test for all estimators

Annex 4: A Simulation-Based Sensitivity Analysis for WAEMU

```
. sensatt gdpperk D goverment oda investment institutions openess consuption fdi industry,
> p(deficit) se(bse) alg(attr)


*** THIS IS THE BASELINE ATT ESTIMATION (WITH NO SIMULATED CONFOUNDER).


 The program is searching for matches of treated units within radius.
 This operation may take a while.


ATT estimation with the Radius Matching method
Analytical standard errors

---------------------------------------------------------
n. treat.   n. contr.        ATT    Std. Err.          t
---------------------------------------------------------

      144         830   -1512.482     184.259     -8.208

---------------------------------------------------------
Note: the numbers of treated and controls refer to actual
matches within radius
```

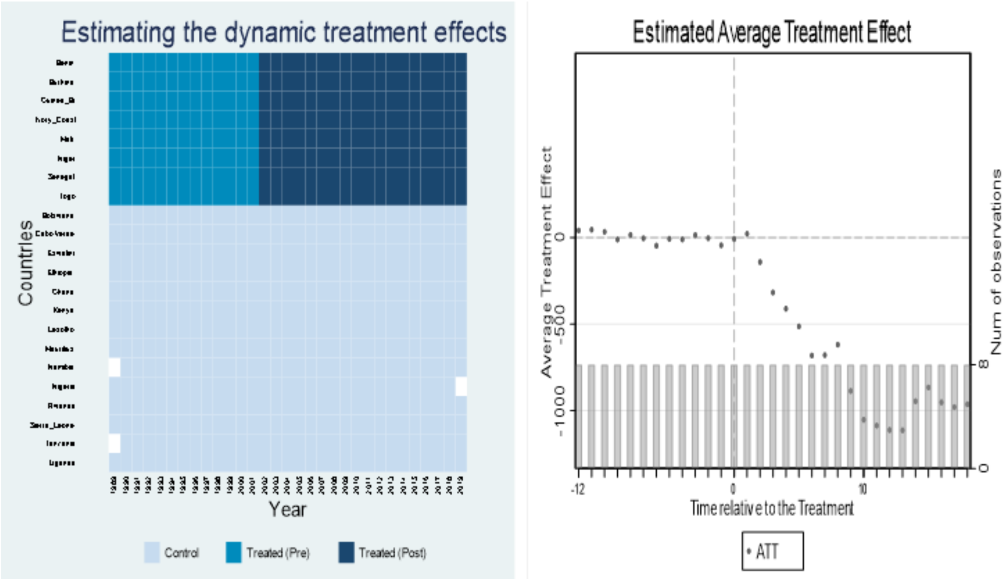
```
*** THIS IS THE SIMULATED ATT ESTIMATION (WITH THE CONFOUNDER U).

The probability of having U=1 if T=1 and Y=1 (p11) is equal to:       .
The probability of having U=1 if T=1 and Y=0 (p10) is equal to:    0.87
The probability of having U=1 if T=0 and Y=1 (p01) is equal to:    0.83
The probability of having U=1 if T=0 and Y=0 (p00) is equal to:    0.84

The probability of having U=1 if T=1 (p1.) is equal to:       .
The probability of having U=1 if T=0 (p0.) is equal to:    0.84


 The program is iterating the ATT estimation with simulated confounder.
 You have chosen to perform 1000 iterations. This step may take a while.


ATT estimation with simulated confounder
Between-imputation standard errors

---------------------------------------------
      ATT    Std. Err.    Out. Eff.   Sel. Eff.
---------------------------------------------

-1517.596      22.777        0.921       1.354

---------------------------------------------
Note: Both the outcome and the selection effect
are odds ratios from logit estimations.
```

Annex 5: A Simulation-Based Sensitivity Analysis for WAEMU

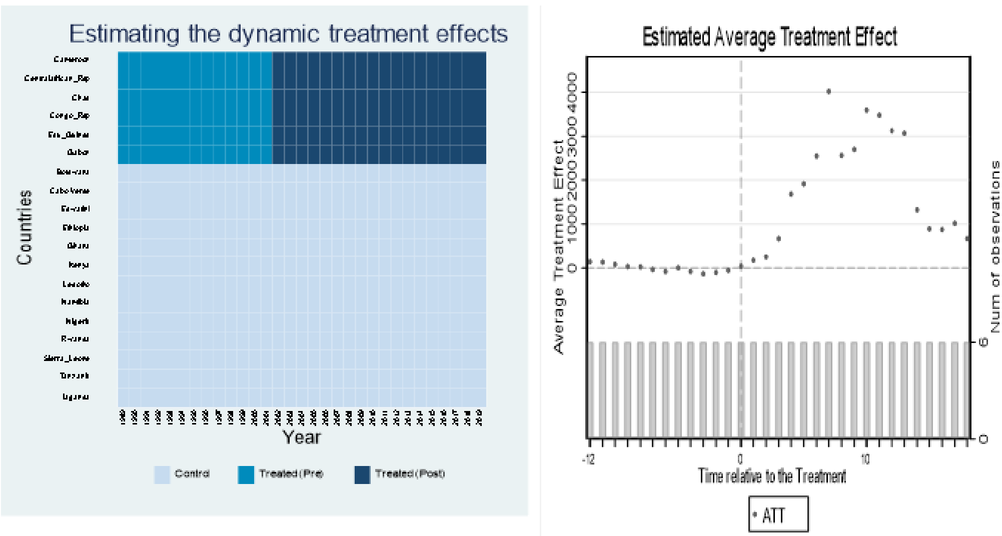
```
. sensatt gdpperk D goverment oda investment institutions openess consuption fdi industry, se(bse)
>  alg(attr)


*** THIS IS THE BASELINE ATT ESTIMATION (WITH NO SIMULATED CONFOUNDER).


 The program is searching for matches of treated units within radius.
 This operation may take a while.


ATT estimation with the Radius Matching method
Analytical standard errors

---------------------------------------------------------
n. treat.   n. contr.        ATT    Std. Err.          t
---------------------------------------------------------

      105         819    1412.803     522.044      2.706

---------------------------------------------------------
Note: the numbers of treated and controls refer to actual
matches within radius
```

```
*** THIS IS THE SIMULATED ATT ESTIMATION (WITH THE CONFOUNDER U).

The probability of having U=1 if T=1 and Y=1 (p11) is equal to:    0.00
The probability of having U=1 if T=1 and Y=0 (p10) is equal to:    0.00
The probability of having U=1 if T=0 and Y=1 (p01) is equal to:    0.00
The probability of having U=1 if T=0 and Y=0 (p00) is equal to:    0.00

The probability of having U=1 if T=1 (p1.) is equal to:    0.00
The probability of having U=1 if T=0 (p0.) is equal to:    0.00


 The program is iterating the ATT estimation with simulated confounder.
 You have chosen to perform 1000 iterations. This step may take a while.


ATT estimation with simulated confounder
Between-imputation standard errors

---------------------------------------------
      ATT    Std. Err.    Out. Eff.   Sel. Eff.
---------------------------------------------

 1412.803       0.000            .           .

---------------------------------------------
Note: Both the outcome and the selection effect
are odds ratios from logit estimations.
```

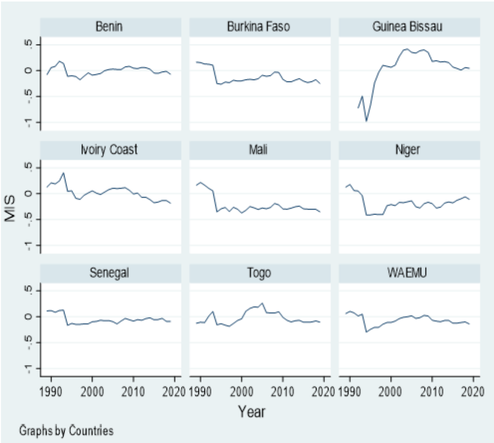
Annex 6: Dynamic Treatment effect GDP per capita for WAEMU, controlled only by African countries

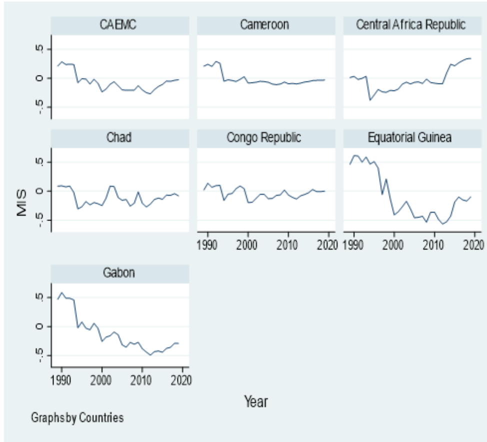


Annex 7: Dynamic Treatment effect GDP per capita for CAEMC, controlled only by African countries



Annex 8: Misalignment of WAEMU and CAEMC countries





Annex 9: Term of trade of WAEMU and CAEMC countries