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SALIMEH ABEDINI BIRANG

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BY THE COMMITTEE CONSISTING OF

Dr. Firat Demir, Chair

Dr. Pallab Ghosh

Dr. Hewei Shen

Dr. Saleh Sahabehtabrizy

Dr. Jaeho Kim

Dr. Fabio Costa Morais de Sá e Silva

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Abstract

This dissertation comprises three essays, each exploring distinct aspects of exchange rates and their economic implications. The first chapter investigates the impact of exchange rate misalignment on structural transformation, broadly defined as the process of reallocating labor from low- to high-productivity sectors, which serves as a mechanism for economic growth. Utilizing data from the GGDC 10-sector and ETD 12-sector databases, as well as UNIDO's 23 manufacturing sectors (classified into three technology-based categories), we explore whether exchange rate misalignment indices contribute to structural change and, consequently, economic growth. Our findings indicate that undervaluation does not appear to play a critical role in promoting growth-enhancing structural change. The results are inconsistent across various misalignment estimation techniques and different model specifications.

The second chapter examines the impact of changes in industry-specific effective real exchange rates (IERER) on industry-level investment. We analyze how variations in industry-specific export intensity and import competition influence the long-run relationship between exchange rates and investment. Our analysis is based on data from 12 manufacturing industries across five European countries—Germany, Italy, the Netherlands, Norway, and the United Kingdom—covering the period from 2007 to 2017. The results indicate that in industries with low export intensity, a depreciation in IERER (i.e. an increase in price competitiveness) leads to a decline in investment. However, for industries with high export intensity, we find no significant effect from IERER depreciation, suggesting that industries heavily engaged in exporting do not reduce their investment levels following a depreciation in IERER. Additionally, we find that variations in import competition do not substantially alter the impact of exchange rate fluctuations on investment decisions.

Finally, the third chapter revisits the issue regarding the uncovered interest rate parity (UIP) puzzle and the associated excess average returns of currency carry trade strategies. The UIP puzzle, which posits that interest rate differentials should be balanced by exchange rate movements, is contradicted by empirical evidence. This discrepancy has led to the widespread adoption of currency carry trade strategies in financial markets. Our investigation focuses on identifying key variables that contribute to UIP violations. We propose a novel regime-switching model with time-varying transition probabilities, integrating variable selection using the horseshoe prior to choose relevant factors from eight macroeconomic variables. Our findings reveal three major predictors—TED spread, term spread, and consumption growth of the U.S. economy—as significant predictors affecting regime shifts within the UIP puzzle.

Chapter 1

The Real Exchange Rate Misalignment and Economic Growth: Exploring Structural Change Channel

1.1 Introduction

The real exchange rate (RER) is a crucial variable in open economies, and its influence on a country's economic performance is broadly recognized. Numerous studies have explored the effects of RER misalignment, either as overvaluation or undervaluation, on economic growth, yet a consensus on the issue remains elusive. Reflecting the complexity of this issue, several research findings indicate that RER misalignment adversely affect economic growth (Aguirre and Calderón, 2005; Cottani et al., 1990; Dollar, 1992; Ghura and Grennes, 1993; Nouira and Sekkat, 2012; Razin and Collins, 1997; Schröder, 2013; Williamson, 1990). These studies primarily focus on the negative effects of overvaluation on economic growth, while neglecting the effects of undervaluation. However, in light of the East Asian growth experience, a new wave of empirical studies challenged this traditional view. This evolving perspective increasingly supports a positive relationship between a more competitive currency and economic growth (Berg et al., 2012; Berg and Miao, 2010; Di Nino et al., 2011; Domac and Shabsigh, 1999; Gala, 2007; Gala and Libanio, 2010; Glüzmann et al., 2012; Guzman et al., 2018; Habib et al., 2017; Hausmann et al., 2005; Levy-Yeyati et al., 2013; Prasad et al., 2007; Rapetti, 2011). This effect is more pronounced in emerging economies (Razmi et al., 2012; Rodrik, 2008; Vieira and MacDonald, 2012).[1]

Despite considerable evidence documenting the influence of RER undervaluation on long-run economic growth, the precise mechanisms involved remain unclear. An undervalued RER can benefit the economy by enhancing the industrial sector; primarily through the reallocation of resources from non-tradable to tradable sectors where technological spillovers, learning-by-

[1] For a comprehensive review of the literature on RER misalignment and its economic implications, see Demir and Razmi (2022) and Rapetti (2020)

doing, and increasing returns to scale are more prevalent (Cimoli et al., 2013; Di Nino et al., 2011; Eichengreen, 2007; Freund and Pierola, 2012; Goya, 2020; Rapetti, 2013b; Rodrik, 2008). Additionally, maintaining a stable and competitive RER can accelerate structural change and spur economic growth by compensating distortions caused by poor institutional quality and market failures, which are common in developing economies (Guzman et al., 2018; Rodrik, 2008). Other studies also reveal that RER undervaluation increases profit margins by reducing real wages, thereby boosting savings, investments, employment, and overall economic output (Gala, 2007; Glüzmann et al., 2012; Ibarra and Blecker, 2016; Levy-Yeyati et al., 2013; Libman et al., 2019; Razmi et al., 2012).

This paper builds on existing research that examines the association between RER levels and economic growth. We contribute to the literature by focusing on the mechanisms through which a competitive RER can foster growth, an area that has received less attention in prior studies. To do this, we begin by developing several RER misalignment indices that quantify deviations from the theoretical equilibrium level, drawing upon international finance literature. Defining undervaluation and accurately estimating the equilibrium RER are challenging due to the lack of a consensus on the best measurement method(s). After estimating these indices, we confirm the previously reported positive relationship between RER undervaluation and economic growth. We then analyze the influence of RER on structural change, considering it as a possible transmission channel through which a competitive RER impacts long-run economic growth. The crucial impact of structural change on economic growth and productivity is well-documented in previous development literature (Chenery and Taylor, 1968; Diao et al., 2019; Kaldor, 1966; Kuznets, 1966; Lewis, 1954; McMillan et al., 2014; Rodrik, 2018). Structural change involves a dynamic shift in resource allocation from lower to higher productivity sectors, resulting in increased overall productivity and economic growth. Economies that manage to escape poverty and achieve higher levels of wealth are those that shift resources away from agriculture and traditional economic activities. The speed of this transformation is a critical factor in determining economic success (McMillan et al., 2014).

Understanding the influence of the RER on sectoral growth and the reallocation of resources across sectors (i.e., structural change) has not been extensively studied. Specifically, our research investigates whether pursuing a competitive RER facilitates the reallocation of resources from low-productivity to high-productivity tradables. A competitive RER can promote a shift towards more modern and complex activities by increasing profitability and financing capacity for investment. This study utilizes a comprehensive database that covers a broad range of advanced, emerging and developing, and low-income economies over an extended period. In assessing the effect of RER on structural change and overall growth, we begin with the Groningen Growth and Development Centre (GGDC)'s ten-sector dataset. We then expand the analysis by incorporating a more detailed twelve-sector dataset, derived from the combination of the GGDC/UNU-WIDER Economic Transformation Database (ETD) and the Economic Transformation Database of Transition Economies (ETD-TE). The industrial sector, particularly manufacturing, is often viewed as the key engine of economic growth and crucial for driving structural change. Given its importance, our study focuses on the manufacturing sector, using the United Nations Industrial Development Organization (UNIDO) database. It is important to recognize that industry sectors consist of a highly heterogeneous set of activities that vary widely in their skill, technological intensity, and productivity. We also categorize manufacturing activities into low-, medium-, and high-tech groups to analyze if a competitive RER facilitates structural change across these different tech-intensity sectors. Based on our empirical analysis, we fail to find any robust evidence to support the hypothesis that RER misalignment consistently promotes structural transformation that enhances economic growth. The results vary across datasets and measures of misalignment, with some showing positive and significant effects, while others showing either insignificant or negative effects. Given these mixed findings, it is difficult to draw a definitive conclusion about the overall impact of RER misalignment on structural change.

The paper is structured as follows: Section 1.2 provides a brief review of the literature on the theoretical and empirical evidence linking exchange rate misalignment to growth, as well as the mechanisms underlying this relationship. Section 1.3 discusses the specifications of the

RER function and the various methods for estimating RER misalignment. Section 1.4.1 and Section 1.4.2 describes the data and RER misalignment measurement. The methodology for the growth regression and its results are detailed in Section 1.4.3. Section 1.4.4 focuses on structural change and its relationship with RER misalignment. The robustness tests are provided in Section 1.5. Finally, Section 1.6 concludes the paper.

1.2 Literature Review

This section provides a concise overview of the evidence in the literature on the link between RER misalignment and economic growth. Early research in development economics often overlooked the impact of the real exchange rate on economic growth. In recent years, a growing recognition, supported by substantial evidence, has emerged regarding the real exchange rate's significant impact on economic growth, though the precise nature of this relationship and its policy implications remain widely debated.

The neoclassical theory, including its variants such as the Washington Consensus, posits that RER misalignment is a form of macroeconomic imbalance, which negatively affects growth. This perspective argues that such misalignments, whether arising as overvaluation or undervaluation, represent a disequilibrium in relative prices, leading to inefficient resource allocation and a subsequent decrease in productivity and economic growth. While the initial focus was primarily on the adverse outcomes of RER overvaluation, later studies extended it to include undervaluation as well. This negative impact of RER misalignment comes not only through overheating and inflationary pressures but also by limiting the resources available for domestic investment, further complicating the growth trajectory (Berg and Miao, 2010; Williamson, 1990). Reflecting the concerns raised by the Washington Consensus, the adverse effects of RER misalignment on economic growth, irrespective of the direction of the misalignment–whether through overvaluation or undervaluation–have been corroborated by a body of empirical studies (Aguirre and Calderón, 2005; Cottani et al., 1990; Dollar, 1992; Gala and Lucinda, 2006; Ghura and Grennes, 1993; Razin and Collins, 1997; Schröder, 2013).[2] Specifically, Razin and Collins (1997) and Aguirre and Calderón (2005) find that significant RER misalignment negatively affects economic growth. Complementing these findings, Schröder (2013) offers additional evidence through an extensive analysis of 63 developing countries, utilizing annual panel data from 1970 to 2007. This investigation into the impact of RER misalignment on economic growth underscores that deviations in the RER from a level maintaining both external and internal equilibrium significantly hinder economic growth. Together, these studies offer a comprehensive view of the negative impacts of RER misalignment on economic development.

An alternative viewpoint, inspired by the growth experiences of East Asian economies, highlights that RER misalignment, specifically in the form of undervaluation, can positively influence economic growth. Supported by a range of studies, this perspective challenges the conventional view and suggests that strategic currency undervaluation may indeed foster economic development, particularly in developing countries where these effects tend to be more significant (Berg et al., 2012; Berg and Miao, 2010; Di Nino et al., 2011; Domac and Shabsigh, 1999; Eichengreen, 2007; Gala, 2007; Gala and Libanio, 2010; Glüzmann et al., 2012; Guzman et al., 2018; Habib et al., 2017; Hausmann et al., 2005; Levy-Yeyati et al., 2013; MacDonald and Vieira, 2010; Prasad et al., 2007; Rapetti, 2011; Razmi et al., 2012; Rodrik, 2008). Among these contributions, Rodrik (2008) is a cornerstone that has drawn significant scholarly attention to the growth benefits of RER undervaluation. In his seminal study, Rodrik (2008) highlight the crucial role of RER undervaluation in promoting productivity and growth. He argues that in low- and middle-income countries, the growth of tradable sectors are significantly hindered by institutional inefficiencies and market failures. According to Rodrik (2008), strategic undervaluation of the RER, by increasing the relative profitability of investing in the tradable sector, acts as an effective, albeit second-best, strat-

[2] These studies primarily focus on the adverse effects of RER misalignment on economic growth with a particular emphasis on overvaluation's more pronounced negative impact. While several of these investigations acknowledge and analyze the detrimental effects of both overvaluation and undervaluation, the consensus points to a larger negative impact from overvaluation. However, it's crucial to note that a subset of these studies exclusively addresses the negative consequences of overvaluation, without addressing the effects of undervaluation.

egy to alleviate these distortions and facilitate growth in such economies. Similarly, Razmi et al. (2012) and Rapetti (2011) demonstrate the positive impact of an undervalued RER on output growth. Guzman et al. (2018) suggests that maintaining a stable and competitive RER has the potential to drive developing economies towards diversification into sectors characterized by more advanced technological content.

A number of studies, have explored the asymmetric and non-linear effects of RER misalignment on economic growth (Aghion et al., 2009; Aguirre and Calderón, 2005; Béreau et al., 2012; Nouira and Sekkat, 2012; Rapetti, 2011; Razin and Collins, 1997). Notably, Aguirre and Calderón (2005) and Razin and Collins (1997) highlight the asymmetric and non-linear impacts of RER misalignment on economic growth, indicating that overvaluation typically hinders growth, whereas undervaluation has the potential to enhance it. Moreover, Razin and Collins (1997) demonstrate that the negative impact of overvaluation on growth is more pronounced than the positive impacts of undervaluation, which decrease in magnitude with greater degrees of undervaluation. Building on this, Aguirre and Calderón (2005) provide further insights, showing that growth is progressively hindered by increasing levels of overvaluation and significantly harmed by large undervaluations, yet small to moderate undervaluations can actually foster growth. Adding to this discourse, the analysis by Nouira and Sekkat (2012) on the asymmetric impact of RER overvaluation and undervaluation on economic growth reveals ambiguous outcomes. The contrasting results challenge the conventional view that undervaluation consistently promotes growth, showing instead that its effects can range from positive, to negative, to insignificant. Similarly, the impact of overvaluation on growth also displays inconsistency, with outcomes varying from negative to at times insignificant. Additional studies have explored the robustness of the RER growth association to measurement errors. For instance, MacDonald and Vieira (2010) constructed seven distinct indices of RER misalignment and sequentially applied them as independent variables in growth regression models. These analyses consistently reveal a significant and positive link between RER competitiveness and economic growth, an effect particularly pronounced in developing and emerging economies. These findings align closely with the work of

Di Nino et al. (2011); Rapetti (2011); Rodrik (2008) which emphasize a stronger correlation in developing countries.

Building upon the established link between RER misalignment and economic growth, it is crucial to delve deeper into the underlying mechanisms that drive this relationship. The following discussion focuses on elucidating the various channels through which RER misalignment impacts growth, highlighting the intricate ways in which misalignment(s) can influence long run economic development. One key mechanism that clarifies the link between an undervalued RER and economic growth involves higher savings and investments. The idea is that RER undervaluation stimulates higher savings, leading to increased capital accumulation and growth. Diaz-Alejandro (1965) demonstrates that the saving rate increases due to the redistribution of income from low-income workers, who have a lower propensity to save, to high-income capitalists with a higher propensity to save. However, his analysis also reveals a short-run contractionary effect of increased savings resulting from RER depreciation. Levy-Yeyati et al. (2013) provide evidence supporting the expansionary effect of depreciated exchange rates through enhanced aggregate savings and capital accumulation. According to their findings, higher savings lead to productive domestic investments, alleviating financial constraints for firms and enabling them to absorb surplus labor into high-productivity industrial jobs, thereby contributing to growth. Additionally, Razmi et al. (2012) develop a model that shows RER undervaluations promote capital accumulation and investment growth, especially in developing countries. Similarly, Gala (2007) underscores the critical role of currency devaluation in encouraging investment and economic growth, arguing that an undervalued currency results in higher tradable prices, reduced real wages, increased profit margins, and, consequently, more investment. Furthermore, another significant aspect to consider is the potential negative impact of RER depreciation on companies with foreign-currency debt as detailed by Krugman (1999).

Another crucial mechanism linking RER misalignment to economic growth is the reallocation of resources towards the tradable sector, driven by profitability. A competitive real exchange rate boosts the profitability of investments in the tradable sector, which not only supports the development of infant industries but also facilitates structural change. This transition results in a reallocation of resources towards sectors associated with higher productivity, which benefit from learning-by-doing, innovative opportunities, and increasing returns to scale. Rodrik (2008) suggests that sustained real depreciation alleviates market and institutional failures in the tradable sector and stimulates economic growth. Similarly, Gala and Libanio (2010) argue that competitive currencies contribute to economic growth by boosting the industrial sector, benefiting from increasing returns and productivity. From a Kaldorian perspective, they posit the industrial sector as the primary driver of growth, with currency undervaluation serving as a strategic tool to support this. Moreover, Razmi et al. (2012) highlight the significance of RER undervaluation for employment levels and its potential to drive sustained capital accumulation and economic growth. A depreciation in RER results in higher profits in the tradable sector, prompting a shift of resources from traditional to modern sectors, thus increasing employment and productivity levels, and consequently, fostering growth. Expanding upon these insights, Rapetti (2013a) suggests that exchange rate policy would be more effective if implemented alongside domestic demand management policies. This combined approach helps prevent increases in non-tradable prices and wages, which could otherwise undermine the profitability of tradable goods within the development path. An essential factor influencing the profitability of the tradable sector is the relative price of tradable goods compared to non-tradable goods and labor costs. However, a competitive RER policy alone primarily affects the price of tradable goods and lacks direct influence over the prices of non-tradable goods and wages. Therefore, implementing complementary policies is imperative to spur economic growth. In line with this, Guzman et al. (2018) argues that maintaining a stable and competitive RER promotes economic diversification and structural change toward activities with higher learning and technological spillovers in developing economies.

Shifting our perspective to firm and sectoral-level empirical evidence, we explore how this supports the channel discussed. McMillan and Rodrik (2011) show that RER undervaluation favors structural transformation toward modern tradables and the flow of labor from low-productivity to high-productivity tradable activities. Vaz and Baer (2014) find that an undervalued currency positively affects the manufacturing sector growth in Latin America. Freund and Pierola (2012) demonstrate that increases in manufacturing exports tend to be preceded by a sizeable RER depreciation in developing countries. The distortion in developing countries leads to limited entry into new export markets; RER depreciation alleviates this distortion and encourages the reallocation of resources into the export sector, thereby enhancing the efficiency of production structures and creating more jobs. Cimoli et al. (2013) suggest that RER depreciation initiates an export surge, rapidly upgrading the export structure toward products intensive in technology and innovation, thus contributing to long-term economic growth. Caglayan and Demir (2019) investigate the effect of RER changes on trade flows, considering the skill content and direction of products in a North-South framework. Their results indicate that higher RER positively affects medium-skill, low-skill, and resource-intensive exports, but has no effect on high-skill or primary goods. Further exploring these dynamics, a growing number of empirical studies have revealed how the heterogeneous firms' responsiveness to real exchange rate movements results in low aggregate elasticity of exports to these fluctuations. High-productive firms often choose to partially absorb exchange rate fluctuations in their markups, whereas less productive firms increase their export volume following the exchange rate movement, as shown by (Berman et al., 2012; Chatterjee et al., 2013; Melitz and Ottaviano, 2008). Specifically, Chatterjee et al. (2013) observe that more productive firms react to a RER depreciation by increasing their product range and raising producer prices for their core products. Berman et al. (2012) find that high-productivity firms increase their markups significantly rather than their export volumes following a RER depreciation.

An additional important mechanism demonstrates the link between the RER and the balance of payment constraint. The balance of payments constraint growth model (BPCG), first introduced by Thirlwall (1979), posits that a country's long-run growth equals the ratio of income elasticity of demand for exports to the income elasticity of import demand. He emphasizes that aggregate demand plays a pivotal role in growth through the balance of payment constraint. To address the balance of payment difficulties, demand can be increased by making exports more appealing and reducing the income elasticity of demand for imports. However, several recent papers have criticized the logic of Thirlwall's law. Blecker (2016) reviews these critiques, which include factors such as foreign income growth, capital accumulation, relative prices, and country size in the BPCG model. Razmi (2016) asserts that capital accumulation and relative prices are the essential criteria for determining the growth rate consistent with the external balance. Additionally, a higher investment rate in the tradable sector can stimulate exports, increasing the growth of imports and output without causing disequilibrium in the current account. Bresser-Pereira et al. (2014) show that both demand and supply-side variables determine the effects of the RER on the balance of payments constrained growth. They suggest that RER undervaluation (overvaluation) tends to increase (decrease) the profitability of the tradable sector and capital accumulation, thereby relaxing (worsening) the balance of payments constraints and promoting (aggravating) growth. Porcile and Lima (2010) propose a balance-of-payments-constrained macro-dynamic model where the interaction between the real exchange rate and labor supply elasticity determines economic growth. This model considers that foreign and domestic capital goods are combined in fixed proportions. Consequently, the investment rate, capital accumulation, and output growth depend on importing foreign capital goods financed by the export of domestic goods, which in turn depends on the RER. The elasticity of labor supply plays a critical role in preventing RER appreciation, thus releasing balance of payments constraints and enhancing the effectiveness of industrial and technological policies in promoting economic growth.

Our research contributes to the existing literature by investigating the mechanisms that connect the real exchange rate to economic growth, particularly emphasizing the role of exchange rate misalignment in driving structural transformation. We utilize sectoral-level data to thoroughly analyze these dynamics.

1.3 Theoretical Analysis

1.3.1 The Real Exchange Rate: Concept and Measurement

The real exchange rate is defined in two primary forms: external and internal. The external RER compares the relative value of currencies across countries by evaluating the relative price of baskets of goods consumed or produced. The internal RER is the ratio of the domestic price of tradable to non-tradable goods within a country or the relative prices of non-tradable to imports and exports (Hinkle and Montiel, 1999). In theory, the internal approach is superior to the external one; however, it is not very commonly used in empirical studies because of limited data availability of tradable and non-tradable price levels across countries and time.

There are several measures to calculate RER empirically and the most standard one is as follows:

$$RER_t = e_t \frac{P^*}{P} \tag{1}$$

where e_t is the nominal exchange rate (the price of foreign currency in terms of home currency), P and P^* are price indexes in domestic and foreign markets respectively. Considering price indexes as a geometric average price of traded and non-traded goods we can define internal RER as follows:

$$RER_t = e_t \frac{(P_t^{N^*})^{\alpha^*}.(P_t^{T^*})^{(1-\alpha^*)}}{(P_t^{N})^{\alpha}.(P_t^{T})^{(1-\alpha)}} \tag{2}$$

From the perspective of a small open economy, it is typically assumed that the economy is a price taker in international markets. Consequently, if the law of one price holds for traded goods and the price indexes are identically constructed in both the domestic and foreign markets, the price of tradable goods is effectively determined by the international market and can be normalized to unity, then Equation (2) simplifies to:

$$RER_t = \frac{P^T}{P^N} \tag{3}$$

Choosing the right measure of RER depends on both the theoretical perspective and data availability. Consumer price index (CPI) and GDP deflator put more weight on nontraded goods; in contrast, producer price index (PPI) and wholesale price index (WPI) assign more weight on traded goods. If the internal balance in the economy has a higher priority, then a measure that captures the relative prices of nontradables to tradables, proxied by the ratio of CPI to PPI, will be better fit.[3]

1.3.2 The Equilibrium Real Exchange Rate: Concept and Measurement

The RER misalignment is measured by the deviation of actual RER from its equilibrium value. Therefore, the identification of misalignment is dependent on the equilibrium level of RER, which is not that easy to pin down. Nurkse (1945) defines the equilibrium RER as the value that maintains internal and external balance simultaneously. For Williamson (1983) the equilibrium RER is the onethat generates a current account surplus or deficit, equal to the underlying capital account. Driver and Westaway (2003) define three types of equilibrium RER according to the time horizon. The short-run equilibrium is the exchange rate at which fundamental determinants are at their actual values after abstracting from the influence of random shocks. The medium-term equilibrium is the exchange rate compatible with the economy's internal and external balance. The long-run equilibrium corresponds to the point at which stock-flow equilibrium is achieved, and there is no endogenous tendency for the economy to change.

There are two broad categories of equilibrium RER measures: i) the direct estimation where a reduced-form equation with the RER as a function of fundamental determinants is used

[3]For further discussion, see Chinn (2006).

to derive the equilibrium RER (where the behavioral equilibrium exchange rate, BEER, is the most popular approach). ii) structural models, where the equilibrium exchange rate maintains internal and external macro balances (including the Fundamental Equilibrium Exchange Rate, FEER, and the Natural Equilibrium Real Exchange Rate, NATRX, approaches). In the next section, we present an overview of some of the approaches for estimating the equilibrium exchange rate.

The Purchasing Power Parity Approach

The first traditional concept for equilibrium real exchange rate is the Purchasing Power Parity (PPP) introduced by Cassel (1918, 1925). The PPP theory's fundamental condition is the law of one price, which states that under perfect competition (no tariff or trade barrier and no transportation cost), the price of all identical goods internationally traded should be the same in any country when converted into a common currency.

$$P_i = P_i^* E \tag{4}$$

where P_i is the domestic price for good i, P_i^* is the foreign price good i, and E is the nominal exchange rate expressed as the domestic price of foreign currency. The PPP theory generalizes the law of one price and posits that given the common currency, the price level of a basket of similar products in any country will always be the same, known as absolute PPP, expressed as:

$$P_t = P_t^* E \tag{5}$$

where P_t and P_t^* are the prices of the identical basket of goods in the domestic and foreign countries, respectively, and E is the nominal exchange rate. Even though absolute PPP may not hold in practice due to impediments like trade barriers or transportation costs, PPP is expected to hold in relative terms since price levels determine the equilibrium exchange rate. According to relative PPP theory, the nominal exchange rate adjusts to offset changes in relative inflation rates, and the real exchange rate would be constant in equilibrium and unchanged over time. The PPP is often indicated as the long-run equilibrium exchange rate; in the short-run, due to price rigidity, the nominal exchange rate may deviate from PPP rate, which is considered under or overvaluation of the domestic currency (Rogoff, 1996; Sarno and Taylor, 2002; Taylor and Taylor, 2004; Taylor, 2006).

One modification of the PPP approach is due to the distinction between tradable and non-tradable goods. The prices of non-tradable goods and services relative to tradable prices in developing economies tend to be lower since wages are lower in these countries. According to the Balassa-Samuelson effect (Balassa, 1964; Samuelson, 1964), the productivity in tradable sectors rises faster than productivity in the non-tradable sectors as economies develop. Assuming high labor mobility, productivity improvement in the tradable sector leads to the expansion of the tradable sector, consequently, higher wages and higher prices of the non-tradable sectors in high-income countries. Furthermore, a developing country's RER tends to appreciate, as the productivity in the tradable sector in a developing country catches up with that of a developed country. The empirical studies via cross-section data support the positive association between real exchange rate and per capita income as a representative for productivity. Hence, the equilibrium relationship between RER and relative GDP per capita levels can be derived by cross-section regression residuals (Isard, 2007).

The Fundamental Equilibrium Exchange Rate

The fundamental equilibrium exchange rate (FEER), first proposed by Williamson (1983, 1994), assumes that the equilibrium exchange rate is consistent with maintaining both internal and external balances simultaneously. The internal balance is interpreted as when the economy operates under full employment and a low inflation rate. The external balance is characterized as when the current account is sustainable. Several other studies, including Cline et al. (2010) and Cline (2008), define FEER as an exchange rate expected to generate a current account surplus or deficit that matches the country's underlying capital flows to achieve internal balance. As shown by MacDonald (2000) and Clark and MacDonald (1998), there are two approaches to estimate the FEER, to either set the current account equation equal to a sustainable capital account or impose external and internal balance on the estimated macroeconomic model. There are challenges and limitations regarding this approach in practice, Driver and Westaway (2003) indicate the analytical issue FEER framework is faced with due to possible fluctuations in net foreign asset return. Moreover, the FEER framework assumes there are no constraints on trade and capital flow in the economy, making the estimation of equilibrium exchange rate difficult (Cline et al., 2010). Another criticism related to the FEER is that it may lead to inaccurate equilibrium exchange rate estimation due to sensitivity to the trade elasticity.

The Natural Equilibrium Exchange Rate

Another method to calculate the equilibrium exchange rate is the natural real exchange rate (NATREX) developed by Stein (1995). It is theoretically grounded on a dynamic stock-flow model. It is very similar to the FEER approach in that the NATREX is defined as the RER that secures both internal and external balances delineated by natural unemployment and equilibrium balance of payment, respectively. Stein (1999) suggests two forms of NATREX equilibrium. In the medium-term, the NATREX ensures internal equilibrium (when the output gap is zero in the economy) and external equilibrium (when the current account balance is sustainable). In the long run, capital stock and net foreign assets/debt reach their steady-state level, and interest rates at home abroad are equal.

The Behavioral Equilibrium Exchange Rate

The Behavioral Equilibrium Exchange Rate (BEER) methodology explains equilibrium exchange rate's behavior based on some fundamental macroeconomic variables (Clark and MacDonald, 1998). This approach confirms that the real exchange rates' main determinants are current and capital account items of the balance of payments (MacDonald, 2000). The estimation of the BEER model is based on the basic concept of arbitrage condition of uncovered interest rate parity (UIP), which holds under perfect capital mobility, free trade, and rational expectation:

$$E_t(rer_{t+1}) - rer_t = -(r_t - r_t^*) \tag{6}$$

where rer_{t+1} and rer_t are the RER at time t and $t+1$,respectively, r_t and r_t^* are the domestic and foreign real interest rates and E_t indicates the expected value at time t. By rearranging the terms in equation 6, the observed RER in time t is a positive function of the expected value of next period RER (equilibrium RER in the absence of any shocks to the domestic and foreign economies) and the current real interest rate differential:

$$rer_t = E(rer_{t+1}) + (r_t - r_t^*) \tag{7}$$

Therefore, the unobserved expected value of RER is assumed to be determined by a vector of the long-run economic fundamentals, and the actual RER depends on both these fundamental drivers and real interest-rate differential (Clark and MacDonald, 1998).

1.4 Empirical Analysis

1.4.1 Data

This section provides a comprehensive overview of the datasets utilized in our analysis. We begin with data from the Penn World Table (PWT) and World Development Indicators (WDI), which are used to examine exchange rate misalignment and economic growth. Next, to focus on structural change, we will discuss data from the GGDC 10-Sector Database and the GGDC/UNU-WIDER Economic Transformation Database. Lastly, we focus on manufacturing sector data obtained from the United Nations Industrial Development Organization (UNIDO).

To define the extent of misalignment, we estimate the long-run relationship between the real exchange rate and its determinants. Our analysis relies on data from the Penn World Tables (PWT 9.1) and the World Bank's World Development Indicators (WDI), which together cover 175 countries from 1950 to 2017. The RER is calculated as the inverse of the price level of GDP (pl_gdpo). To compute the equilibrium exchange rate, we follow the literature and include the following controls: GDP per capita (GDP^o/POP), and terms of trade, defined as the ratio of a country's export price index to its import price index, both sourced from PWT. Government spending, measured as the share of government consumption in GDP, is extracted from the World Bank's WDI database, while the variable NFA, constructed as the ratio of the net foreign assets position to GDP, is from Lane and Milesi-Ferretti (2017).

In analyzing economic growth, we consider a variety of variables that are commonly used in the literature to maintain consistency and comparability. Our dependent variable is the growth rate of real GDP per capita, calculated as the 5-year geometric average of the log difference of GDP per capita. To account for conditional convergence, we use the initial value of GDP per capita at the start of the 5-year period. Government burden is measured by the ratio of government consumption to GDP, with data sourced from the WDI. Investment is represented by gross capital formation as a percentage of GDP, also from the WDI. Human capital is proxied by the average years of schooling, as reported by the PWT. Additionally, we include terms of trade to account for external factors affecting growth, also sourced from the PWT. Table 1 provides a summary of the main variables, their sources, and methods employed to calculate RER misalignment. Additionally, Table A4 in the Appendix shows the descriptive statistics on growth and misalignment variables.

Our measures of structural change are from three sources: the Groningen Growth and Development Center (GGDC),[4] the Economic Transformation Database (ETD),[5] [6] and the United Nations Industrial Development Organization (UNIDO). The GGDC database, the 2014 version, encompasses the 10 main sectors, representing the entire economy, Table 2 provides a detailed list of the industries included. A significant advantage of the GGDC data is its extensive coverage of employment and value added at the sector level from 1960 to 2010,

[4]Data available for download at[https://www.rug.nl/ggdc/structuralchange/previous-sector-database/10-sector-2014].

[5]Data available for download at [https://www.rug.nl/ggdc/structuralchange/etd-transition-economies].

[6]Data available for download at [https://www.rug.nl/ggdc/structuralchange/etd/].

and for some countries, up to 2013. The database includes annual data on gross value added at both current and constant prices, as well as the number of workers, which is based on the broadest employment concept, including self-employed individuals, family workers, and other informal workers Timmer et al. (2015). Summary statistics for the GGDC 10-Sector dataset are presented in Appendix Table A5.

Additionally, we utilize a combined dataset from the GGDC/UNU-WIDER Economic Transformation Database, including the 12-Sector versions of 2021 (Kruse et al., 2023) and the Economic Transformation Database of Transition Economies (ETD-TE) version of 2023 (Hamilton and de Vries, 2023), which are successors to the GGDC 10-Sector Database. The ETD, built from primary data sources rather than simply updating the existing sectoral dataset's time series, offers enhanced coverage of low-income developing countries. It identifies 12 sectors based on the International Standard Industrial Classification revision 4 (ISIC rev 4), collectively representing the entire economy, and includes time series data extending up to 2018. A detailed list of the industries included in these versions can be found in Table 3. For further insights, summary statistics for these datasets are provided in Appendix Table A6. The GGDC/UNU-WIDER Economic Transformation Database offers comprehensive data on Africa, Asia, and Latin America. The dataset consists of 51 countries at varying levels of economic development: 20 Asian, 9 Latin American, 4 Middle-Eastern and North African (MENA), and 18 sub-Saharan African economies. Furthermore, the ETD-TE dataset enhances this geographic coverage by providing a balanced panel of internationally comparable sectoral data on output and employment for fourteen former-Soviet Republics. This combined dataset enables a comparative analysis of growth and structural transformation across these diverse regions. The countries and their respective geographical regions are detailed in Table A1. The Economic Transformation Database provides annual data on gross value added at both real and nominal prices from 1990 to 2018. The value added data, derived from National Accounts, account for income from both formal and informal activities, ensuring high international comparability. Employment data in the ETD includes all individuals engaged in work, encompassing paid employees, self-employed individuals, and family workers aged 15 years and older, thus covering both formal and informal sectors.[7]

Given the pivotal role of the manufacturing sector in driving economic development and productivity growth, our analysis focuses extensively on this area. We use the UNIDO Industrial Statistics Database (INDSTAT2), which includes time series data at the 2-digit ISIC Revision 3 level from 1963 to 2017. This database offers comprehensive value-added and employment statistics for the manufacturing sector, covering 23 industries. The list of these industries and their classification by technological intensity are detailed in Table 4. The data from UNIDO are derived from industrial surveys, but the extent of coverage varies by country. In developed countries, these surveys typically include all establishments, whereas in developing countries, they often exclude smaller enterprises with fewer than 5 or 10 employees. Despite these discrepancies, the data remain valuable for comparative analysis. The list of countries within this dataset used in our analysis is presented in Table A3.[8]

1.4.2 The Real Exchange Rate Misalignment Estimation

In this section, we explore the methods for measuring RER misalignment that we apply in our analysis. The RER misalignment is defined as the deviation of the observed RER from its equilibrium level, shown in Equation (8):

$$ln(Mis_{it}) = ln(RER_{it}) - ln(\widehat{RER}_{it}) \tag{8}$$

where $ln(Mis_{it})$ represents the degree of currency misalignment, RER_{it} denotes the real exchange rate, defined as units of home currency per unit of foreign currency. $ln(\widehat{RER}_{it})$ is the predicted value of $ln(RER_{it})$. An increase (decrease) in RER_{it} indicates depreciation (appreciation) of the real exchange rate, and a positive (negative) value of misalignment refers to a currency undervaluation (overvaluation).

We adopted different model specifications to derive the RER misalignment index. To esti-

[7]For detailed documentation of the sources and methods, see De Vries et al. (2021).

[8]For both GGDC and UNIDO data, we measure productivity as value added per employee.

mate the equilibrium RER, we define a model that associates RER to a set of its fundamentals. In choosing RER determinants, we follow MacDonald (2000), and extend the model as follows:

$$ln(RER_{it}) = \beta_0 + \beta_1 ln(GDPC_{it}) + \beta_2 ln(GOV_{it}) + \beta_3 ln(TOT_{it}) + \beta_4 NFA_{it} + \nu_t + \epsilon_{it} \quad (9)$$

The Equation (9) includes the following explanatory variables:

- According to Balassa-Samuelson, productivity gains in traded goods production are positively related to growth rate and tend to be higher in the tradable sector than in non-tradable sector. We use relative GDP per capita as a proxy for productivity, as it is available for many countries. The Balassa-Samuelson effect refers to the real exchange rate appreciation that occurs following significant productivity growth in the domestic tradable sector.

- The fiscal policy, captured by final government spending as a percentage of GDP (GOV) can affect the real exchange rate through a composition effect (Froot and Rogoff, 1995; Hinkle and Montiel, 1999; Obstfeld et al., 1996). An increase in government consumption, which is biased disproportionately toward non-tradable goods, leads to a real exchange rate appreciation through an increase in demand for non-traded goods and a rise in their prices. However, excessive government spending may have a destabilizing effect on the economy and lead to currency depreciation (Melecký and Komárek, 2007). In another study Ravn et al. (2012) argue that an increase in government spending raises output and private consumption, leading to a depreciation of RER.

- A positive net foreign asset (NFA) position enables a country to run persistent trade deficits; in turn, all else being equal, to sustain a negative net export balance in equilibrium, the real exchange rate should appreciate. However, a country with significant external liabilities must run trade surpluses to service the interest payments due, therefore, expected to experience a depreciated RER (Lane and Milesi-Ferretti, 2002).

- The influence of terms of trade (TOT) on the RER is ambiguous due to the income and substitution effect operating in the opposite direction (De Gregorio and Wolf, 1994). An improvement in terms of trade (increase in export prices relative to import prices) leads to a positive income or wealth effect in the domestic economy; increasing domestic demand will raise domestic prices and appreciate the real exchange rate. On the other hand, by increasing the relative price of export to import, domestic agents might shift their demand toward imported goods; therefore, the currency would have to depreciate to restore the external equilibrium.

To construct the RER misalignment index, we implement six different model specifications, shown in Table 5, and based on Equation (9). We start with the PPP adjusted by the Balassa-Samuelson effect, which accounts for the fact that non-tradable goods are cheaper in lower income countries. The standard approach to applying the PPP concept involves estimating the relationship between price levels and per capita real income using linear regression, following Rodrik (2008). We then expanded the model by incorporating additional RER fundamentals to derive alternative measures of RER misalignment.

We also estimate an error-correction version of Equation (9) to calculate RER misalignment. In this work, we use the panel Autoregressive Distributed Lag (ARDL) cointegration technique, as proposed by Pesaran et al. (2001, 1999); Pesaran and Smith (1995). This approach is particularly reliable, as it performs well regardless of whether the variables are stationary (I(0)), non-stationary (I(1)), or mutually cointegrated (Pesaran et al., 1999). We analyze unit roots using IPS, PP, and ADF tests; however, some studies highlight that cross-sectional dependence can bias standard panel unit root tests. To address this, we also employ the cross-sectional augmented IM-Pesaran-Shin (CIPS) test (Pesaran, 2007), which is based on augmented Dickey-Fuller regressions. This test accounts for cross-sectional dependence and allows for heterogeneous autoregressive parameters across units. Table A7 in the appendix reports the results of panel unit root estimations.[9] There is a mix of I(0) and I(1) variables;

[9]Despite the conflicting results on the order of integration, we ran cointegration tests according to Pedroni (1999, 2004) and Kao (1999). The results presented in Appendix Table A8 provide evidence of cointegration,

therefore, the Panel ARDL approach would be particularly appropriate for our analysis. A basic ARDL(p_y, p_x) model can be specified as follows:

$$y_{i,t} = \alpha_i + \sum_{\ell=1}^{p_y} \lambda_{\ell,i} y_{i,t-1} + \sum_{\ell=0}^{p_x} \beta_{\ell,i} x_{i,t-\ell} + u_{i,t} \tag{10}$$

where y_{it} is the dependent variable (RER), x_{it} is a $k \times 1$ vector of explanatory variables.

The mean group (MG) estimator is based on estimating separate equations for each group and computing an unweighted mean of coefficients across different groups (Pesaran and Smith, 1995). It controls for complete heterogeneity across groups by allowing the intercept, all the coefficients, and the error variance to differ across groups. An alternative method, the pooled mean group (PMG) estimator developed by Pesaran et al. (1999), is based on a cointegrated ARDL framework adapted for panel data. The PMG estimator enables the intercepts, short-run coefficients, and error variances to differ across groups but constrains the long-run coefficient to be equal. This estimator employs the maximum likelihood method to estimate the long-run coefficients, capturing the pooling behavior of homogeneity restrictions and short-run coefficients along with intercepts, and means of estimated error-correction coefficients by the averaging across groups. The third technique, the dynamic fixed effect (DFE) estimator, is very similar to the PMG estimator. It assumes homogeneity in all coefficients (both short-run and long-run) across countries, except for the intercept, which is allowed to be heterogeneous.

These three approaches, PMG, MG, and DFE, assume cross-sectional independence of the residuals in their specifications, treating unobservable factors as a linear trend. However, if an unobserved common factor correlates with the regressors, it will lead to incorrect inference and inconsistent estimates using the ARDL approach (Chudik and Pesaran, 2013). To filter out the effects of unobserved common factors, we employ the Cross-Section Augmented

as most of the Pedroni test statistics reject the null hypothesis of no cointegration, a finding corroborated by the Kao test statistics, where the null of no cointegration is rejected in both models.

ARDL estimator (CS-ARDL), as proposed by Chudik et al. (2016); Chudik and Pesaran (2013). The CS-ARDL estimator is based on the following regressions:

$$y_{it} = c^*_{yi} + \sum_{\ell=1}^{p_y} \phi_{i\ell} y_{i,t-\ell} + \sum_{\ell=0}^{p_x} \beta'_{i\ell} x_{i,t-\ell} + \sum_{\ell=0}^{p_{\bar{z}}} \psi'_{i\ell} \bar{z}_{t-\ell} + e^*_{it} \tag{11}$$

where c^*_{yi} are fixed-effects which might be correlated with the regressors x_{it}, $\bar{z}_t = (\bar{y}_t, \bar{x}'_t)'$,$p_{\bar{z}} = [T^{1/3}]$. The CS-ARDL estimates of individual mean level coefficient are as follows:

$$\hat{\theta}_{CS-ARDL} = \frac{\sum_{\ell=0}^{p_x} \hat{\beta}_{i\ell}}{1 - \sum_{\ell=1}^{p_y} \hat{\phi}_{i\ell}} \tag{12}$$

As discussed by Chudik et al. (2016), the main drawback of using the CS-ARDL approach to compute the long-run coefficients is that, due to the inclusion of the lagged dependent variable, a relatively large time dimension is required. Therefore, Chudik et al. (2016) propose the cross-sectionally augmented distributed lag (CS-DL) approach to estimate the long-run effect directly. The main advantage of the CS-DL approach is that it performs better compared to CS-ARDL when the sample size is not too large.[10]

The CS-DL specification is given by:

$$y_{i,t} = c_{yi} + \theta'_i x_{it} + \sum_{\ell=0}^{p-1} \delta_{i\ell} \Delta x_{i,t-\ell} + \sum_{\ell=0}^{p_{\bar{y}}} \omega_{y,i\ell} \bar{y}_{t-\ell} + \sum_{\ell=0}^{p_{\bar{x}}} \omega'_{x,i\ell} \bar{x}_{t-\ell} + e_{it} \tag{13}$$

where $\bar{x}_t = N^{-1} \sum_{i=1}^{N} x_{it}$, $\bar{y}_t = N^{-1} \sum_{i=1}^{N} y_{it}$, and $p_{\bar{x}}, p_{\bar{y}}$ are the number of lags of cross-sectional averages and set equal to the integer part of $T^{1/3}$.[11] The long-run unit-specific impacts are directly estimated and the mean group estimates are calculated as $\bar{\theta}_{MG} = \frac{1}{N} \sum_{i=1}^{N} \hat{\theta}_i$.

[10]For detailed information on ARDL, CS-ARDL, and CS-DL, refer to Chudik et al. (2016); Chudik and Pesaran (2013).

[11]The number of lags (i.e., three in this case) is chosen based on the integer part of $T^{\frac{1}{3}}$.

To determine the appropriate lag length, different authors have applied different approaches; many studies have imposed a common lag structure for all units (Chudik and Pesaran, 2013), while others have suggested that lag selection should be based on information criteria (Arnold et al., 2011; De V. Cavalcanti et al., 2015). This study selected the optimal lag using the Schwarz bayesian information criterion (SBIC), subject to a maximum lag of 3 for each explanatory variables in the ARDl model. The optimal ARDL specification is found to be (0,1,1,0); terms of trade and government expenditure should be modeled with one lag, while net foreign assets and productivity should be modeled without any lag.

Table 6 reports our estimates of Equation (9), based on PMG, MG, and DFE approaches. The results are broadly consistent with the literature. Regarding the long-run parameters, terms of trade, GDP per capita, and net foreign assets carry the expected negative signs, suggesting that they are positively (negatively) associated with RER appreciation (depreciation). Conversely, an increase in government consumption is associated with RER depreciation, which is only statistically significant in the MG estimation. The speed of adjustment coefficient (i.e., the coefficient on the error correction term) is statistically significant and negative (-0.104), indicating that in the case of disequilibrium, the model will return to equilibrium with an adjustment speed of 10%. For all specifications, the CD test rejects the null hypothesis of only weak dependence of the residuals and provides evidence of strong cross-sectional dependence. As discussed previously, the presence of cross-sectional dependence (the assumption that residuals are independent across countries does not hold) makes the estimates from the PMG, MG, and DFE approaches biased. To address this issue, we estimate the CS-ARDL and CS-DL models, which include additional lagged cross-sectional averages of both dependent and independent variables (up to 3 lags) in Table 7.

The CS-ARDL results indicate that only net foreign assets and government expenditure are significant, with the former being negative and the latter positive.The speed of adjustment coefficient is negative and statistically significant, indicative of a stable long-run relationship between the real exchange rate and the right-hand side variables in the equation Equation (9).

In the CS-DL estimation, terms of trade and net foreign assets display the expected negative sign. GDP per capita, used as a proxy for productivity is significant and positive, suggesting that an increase in productivity will lead to a depreciation of the real exchange rate. This finding contrasts with the majority of the literature. Tipoy et al. (2016) find a positive and statistically significant relationship between RER and productivity (GDP per capita), while Demir and Razmi (2022) also find a positive sign for the Balassa-Samuelson effect when including country fixed effect. Kamar and Ben Naceur (2007) suggests that the expected sign of the Balassa-Samuelson proxy cannot be determined a priori, as it relates to how consumption is allocated between tradable and non-tradable goods. Breitenbach et al. (2017) finds that an increase in relative productivity leads to a depreciation of the real exchange rate for emerging countries, implying the absence of the Balassa-Samuelson effect for most emerging countries. As depicted in Table 7, under both CS-ARDL and CS-DL estimates, the Pesaran (2015) CD test indicates a significant decrease in cross-sectional dependence, as the null hypothesis of weak cross-sectional dependence cannot be rejected. This suggests that any cross-sectional dependence caused by common factors has been adequately addressed.

To construct the equilibrium RER, we begin by decomposing the fundamentals into permanent (trend) and transitory(cyclical) components using the Hodrick-Prescott (HP) filter Hodrick and Prescott (1997). The permanent component of each fundamental represents sustainable levels that persist over time, whereas the transitory components decay more rapidly. We then utilize the permanent components of the RER fundamentals in the estimated version of the RER model denoted by Equation (9).[12]

$$RER_{it}^{E} = \tilde{\delta}_i + \hat{\beta}' F_{it}^{S} \tag{14}$$

where the vector F_{it}^{S} refers to the sustainable fundamentals, given by the permanent compo-

[12]Equation (9) is estimated using various specifications, including Pooled Mean Group, Mean Group, Dynamic Fixed Effects, Cross-Sectional Augmented ARDL, and Cross-Sectional Augmented distributed lag models.

nents of the fundamentals and the parameter $\tilde{\delta}_i$ is a scaled country-specific intercept term, which is given by:

$$\tilde{\delta}_i = \overline{RER}_i - \hat{\beta}' \bar{F}_i^S \tag{15}$$

where $\overline{RER}_i$ denote the mean values of actual RER and $\bar{F}_i^S$ is the vector of the average of the permanent components RER fundamentals. The scaled intercept term ensures that the expected value of the RER misalignment index over time must be zero for any given country. This is because the RER is expected to revert to its long-run equilibrium whenever it diverges; otherwise, any deviation would not be temporary but rather a permanent phenomenon. To derive the ultimate expression of the equilibrium RER index, we substitute $\tilde{\delta}_i$ from Equation (15) into Equation (14) as:

$$RER_{it}^E = \overline{RER}_i + \hat{\beta}'(F_{it}^S - \bar{F}_i^S) \tag{16}$$

This expression shows that for each country i, the equilibrium RER equals the average of the observed RER plus a component reflecting the weighted deviation of RER fundamentals from their averages.

We can derive the misalignment index by calculating the difference between the observed and the estimated equilibrium RER in Equation (16) as follows:

$$Mis_{it} = (RER_{it} - \overline{RER}_i) - \hat{\beta}'(F_{it}^S - \bar{F}_i^S) \tag{17}$$

where Equation (17) consists of two parts. The first term on the right-hand side represents the difference between the actual RER and its average value, while the second term indicates the adjustments of the RER that should occur in equilibrium. A positive (negative) value of misalignment index in Equation (17) corresponds to undervaluation (overvaluation).[13]

1.4.3 The Growth Regressions

This section examines the relationship between RER misalignment and economic growth. Following empirical growth literature, we estimate a series of growth regressions for a panel of 175 countries over the period from 1950 to 2017. These regressions use five-year periods to control for cyclical variations, given data availability. Our empirical model is specified as follows:

$$Growth_{it} = \alpha + \beta_1 ln(y_{i,t-1}) + \beta_2 ln(Mis_{it}) + \beta_3 ln(X_{it}) + \nu_i + \kappa_t + \varepsilon_{it} \tag{18}$$

where the dependent variable represents the 5-year geometric average of the growth rate of real GDP per capita. The term $y_{i,t-1}$ denotes the initial income per capita, capturing the convergence effect and implying that initial conditions matter for growth performance. This indicates that as a country's income level rises, its growth rate tends to slow down, while lower-income economies typically experience faster growth compared to wealthier ones. Mis_{it} is the misalignment index based on the first measure following Rodrik (2008). Figure 1 illustrates the distributions of our annual undervaluation index, which is centered around -0.014 with a standard deviation of 0.673. X_{it} is a vector of control variables (government consumption, terms of trade, investment and human capital),which are commonly included in growth literature. ν_i and κ_t represent unobserved country and time-specific effect, respectively, and ε_{it} is the error term. All variables are averaged over a 5-year period. The primary focus of this equation is on β_2, the coefficient of the misalignment index. Since per capita GDP growth is expressed in decimal form and the real exchange rate is in logs, β_2 can be interpreted as the effect on average real output growth over a five-year period resulting from a 10% change in the real exchange rate.

To address measurement errors, endogeneity, or reverse causality, we employ the General-

[13]For more details, see Appendix C Elbadawi et al. (2012).

ized Method of Moments (GMM) technique to estimate the model's parameters (Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998). GMM estimators control for unobserved effects by using differencing regressions or instruments and also utilize prior observations of explanatory and lagged dependent variables as instruments. There are two types of GMM estimation methods: difference GMM and the system GMM. The first-difference GMM estimator, introduced by Arellano and Bond (1991), seeks to eliminate individual-specific effects and employs lagged observations of explanatory variables as instruments. However, this method struggles with variables that exhibit persistence over time within countries. In order to alleviate this problem, we also implement the system GMM, as proposed by Arellano and Bover (1995); Blundell and Bond (1998), which is expected to perform better when instruments exhibit a high degree of persistence. This method creates a system of regressions both in differences and in levels. The instruments used in the regressions in first differences remain the same as those in the GMM difference. In the regressions conducted in levels, the instruments employed are the lagged differences of the explanatory variables.

Thus, we analyze the impact of RER misalingment on economic growth using three different estimation approaches—fixed effect estimation, first-difference GMM, and system GMM—applied to 5-year averages. The estimation results are reported in Table 8. Consistent with previous literature, our findings suggest that maintaining a competitive currency can spur economic growth. Specifically, the results from the fixed effect estimation demonstrate a positive and statistically significant impact of currency undervaluation on economic growth, with more pronounced effects in developing countries. Given the potential for reverse causality, as noted in previous discussions, our analysis emphasizes the system GMM results, which account for this issue by using lagged differences and levels of endogenous variables as instruments. Both the GMM difference and system estimates confirm that RER misalignment has a positive and statistically significant effect on growth across all specifications, particularly for developing countries. This is reflected in the results of system GMM (columns VI and VII of Table 8), where a 10% undervaluation (overvaluation) of the currency leads to a 1.11 percentage point increase (decrease) in annual real income growth during the 5-year period. The effect is even more pronounced for developing countries, where a 10% undervaluation (or overvaluation) leads to a 1.43 percentage point increase (or decrease) in annual real income growth over the same period. Moreover, the robustness of our system GMM results is supported by the Hansen test, which does not reject the null hypothesis of the joint validity of instruments. Additionally, the AR(2) test results suggest that there is no serial correlation in the residual term, further validating our model specifications. Hence, our analysis conclude that the RER undervaluation significantly impacts growth, specifically in developing countries, which broadly confirms the findings of Rodrik (2008).[14]

The economic growth literature primarily relies on theoretical models underpinned by an aggregate production function, such as Solow's neoclassical growth model. This approach emphasizes that economy-wide factors, including capital accumulation, technology, and productivity improvements, play a crucial role in driving economic growth. However, there is renewed interest in the literature on dual economy models and the role of structural change in the growth process (Duarte and Restuccia, 2010; Herrendorf et al., 2014; Martins, 2019; McMillan et al., 2014; Rodrik, 2016). Structural change, characterized by the reallocation of labor and other resources from traditional, low-productivity sectors to modern, high-productivity sectors, contributes significantly to aggregate productivity and economic growth. Our work is motivated by Rodrik (2008), who suggests that a weak RER can help compensate for institutional weaknesses and other market failures, which particularly affect tradable sectors, and more so in developing countries, thereby fostering desirable structural changes and enhancing economic growth. We aim to explore the role of exchange rate policies in achieving growth-enhancing structural change and whether the RER can help reallocate

[14] Alternative measures of RER misalignment are also explored, and the results are reported in the appendix Table A10, Table A11 and Table A12. For misalignment(4), the system GMM results show that while the coefficient is not significant for the full sample, a 10% undervaluation (or overvaluation) of the currency leads to a 1.26 percentage point increase (or decrease) in growth for developing countries (significant at the 10% level) and a 0.97 percentage point increase (or decrease) for developed countries (significant at the 1% level). For the misalignment(pmg) and misalignment(csardl) measures, the significant effects are limited to developing countries, where a 10% undervaluation (or overvaluation) leads to a 1.34 percentage point increase and 1.17 percentage point increase in growth, respectively.

resources toward sectors with learning spillovers.

1.4.4 Structural Change

Structural change is a fundamental aspect of economic development. As countries become wealthier, they experience significant shifts in labor and resource allocation from agriculture to modern sectors, leading to enhanced productivity and higher incomes. This process is illustrated in the sectoral composition of employment and value-added over time. Figure 2A shows that in Low-Income Countries (LICs), the average share of employment in agriculture was high, starting at 73% in 1990 and steadily declining to 50% by 2018. This decline indicates a reallocation of labor from agriculture to non-agricultural sectors, a crucial aspect of structural transformation that can enhance productivity, if it was towards industrial sectors and higher value added services. However, in 2018, the share of employment in agriculture in LICs remained high at around 50%, compared to just 3% in Advanced Economies (AEs). In Emerging Market and Developing Economies (EMDEs), the share of agricultural employment decrease moderately, while employment in manufacturing and services increased, signaling gradual progress towards a more diversified and productive economic structure.

Additionally, Figure 2B reveals that the value-added from agriculture in LICs remains significant, highlighting the sector's importance in these economies. The growth of the agriculture sector has been a key driver of aggregate productivity in LICs, even though labor productivity gains have been slower compared to advanced economies. The ongoing shift of labor to higher productivity sectors such as manufacturing and services is crucial for sustaining economic growth and achieving long-term convergence. For instance, the rapid de-agriculturalization observed in East Asia over the past 40 years exemplifies the significant impact of such structural shifts. This transformation aligns with the engine of growth hypothesis, which highlights the industrial sector, particularly manufacturing, as a pivotal driver of economic growth. Furthermore, it is important to recognize that the industrial sectors comprise a diverse array of activities, varying widely in terms of skill requirements, technological intensity, and productivity levels.

Figure 3 highlights how the composition of employment and value-added in the manufacturing sector, based on tech intensity, has evolved in different economies. In Advanced Economies, the share of medium-tech and high-tech manufacturing sectors in both employment and value-added is higher compared to EMDEs and LICs. Although low-tech sectors still play a significant role in EMDEs, there has been a gradual increase in the share of both employment and value-added in medium-tech and high-tech sectors, indicating some improvement in labor productivity driven by technological adoption. In contrast, LICs continue to rely heavily on low-tech sectors for employment, leading to lower overall productivity. These figures make it evident that a significant portion of employment in low-income countries is concentrated in the least productive sectors. The wide productivity gaps are indicative of underdevelopment, with the largest disparities seen in the poorest countries. However, these gaps tend to narrow with sustained economic growth, as documented by McMillan et al. (2014). This trend is depicted in Figure 4, which plots the coefficient of variation on the vertical axis against the log of sectoral labor productivity on the horizontal axis. The graph indicates an inverse relationship between the two variables, highlighting that as countries become wealthier, the productivity gaps across sectors shrink. This suggests that there is considerable potential for labor productivity improvements in poorer countries by reallocating labor from agriculture to more productive sectors.

In addressing our main research question of whether RER undervaluation facilitates growth-enhancing structural change, we utilize the decomposition method applied by McMillan et al. (2014). This approach breaks down the increase in overall labor productivity into two distinct components: productivity gains within existing economic activities due to the accumulation of human and physical capital or technological change, and the migration of workers from low-productivity sectors to high-productivity sectors, a process known as structural transformation. The decomposition of these two components can be expressed as follows:

$$\Delta Y_t = \sum_{i=n} \theta_{i,t-k} \Delta y_{i,t} + \sum_{i=1} y_{i,t} \Delta \theta_{i,t} \tag{19}$$

where Y_t and $y_{i,t}$ refer to economy-wide and sectoral labor productivity levels (measured by value added per employee)[15] in period t, respectively, and $\theta_{i,t}$ is the share of employment in sector i in period t (calculated as sectoral employment divided by total employment). The Δ operator indicates the change in productivity or employment shares between $t-k$ and t, considering there are n sectors in the economy. The first term on the right-hand side refers to the within-sector component, calculated as the weighted sum of productivity growth within individual sectors, with the weights determined by the employment shares of each sector at the beginning of the period. A positive value for this term indicates that there is productivity growth within most sectors over time. The second term denotes the structural change component, reflecting the shift in labor across different sectors. This component is calculated as the inner product of productivity levels and changes in employment shares across sectors. A positive value for this term indicates that changes in employment shares have positively contributed to overall productivity levels.

Timmer et al. (2015) further decomposed the structural change term in Equation (19) into static and dynamic effects. However, in line with McMillan and Rodrik (2011), we have opted not to separate these components at this stage, as the dynamic term is often negative and difficult to interpret in many studies. For instance, in a two-sector economy, even if a less productive sector shows positive productivity growth, a decrease in its employment share will negatively impact the dynamic term. However, as De Vries et al. (2012) and McMillan et al. (2017) have noted, the overall reallocation of labor from less productive to more productive sectors typically leads to positive contributions to structural change and overall productivity growth. Furthermore, Diao et al. (2017) contend that since structural change is inherently dynamic, classifying part of it as static seems counter intuitive.

[15] Following McMillan and Rodrik (2011), local currency value-added is converted to U.S. dollars using the purchasing power parity (PPP) exchange rate from the Penn World Table to measure labor productivity.

A key challenge in examining structural transformation, particularly in developing countries, is the lack of reliable and comparable data on sectoral employment and value-added across different countries and time periods. To address this challenge and gain deeper insights, we draw on three distinct datasets. First, we analyze sectoral heterogeneity using the GGDC's ten-sector dataset, which is based on ISIC Revision 3.1. Second, we extend the analysis to a twelve-sector dataset derived from the combination of the GGDC/UNU-WIDER Economic Transformation Database (ETD) and the Economic Transformation Database of Transition Economies (ETD-TE), which are classified according to ISIC Revision 4 (hereafter referred to collectively as ETD). These datasets allow us to go beyond the traditional two-sector (agriculture/non-agriculture) or three-sector (agriculture/industry/services) frameworks. GGDC has earned a reputation for providing harmonized and consistent data on sectoral value added from national accounts and employment from labor force surveys and census data, with particular attention to the challenges posed by the high incidence of informal and self-employed workers in poor countries. This meticulous approach lends credibility to the data used in many structural transformation studies (Herrendorf et al., 2014; McMillan et al., 2014; Timmer et al., 2015). However, the commonly used GGDC ten-sector database has limitations, including a limited number of low-income countries and a data series that ends in 2010 for most countries. This cutoff is significant because the period after 2010 has seen substantial shifts in sectoral employment and value-added patterns, particularly in sub-Saharan Africa Kruse et al. (2023). In contrast, the newly constructed ETD and ETD-TE offer broader coverage, particularly for low-income developing countries. These databases disaggregate data into twelve sectors according to ISIC Revision 4 classification,and unlike the GGDC ten-sector database, the ETD distinguishes between financial services and business services due to the availability of more detailed sectoral data. Additionally, the ETD includes time-series data extending through 2018. The ETD is a new dataset, not merely an update of an existing one; it is constructed from an in-depth investigation of statistical sources on a country-by-country basis, ensuring the relevance and accuracy of the data. This makes the ETD a valuable resource for analyzing more recent structural changes, especially in regions and sectors that have undergone significant transformations in the past decade.While we rely primarily on ETD data for the majority of the analysis, estimations based on GGDC data are utilized as a benchmark for comparison.

Finally, we focus on detailed manufacturing sectors due to their potential importance in enhancing aggregate productivity. There is substantial empirical evidence supporting the “engine of growth" hypothesis for manufacturing, which is especially pronounced in low-income countries Rodrik (2013). The essential feature of manufacturing is its potential to generate higher levels of labor productivity, accelerate productivity growth, and drive technological advancements more effectively compared to agriculture or many service industries. Üngör (2017) highlights the importance of boosting productivity in manufacturing and wholesale sectors as a key driver for significantly increasing aggregate productivity growth rates in Latin America. Given the manufacturing sector's critical role in overall productivity growth, it is crucial to examine structural changes within this sector in greater detail. For example, if the expansion of manufacturing characterizes structural change in a particular country, detailed data can be used to identify which specific industries expanded, how many people were employed, and whether specific events or policies contributed to the expansion or contraction of a particular sector. The UNIDO dataset, which includes 23 distinct manufacturing sectors, allows us to isolate manufacturing as the most significant component of industry, facilitating a focused analysis of its structural dynamics and its specific role in structural transformation. This multi-dataset approach provides a more nuanced understanding of sectoral dynamics and structural change.

1.4.5 Real Exchange Rate Misalignment and Structural Change

This section delves into empirical analysis to explore the relationship between RER misalignment and structural transformation. Our objective is to study whether maintaining competitive or undervalued currencies acts as a catalyst for driving growth-oriented structural shifts. To analyze the potential link between exchange rate misalignment index and structural change, we apply the following regression:

$$\mathcal{ST}_{i,t} = \alpha + \beta Mis_{i,t} + \nu_i + \kappa_t + \varepsilon_{it} \tag{20}$$

where $\mathcal{ST}_{i,t}$ denotes structural change (represented by the second term in Equation (19)) for country i and period t. It captures effective structural transformation, contributing to productivity growth through the reallocation of labor across different sectors. $Mis_{i,t}$ is the misalignment measure, ν_i and κ_t are country and time dummies, respectively, and ε is the error term. In terms of the estimation method, we employ the fixed effects estimator, utilizing the panel structure of the data and focusing specifically on within-country variations over time.[16]

Building on the importance of sectoral heterogeneity—i.e., the disaggregation of sectors—highlighted in recent literature (Buera and Kaboski, 2009; Eberhardt and Teal, 2013; Herrendorf et al., 2014; Herrendorf and Valentinyi, 2012), our analysis initially focuses on the GGDC ten-sector database, following McMillan et al. (2014). We calculate structural change using Equation (19), based on these disaggregated sectoral data measured over five-year intervals. This approach allows us to capture sectoral heterogeneity and gain a more precise understanding of the dynamics of structural change. Next, using Equation (20), with the estimated structural change as the dependent variable, we examine the effect of exchange rate misalignment on structural change. Table 9 presents our baseline results for the full sample, as well as for developing and developed countries separately. These results indicate that all estimated coefficients for the different RER misalignment specifications are positive and statistically significant, suggesting that undervaluation contributes to fostering structural transformation. Additionally, we observe that the positive impact of real undervaluation on structural change is notably stronger in emerging and developing economies. Conversely, in developed country subsamples, the coefficient is comparatively smaller.

[16] McMillan et al. (2014), however, builds a cross-sectional dataset that primarily explains differences across countries. Our study offers a more dynamic perspective by constructing a panel dataset that captures within-country changes in structural transformation.

These findings align with prior evidence regarding the relationship between undervaluation and economic growth. As documented by previous studies, currency undervaluation positively and significantly affects growth in developing countries, while this effect is marginal and statistically insignificant in wealthier nations (McMillan et al., 2014; Rodrik, 2008). We supplement our analysis of the original GGDC data by incorporating the newly launched GGDC/UNU-WIDER Economic Transformation Database (ETD) and the Economic Transformation Database of Transition Economies (ETD-TE). As discussed earlier, compared to the GGDC ten-sector database, the ETD offers broader coverage of low-income developing countries, distinguishes twelve sectors based on the ISIC Revision 4 classification, and extends time-series data through 2018, providing deeper insights and a more granular perspective on the patterns of structural transformation. Table 10, presents the results of Equation (20), based on structural change calculated using the ETD dataset. However, we find no significant impact of exchange rate misalignment on structural change, as none of the coefficients are statistically significant.

Next, we shift our focus to the impact of undervaluation on growth-enhancing structural change within the manufacturing sector, given its critical role in driving economic growth in developing countries. Using the UNIDO dataset, which includes 23 distinct sectors within manufacturing across countries, we calculate structural change following the same approach as in Equation (19). This dataset allows for a more targeted analysis of structural transformation within manufacturing, which is often seen as the engine of growth in developing economies. The structural change calculated from the UNIDO data is then used as the dependent variable in Equation (20) to estimate the effects of exchange rate misalignment. The results of this analysis are presented in Table 11, show that only one measure of misalignment is significant and positively associated with structural transformation in developing countries, as indicated in column V. The β estimate of 0.0462 suggests that a 10% undervaluation(which implies a 10% increase in the misalignment variable) is associated with an approximate 0.46 percentage point increase in growth-enhancing structural change. Conversely, in developed countries, the relationship between structural transformation and undervaluation is negative, though not statistically significant.

We further investigate the effect of RER misalignment on structural change within each manufacturing sectors based on their technological intensity using Equation (20). Specifically, we examine whether undervaluation facilitates structural change within groups of low, medium, and high technology intensity manufacturing sectors. The classification of industries by their technological intensity, a widely applied method for grouping industries, is based on the research and development (R&D) expenditure incurred in the production of manufactured goods. Industries with higher R&D intensity are considered high-technology. The list of manufacturing sectors for each group is presented in Table 4. To measure structural change, we first summed the employment and value-added shares of industries within each of the low, medium, and high technology manufacturing sectors. Then, using Equation (19) we calculated structural transformation as the reallocation of labor between these three categories, capturing the shift in resources towards more technology-intensive industries. The results of the effect of exchange rate misalignment on the aforementioned structural change are shown in Table 12. For developing countries, the results are negative and statistically insignificant. In contrast, for developed countries, the effect is generally positive across most columns, except in column XII. However, the results are largely insignificant, with a significant positive effect found only in column VI for developed countries.

Differences in datasets can contribute to some of our contrasting results. A primary reason for these discrepancies may be the significant differences in the scope and coverage of the datasets. While the GGDC aims to provide comprehensive measures of value added and employment, accounting for self-employment and informal enterprises, particularly in poorer countries, the UNIDO data primarily focuses on larger firms operating in the formal sector through its surveys. Beyond differences in coverage, there are also variations in how value added is measured across the datasets, further contributing to the discrepancies in these results. As highlighted by Herrendorf et al. (2022), the use of different datasets, such as GGDC and UNIDO, to study productivity convergence across countries and time periods can lead to notably different conclusions. Specifically, Herrendorf et al. (2022) compared the convergence properties of manufacturing productivity using these two datasets and found that while the UNIDO data showed significant convergence, the GGDC data did not, despite analyzing the same time period and set of countries. This underscores how differences in data coverage and methodology can influence outcomes, which aligns with the variations observed in our analysis depending on the dataset used.

1.4.6 Overvaluation, Undervaluation and Structural Change

Our analysis has so far assumed that RER under- and over-valuation affect structural change symmetrically. However, RER under- and over-valuation are different types of RER distortions with potentially different effects on structural transformation (Habib et al., 2017; Nouira and Sekkat, 2012; Schröder, 2013). To study if the effect of RER misalignment is asymmetric, we follow Schröder (2013) and define RER overvaluation (*overval*) as the negative part of misalignment measure and RER undervaluation (*underval*) as the positive part. We then repeat the baseline regression Equation (20), including undervaluation and overvaluation as separate regressors, using four different measures of RER misalignment. Tables 13–16 present the results of the asymmetric effect of misalignment on structural change using the ten-sector GGDC, twelve-sector ETD, and the manufacturing sectors by UNIDO, respectively.

The coefficient for overvaluation is consistently positive and significant across all specifications for the full sample, as well as for developing and developed countries. In contrast, the effect of undervaluation exhibits mixed results, with both positive and negative values, though these are mostly close to zero and generally not significant. In developed countries, neither undervaluation nor overvaluation is significant, except in the first measure of misalignment, where both coefficients are positive and significant, as shown in column III of Table 13. However, in the second measure, only overvaluation remains positive and significant, as indicated in column VI. Undervaluation is negative and significant only for the full sample, as illustrated in column IV, while it remains generally insignificant for both developing and developed countries. This pattern is detailed in Table 13. For the twelve-sector ETD data, undervaluation is negative and significant in only one specification, as reported in column VI of Table 14. In the context of developing countries, there are no significant results. However, for developed countries, overvaluation is significant and positive in three out of four specifications, while undervaluation is negative and significant in only one specification, as presented in Table 14. Finally, when focusing on the manufacturing sectors using the UNIDO data, no significant results were found, as indicated in Table 15. However, when focusing on the results for technology-intensive manufacturing sectors, undervaluation is consistently negative and significant across all misalignment measures for both the full and developing country samples, while overvaluation remains insignificant, as shown in Table 16.

It's possible that these effects may take time to materialize. Studies have often focused on specific episodes of economic growth, export expansion, and investment driven by exchange rate fluctuations. For instance, Hausmann et al. (2005) analyze episodes of sustained growth acceleration and found that these episodes are often preceded by significant RER depreciation, emphasizing the role of depreciation in spurring rapid economic growth. Similarly, Freund and Pierola (2012) identify episodes of sustained manufacturing export growth, finding that these surges are typically linked to RER undervaluation, which they argue stimulates resource reallocation towards exportable goods and facilitates entry into new export markets, thereby potentially driving economic growth.Further supporting this view, Berg et al. (2012) provide evidence that the duration of growth spells is positively related to the level of the RER, highlighting the importance of a stable and competitive exchange rate for sustained economic expansion. Additionally, Libman et al. (2019) identify episodes of accelerated capital stock growth, noting that these episodes are often preceded by RER undervaluation.

In Rodrik (2008)'s view, tradable economic activities hold special importance in developing countries because they are disproportionately affected by the institutional imperfections and market failures that keep these countries poor. These activities are intrinsically very productive and generate various externalities, such as learning by doing and technological spillovers. Given these traits, reallocating current and future resources to tradable activities — i.e., structural change — can accelerate economic growth. A sustained real depreciation increases the relative profitability of investing in tradables and serves as a second-best solution to alleviate the economic costs of these distortions. Korinek and Serven (2016) argue that a policy mix of capital controls and foreign reserve accumulation can achieve sustainable RER undervaluation, which fosters learning-by-investing externalities and stimulates tradable sector growth. By concentrating on significant and sustained deviations in the RER, we can reduce measurement errors and minimize the impact of macroeconomic changes that result from one-time large RER shifts, such as those triggered by a currency crisis. Therefore, we examine the impact of persistent undervaluation on structural change. Analyzing episodes of undervaluation over a span of five successive years could provide insights into how exchange rate movements affect structural transformation. If the exchange rate remained consistently undervalued for 5 consecutive years, we assign the persistent undervaluation variable the value of the average undervaluation during those years; otherwise, the variable is set to 0, following the methodology of Nouira and Sekkat (2012). To ensure that the analysis of structural change aligns with the periods of persistent undervaluation, we calculate structural change using a 5-year rolling window,consistent with the methodology outlined earlier in Equation (19). This approach allows us to accurately capture the effects of sustained exchange rate misalignment on structural transformation. However, as seen in Tables 17, 18, 19 and 20, Persistent undervaluation is significant and negative for developing countries when using the 10-sector data with the first two misalignment measures. It is also significant and negative in only one specification for developing countries when using the ETD data. In contrast, it is positive and significant for developing countries in the first specification when using the UNIDO manufacturing dataset. Additionally, persistent undervaluation is negative and significant for both the full sample and developed countries when measured using the CSARDL approach in both the manufacturing sector data and the technology-intensive manufacturing sector data.

1.5 Robustness

This section will briefly discuss some of the additional tests conducted to confirm the robustness of the main results. In particular, we addressed potential outliers by removing the top and bottom 1% and 5% of the dependent and independent variables, using the 12-sector ETD dataset and the UNIDO dataset for both manufacturing sector and technology-intensive manufacturing sector. The results of these tests are shown in Tables 21-24 for the ETD dataset, Tables 26-29 for the UNIDO manufacturing sector, and Tables 31-34 for the technology-intensive manufacturing sector.As shown in Table 22, dropping the top and bottom 5% of the dependent variable makes the results statistically significant across all misalignment measures. However, the results are not consistent for the manufacturing and technology-intensive manufacturing sectors. We also excluded regions one at a time, based on World Bank categories, as shown in the Tables 25,30 and 35 and found that the results remained insignificant overall.

To address the possibility that a five-year time frame is insufficient for capturing structural transformation, we conducted robustness checks by extending the analysis to seven- and ten-year periods. This extended time horizon allows for a more comprehensive understanding of the potential long-term effects of exchange rate misalignment on structural transformation. Despite our extensive analysis, we fail to find any significant effect of undervaluation on structural change across the twelve-sectors of ETD or the UNIDO manufacturing sectors. This remain true even when we group manufacturing sectors based on their technological intensity. Our results were predominantly insignificant, highlighting the lack of a discernible relationship between undervaluation and structural transformation. Focusing on the seven-year period, as shown in Tables 36 and 37, we find no significant effect of undervaluation on structural transformation. However, in Table 38, where we groupe the manufacturing sectors based on technological intensity, we observe a positive and statistically significant effect of misalignment using measure 4 for developed country group, although the coefficient remains small. Interestingly, this effect turns negative when using the CSARDL measure. Turning to the ten-year period, as shown in Table 39, using the ETD twelve-sector database, we obtain a statistically significant coefficient of 0.012 for the full set of countries using misalignment (pmg). Additionally, we find a positive and statistically significant effect for developed countries using both the first measure of misalignment and the PMG one. However, we do not find significant results for the ten-year period when analyzing the manufacturing sectors, as shown in Tables 40 and 41.

Generating cross-country measures of sectoral productivity requires two inputs: sectoral employment data and sectoral real value added based on a common set of prices. A key issue in comparing productivity across countries is determining how to convert value added into a common currency. For our baseline results, we use value-added shares in terms of 2011 PPPs at the aggregate level from the PWT. Conceptually, using the PPP exchange rate is appropriate; however, the Balassa-Samuelson effect implies that relative prices vary substantially between tradable and non-tradable sectors (De Vries et al., 2015). To address the potential drawbacks of using an aggregate PPP for productivity comparison involving disaggregated data, we use sector-specific PPPs as provided by Inklaar et al. (2023). The new dataset produced by GGDC, the Productivity Level Database (PLD) 2023 Edition, provides sectoral PPPs for the benchmark years 2005, 2011, and 2017 for a sample of 84 countries across 12 sectors. This allows for the calculation of sectoral value added in a common set of international prices for 2011. Importantly, the sectoral PPPs match with 52 countries in the ETD dataset. First, we use the sectoral PPPs to convert sectoral value added from national currency to international prices for 2011 by dividing the sectoral value added in national currency by the 2011 PPP. Next, we calculate sectoral productivity in 2011 international prices by dividing the sectoral value added from the first step by sectoral employment. However, due to data constraints, this approach is limited to a specific set of industries and countries. Compared to our benchmark model, the results in Table 42 reveal that the coefficients, though somewhat larger, are not statistically significant.

1.6 Conclusion

This paper contributes to the debate on whether exchange rate undervaluation enhances economic growth. A substantial portion of the existing literature consists of aggregate studies that lack a clear identification of the specific channels through which the real exchange rate affects growth. Our primary objective is to assess the influence of the RER on structural change, considering it as a potential transmission channel for the impact of a competitive RER on long-term growth. We investigate whether a competitive RER affects sector-specific sources of growth and the changing sectoral composition (i.e., structural change), thereby enabling poor countries to close productivity gaps with advanced economies by promoting industrialization, shifting labor into manufacturing, and contributing to aggregate productivity and economic growth.

We employ several approaches to estimate exchange rate misalignment, acknowledging the lack of consensus over the best method to do so, and assess their potential impact on structural transformation. We first analyze the broader economic sectors using disaggregated data from the GGDC ten-sector and ETD twelve-sector databases. We then focus specifically on the manufacturing sector, using the UNIDO dataset, due to its potential advantages. The productivity growth it drives at early stages of development also promotes productivity growth in other key sectors, highlighting its significance as a key driver of overall economic growth. Our investigation do not support the hypothesis that exchange rate misalignment facilitates growth-enhancing structural change. The results do not consistently demonstrate a statistically significant effect of exchange rate misalignment on the reallocation of resources from traditional to modern sectors of the economy, indicating that a competitive RER has no direct impact on structural change. This finding contrasts with the results of McMillan et al. (2014), which suggested otherwise. Ultimately, the impact of undervaluation on structural change and growth is an open empirical question. Structural change has gained renewed attention as a key policy priority for many developing countries. Transforming economic structure is undeniably essential for achieving development goals. However, there is still little research on how to accelerate its pace, especially for developing countries. This gap highlights the need for further investigation to identify effective strategies for promoting structural transformation and achieving sustainable development.

Figure 1: Distribution of the Misalignment (m1)

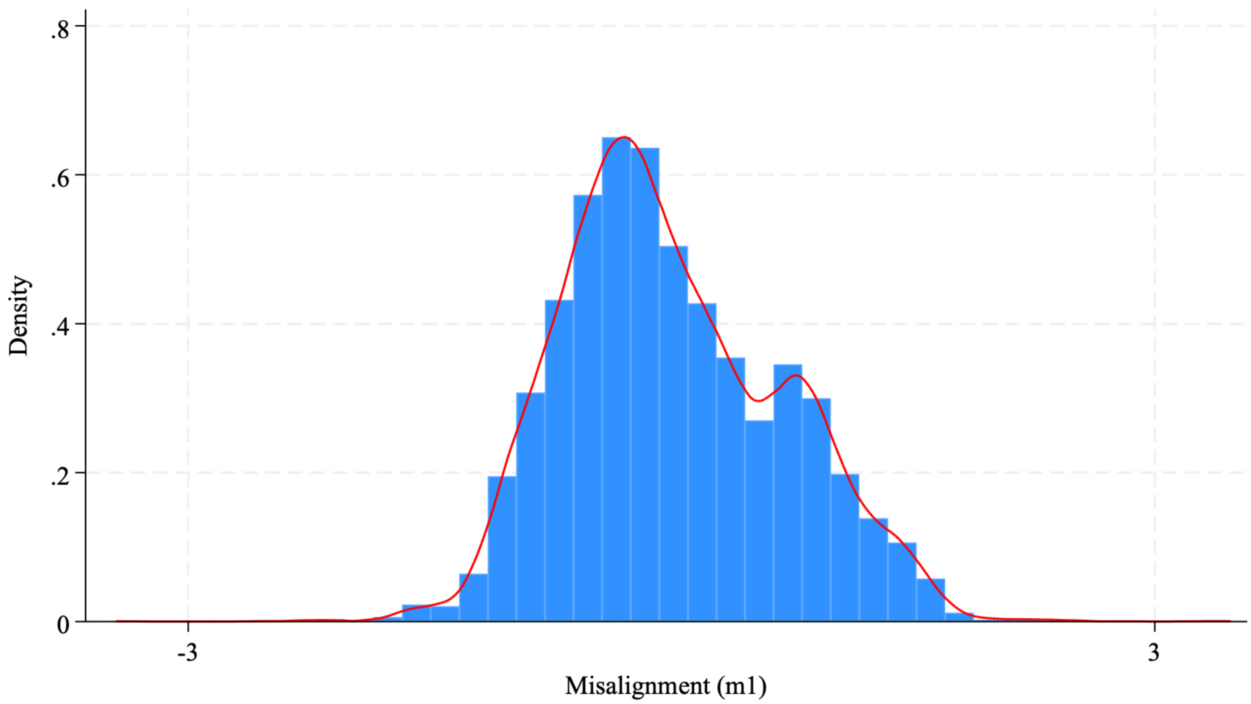
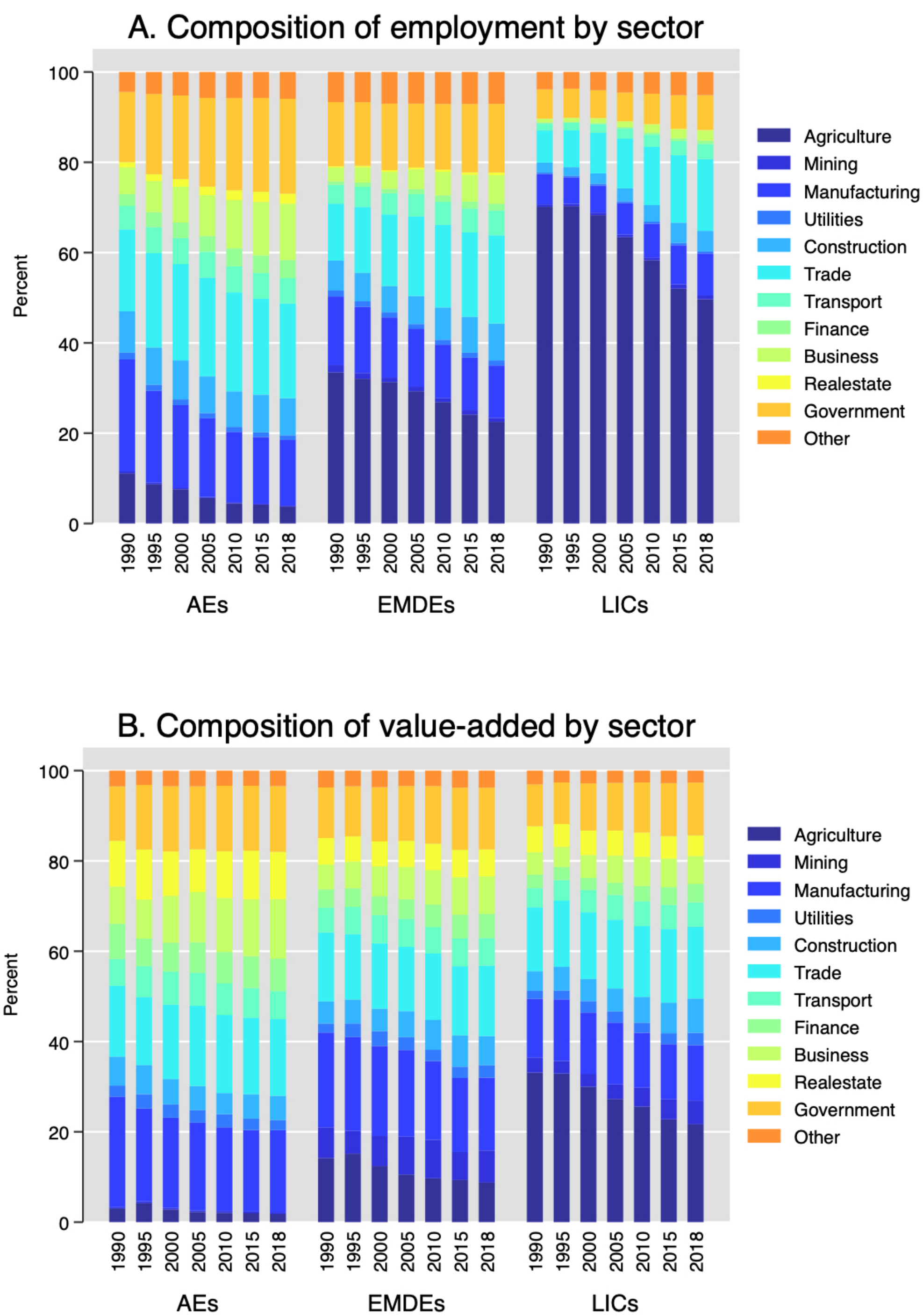
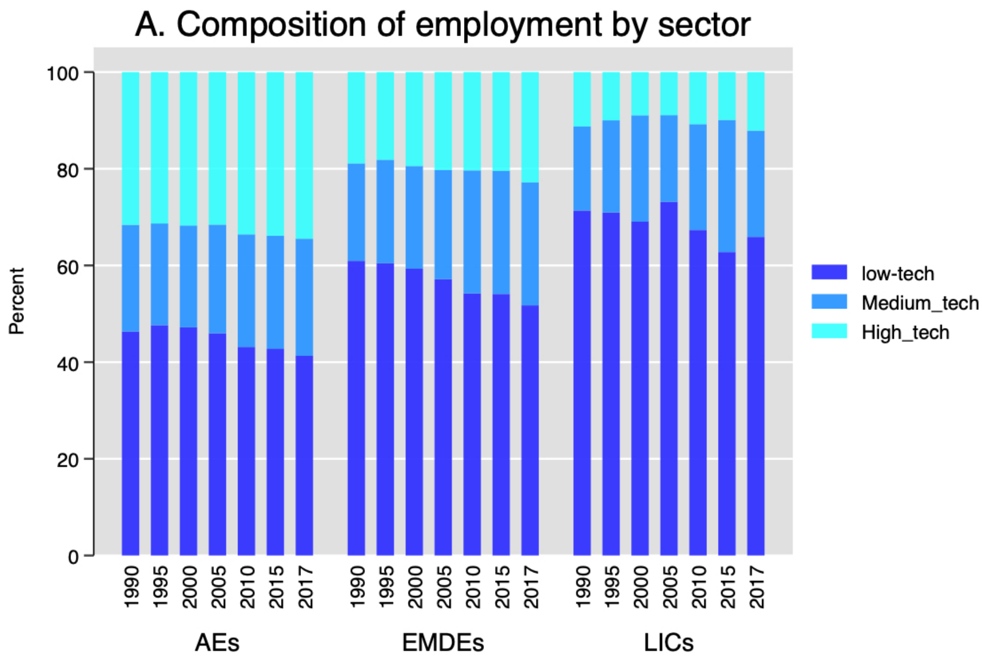


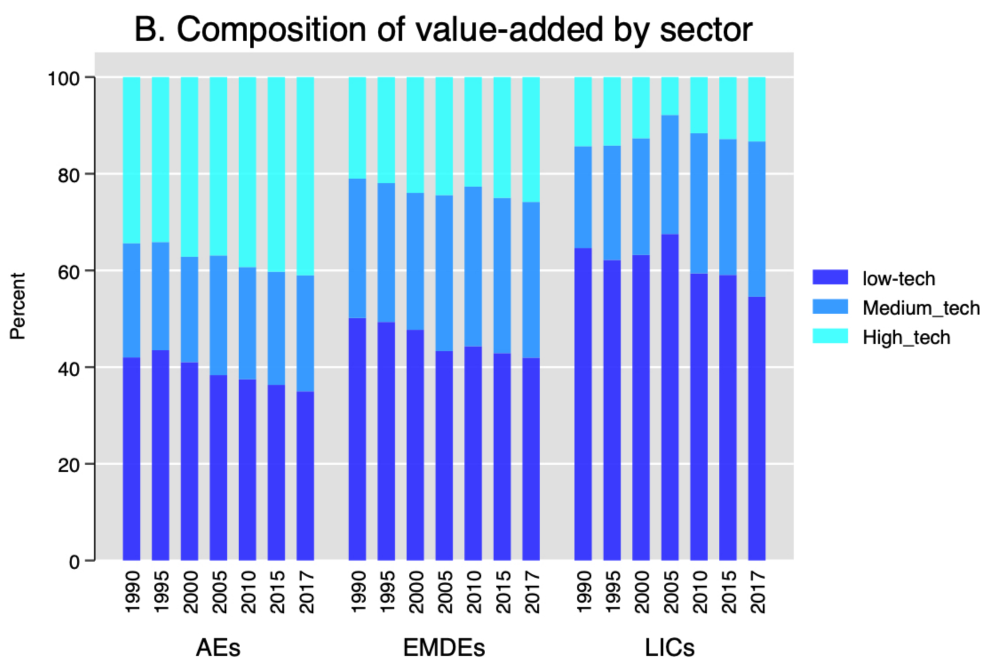
Figure 2: Employment and value-added shares across sectors in advanced, emerging, and low-income countries



Notes: AEs refer to Advanced Economies, EMDEs refer to Emerging Markets and Developing Economies, and LICs refer to Low-Income Countries. A full list of countries categorized under each group can be found in Table A2.

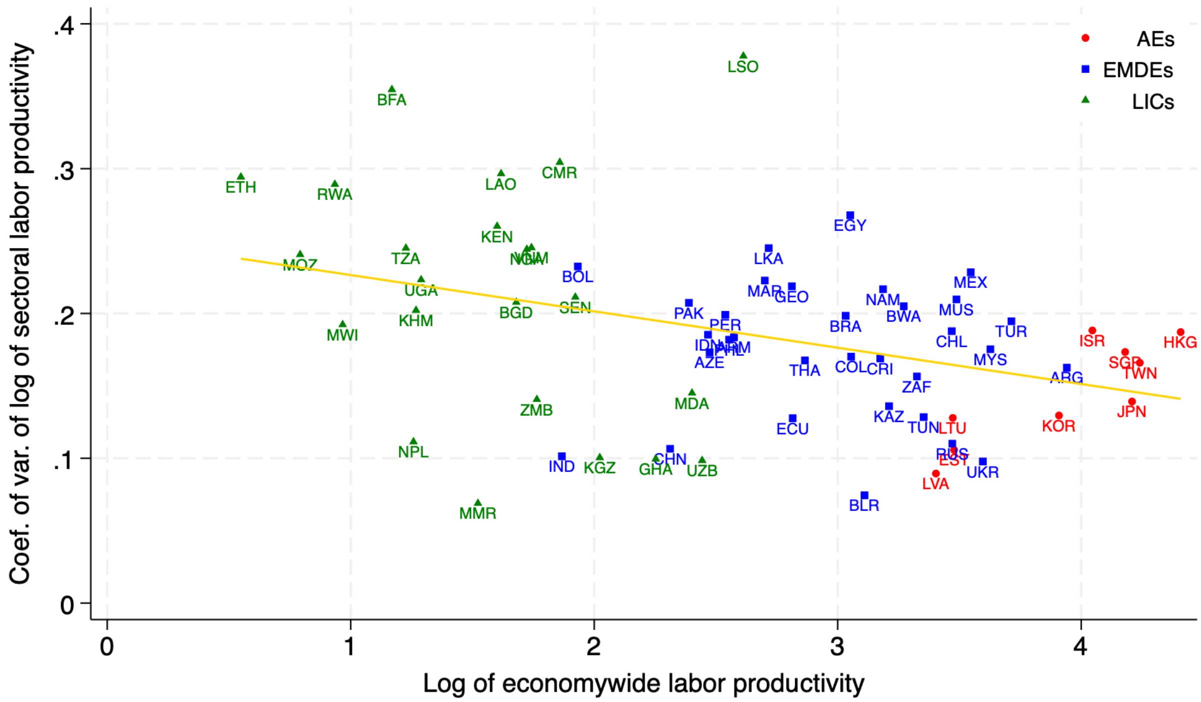
Figure 3: Employment and value-added shares across high-tech, medium-tech, and low-tech manufacturing sectors in advanced, emerging, and low-income countries





Notes: AEs refer to Advanced Economies, EMDEs refer to Emerging Markets and Developing Economies, and LICs refer to Low-Income Countries. A full list of countries categorized under each group can be found in Table A2.

Figure 4: Sectoral gaps in labor productivity decrease with increasing income levels



Notes: AEs refer to Advanced Economies, EMDEs refer to Emerging Markets and Developing Economies, and LICs refer to Low-Income Countries. A full list of countries categorized under each group can be found in Table A2.
Source: Authors' calculation based on McMillan et al. (2014).

Table 1: Description of Variables and Sources

Variable	**Description**	**Source**
Real Exchange Rate (RER)	$RER = (\frac{1}{PL_{GDP^o}})$	PWT 9.1
PL_X	Price level of exports, price level of USA GDP^o in 2011	PWT 9.1
PL_M	Price level of imports, price level of USA GDP^o in 2011	PWT 9.1
Terms of Trade (TOT)	The ratio of price level of export to price level of import (PL_X/PL_M)	Authors' calculation
Government Consumption (GOV)	GDP share of total government consumption expenditure	WDI
Net Foreign Asset Position (NFA)	The ratio of net foreign assets relative to GDP	Lane and Milesi-Ferretti (2017)
Investment	Gross capital formation (% of GDP)	WDI
GDP per capita	Output side real GDP at chained PPPs divided by population	PWT 9.1
Human capital	Human capital (average years of schooling)	PWT 9.1
Misalignment(m1)	Measure of RER misalignment using GDP per capita	Authors' calculation
Misalignment(m2)	Measure of RER misalignment using GDP per capita and NFA	Authors' calculation
Misalignment(m3)	Measure of RER misalignment using GDP per capita, NFA, and TOT	Authors' calculation
Misalignment(m4)	Measure of RER misalignment using GDP per capita, NFA, TOT, and GOV	Authors' calculation
Misalignment(m5)	Measure of RER misalignment using NFA and GOV	Authors' calculation
Misalignment(m6)	Measure of RER misalignment using NFA, TOT, and GOV	Authors' calculation
Misalignment(pmg)	Measure of RER misalignment - pooled mean group using GDP per capita, NFA, TOT, and GOV	Authors' calculation
Misalignment(mg)	Measure of RER misalignment - mean group using GDP per capita, NFA, TOT, and GOV	Authors' calculation
Misalignment(dfe)	Measure of RER misalignment - dynamic fixed effect using GDP per capita, NFA, TOT, and GOV	Authors' calculation

Table 1 – continued from previous page

Variable	**Description**	**Source**
Misalignment(cs-ardl)	Measure of RER misalignment - cross-sectionally augmented autoregressive distributed lag using GDP per capita, NFA, TOT, and GOV	Authors' calculation
Misalignment(cs-dl)	Measure of RER misalignment - cross-sectionally autoregressive distributed lag using GDP per capita, NFA, TOT, and GOV	Authors' calculation
Growth rate	Growth rate $= \frac{\text{GDP per capita}_t - \text{GDP per capita}_{t-1}}{5}$	Authors' calculation
Value added	Gross value added at the sectoral level	GGDC 10-Sector Database ETD UNIDO
Employment	Number of persons engaged at the sectoral level	GGDC 10-Sector Database ETD UNIDO
productivity(y_{it})	Value added per employee in sector i at time t	Authors' calculation
Employment share(θ_{it})	Ratio of employment in sector i to total employment at time t	Authors' calculation
Structural change	Between-sector productivity ($\sum_{i=1} y_{i,t}\Delta\theta_{i,t}$)	Authors' calculation

Note: WDI (World Development Indicators, World Bank); PWT (Penn World Table 9.1); UNIDO (United Nations Industrial Development Organization); GGDC (Groningen Growth and Development Centre 10-Sector Database Timmer et al. (2015)); ETD (GGDC/UNU-WIDER Economic Transformation Database Kruse et al. (2023) and ETD-TE Economic Transformation Database Transition Economies Hamilton and de Vries (2023).)

Table 2: Industry Codes and Names for GGDC Version 2014

ISIC-3.1 code	**Sector Name**	**Description**
A+B	Agriculture	Agriculture, Hunting and Forestry, Fishing
C	Mining	Mining and Quarrying
D	Manufacturing	Manufacturing
E	Utilities	Electricity, Gas and Water supply
F	Construction	Construction
G+H	Trade services	Wholesale and Retail trade; repair of motor vehicles, motorcycles and personal and household goods; Hotels and Restaurants
I	Transport services	Transport, Storage and Communications
J+K	Business services	Financial Intermediation, Renting and Business Activities (excluding owner occupied rents)
L,M,N	Government services	Public Administration and Defense, Education, Health and Social work
O,P	Personal services	Other Community, Social and Personal service activities; Activities of Private Households

Source: GGDC 10-sector database

Table 3: Industry Codes and Names for GGDC Version 2021 and 2023

ISIC-4 code	**Sector Name**	**Description**
A	Agriculture	Agriculture, forestry, fishing
B	Mining	Mining and quarrying
C	Manufacturing	Manufacturing
D+E	Utilities	Electricity, gas, steam and air conditioning supply; Water supply; sewerage, waste management and remediation activities
F	Construction	Construction
G+I	Trade services	Wholesale and retail trade; repair of motor vehicles and motorcycles; Accommodation and food service activities
H	Transport services	Transportation and storage
J+M+N	Business services	Information and communication; Professional, scientific and technical activities; Administrative and support service activities
K	Financial services	Financial and insurance activities
L	Real estate	Real estate activities
O+P+Q	Government services	Public administration and defence; compulsory social security; Education; Human health and social work activities
R+S+T+U	Other services	Arts, entertainment and recreation; Other service activities; Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use; Activities of extraterritorial organizations and bodies

Source: GGDC/UNU-WIDER and GGDC-ETD-TE Economic Transformation database

Table 4: Industry Codes and Names for UNIDO Manufacturing Sectors with Technology Classification

ISIC-3 Code	Sector Name	Tech Category
24	Chemicals and chemical products	High & Medium-High Tech
29	Machinery and equipment n.e.c.	High & Medium-High Tech
30	Office, accounting, computing machinery	High & Medium-High Tech
31	Electrical machinery and apparatus	High & Medium-High Tech
32	Radio, television and communication equipment	High & Medium-High Tech
33	Medical, precision and optical instruments	High & Medium-High Tech
34	Motor vehicles, trailers, semi-trailers	High & Medium-High Tech
35	Other transport equipment	High & Medium-High Tech
23	Coke, refined petroleum products, nuclear fuel	Medium
25	Rubber and plastics products	Medium
26	Non-metallic mineral products	Medium
27	Basic metals	Medium
28	Fabricated metal products	Medium
15	Food and beverages	Low
16	Tobacco products	Low
17	Textiles	Low
18	Wearing apparel, fur	Low
19	Leather, leather products and footwear	Low
20	Wood products (excl. furniture)	Low
21	Paper and paper products	Low
22	Printing and publishing	Low
36	Furniture; manufacturing n.e.c.	Low
37	Recycling	Low

Source: UNIDO dataset

Table 5: Model Estimation for Real Exchange Rate

	Dependent variable: Real exchange rate					
	I	II	III	IV	V	VI
GDP per capita (in logs)	-0.173***	-0.224***	-0.222***	-0.237***		
	(0.004)	(0.004)	(0.004)	(0.005)		
Net foreign asset		0.038***	0.034***	0.041***	-0.044***	-0.049***
		(0.003)	(0.003)	(0.005)	(0.005)	(0.006)
Terms of trade (in logs)			-0.255***	-0.204***		-0.226***
			(0.029)	(0.032)		(0.038)
Government expenditure (in logs)				-0.109***	-0.361***	-0.355***
				(0.013)	(0.015)	(0.015)
Constant	2.756***	2.973***	2.953***	3.370***	1.949***	1.931***
	(0.035)	(0.038)	(0.038)	(0.046)	(0.041)	(0.041)
Country FE	No	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9684	6861	6861	5706	5706	5706
R-squared	0.664	0.561	0.566	0.598	0.430	0.433

Source: Authors' calculation
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively.

Table 6: Pooled Mean Group (PMG), Mean Group (MG), Dynamic Fixed Effect (DFE)

	I	II	III
	Pooled Mean group(PMG)	Mean group(MG)	Dynamic Fixed Effects(DFE)
Long-run coefficients:			
Terms of trade(in logs)	-0.509***	2.107	-0.347***
	(0.092)	(2.661)	(0.125)
GDP per capita(in logs)	-0.190***	-0.013	-0.104**
	(0.030)	(0.455)	(0.042)
Government expenditure(in logs)	0.044	1.316*	0.056
	(0.060)	(0.710)	(0.077)
Net foreign asset	-0.080***	0.599	-0.053***
	(0.015)	(1.322)	(0.018)
Short-run coefficients:			
Error correction coefficient	-0.104***	-0.179***	-0.088***
	(0.005)	(0.011)	(0.003)
D.(terms of trade, logs)	-0.252***	-0.216***	-0.133***
	(0.053)	(0.067)	(0.017)
D.(govenrment expenditure,logs)	0.036	-0.007	0.028**
	(0.028)	(0.027)	(0.012)
Constant	0.238***	0.187	0.128***
	(0.013)	(0.174)	(0.040)
observation	7932	7932	7932
CD test statistics	296.302	63.117	267.180
CD(p-values)	0.000	0.000	0.000

Source: Authors' calculation

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dynamic specification of the real exchange rate model presented here is chosen using the Schwarz Bayesian information criterion, following Pesaran et al. (1999).

CD test statistics present the cross section dependence tests of Pesaran (2015) on the model residuals with the null of weak cross-sectional dependence.

In the PMG estimation, no heterogeniety of the slopes and intercepts are assumed; in the MG estimation, the estimation is done separately for each cross-sectional unit with full heterogeniety in the slopes and intercepts; in the DFE estimation, only intercepts could vary across groups.

Table 7: The Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) and the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-DL) Estimators

Variables	Estimation methods	
	CS-ARDL	CS-DL
Long-run coefficients:		
Terms of trade(in logs)	0.667	-0.496**
	(0.897)	(0.230)
GDP per capita(in logs)	0.460	0.419**
	(0.472)	(0.169)
Government expenditure(in logs)	0.705**	-0.591
	(0.344)	(0.361)
Net foreign asset	-0.166*	-0.238***
	(0.100)	(0.092)
speed of adjustment	-0.604***	
	(0.024)	
observation	6107	6682
CD-test	-0.524	1.174
statistic	0.600	0.240

Source: Authors' calculation
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. Only the long run coefficients are reported.
The dynamic specification of the real exchange rate model presented here is chosen using the Schwarz Bayesian information criterion, following Pesaran et al. (1999).
CD test statistics present the cross section dependence tests of Pesaran (2015) on the model residuals with the null of weak cross-sectional dependence.

Table 8: Growth and RER Misalignment(m1)

	Fixed-Effects			GMM-Diff			GMM-Sys		
	I	II	III	IV	V	VI	VII	VIII	IX
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Initial income	-0.054***	-0.067***	-0.078***	-0.129***	-0.140***	-0.077*	-0.102***	-0.111***	-0.045*
	(0.004)	(0.006)	(0.006)	(0.019)	(0.027)	(0.042)	(0.028)	(0.032)	(0.027)
Misalignment(m1)	0.049***	0.066***	0.028***	0.069**	0.106**	0.075***	0.111***	0.143***	0.070*
	(0.005)	(0.007)	(0.008)	(0.027)	(0.045)	(0.028)	(0.028)	(0.040)	(0.039)
Investment	0.008***	0.006***	0.006*	-0.011	-0.008	0.004	-0.010	-0.014	0.014
	(0.002)	(0.002)	(0.003)	(0.011)	(0.014)	(0.011)	(0.010)	(0.019)	(0.010)
Government expenditure	-0.002	0.011*	-0.065***	0.007	0.038	-0.016	-0.022	-0.002	-0.078***
	(0.005)	(0.006)	(0.009)	(0.040)	(0.030)	(0.048)	(0.032)	(0.027)	(0.028)
Human capital	0.040**	0.096***	-0.020	0.541	0.098	0.706*	0.479***	0.388**	0.379***
	(0.017)	(0.029)	(0.022)	(0.361)	(0.224)	(0.387)	(0.123)	(0.182)	(0.133)
Terms of trade	-0.014*	-0.002	-0.035**	-0.035	0.112	-0.176*	-0.230*	-0.137	-0.163
	(0.008)	(0.011)	(0.014)	(0.198)	(0.092)	(0.102)	(0.133)	(0.112)	(0.104)
Constant	0.467***	0.468***	0.994***				0.710***	0.782***	0.293
	(0.036)	(0.052)	(0.069)				(0.185)	(0.199)	(0.212)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	974	485	489	830	404	426	974	485	489
R-squared	0.366	0.419	0.539						
Instruments				19	27	27	24	28	36
AR2 (p-value)				0.482	0.453	0.766	0.120	0.209	0.087
Hansen-J (p-value)				0.544	0.407	0.342	0.319	0.611	0.122

Source: Authors' calculation
Observations are averages over a 5-year period. The misalignment measure is associated with Rodrik (2008) where the only explanatory variable to estimate equilibrium real exchange rate is GDP per capita.
Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).
We have collapsed the instruments in order to restrict the number of instruments Roodman et al. (2006).
In both GMM-diff and -system only time dummies are assumed exogenous and used as instruments.
The Hansen test: the null hypothesis is that instruments are not correlated with the residuals.
The Arellano-Bond test, for AR(2) in first difference: the null hypothesis is that the errors in the first difference regression have no second order serial correlation.
Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively.

Table 9: Structural Change and RER Misalignment (GGDC 10-Sector Data)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.016***	0.029***	0.007**									
	(0.003)	(0.006)	(0.003)									
Misalignment(m4)				0.010***	0.027***	0.005**						
				(0.003)	(0.008)	(0.003)						
Misalignment(pmg)							0.014***	0.025***	0.004*			
							(0.003)	(0.006)	(0.002)			
Misalignment(csardl)										0.009**	0.030***	0.003
										(0.003)	(0.009)	(0.002)
constant	-0.003	-0.007	0.001	-0.002	-0.010	-0.000	-0.006*	-0.010*	0.000	-0.002	-0.016**	0.001
	(0.003)	(0.005)	(0.002)	(0.003)	(0.006)	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)	(0.008)	(0.003)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	324	147	177	290	121	169	316	146	170	316	146	170
R-squared	0.136	0.213	0.235	0.098	0.193	0.230	0.132	0.194	0.223	0.084	0.159	0.216

Source: Authors' calculation using GGDC 10-sector database Timmer et al. (2015)
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 10: Structural Change and RER Misalignment (ETD 12-Sector Data)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.004	0.003	0.006									
	(0.005)	(0.009)	(0.004)									
Misalignment(m4)				0.004	0.001	0.005						
				(0.005)	(0.009)	(0.004)						
Misalignment(pmg)							0.003	0.002	0.007			
							(0.005)	(0.009)	(0.004)			
Misalignment(csardl)										0.0004	0.004	0.003
										(0.005)	(0.010)	(0.004)
constant	0.005**	0.004	0.008***	0.004*	0.004	0.006***	0.005**	0.004	0.007***	0.004*	0.004	0.007***
	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.003)	(0.002)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	371	187	184	347	169	178	365	187	178	365	187	178
R-squared	0.036	0.063	0.094	0.035	0.070	0.092	0.036	0.063	0.098	0.034	0.064	0.087

Source: Authors' calculation using GGDC/UNU-WIDER Economic Transformation database Hamilton and de Vries (2023); Kruse et al. (2023)

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 11: The Impact of RER Misalignment on Structural Change in Manufacturing Sectors

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.008	0.048	-0.004									
	(0.016)	(0.052)	(0.019)									
Misalignment(m4)				0.010	0.046*	-0.0003						
				(0.012)	(0.026)	(0.021)						
Misalignment(pmg)							0.009	0.045	-0.007			
							(0.015)	(0.050)	(0.019)			
Misalignment(csardl)										0.0002	0.051	-0.010
										(0.016)	(0.062)	(0.017)
constant	-0.007	-0.041	0.007	-0.005	-0.032	0.004	-0.009	-0.043	0.011	-0.001	-0.053	0.015
	(0.015)	(0.045)	(0.018)	(0.014)	(0.026)	(0.023)	(0.018)	(0.048)	(0.023)	(0.020)	(0.062)	(0.022)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	800	224	576	744	196	548	774	214	560	774	214	560
R-squared	0.015	0.041	0.013	0.018	0.108	0.013	0.016	0.044	0.013	0.015	0.043	0.014

Source: Authors' calculation using UNIDO database
Note: Standard errors in parentheses. *, **, *** represent the levels of statistical significance at 10%, 5%, and 1%, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 12: The Impact of RER Misalignment on Structural Change in Technology-Intensive Manufacturing Sectors

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	-0.003	-0.009	0.004									
	(0.003)	(0.008)	(0.004)									
Misalignment(m4)				-0.002	-0.011	0.005						
				(0.003)	(0.009)	(0.004)						
Misalignment(pmg)							-0.004	-0.009	0.001			
							(0.003)	(0.009)	(0.004)			
Misalignment(csardl)										-0.007**	-0.019*	-0.003
										(0.003)	(0.011)	(0.003)
constant	0.003	0.006	-0.003	0.003	0.008	-0.005	0.004	0.007	-0.001	0.008*	0.017	0.004
	(0.003)	(0.008)	(0.004)	(0.004)	(0.010)	(0.005)	(0.004)	(0.008)	(0.005)	(0.004)	(0.011)	(0.005)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	749	199	550	695	173	522	723	189	534	723	189	534
R-squared	0.011	0.069	0.012	0.012	0.085	0.014	0.013	0.071	0.010	0.018	0.086	0.012

Source: Authors' calculation using UNIDO database
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 13: Structural Change and RER Misalignment: Asymmetric Effects of Under-vs Overvaluation (GGDC 10-Sector Data)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
undervaluation(m1)	0.002	0.004	0.010^{**}									
	(0.006)	(0.011)	(0.005)									
overvaluation(m1)	0.020^{***}	0.042^{***}	0.006^{**}									
	(0.004)	(0.008)	(0.003)									
undervaluation(m4)				-0.008^{**}	-0.008	0.003						
				(0.004)	(0.007)	(0.004)						
overvaluation(m4)				0.030^{***}	0.049^{***}	0.005^{*}						
				(0.004)	(0.008)	(0.003)						
undervaluation(pmg)							-0.002	-0.002	0.004			
							(0.005)	(0.010)	(0.005)			
overvaluation(pmg)							0.032^{***}	0.054^{***}	0.004			
							(0.006)	(0.010)	(0.004)			
undervaluation(csardl)										-0.003	0.006	0.002
										(0.006)	(0.012)	(0.004)
overvaluation(csardl)										0.021^{***}	0.063^{***}	0.003
										(0.006)	(0.015)	(0.004)
constant	0.005	0.006	-0.001	0.010^{***}	0.011^{**}	0.002	0.008^{*}	0.009	0.001	0.009	0.003	0.003
	(0.004)	(0.007)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.007)	(0.005)	(0.006)	(0.011)	(0.005)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	324	147	177	324	147	177	324	147	177	324	147	177
R-squared	0.158	0.258	0.239	0.228	0.322	0.221	0.170	0.275	0.214	0.099	0.207	0.209

Source: Authors' calculation using GGDC 10-sector database Timmer et al. (2015)
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 14: Structural Change and RER Misalignment: Asymmetric Effects of Under-vs Overvaluation (ETD 12-Sector Data)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
undervaluation(m1)	-0.004	-0.002	-0.015									
	(0.010)	(0.017)	(0.012)									
overvaluation(m1)	0.008	0.004	0.010**									
	(0.006)	(0.010)	(0.005)									
undervaluation(m4)				-0.006	-0.003	-0.012*						
				(0.008)	(0.014)	(0.007)						
overvaluation(m4)				0.009	0.002	0.014***						
				(0.006)	(0.010)	(0.005)						
undervaluation(pmg)							-0.016	-0.018	-0.003			
							(0.014)	(0.028)	(0.010)			
overvaluation(pmg)							0.008	0.006	0.009*			
							(0.006)	(0.010)	(0.005)			
undervaluation(csardl)										-0.022*	-0.027	-0.002
										(0.013)	(0.024)	(0.010)
overvaluation(csardl)										0.007	0.012	0.005
										(0.006)	(0.011)	(0.005)
constant	0.007**	0.005	0.010***	0.006**	0.005	0.010***	0.006**	0.006	0.008***	0.006**	0.007*	0.008***
	(0.003)	(0.005)	(0.002)	(0.003)	(0.004)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)	(0.002)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	371	187	184	371	187	184	371	187	184	371	187	184
R-squared	0.040	0.064	0.120	0.042	0.063	0.144	0.043	0.067	0.102	0.045	0.077	0.087

Source: Authors' calculation using GGDC/UNU-WIDER Economic Transformation database Hamilton and de Vries (2023); Kruse et al. (2023)

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 15: Structural Change and RER Misalignment: Asymmetric Effects of Under-vs Overvaluation (UNIDO Manufacturing Sector Data)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
undervaluation(m1)	0.010	0.064	-0.008									
	(0.025)	(0.079)	(0.025)									
overvaluation(m1)	0.007	0.027	-0.003									
	(0.016)	(0.052)	(0.020)									
undervaluation(m4)				0.004	0.016	-0.003						
				(0.019)	(0.054)	(0.022)						
overvaluation(m4)				0.017	0.055	0.004						
				(0.020)	(0.065)	(0.021)						
undervaluation(pmg)							-0.015	-0.00001	-0.024			
							(0.026)	(0.062)	(0.030)			
overvaluation(pmg)							0.029	0.081	0.008			
							(0.023)	(0.073)	(0.026)			
undervaluation(csardl)										-0.006	0.019	-0.011
										(0.025)	(0.073)	(0.026)
overvaluation(csardl)										0.005	0.059	-0.006
										(0.023)	(0.085)	(0.024)
constant	-0.001	-0.009	0.003	-0.001	-0.008	0.002	-0.001	-0.008	0.002	0.000	-0.006	0.003
	(0.012)	(0.027)	(0.014)	(0.012)	(0.027)	(0.014)	(0.012)	(0.027)	(0.013)	(0.012)	(0.027)	(0.013)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	857	258	599	857	258	599	857	258	599	857	258	599
R-squared	0.016	0.041	0.013	0.016	0.041	0.013	0.017	0.043	0.014	0.015	0.040	0.014

Source: Authors' calculation using UNIDO database

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 16: Structural Change and RER Misalignment: Asymmetric Effects of Under-vs Overvaluation (UNIDO Technology-Intensive Manufacturing Data)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
undervaluation(m1)	-0.011**	-0.030*	0.003									
	(0.006)	(0.017)	(0.006)									
overvaluation(m1)	-0.001	-0.002	0.004									
	(0.004)	(0.010)	(0.004)									
undervaluation(m4)				-0.008*	-0.018*	0.002						
				(0.004)	(0.010)	(0.005)						
overvaluation(m4)				0.005	0.003	0.006						
				(0.004)	(0.013)	(0.005)						
undervaluation(pmg)							-0.014**	-0.021*	0.002			
							(0.006)	(0.013)	(0.006)			
overvaluation(pmg)							0.005	0.008	-0.0004			
							(0.005)	(0.015)	(0.005)			
undervaluation(csardl)										-0.016***	-0.036**	-0.004
										(0.006)	(0.015)	(0.006)
overvaluation(csardl)										0.002	0.009	-0.001
										(0.005)	(0.016)	(0.005)
constant	0.008*	0.020	-0.002	0.006*	0.010	-0.002	0.013**	0.015	-0.001	0.017***	0.031**	0.005
	(0.004)	(0.012)	(0.005)	(0.004)	(0.008)	(0.004)	(0.005)	(0.010)	(0.007)	(0.006)	(0.014)	(0.007)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	800	224	576	800	224	576	800	224	576	800	224	576
R-squared	0.016	0.083	0.012	0.017	0.080	0.014	0.019	0.080	0.010	0.023	0.101	0.012

Source: Authors' calculation using UNIDO database
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 17: Structural Change and Persistent RER Undervaluation (GGDC 10-Sector Data)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
underval(m1)	-0.010	-0.023**	0.007*									
	(0.006)	(0.011)	(0.004)									
underval(m4)				-0.013***	-0.010**	0.006						
				(0.003)	(0.004)	(0.009)						
underval(pmg)							-0.007	-0.002	0.003			
							(0.005)	(0.006)	(0.008)			
underval(csardl)										-0.007	0.003	-0.003
										(0.005)	(0.006)	(0.009)
constant	0.012*	0.018	0.003	0.017***	0.016***	-0.003	0.012***	0.010**	0.002	0.012**	0.005	0.008
	(0.007)	(0.011)	(0.004)	(0.003)	(0.004)	(0.009)	(0.004)	(0.005)	(0.008)	(0.005)	(0.006)	(0.011)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	456.000	274.000	182.000	416.000	228.000	188.000	348.000	166.000	182.000	364.000	196.000	168.000
R-squared	0.092	0.179	0.549	0.193	0.219	0.309	0.140	0.205	0.200	0.097	0.189	0.163

Source: Authors' calculation using GGDC 10-sector database Timmer et al. (2015)
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 18: Structural Change and Persistent RER Undervaluation (ETD 12-Sector Data)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
underval(m1)	0.016	0.018	0.014									
	(0.014)	(0.016)	(0.012)									
underval(m4)				-0.005	-0.018	-0.004						
				(0.008)	(0.012)	(0.012)						
underval(pmg)							-0.013	-0.045**	0.013			
							(0.011)	(0.019)	(0.012)			
underval(csardl)										0.003	0.002	0.008
										(0.045)	(0.060)	(0.014)
constant	-0.002	-0.001	-0.001	0.011**	0.017**	0.008	0.016***	0.022***	-0.005	0.002	0.002	-0.000
	(0.006)	(0.007)	(0.004)	(0.005)	(0.007)	(0.008)	(0.006)	(0.006)	(0.004)	(0.021)	(0.025)	(0.005)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	165	138	27	299	211	88	147	99	48	90	68	22
R-squared	0.215	0.238	0.988	0.212	0.253	0.442	0.373	0.518	0.689	0.111	0.153	0.320

Source: Authors' calculation using GGDC/UNU-WIDER Economic Transformation database Hamilton and de Vries (2023); Kruse et al. (2023)

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 19: Structural Change and Persistent RER Undervaluation in Manufacturing Sectors

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
underval(m1)	0.043	0.138*	-0.015									
	(0.032)	(0.072)	(0.019)									
underval(m4)				-0.002	0.007	0.002						
				(0.014)	(0.023)	(0.021)						
underval(pmg)							-0.008	-0.032	0.001			
							(0.012)	(0.038)	(0.008)			
underval(csardl)										-0.029**	-0.014	-0.024***
										(0.011)	(0.031)	(0.006)
constant	-0.054	-0.149*	0.014	0.003	-0.006	-0.001	0.011	0.028	0.001	0.034***	0.018	0.030***
	(0.038)	(0.078)	(0.022)	(0.015)	(0.024)	(0.024)	(0.012)	(0.034)	(0.009)	(0.013)	(0.031)	(0.008)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	730	373	357	890	378	512	768	242	526	784	270	514
R-squared	0.079	0.137	0.184	0.054	0.126	0.103	0.154	0.271	0.268	0.131	0.330	0.259

Source: Authors' calculation using UNIDO database
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 20: Structural Change and Persistent RER Undervaluation in Technology-Intensive Manufacturing Sectors

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
underval(m1)	0.006	0.013	0.005***									
	(0.007)	(0.017)	(0.002)									
underval(m4)				-0.001	-0.005	0.006						
				(0.007)	(0.015)	(0.004)						
underval(pmg)							0.002	-0.010	0.005*			
							(0.007)	(0.026)	(0.003)			
underval(csardl)										-0.015*	-0.0002	-0.008***
										(0.008)	(0.023)	(0.002)
constant	-0.008	-0.015	-0.005**	0.002	0.004	-0.005	-0.001	0.005	-0.004	0.016*	0.001	0.009***
	(0.009)	(0.018)	(0.002)	(0.007)	(0.016)	(0.005)	(0.007)	(0.023)	(0.003)	(0.009)	(0.022)	(0.003)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	730	373	357	890	378	512	768	242	526	784	270	514
R-squared	0.085	0.125	0.354	0.054	0.112	0.147	0.135	0.248	0.320	0.131	0.289	0.276

Source: Authors' calculation using UNIDO database
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 21: Robustness Checks: The Impact of RER Misalignment on Structural Change(Excluding Top/Bottom 1% of Dependent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.007**	0.007	0.009**									
	(0.003)	(0.006)	(0.004)									
Misalignment(m4)				0.006*	0.006	0.008*						
				(0.004)	(0.006)	(0.004)						
Misalignment(pmg)							0.007**	0.007	0.009**			
							(0.003)	(0.006)	(0.004)			
Misalignment(csardl)										0.005	0.011*	0.004
										(0.003)	(0.007)	(0.003)
constant	0.006***	0.006**	0.009***	0.004***	0.004	0.007***	0.006***	0.006**	0.008***	0.005***	0.005**	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	364	181	183	340	163	177	358	181	177	358	181	177
R-squared	0.059	0.087	0.099	0.054	0.089	0.095	0.059	0.087	0.106	0.053	0.096	0.080

Source: Authors' calculation using GGDC/UNU-WIDER Economic Transformation database Hamilton and de Vries (2023); Kruse et al. (2023)

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 22: Robustness Checks: The Impact of RER Misalignment on Structural Change(Excluding Top/Bottom 5% of Dependent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.009***	0.013***	0.006**									
	(0.002)	(0.005)	(0.003)									
Misalignment(m4)				0.007***	0.010**	0.006*						
				(0.003)	(0.005)	(0.003)						
Misalignment(pmg)							0.009***	0.013***	0.007**			
							(0.002)	(0.005)	(0.003)			
Misalignment(csardl)										0.007***	0.015***	0.004
										(0.002)	(0.005)	(0.002)
constant	0.005***	0.006***	0.007***	0.004***	0.004*	0.006***	0.005***	0.006***	0.007***	0.005***	0.005***	0.007***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	335	157	178	313	141	172	329	157	172	329	157	172
R-squared	0.089	0.128	0.105	0.073	0.107	0.101	0.093	0.135	0.118	0.075	0.135	0.095

Source: Authors' calculation using GGDC/UNU-WIDER Economic Transformation database Hamilton and de Vries (2023); Kruse et al. (2023)

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 23: Robustness Checks: The Impact of RER Misalignment on Structural Change(Excluding Top/Bottom 1% of Independent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	-0.0004	-0.006	0.006									
	(0.006)	(0.010)	(0.005)									
Misalignment(m4)				0.0004	-0.012	0.005						
				(0.006)	(0.013)	(0.004)						
Misalignment(pmg)							0.002	-0.002	0.007			
							(0.005)	(0.009)	(0.004)			
Misalignment(csardl)										-0.001	0.002	0.003
										(0.005)	(0.010)	(0.004)
constant	0.005**	0.004	0.008***	0.005*	0.005	0.006***	0.005*	0.004	0.007***	0.004*	0.004	0.007***
	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.003)	(0.002)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	367	185	182	342	165	177	359	184	175	362	185	177
R-squared	0.034	0.063	0.094	0.032	0.072	0.092	0.033	0.065	0.093	0.034	0.062	0.089

Source: Authors' calculation using GGDC/UNU-WIDER Economic Transformation database Hamilton and de Vries (2023); Kruse et al. (2023)

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 24: Robustness Checks: The Impact of RER Misalignment on Structural Change(Excluding Top/Bottom 5% of Independent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	-0.001	-0.008	0.005									
	(0.007)	(0.012)	(0.006)									
Misalignment(m4)				0.001	-0.008	0.002						
				(0.007)	(0.015)	(0.006)						
Misalignment(pmg)							-0.001	-0.003	0.005			
							(0.006)	(0.012)	(0.005)			
Misalignment(csardl)										-0.002	-0.001	0.005
										(0.006)	(0.011)	(0.004)
constant	0.005*	0.003	0.008***	0.005*	0.005	0.007***	0.005*	0.005	0.007***	0.004	0.003	0.007***
	(0.003)	(0.004)	(0.002)	(0.003)	(0.004)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)	(0.002)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	341	176	165	317	155	162	335	173	162	341	178	163
R-squared	0.028	0.060	0.082	0.029	0.073	0.076	0.029	0.065	0.058	0.035	0.061	0.093

Source: Authors' calculation using GGDC/UNU-WIDER Economic Transformation database Hamilton and de Vries (2023); Kruse et al. (2023)

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 25: Robustness Checks: The Impact of RER Misalignment on Structural Change: Analysis by Region Exclusion

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Results Excluding Region: Asia												
Misalignment(m1)	0.005	0.001	0.009									
	(0.007)	(0.012)	(0.006)									
Misalignment(m4)				0.005	-0.001	0.006						
				(0.007)	(0.012)	(0.005)						
Misalignment(pmg)							0.004	-0.000	0.008			
							(0.006)	(0.011)	(0.005)			
Misalignment(csardl)										-0.001	-0.003	0.004
										(0.007)	(0.015)	(0.004)
Observations	257	127	130	246	116	130	257	127	130	257	127	130
R-squared	0.048	0.082	0.102	0.041	0.081	0.095	0.046	0.082	0.103	0.045	0.082	0.089
Results Excluding Region: Europe and Central Asia												
Misalignment(m1)	0.008*	0.007	0.014***									
	(0.005)	(0.008)	(0.005)									
Misalignment(m4)				0.007	0.006	0.011**						
				(0.005)	(0.009)	(0.005)						
Misalignment(pmg)							0.009*	0.008	0.014***			
							(0.005)	(0.008)	(0.005)			
Misalignment(csardl)										0.007	0.009	0.009**
										(0.005)	(0.009)	(0.004)
Observations	300	166	134	276	148	128	294	166	128	294	166	128
R-squared	0.050	0.057	0.153	0.049	0.069	0.132	0.050	0.058	0.163	0.048	0.058	0.126
Results Excluding Region: Latin America												
Misalignment(m1)	0.003	0.003	0.004									
	(0.006)	(0.009)	(0.006)									
Misalignment(m4)				0.003	0.001	0.004						
				(0.006)	(0.010)	(0.006)						
Misalignment(pmg)							0.002	0.002	0.005			
							(0.006)	(0.009)	(0.006)			
Misalignment(csardl)										-0.001	0.004	0.002
										(0.005)	(0.010)	(0.004)
Observations	311	175	136	287	157	130	305	175	130	305	175	130
R-squared	0.031	0.065	0.049	0.030	0.072	0.052	0.031	0.065	0.056	0.031	0.065	0.050
Results Excluding Region: Sub-Saharan Africa												
Misalignment(m1)	0.001	-0.012	0.004									
	(0.005)	(0.014)	(0.004)									
Misalignment(m4)				0.003	-0.011	0.003						
				(0.006)	(0.016)	(0.004)						
Misalignment(pmg)							0.000	-0.013	0.003			
							(0.005)	(0.013)	(0.004)			
Misalignment(csardl)										-0.003	-0.008	0.002
										(0.005)	(0.014)	(0.004)
Observations	263	100	163	250	93	157	257	100	157	257	100	157
R-squared	0.085	0.145	0.168	0.091	0.152	0.172	0.088	0.149	0.174	0.090	0.141	0.171
Results Excluding Region: Middle-East and North Africa												
Misalignment(m1)	0.005	0.004	0.006									
	(0.005)	(0.009)	(0.004)									
Misalignment(m4)				0.005	0.003	0.006						
				(0.005)	(0.009)	(0.004)						
Misalignment(pmg)							0.004	0.003	0.006			
							(0.005)	(0.009)	(0.004)			
Misalignment(csardl)										0.000	0.005	0.004
										(0.005)	(0.010)	(0.004)
Observations	353	180	173	329	162	167	347	180	167	347	180	167
R-squared	0.040	0.071	0.107	0.039	0.080	0.106	0.040	0.071	0.111	0.038	0.071	0.102

Source: Authors' calculation using GGDC/UNU-WIDER Economic Transformation database Hamilton and de Vries (2023); Kruse et al. (2023)

Note: All regressions include country and year fixed effects. The constant terms are estimated but not reported. Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 26: Robustness Checks: The Impact of RER Misalignment on Structural Change in Manufacturing Sectors (Excluding Top/Bottom1% of Dependent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	-0.002	-0.003	0.003									
	(0.004)	(0.010)	(0.007)									
Misalignment(m4)				0.0002	0.011	0.001						
				(0.004)	(0.010)	(0.007)						
Misalignment(pmg)							0.0005	0.003	0.006			
							(0.004)	(0.009)	(0.007)			
Misalignment(csardl)										-0.001	-0.004	0.005
										(0.004)	(0.011)	(0.006)
constant	0.002	0.002	-0.002	0.002	-0.006	-0.001	0.000	-0.001	-0.007	0.001	0.004	-0.007
	(0.004)	(0.008)	(0.006)	(0.005)	(0.010)	(0.008)	(0.005)	(0.009)	(0.008)	(0.005)	(0.011)	(0.008)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	784	218	566	729	191	538	758	208	550	758	208	550
R-squared	0.024	0.134	0.011	0.027	0.158	0.011	0.025	0.139	0.013	0.025	0.139	0.013

Source: Authors' calculation using UNIDO database constant ppp2011
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 27: Robustness Checks: The Impact of RER Misalignment on Structural Change in Manufacturing Sectors (Excluding Top/Bottom 5% of Dependent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	-0.003	-0.010*	-0.002									
	(0.002)	(0.005)	(0.003)									
Misalignment(m4)				-0.004*	-0.010*	-0.005						
				(0.002)	(0.005)	(0.003)						
Misalignment(pmg)							-0.001	-0.008	0.002			
							(0.002)	(0.005)	(0.003)			
Misalignment(csardl)										-0.001	-0.011	0.003
										(0.002)	(0.006)	(0.003)
constant	0.002	0.007*	0.001	0.004*	0.008	0.005	0.002	0.007	-0.002	0.002	0.010*	-0.003
	(0.002)	(0.004)	(0.003)	(0.002)	(0.005)	(0.004)	(0.002)	(0.004)	(0.004)	(0.003)	(0.006)	(0.004)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	715	192	523	666	170	496	692	184	508	692	184	508
R-squared	0.042	0.142	0.046	0.046	0.167	0.052	0.040	0.150	0.048	0.040	0.151	0.050

Source: Authors' calculation using UNIDO database constant ppp2011
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 28: Robustness Checks: The Impact of RER Misalignment on Structural Change in Manufacturing Sectors (Excluding Top/Bottom 1% of Independent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.008	0.051	-0.006									
	(0.016)	(0.058)	(0.020)									
Misalignment(m4)				0.009	0.058*	0.0003						
				(0.013)	(0.033)	(0.021)						
Misalignment(pmg)							0.012	0.064	-0.005			
							(0.017)	(0.060)	(0.020)			
Misalignment(csardl)										0.002	0.059	-0.009
										(0.017)	(0.068)	(0.017)
constant	-0.005	-0.042	0.009	-0.003	-0.035	0.005	-0.010	-0.050	0.010	-0.002	-0.059	0.015
	(0.015)	(0.048)	(0.018)	(0.015)	(0.030)	(0.024)	(0.018)	(0.052)	(0.023)	(0.021)	(0.067)	(0.023)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	790	221	569	732	190	542	764	209	555	760	209	551
R-squared	0.015	0.037	0.014	0.017	0.107	0.013	0.016	0.046	0.014	0.015	0.044	0.014

Source: Authors' calculation using UNIDO database constant ppp2011
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 29: Robustness Checks: The Impact of RER Misalignment on Structural Change in Manufacturing Sectors (Excluding Top/Bottom 5% of Independent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.002	0.074	-0.024*									
	(0.017)	(0.069)	(0.014)									
Misalignment(m4)				0.013	0.071*	0.005						
				(0.015)	(0.038)	(0.023)						
Misalignment(pmg)							0.004	0.079	-0.025			
							(0.018)	(0.070)	(0.015)			
Misalignment(csardl)										0.003	0.076	-0.011
										(0.020)	(0.077)	(0.020)
constant	-0.000	-0.042	0.019	-0.004	-0.030	-0.005	0.002	-0.051	0.027	0.001	-0.063	0.009
	(0.016)	(0.058)	(0.014)	(0.019)	(0.036)	(0.030)	(0.020)	(0.058)	(0.022)	(0.026)	(0.072)	(0.038)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	720	204	516	664	175	489	699	196	503	681	197	484
R-squared	0.014	0.041	0.015	0.019	0.119	0.014	0.014	0.045	0.014	0.016	0.046	0.014

Source: Authors' calculation using UNIDO database constant ppp2011

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 30: Robustness Checks: The Impact of RER Misalignment on Structural Change: Analysis by Region Exclusion

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Results Excluding Region: East Asia and Pacific												
Misalignment(m1)	0.009	0.024	0.017									
	(0.013)	(0.029)	(0.021)									
Misalignment(m4)				0.018	0.048	0.024						
				(0.014)	(0.031)	(0.023)						
Misalignment(pmg)							0.012	0.032	0.019			
							(0.013)	(0.028)	(0.021)			
Misalignment(csardl)										0.002	0.028	0.007
										(0.013)	(0.034)	(0.018)
Observations	658	177	481	621	158	463	649	174	475	649	174	475
R-squared	0.025	0.096	0.025	0.028	0.118	0.026	0.026	0.103	0.025	0.024	0.097	0.024
Results Excluding Region: South Asia												
Misalignment(m1)	0.008	0.050	-0.004									
	(0.016)	(0.056)	(0.019)									
Misalignment(m4)				0.010	0.050*	-0.000						
				(0.013)	(0.029)	(0.021)						
Misalignment(pmg)							0.009	0.049	-0.007			
							(0.016)	(0.055)	(0.019)			
Misalignment(csardl)										-0.000	0.054	-0.010
										(0.016)	(0.067)	(0.017)
Observations	776	203	573	720	175	545	750	193	557	750	193	557
R-squared	0.015	0.044	0.013	0.018	0.117	0.013	0.016	0.047	0.013	0.015	0.045	0.013
Results Excluding Region: Europe and Central Asia												
Misalignment(m1)	0.018	0.047	0.005									
	(0.021)	(0.052)	(0.031)									
Misalignment(m4)				0.017	0.041*	0.009						
				(0.015)	(0.022)	(0.033)						
Misalignment(pmg)							0.022	0.045	0.006			
							(0.022)	(0.050)	(0.033)			
Misalignment(csardl)										0.011	0.047	0.003
										(0.023)	(0.064)	(0.029)
Observations	501	208	293	458	182	276	475	198	277	475	198	277
R-squared	0.028	0.068	0.031	0.035	0.142	0.032	0.031	0.071	0.031	0.029	0.069	0.031
Results Excluding Region: Latin America												
Misalignment(m1)	0.008	0.050	-0.006									
	(0.018)	(0.059)	(0.023)									
Misalignment(m4)				0.009	0.049*	-0.002						
				(0.014)	(0.030)	(0.025)						
Misalignment(pmg)							0.008	0.045	-0.011			
							(0.018)	(0.058)	(0.023)			
Misalignment(csardl)										-0.002	0.052	-0.012
										(0.018)	(0.072)	(0.019)
Observations	676	186	490	629	160	469	656	176	480	656	176	480
R-squared	0.019	0.052	0.016	0.019	0.119	0.016	0.020	0.055	0.016	0.020	0.054	0.017
Results Excluding Region: Sub-Saharan Africa												
Misalignment(m1)	0.012	0.050	-0.005									
	(0.016)	(0.066)	(0.019)									
Misalignment(m4)				0.012	0.032	-0.001						
				(0.013)	(0.024)	(0.022)						
Misalignment(pmg)							0.010	0.041	-0.011			
							(0.016)	(0.064)	(0.020)			
Misalignment(csardl)										0.006	0.081	-0.014
										(0.018)	(0.086)	(0.018)
Observations	711	157	554	665	139	526	685	147	538	685	147	538
R-squared	0.013	0.034	0.014	0.014	0.105	0.014	0.013	0.034	0.014	0.012	0.039	0.015
Results Excluding Region: Middle-East and North Africa												

Continued on next page

Table 30: Robustness Checks: The Impact of RER Misalignment on Structural Change:Analysis by Region Exclusion (Continued)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	-0.006	0.089	-0.028*									
	(0.019)	(0.083)	(0.014)									
Misalignment(m4)				-0.011	0.071	-0.029*						
				(0.013)	(0.043)	(0.016)						
Misalignment(pmg)							-0.007	0.065	-0.028**			
							(0.018)	(0.075)	(0.014)			
Misalignment(csardl)										-0.010	0.069	-0.022*
										(0.017)	(0.085)	(0.012)
Observations	698	189	509	647	166	481	675	182	493	675	182	493
R-squared	0.016	0.047	0.016	0.019	0.113	0.015	0.017	0.047	0.017	0.017	0.046	0.015
	Results Excluding Region: North America											
Misalignment(m1)	0.009	0.048	-0.004									
	(0.016)	(0.052)	(0.019)									
Misalignment(m4)				0.010	0.046*	-0.000						
				(0.013)	(0.026)	(0.021)						
Misalignment(pmg)							0.009	0.045	-0.007			
							(0.016)	(0.050)	(0.020)			
Misalignment(csardl)										0.001	0.051	-0.010
										(0.016)	(0.062)	(0.017)
Observations	780	224	556	724	196	528	754	214	540	754	214	540
R-squared	0.016	0.041	0.014	0.019	0.108	0.014	0.016	0.044	0.014	0.016	0.043	0.014

Source: Authors' calculation using UNIDO database constant ppp 2011
Note: All regressions include country and year fixed effects. The constant terms are estimated but not reported. Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 31: Robustness Checks: The Impact of RER Misalignment on Structural Change in Technology-Intensive Manufacturing Sectors(Excluding Top/Bottom 1% of Dependent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	-0.001	-0.001	0.001									
	(0.001)	(0.002)	(0.001)									
Misalignment(m4)				-0.000	-0.001	0.003**						
				(0.001)	(0.002)	(0.001)						
Misalignment(pmg)							-0.001	-0.001	0.001			
							(0.001)	(0.002)	(0.001)			
Misalignment(csardl)										-0.002**	-0.003	-0.002*
										(0.001)	(0.003)	(0.001)
constant	0.001	0.002	-0.001	0.000	0.002	-0.002*	0.001	0.002	-0.001	0.003**	0.004	0.002
	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)	(0.001)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	734	193	541	682	168	514	709	183	526	709	183	526
R-squared	0.033	0.093	0.028	0.034	0.091	0.035	0.034	0.087	0.027	0.041	0.093	0.032

Source: Authors' calculation using UNIDO database

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 32: Robustness Checks: The Impact of RER Misalignment on Structural Change in Technology-Intensive Manufacturing Sectors(Excluding Top/Bottom 5% of Dependent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	-0.001	-0.002	-0.001									
	(0.000)	(0.001)	(0.001)									
Misalignment(m4)				-0.001	-0.002	-0.001						
				(0.000)	(0.001)	(0.001)						
Misalignment(pmg)							-0.001	-0.002*	-0.000			
							(0.000)	(0.001)	(0.001)			
Misalignment(csardl)										-0.001*	-0.003*	-0.000
										(0.000)	(0.002)	(0.001)
constant	0.001**	0.002*	0.001**	0.001**	0.002*	0.001**	0.001**	0.003**	0.001	0.001**	0.003**	0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	674	173	501	625	149	476	651	163	488	651	163	488
R-squared	0.042	0.089	0.043	0.039	0.090	0.045	0.039	0.088	0.041	0.040	0.084	0.040

Source: Authors' calculation using UNIDO database
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 33: Robustness Checks: The Impact of RER Misalignment on Structural Change in Technology-Intensive Manufacturing Sectors(Excluding Top/Bottom 1% of Independent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	-0.003	-0.012	0.004									
	(0.003)	(0.009)	(0.004)									
Misalignment(m4)				-0.003	-0.021	0.006						
				(0.004)	(0.013)	(0.004)						
Misalignment(pmg)							-0.005	-0.012	0.001			
							(0.003)	(0.010)	(0.004)			
Misalignment(csardl)										-0.007**	-0.022*	-0.002
										(0.003)	(0.012)	(0.004)
constant	0.003	0.008	-0.003	0.003	0.013	-0.006	0.005	0.008	-0.001	0.008*	0.019	0.002
	(0.003)	(0.008)	(0.004)	(0.004)	(0.011)	(0.005)	(0.004)	(0.009)	(0.005)	(0.004)	(0.012)	(0.005)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	741	196	545	685	167	518	714	185	529	709	184	525
R-squared	0.010	0.072	0.012	0.012	0.098	0.014	0.014	0.073	0.010	0.017	0.090	0.010

Source: Authors' calculation using UNIDO database

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 34: Robustness Checks: The Impact of RER Misalignment on Structural Change in Technology-Intensive Manufacturing Sectors(Excluding Top/Bottom 5% of Independent Variable, 5-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	-0.004	-0.016	0.004									
	(0.004)	(0.012)	(0.005)									
Misalignment(m4)				-0.003	-0.024	0.006						
				(0.004)	(0.014)	(0.005)						
Misalignment(pmg)							-0.006	-0.017	0.001			
							(0.004)	(0.012)	(0.005)			
Misalignment(csardl)										-0.008*	-0.027*	-0.000
										(0.004)	(0.014)	(0.004)
constant	0.004	0.011	-0.003	0.004	0.016	-0.006	0.005	0.010	-0.003	0.009*	0.021	0.001
	(0.004)	(0.010)	(0.005)	(0.006)	(0.014)	(0.006)	(0.005)	(0.010)	(0.007)	(0.006)	(0.013)	(0.009)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	676	181	495	628	156	472	656	173	483	637	174	463
R-squared	0.010	0.077	0.014	0.013	0.101	0.016	0.014	0.080	0.011	0.017	0.096	0.011

Source: Authors' calculation using UNIDO database
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 35: Robustness Checks: The Impact of RER Misalignment on Structural Change in Technology-Intensive Manufacturing Sectors: Analysis by Region Exclusion

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Results Excluding Region: East Asia and Pacific												
Misalignment(m1)	-0.004	-0.011	0.004									
	(0.004)	(0.010)	(0.005)									
Misalignment(m4)				-0.003	-0.012	0.006						
				(0.004)	(0.011)	(0.005)						
Misalignment(pmg)							-0.005	-0.011	0.000			
							(0.004)	(0.010)	(0.005)			
Misalignment(csardl)										-0.008**	-0.022*	-0.004
										(0.004)	(0.013)	(0.004)
Observations	614	155	459	579	138	441	605	152	453	605	152	453
R-squared	0.016	0.102	0.013	0.017	0.113	0.015	0.018	0.104	0.011	0.024	0.121	0.014
Results Excluding Region: South Asia												
Misalignment(m1)	-0.004	-0.010	0.004									
	(0.003)	(0.009)	(0.004)									
Misalignment(m4)				-0.003	-0.011	0.005						
				(0.004)	(0.010)	(0.004)						
Misalignment(pmg)							-0.004	-0.009	0.001			
							(0.003)	(0.009)	(0.004)			
Misalignment(csardl)										-0.007**	-0.020*	-0.003
										(0.003)	(0.012)	(0.003)
Observations	729	182	547	675	156	519	703	172	531	703	172	531
R-squared	0.012	0.071	0.012	0.013	0.089	0.014	0.014	0.073	0.010	0.019	0.089	0.011
Results Excluding Region: Europe and Central Asia												
Misalignment(m1)	0.003	-0.000	0.012									
	(0.003)	(0.003)	(0.008)									
Misalignment(m4)				0.004	-0.001	0.013						
				(0.003)	(0.003)	(0.008)						
Misalignment(pmg)							0.002	-0.000	0.007			
							(0.003)	(0.003)	(0.008)			
Misalignment(csardl)										-0.001	-0.002	-0.002
										(0.004)	(0.004)	(0.007)
Observations	458	186	272	416	161	255	432	176	256	432	176	256
R-squared	0.013	0.068	0.031	0.015	0.094	0.034	0.012	0.065	0.025	0.012	0.067	0.021
Results Excluding Region: Latin America												
Misalignment(m1)	-0.004	-0.009	0.004									
	(0.004)	(0.009)	(0.005)									
Misalignment(m4)				-0.003	-0.011	0.006						
				(0.004)	(0.011)	(0.005)						
Misalignment(pmg)							-0.005	-0.009	0.000			
							(0.004)	(0.010)	(0.005)			
Misalignment(csardl)										-0.008**	-0.020*	-0.004
										(0.004)	(0.012)	(0.004)
Observations	645	168	477	600	144	456	625	158	467	625	158	467
R-squared	0.012	0.071	0.015	0.012	0.089	0.018	0.013	0.075	0.013	0.019	0.091	0.016
Results Excluding Region: Sub-Saharan Africa												
Misalignment(m1)	-0.003	-0.010	0.004									
	(0.004)	(0.011)	(0.004)									
Misalignment(m4)				-0.002	-0.012	0.006						
				(0.004)	(0.012)	(0.004)						
Misalignment(pmg)							-0.004	-0.010	0.000			
							(0.003)	(0.011)	(0.004)			
Misalignment(csardl)										-0.008**	-0.023	-0.004
										(0.004)	(0.016)	(0.004)
Observations	666	138	528	621	121	500	640	128	512	640	128	512
R-squared	0.012	0.085	0.015	0.013	0.101	0.018	0.014	0.089	0.013	0.021	0.105	0.016
Results Excluding Region: Middle-East and North Africa												
Misalignment(m1)	-0.008**	-0.025*	-0.000									
	(0.004)	(0.014)	(0.002)									
Misalignment(m4)				-0.008*	-0.030*	0.000						
				(0.004)	(0.017)	(0.002)						
Misalignment(pmg)							-0.006*	-0.021	0.001			
							(0.003)	(0.014)	(0.001)			
Misalignment(csardl)										-0.007**	-0.034**	-0.000
										(0.003)	(0.016)	(0.001)

Continued on next page

Table 35: Robustness Checks: The Impact of RER Misalignment on Structural Change in Technology-Intensive Manufacturing Sectors:Analysis by Region Exclusion (Continued)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Observations	653	166	487	604	145	459	630	159	471	630	159	471
R-squared	0.024	0.091	0.010	0.027	0.115	0.006	0.023	0.088	0.007	0.027	0.110	0.006
Results Excluding Region: North America												
Misalignment(m1)	-0.003	-0.009	0.004									
	(0.003)	(0.008)	(0.004)									
Misalignment(m4)				-0.002	-0.011	0.006						
				(0.004)	(0.009)	(0.004)						
Misalignment(pmg)							-0.004	-0.009	0.001			
							(0.003)	(0.009)	(0.004)			
Misalignment(csardl)										-0.007**	-0.019*	-0.003
										(0.003)	(0.011)	(0.003)
Observations	729	199	530	675	173	502	703	189	514	703	189	514
R-squared	0.011	0.069	0.012	0.013	0.085	0.014	0.013	0.071	0.010	0.018	0.086	0.012

Source: Authors' calculation using UNIDO database constant ppp 2011

Note: All regressions include country and year fixed effects. The constant terms are estimated but not reported. Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 36: Robustness Checks: The Impact of RER Misalignment on Structural Change (7-year period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.002	0.003	0.007									
	(0.008)	(0.016)	(0.005)									
Misalignment(m4)				-0.0003	0.0004	0.004						
				(0.008)	(0.017)	(0.005)						
Misalignment(pmg)							0.003	0.005	0.007			
							(0.008)	(0.016)	(0.005)			
Misalignment(csardl)										-0.001	0.006	0.005
										(0.008)	(0.018)	(0.004)
constant	0.006*	0.007	0.007***	0.006**	0.008	0.005***	0.006**	0.007	0.007***	0.005*	0.007	0.007***
	(0.003)	(0.005)	(0.002)	(0.003)	(0.005)	(0.002)	(0.003)	(0.005)	(0.002)	(0.003)	(0.005)	(0.002)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	243	125	118	229	115	114	239	125	114	239	125	114
R-squared	0.005	0.004	0.105	0.005	0.011	0.093	0.006	0.005	0.110	0.005	0.005	0.101

Source: Authors' calculation using GGDC/UNU-WIDER Economic Transformation database Hamilton and de Vries (2023); Kruse et al. (2023)

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 37: Robustness Checks: The Impact of RER Misalignment on Structural Change in Manufacturing Sectors (7-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.011	-0.002	-0.032									
	(0.051)	(0.016)	(0.097)									
Misalignment(m4)				0.019	-0.004	-0.014						
				(0.053)	(0.017)	(0.108)						
Misalignment(pmg)							0.018	-0.001	-0.018			
							(0.050)	(0.016)	(0.095)			
Misalignment(csardl)										0.004	0.001	-0.014
										(0.052)	(0.021)	(0.083)
constant	-0.002	0.005	0.044	-0.012	-0.005	0.037	-0.010	0.004	0.040	0.001	0.003	0.038
	(0.040)	(0.011)	(0.074)	(0.050)	(0.013)	(0.104)	(0.048)	(0.012)	(0.097)	(0.056)	(0.017)	(0.096)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	535	146	389	507	134	373	520	141	379	520	141	379
R-squared	0.016	0.109	0.025	0.017	0.111	0.025	0.017	0.107	0.025	0.017	0.107	0.025

Source: Authors' calculation using UNIDO database constant ppp2011
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 38: Robustness Checks: The Impact of RER Misalignment on Structural Change in Technology-Intensive Manufacturing (7-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.001	0.003	0.003									
	(0.002)	(0.005)	(0.003)									
Misalignment(m4)				0.002	0.003	0.007**						
				(0.002)	(0.005)	(0.003)						
Misalignment(pmg)							-0.001	0.002	-0.001			
							(0.002)	(0.005)	(0.003)			
Misalignment(csardl)										-0.004**	0.004	-0.006***
										(0.002)	(0.006)	(0.002)
constant	0.000	-0.002	-0.001	-0.001	-0.001	-0.006**	0.001	-0.001	0.001	0.005**	-0.003	0.007***
	(0.001)	(0.003)	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)	(0.004)	(0.003)	(0.002)	(0.005)	(0.003)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	534	145	389	506	133	373	519	140	379	519	140	379
R-squared	0.042	0.114	0.029	0.042	0.119	0.043	0.037	0.110	0.023	0.047	0.112	0.047

Source: Authors' calculation using UNIDO database constant ppp2011
Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 39: Robustness Checks: The Impact of RER Misalignment on Structural Change (10-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.011	0.013	0.008*									
	(0.007)	(0.013)	(0.005)									
Misalignment(m4)				0.009	0.011	0.007						
				(0.007)	(0.014)	(0.004)						
Misalignment(pmg)							0.012*	0.016	0.008*			
							(0.007)	(0.013)	(0.005)			
Misalignment(csardl)										0.009	0.014	0.004
										(0.007)	(0.015)	(0.004)
constant	0.007***	0.009**	0.005***	0.005***	0.008**	0.003**	0.006***	0.009***	0.004***	0.006***	0.009**	0.004**
	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)	(0.001)	(0.002)	(0.003)	(0.001)	(0.002)	(0.003)	(0.002)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	179	91	88	168	83	85	176	91	85	176	91	85
R-squared	0.042	0.031	0.161	0.032	0.019	0.156	0.049	0.040	0.167	0.034	0.030	0.118

Source: Authors' calculation using GGDC/UNU-WIDER Economic Transformation database Hamilton and de Vries (2023); Kruse et al. (2023)

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 40: Robustness Checks: The Impact of RER Misalignment on Structural Change in Manufacturing Sectors (10-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.027	0.054	0.011									
	(0.041)	(0.123)	(0.055)									
Misalignment(m4)				0.009	0.012	0.006						
				(0.031)	(0.027)	(0.063)						
Misalignment(pmg)							0.034	0.061	0.030			
							(0.040)	(0.119)	(0.056)			
Misalignment(csardl)										0.048	0.077	0.026
										(0.042)	(0.156)	(0.049)
constant	-0.007	-0.002	-0.003	-0.005	0.001	-0.002	-0.017	-0.006	-0.021	-0.033	-0.024	-0.021
	(0.024)	(0.069)	(0.031)	(0.024)	(0.018)	(0.049)	(0.031)	(0.073)	(0.046)	(0.037)	(0.104)	(0.046)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	376	103	273	356	94	262	365	99	266	365	99	266
R-squared	0.003	0.066	0.016	0.014	0.031	0.016	0.004	0.068	0.017	0.006	0.068	0.017

Source: Authors' calculation using UNIDO database constant ppp2011

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 41: Robustness Checks: The Impact of RER Misalignment on Structural Change in Technology-Intensive Manufacturing (10-Year Period)

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	-0.0002	0.002	0.004									
	(0.003)	(0.005)	(0.005)									
Misalignment(m4)				-0.0002	0.001	0.005						
				(0.003)	(0.005)	(0.005)						
Misalignment(pmg)							-0.002	0.002	-0.0004			
							(0.003)	(0.005)	(0.005)			
Misalignment(csardl)										-0.003	0.003	-0.004
										(0.003)	(0.006)	(0.004)
constant	0.002	0.002	-0.001	0.002	0.001	-0.003	0.003	0.002	0.001	0.004	0.001	0.004
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.004)	(0.002)	(0.004)	(0.004)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	375	102	273	355	93	262	364	98	266	364	98	266
R-squared	0.015	0.119	0.007	0.013	0.105	0.006	0.016	0.119	0.002	0.019	0.121	0.007

Source: Authors' calculation using UNIDO database constant ppp2011

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Table 42: Robustness Checks: Structural Change and RER Misalignment in ETD 12-Sector Data Using Industry-Specific PPP

	Dependent variable: Structural change											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Misalignment(m1)	0.013	0.021	0.007									
	(0.017)	(0.033)	(0.015)									
Misalignment(m4)				0.006	0.010	0.008						
				(0.017)	(0.034)	(0.015)						
Misalignment(pmg)							0.012	0.021	0.004			
							(0.017)	(0.033)	(0.015)			
Misalignment(csardl)										0.009	0.029	-0.001
										(0.016)	(0.037)	(0.012)
constant	0.014*	0.023*	0.005	0.012	0.021	0.002	0.013*	0.022*	0.003	0.012*	0.021*	0.002
	(0.008)	(0.013)	(0.008)	(0.008)	(0.014)	(0.007)	(0.007)	(0.013)	(0.007)	(0.007)	(0.013)	(0.007)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	308	148	160	287	133	154	302	148	154	302	148	154
R-squared	0.008	0.020	0.021	0.009	0.030	0.022	0.008	0.020	0.020	0.008	0.022	0.020

Source: Authors' calculation using GGDC/UNU-WIDER Economic Transformation database Hamilton and de Vries (2023); Kruse et al. (2023)

The calculations are based on 2011 sectoral PPPs.

Note: Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively. The dependent variable is structural transformation. Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).

Chapter 2
Exchange Rates and Investments: Comparing the Effects of Exports and Imports

2.1 Introduction

In international economics, a considerable body of literature has explored the impact of exchange rate fluctuations and their volatility on investment decisions Avdjiev et al. (2019); Bøler et al. (2015); Bruno and Shin (2019); Caglayan and Torres (2011); Campa and Goldberg (1995, 1999); Dao et al. (2021); Goldberg (1993); Kandilov and Leblebicioğlu (2011); Nucci and Pozzolo (2001). These movements can have positive, negative, or indeterminate impacts on investment, depending on a range of economic conditions. Exchange rate swings influence investment through various mechanisms, including trade and financial channels, leading to diverse outcomes. The trade channel is one mechanism through which exchange rate swings affect investment, as they influence export revenues, import competition in the domestic market, and the cost of imported inputs. A depreciation in the exchange rate can enhance export competitiveness and reduce import competition, potentially increasing both the marginal return on capital and production, thereby stimulating investment. However, depreciation can also raise the cost of essential imported inputs, which are crucial for investments Brito et al. (2018). In addition to the trade channel, exchange rates can significantly influence investment through financial channels. A depreciating currency can tighten financial conditions and negatively impact investment, particularly when liabilities are denominated in foreign currencies Banerjee et al. (2020). This depreciation can reduce the availability of credit from banks, further exacerbating financial constraints and amplifying the adverse effects on investment Bruno and Shin (2019);Avdjiev et al. (2019).On the other hand, by lowering real wages, depreciation can strengthen internal financing and boost investment levels Dao et al. (2021).

In this study, we analyze the impact of exchange rate swings on industry-level investments by utilizing variations in industry-specific effective real exchange rates (IERER), which provide a more precise measure of relative national prices than aggregate exchange rates. These industry-specific exchange rates enable us to more accurately capture the effects of relative price changes on investment decisions, considering the substantial variations across different industries within each country Neumann and Tabrizy (2021); Sato et al. (2020). We specifically focus on industry-level tangible asset investments by excluding the variation in intangible investments (e.g., R&D) from gross fixed capital formation, ensuring a targeted analysis of tangible investments alongside total investment figures. For this analysis,we use a panel dataset covering 12 manufacturing industries across five European countries—Germany, Italy, the Netherlands, Norway, and the United Kingdom—spanning the period from 2007 to 2017.

Our findings indicate that depreciation of the industry-level effective real exchange rate negatively impacts total and tangible investments in industries that are not primarily export-oriented. In contrast, heavily export-oriented industries are insulated from these changes, maintaining their investment levels regardless of exchange rate movements. Additionally, we find that variations in import competition do not affect the relationship between exchange rates and investments. These insights improve our understanding of how investments across manufacturing industries respond to shifts in relative national prices.

The remainder of the paper is structured as follows: Section 2.2 reviews the existing empirical literature on the relationship between exchange rates and investment. Section 2.3 outlines the data used and describes our empirical approach. Section 2.4 presents the results of our estimations, and Section 2.5 concludes the paper.

2.2 Literature Review

There is extensive literature on the effects of real exchange rates on investment. Existing empirical investigations can be broadly categorized into two groups: one strand of research explores the impact of exchange rate uncertainty or volatility on investment, while the other, to which our paper contributes, focuses on changes in investment in response to directional shifts in exchange rates, particularly appreciations and depreciations. This literature review will begin with a brief overview of the first strand, then move on to the second, summarizing key findings and positioning our research within this broader context.

The relationship between exchange rate volatility and investment is complex, shaped by factors such as risk aversion, risk-neutral behavior, adjustment costs, investment irreversibility, market competition, the share of variable inputs, market power, and international exposure Abel (1983); Bernanke (1983); Bloom et al. (2007); Caballero (1991); Darby et al. (1999); Dixit and Pindyck (1994); Hartman (1972); Kandilov and Leblebicioğlu (2011); Lee and Shin (2000); Li et al. (2019); Servén (2003); Zeira (1990). Theoretical models emphasize that the direction of this relationship depends on the assumptions outlined above. For instance, under perfect competition and zero adjustment costs, uncertainty might stimulate investment Abel (1983); Hartman (1972). However, when investments are considered irreversible, uncertainty often prompts firms to delay capital expenditures Dixit and Pindyck (1994). Moreover, Caballero (1991); Zeira (1990) indicate that factors such as risk aversion and imperfect competition can contribute to a negative correlation between uncertainty and investment. Campa and Goldberg (1995) and Kandilov and Leblebicioğlu (2011) posit that firms with greater market power, denoted by higher markups, are better equipped to mitigate this negative effect, as they can absorb some exchange rate fluctuations within their profit margins. This protective mechanism, however, is not uniform across all contexts. Servén (2003) emphasizes that the negative effects of exchange rate volatility are significantly amplified in developing countries with high trade openness and weaker financial systems, demonstrating the role of economic structure and financial stability in determining the degree of vulnerability to exchange rate uncertainty. Furthermore, Alfaro et al. (2016); Binding and Dibiasi (2017); Bloom et al. (2007) and Demir (2009) corroborate the view that heightened uncertainty tends to reduce real investment, with Demir (2009) specifically observing this trend in industries within Argentina, Mexico, and Turkey. Consequently, increased volatility in the exchange rate often leads firms to curtail their investment activities.

Theoretical perspectives on the effects of exchange rate changes on both aggregate and sectoral investments have been extensively documented in the literature. Pioneering studies by Campa and Goldberg (1995, 1999); Goldberg (1993); Nucci and Pozzolo (2001) and Harchaoui et al. (2005) among others, offer important insights into these effects. Goldberg (1993) examines the relationship between exchange rates and investment activity in U.S. manufacturing industries, highlighting a contrasting pattern between the 1970s and 1980s. While a real depreciation of the dollar in the 1970s tended to stimulate investment, the 1980s saw the opposite effect, with depreciations reducing investment. This shift can be attributed to sectors with limited export markets and a heavy reliance on imported inputs, where depreciation increases production costs and reduces profitability Campa and Goldberg (1995). Building on these findings, Campa and Goldberg (1999) analyze the effects of exchange rates on investment across manufacturing sectors in the U.S., U.K., Canada, and Japan. They find that exchange rates influence investment through export revenues, the cost of imported inputs, and market power measured by markups. In high-markup sectors, large price-cost margins tend to absorb exchange rate swings into prices, minimizing the impact on investment. Conversely, low-markup sectors remain more sensitive to exchange rate changes, making their investment decisions more vulnerable to such fluctuations. Additionally, a greater share of exports and reduced reliance on imported inputs help moderate the negative impact of depreciation. Similarly, Nucci and Pozzolo (2001) and Atella et al. (2003) demonstrate, using panel data regressions on Italian manufacturing firms, that the impact of exchange rates on investment is strongly influenced by export orientation and market power. Firms with less market power and greater exposure to import competition in the domestic market experience more pronounced effects from exchange rate fluctuations. For Brazilian manufacturing industries, Baltar et al. (2016) draw similar conclusions, emphasizing the importance of accounting for sectoral differences when evaluating the relationship between exchange rates and investment. Their findings suggest that increased competition from imported products may sometimes offset the benefits of cheaper imported inputs. Additionally, Harchaoui et al. (2005) highlight the importance of exchange rate volatility in shaping investment outcomes in Canadian manufacturing industries. They emphasize that in low-volatility environments, depreciations can positively influence investment through increased demand. However, this stimulative effect diminishes considerably as volatility rises. In line with these findings, Caglayan and Torres (2011) explore the impact of exchange rate levels and volatility on investment in Mexico's manufacturing sectors, highlighting the role of external exposure, market structure, and product characteristics. Depreciation boosts investment through the export channel but reduces expected profits for firms heavily reliant on imported inputs. They also find that exchange rate volatility primarily affects export-oriented sectors, and firms in low-markup industries and non-durable goods producers are particularly sensitive to both exchange rate levels and volatility. Expanding on these findings, Brito et al. (2018) argue that the impact of real exchange rate movements on firm-level investment is contingent on the complexity of a country's production structure. The response varies significantly across economies, with advanced economies and emerging Asia showing increased investment during currency depreciations, while in less complex economies, investment tends to rise when the domestic currency appreciates.[17]

Studies by Avdjiev et al. (2019); Banerjee et al. (2020); Bruno and Shin (2020); Dao et al. (2021) explore how exchange rate fluctuations influence investment through financial mechanisms, highlighting the role of cross-border banking flows and foreign currency-denominated debt in shaping investment decisions and demonstrating that depreciations tighten financial conditions and impose contractionary pressures on firms heavily reliant on dollar funding. Bruno and Shin (2020) further illustrate that banks dependent on US dollar funding tend to contract their credit supply in response to local currency depreciation, resulting in a significant decline in exports for firms that rely on these banks, which in turn dampens overall economic activity. Similarly, Banerjee et al. (2020) find that exchange rate depreciation negatively impacts corporate investment through a financial channel, particularly by increasing the burden of firm leverage and FX debt. Moreover, Avdjiev et al. (2019) show

[17] According to Hausmann and Hidalgo (2011), economic complexity reflects the extent of productive capabilities, diversification, and knowledge intensity within an economy. Economies with lower complexity often rely more on commodity exports and place less emphasis on advanced manufacturing.

that a stronger dollar is associated with slower growth in dollar-denominated cross-border bank flows and a decline in real investment.

Lastly, expanding the analysis beyond tangible investments,studies by Alfaro et al. (2016); Chen (2017); Funk (2003); Kaiser et al. (2018), Tabrizy (2020), and Alfaro et al. (2023) explore the effects of exchange rate fluctuations on R&D investments. Chen (2017) examines the effect of real exchange rate undervaluation on R&D activity, finding that undervaluation reduces R&D expenditures, particularly in developed economies, due to higher import costs for machinery and inputs. This suggests that undervaluation policies may hinder technological progress by raising R&D investment costs. Tabrizy (2020) further emphasizes that the effect of exchange rate depreciation on R&D depends on export intensity, with medium-exporting industries being more likely to reduce R&D investment,while industries with low or high export levels experience no significant effect. This pattern is linked to variations in pass-through elasticities, as industries more inclined toward strategic pricing are also more likely to cut R&D investments in response to depreciation. Alfaro et al. (2023) also indicate that RER depreciations boost cash flow, R&D, and productivity for exporters, particularly in export-oriented emerging Asia, while firms in import-dependent economies experience negative effects,with no significant relationship found in industrialized economies.

Building on previous research, our study investigates the role of export intensity and import competition in mediating the relationship between industry-specific effective real exchange rates (IERER) and industry investment. We use an industry-specific real exchange rate measure to capture the substantial variations across industries within the same country—variations often overlooked when relying on national-level aggregate exchange rate measures. Additionally, we explore the varying elasticity of industry-level investment with respect to IERER across the full spectrum of export intensity and import competition, accounting for potential heterogeneities across industries.

2.3 Data and Empirical Approach

2.3.1 Data

For our empirical analysis, we employ an annual panel dataset that covers 12 manufacturing industries across five European countries, including Germany, Italy, the Netherlands, Norway, and the United Kingdom, from 2007 to 2017. Table 43 presents the industries included in our panel, which focus on modern manufacturing activities.

We investigate the impact of changes in IERER on overall investments as well as tangible investments within the manufacturing industries. To determine the total investment at the industry level, we use the Gross Fixed Capital Formation (GFCF) data from the OECD's Structural Analysis database (OECD, 2021b). GFCF includes the net acquisition of both tangible assets (e.g., machinery) and intangible assets (e.g., R&D). To focus exclusively on tangible asset investments, we remove the intangible component by subtracting the industry-level R&D expenditures obtained from the OECD's Business Enterprise R&D Expenditure by Industry dataset (OECD, 2021a). By excluding the intangible portion from GFCF, we can more precisely focus on the industry's investment in physical resources, providing a more detailed picture of spending on tangible assets. The annual GFCF and R&D figures, sourced from the aforementioned OECD databases,are reported in domestic currencies and nominal terms. To convert these nominal values to US dollars and compute their real values for our analysis, we use annual nominal exchange rates and producer price indexes obtained from the IMF's International Financial Statistics (IMF, 2021).

For IERER, we rely on the Industry-Specific Effective Real Exchange Rates data provided by the Research Institute of Economy, Trade, and Industry (RIETI, 2021). This measure is calculated using industry-specific producer price indexes, trade weights, and aggregate nominal exchange rates, and are available in both daily and monthly formats. To align with the annual industry-level investment data, we compute annual IERERs by averaging the monthly rates for each industry, country, and year.

Below is a concise overview of the approach used to calculate the IERERs, which is based on an industry-specific bilateral real exchange rate following the methodology outlined by Sato et al. (2015):

$$BRER_{i,t}^{(f)} = \frac{(1/NER_{f,t}) \times P_{i,t}^{(h)}}{P_{i,t}^{(f)}} \tag{21}$$

where $NER_{f,t}$ represents the nominal exchange rate, which is the price of a foreign currency in terms of the home country's currency. Industry prices in the home and foreign countries are denoted as $P_{i,t}^{(h)}$ and $P_{i,t}^{(f)}$, respectively, where h stands for the home country, and f stands for the foreign country, and i denotes the industry. According to Equation (21), the ratio reflects the industry-specific price level in the home country (in terms of the foreign currency) relative to the industry-specific price level in the foreign country (also in terms of the foreign currency). Both the price level and the nominal exchange rate are crucial factors in determining the bilateral real exchange rate.

As discussed in Neumann and Tabrizy (2021), if home country prices increase while the nominal exchange rate and foreign price index remain constant, it implies a loss of price competitiveness and results in an appreciation of the bilateral real exchange rate. Conversely, a decrease in home country prices would imply a gain in price competitiveness and lead to a depreciation of the bilateral real exchange rate. Similarly, if foreign prices rise while domestic prices and the nominal exchange rate remain unchanged, the home country gains price competitiveness, resulting in a depreciation of the bilateral real exchange rate. On the other hand, a decline in foreign prices under the same conditions would reduce the home country's price competitiveness and cause an appreciation of the bilateral real exchange rate. Additionally, maintaining constant home and foreign prices, a decrease in the nominal exchange rate (i.e., an appreciation of the home country's currency) would result in an appreciation of the bilateral real exchange rate, while an increase in the nominal exchange rate (i.e., a depreciation of the home country's currency) would lead to a depreciation of the bilateral real exchange rate. Thus, both an increase in industry-specific price competitiveness at home and a depreciation of the nominal exchange rate could cause a depreciation in the industry-specific bilateral real exchange rate.

However, since countries engage with multiple trading partners, there are multiple bilateral real exchange rates for a given industry and time. Additionally, due to the potential variation in export volumes to different trade partners within a particular industry, it is crucial to incorporate the export share to each destination in order to develop an effective real exchange rate measure. Consequently, Sato et al. (2015) utilize export shares by destination to construct a measure of the industry-specific effective real exchange rate (IERER) for industry i at time t:

$$IERER_{i,t} = \prod_{f=1}^{n} (BRER_{i,t}^{(f)})^{\alpha_{i,t}^{(f)}} \tag{22}$$

where $BRER_{i,t}^{(f)}$ is the industry-specific bilateral real exchange rate, n is the number of trading partners for industry i in the home country, and $\alpha_{i,t}^{(f)}$ is the share of industry i's exports to each foreign country , varying between 0 and 1. An increase in $IERER_{i,t}$ indicates an appreciation, resulting in lower price competitiveness for a particular industry in the home country. Conversely, a decline in this measure suggests a depreciation, leading to higher price competitiveness.

Figure 5 illustrates the time series of the IERER measure for all country-industry pairs in our dataset. To enable a clear comparison of different time series, we normalize the variations by setting all IERERs to 100 in the year 2007 and convert them into natural logarithms. The graph highlights the considerable differences in IERER levels across industries within a given country. Unlike an aggregate measure of the real exchange rate, this measure takes into account not only the country-specific exchange rates ($NER_{f,t}$) but also the industry-specific prices ($P_{i,t}^{(h)}$ and $P_{i,t}^{(f)}$), and export shares ($\alpha_{i,t}^{(f)}$) individually.

In our analysis, we account for variations in real output, real interest rates, export intensity, and import competition. Additionally, we include dummy variables to control for time, country, and industry effects. To address the time-invariant characteristics of our cross-sectional units (the country-industry pairs), we incorporate a fixed effect.To control for output variations, we incorporate the annual industry-specific output measure based on the ISIC Rev.4 classification, sourced from the OECD's Structural Analysis dataset (OECD, 2021b). These values are reported in local currency, which we convert to US dollars using the average annual nominal exchange rate, and then adjust to real values before using them in our regressions.

We use the real interest rate as an explanatory variable in our regression models to investigate its impact on industry-level investment. To compute the real interest rates, we follow Blanchard et al. (2010, pp. 291-293) and use the formula:

$$r_t = \frac{(1 + i_t) \times P_t}{P_{t+1}} - 1 \tag{23}$$

where i_t is the nominal interest rate and P_t is the producer price index, sourced from the IMF's International Financial Statistics (IMF, 2021). This equation accounts for changes in the price level between two time periods (t and t + 1) to provide a more accurate estimate of the true return on an investment.

Additionally, we obtain the annual industry-specific exports and imports data from the World Bank's World Integrated Trade Solution dataset (World Bank, 2021), which reports values in US dollars. We determine export intensity by calculating the export-to-output ratio ($ExpInt_{i,t}$) and measure import competition using the import-to-total consumption ratio ($ImpComp_{i,t}$):

$$ExpInt_{i,t} = \frac{Exp_{i,t}}{Y_{i,t}} \tag{24}$$

$$ImpComp_{i,t} = \frac{Imp_{i,t}}{Y_{i,t} + Imp_{i,t}} \tag{25}$$

where $Exp_{i,t}$, $Imp_{i,t}$, and $Y_{i,t}$ represent industry-level exports, imports, and output, respectively.

We focus on industry-specific exchange rate movements and investment across a broad range of industries. Although annual variations in GFCF are observable for all 12 industries, the IERER measures are not available for certain industry categories. For instance, while OECD (2021b) reports the annual GFCF for food products, beverages, and tobacco industries separately, RIETI (2021) provides the IERER measure only for the combined group of food, beverages, and tobacco industries. Similarly, IERER data is available only for the combined paper, paper products, and printing and publishing industries, despite the availability of separate GFCF data for each of these industries.Therefore, we use the IERER data as our primary dataset and match the available GFCF figures accordingly. Table A13 provides more details about our matching process.

In our estimations, we use the logarithmic changes of total investments, tangible investments, IERER, output, and the real interest rate. Additionally, we utilize the export-to-production and import-to-consumption ratios without applying logarithmic transformations. Table 44 presents the summary statistics for these variables, and Figure A4 displays their density plots.

2.3.2 Estimation Approach

This study aims to explore the impact of exchange rate fluctuations on industry-level investment by focusing on the industry-specific real effective exchange rate (IERER), a more precise measure than the country-level exchange rate. We use the system generalized method of moment method (System GMM), as proposed by Arellano and Bover (1995) and Blundell and Bond (1998), to estimate the effects of IERER and other variables on industry-level investment. Our analysis utilizes a panel dataset that includes country-industry pairs as cross-sectional units, along with observations over annual time variations. The baseline regression model used in our analysis is as follows:

$$\begin{aligned}\Delta Log(Inv_{ci,t}) = \gamma Log(Inv_{ci,t-1}) + \alpha Log(IERER_{ci,t-1}) + X'_{ci,t-1}\beta_1 \\ + \Delta X'_{ci,t}\beta_2 + \beta_3 t + T'\beta_4 + C'\beta_5 + I'\beta_6 + \eta_{ci} + \epsilon_{ci,t}\end{aligned} \tag{26}$$

where $Inv_{ci,t}$ refers to either the total real investments (including both tangible and intangible assets) or exclusively the real tangible investments for each country-industry pair. $IERER_{ci,t-1}$ denotes the lagged industry-specific real effective exchange rate. The control vector $X_{ci,t-1}$ includes lagged industry output and the country-specific real interest rate. $\Delta X_{ci,t-1}$ captures the contemporaneous changes in output and interest rate. Additionally, we incorporate a time trend (t) to account for time-related changes in investment and include dummy variables for time periods (T), countries (C), and industries (I). Furthermore, we use fixed effects η_{ci} to capture the time-invariant characteristics of each country-industry pair, while $\epsilon_{ci,t}$ accounts for the residual error term. The key parameter of interest in our analysis is α. A positive and statistically significant α would indicate that a lagged decline in the IERER, representing exchange rate depreciation, corresponds to a reduction in contemporaneous investment levels. Conversely, a negative and significant α would suggest that such a depreciation leads to an increase in investment.

As outlined in Equation (26), we use the lagged level of IERER measures to ensure the exogeneity of our key independent variable. This approach accounts for the possibility that industries may not immediately respond to changes in relative national prices, often due to factors like adjustment costs or delays in expectation formation and decision-making. We build on this temporal framework by also controlling for the lagged levels and first-differences of industry-level output and the country-specific real interest rate. The lagged level coefficients capture the long-term effects, while the first-difference coefficients reflect the short-term impacts on investment behavior.

In our model, the dependent variable is expressed in first differences, leading it to behave similarly to a standard dynamic panel regression in levels. As demonstrated by Demir and Tabrizy (2022), models employing the first-difference of the dependent variable exhibit characteristics similar to those using level variations. Roodman (2009) further discusses the parallels between these models. This approach,however, can lead to dynamic panel bias. To address this issue, we utilize System GMM estimation, which enables the accurate identification of both the autoregressive parameter and other associated variables. The validity of the dynamic GMM estimation is assessed through two essential specification tests. First, we use the Hansen statistic,introduced by Hansen (1982), to evaluate the validity of the instruments. The null hypothesis of this test implies the joint validity of the instruments; therefore, failure to reject the null suggests that the instruments are exogenous, confirming the consistency of the GMM estimator. This test is particularly useful when a limited number of instruments are employed Roodman (2009).Additionally, the Arellano-Bond test, developed by Arellano and Bond (1991), is applied to detect serial correlation in the error terms. The AR(1) test checks for first-order autocorrelation in the differenced residuals, while the AR(2) test examines second-order autocorrelation. Although the AR(1) test often rejects the null hypothesis of no first-order autocorrelation—which is expected and does not compromise the model—the AR(2) test is more crucial. Failure to reject the null hypothesis of no second-order autocorrelation strengthens the validity of our instrumentation strategy, particularly the use of lagged regressors as instruments.

Building on the same estimation method,we modify Equation (26) to examine whether export intensity and/or import competition play a role in shaping the relationship between IERER and investments:

$$\begin{aligned}\Delta Log(Inv_{ci,t}) = \gamma Log(Inv_{ci,t-1}) + \alpha_1 Log(IERER_{ci,t-1}) + \alpha_2^x Log(IERER_{ci,t-1}) \times ExpInt_{ci,t-1} \\ + \alpha_3^x ExpInt_{ci,t-1} + X'_{ci,t-1}\beta_1 + \Delta X'_{ci,t}\beta_2 + \beta_3 t + T'\beta_4 + C'\beta_5 + I'\beta_6 + \eta_{ci} + \epsilon_{ci,t}\end{aligned} \tag{27}$$

$$\Delta Log(Inv_{ci,t}) = \gamma Log(Inv_{ci,t-1}) + \alpha_1 Log(IERER_{ci,t-1}) + \alpha_2^m Log(IERER_{ci,t-1}) \times ImpComp_{ci,t-1} + \alpha_3^m ImpComp_{ci,t-1} + X'_{ci,t-1}\beta_1 + \Delta X'_{ci,t}\beta_2 + \beta_3 t + T'\beta_4 + C'\beta_5 + I'\beta_6 + \eta_{ci} + \epsilon_{ci,t} \quad (28)$$

where $ExpInt_{ci,t-1}$ is the export-to-production and $ImpComp_{ci,t-1}$ is the import-to-consumption ratios as defined by Equation (24) and Equation (25), respectively. The remaining variables are consistent with those outlined in Equation (26).

In Equation (27) and Equation (28), we focus on parameter α_1 and interactions parameters: α_2^x and α_2^m. Consider Equation (27), for instance; if both α_1 and α_2^x are statistically significant but have opposite signs, this suggests that export intensity moderates the influence of IERER fluctuations on investments. On the contrary, if these coefficients are significant and share the same sign, it implies that export intensity amplifies the effect of IERER swings on investments. In either scenario, we investigate how varying levels of the export-to-output ratio impact the long-term relationship between IERER and investments by leveraging the continuous variation in our export intensity measure. However, if α_2^x turns out to be statistically insignificant, it indicates that export intensity does not influence the long-term relationship between exchange rates and investments. A similar logic applies when analyzing α_1 and α_2^m in Equation (28).

2.4 Results

Table 45 presents the results of our estimations for total industry-level investments, which include both tangible and intangible assets. Column *I* specifically shows the estimation based on Equation (26) without accounting for any interaction terms, where the coefficient for lagged changes in IERER is positive but not statistically significant. A key contribution of this paper is examining how variations in export intensity influence the relationship between IERER and industry-level investment. Columns *II* and *III* report the results of this analysis, where we introduce controls for export intensity and its interaction with the lagged IERER. In these columns, the lagged IERER coefficient remains positive and becomes statistically significant. This finding suggests that, holding all other variables constant, a decline in lagged IERER, which reflects a real depreciation, negatively impacts industry-level investment. Furthermore, the negative and statistically significant coefficient of the interaction term indicates that the export-to-production ratio plays a crucial role in shaping the long-term effects of IERER changes on total industry-level investments. For example, in column *III*, the estimated coefficients for $Log(IERER_{ci,t-1})$ and its interaction with export intensity, $Log(IERER_{ci,t-1}) \times ExpInt_{ci,t-1}$, are 1.431 (SE=0.518) and -1.918 (SE=0.819), respectively, further illustrating the significant impact of these factors. To further explore the relationship between IERER and industry-level investment, we analyze how this relationship varies across different levels of export intensity, as illustrated in Figure 6 using the coefficients from column III of Table 45.[18] At lower levels of export intensity, the long-run marginal effect of IERER on total investments is statistically greater than zero. In contrast, as export intensity increases, this effect diminishes and becomes statistically indistinguishable from zero. For example, when all other variables are held at their mean values, the marginal effect of IERER on total investments is calculated to be 0.915 (SE=0.410) when $ExpInt_{ci,t-1}$ is set to the first quartile of the export intensity distribution ($ExpInt_{ci,t-1}$=0.269). In contrast, this effect is estimated to be 0.091 (SE=0.457) and becomes statistically indistinguishable from zero when $ExpInt_{ci,t-1}$ is adjusted to the third quartile ($ExpInt_{ci,t-1}$=0.699). This suggests that a decrease in lagged IERER, indicating a real depreciation, leads to a decline in total industry-level investments in industries that do not heavily rely on exports. However, for industries with high export intensity, the effect is not statistically significant.

Turning our attention to imports, columns *IV* and *V* show that the coefficient for lagged IERER variations is positive and statistically significant when interactions with import competition are included. The coefficient for the interaction term is negative, with marginal

[18] We plot the marginal effects in Figure 6 across a broad range of export intensity variations. As shown in Figure A4, the distribution of export intensity is skewed to the right, prompting adjustments in our analysis. Specifically, we focus on comparisons at the first and third quartile values and cap our visualization at an export intensity of 2. This approach allows us to emphasize the majority of the data points and minimize distortion from outliers. It is important to note that while our visualizations are limited to an export intensity of 2 for clarity, our estimations include the full distribution, including the skewed tail.

significance—slightly insignificant in column IV and marginally significant in column V. However, despite these results, Figure 7, based on the estimation results reported in column V of Table 45, shows that the confidence intervals for the marginal effects are quite broad, preventing us from concluding that the import-to-consumption ratio significantly influences the impact of IERER variations on total investments. When holding other variables at their mean values, the marginal effect of IERER on total investments is estimated to be 1.051 when import competition is at the first quartile level ($ImpComp_{ci,t-1}$=0.221). Conversely, when import competition is at the third quartile ($ImpComp_{ci,t-1}$=0.463), the effect is estimated to be -0.071. However, neither of these effects is statistically significant at the 5% level, suggesting that import competition does not modify the influence of lagged IERER depreciation on total industry-level investments.

As for control covariates, we find a significant negative relationship between lagged investment and contemporaneous change in total industry-level investments, suggesting that higher past investments lead to slower current investment growth, indicating an adjustment process. Furthermore, we observe that industry-level output, both in lagged form ($Log(Y_{ci,t-1})$) and contemporaneous changes ($\Delta Log(Y_{ci,t})$), is positively associated with total investments. However, variations in the country-specific interest rate, whether in lagged form ($Log(r_{c,t-1})$) or first-differences ($\Delta Log(r_{c,t})$), do not significantly affect total investments. We also find that lagged export intensity ($ExpInt_{ci,t-1}$) is positively linked to total investments, as shown in columns *II* and *III*, while lagged import competition ($ImpComp_{ci,t-1}$) exhibits a similar positive relationship, though it is statistically significant only in column *V*. Finally, contemporaneous changes in export intensity and import competition ($\Delta ExpInt_{ci,t}$ and $\Delta ImpComp_{ci,t}$, respectively) do not significantly influence total investments.

The results in Table 46 focus on industry-level investments in tangible assets. In the baseline model (column *I*), lagged IERER shows a statistically significant positive effect. This effect remains significant when interactions with export intensity are included, as seen in columns *II* and *III*. However, it becomes insignificant when interactions with import competition are introduced in columns IV and V. Regarding the interaction with export intensity, we find that the coefficient for $Log(IERER_{ci,t-1}) \times ExpInt_{ci,t-1}$ is negative, but it only becomes statistically significant once all control covariates are included in column *III*. As shown in Figure 8, which is based on the estimation results from column *III*, export intensity appears to modify the effect of IERER on tangible investments. For example, the marginal effect is estimated to be 1.193 (SE=0.439) when $ExpInt_{ci,t-1}$ is at the first quartile of the export intensity distribution, but it declines to 0.651 (SE=0.332) when $ExpInt_{ci,t-1}$ reaches the third quartile. In the case of import competition, the coefficient for $Log(IERER_{ci,t-1}) \times ImpComp_{ci,t-1}$ is negative but remains statistically insignificant, even after accounting for all control covariates.These results indicate that import competition does not have a significant effect on the relationship between IERER and tangible investments. Lastly, the estimated coefficients for the autoregressive term and control covariates are consistent with the earlier findings where total investments were used as the dependent variable.

In terms of model diagnostics, the AR(1) and AR(2) tests for both Table 3 and Table 4 reveal the presence of first-order autocorrelation but show no signs of second-order autocorrelation, suggesting that the dynamic models are correctly specified. Additionally, the Hansen test results across both tables support the validity of the instruments employed in the analysis.

2.5 Conclusion

This paper explores whether variations in export intensity and import competition play a role in moderating the relationship between the industry-specific real effective exchange rate and both total and tangible investments across a range of manufacturing industries in five European countries. Our findings indicate that the depreciation of the effective real exchange rate affects industry-level investment differently depending on the degree of export activity. Industries with relatively low export-to-production ratios experience a negative impact on investments due to real depreciation. In other words, these industries are more likely to cut back on investments when the effective real exchange rate depreciates. Conversely, industries heavily engaged in export activities exhibit a different pattern. For these export-intensive industries, the depreciation of the effective real exchange rate seems to have little to no effect on investment. They tend to maintain their investment levels despite increased price competitiveness, suggesting that these industries are more resilient to exchange rate fluctuations, likely due to the mitigating effects of their export earnings. Additionally, we find that changes in import competition, as measured by the import-to-consumption ratio, do not significantly influence investment behavior in response to exchange rate fluctuations. Unlike export intensity, import competition does not play a major role in shaping the effects of exchange rate movements on investment.

The results of this study hold considerable significance for economic policymakers for several reasons. Primarily, our research presents a quantitative analysis of how exchange rate swings can influence both total and tangible investment. Given that these investments are intrinsically tied to productivity and growth, they consequently play a crucial role in driving long-term structural changes within the economy. Furthermore, our empirical results highlight the importance of the partially counteracting mechanisms through which exchange rates function. Beyond its policy implications, this study also contributes to the broader academic discourse by deepening our understanding of the relationship between exchange rates and investment, offering valuable insights for future research.

Figure 5: Industry-specific Effective Real Exchange Rates (IERER)

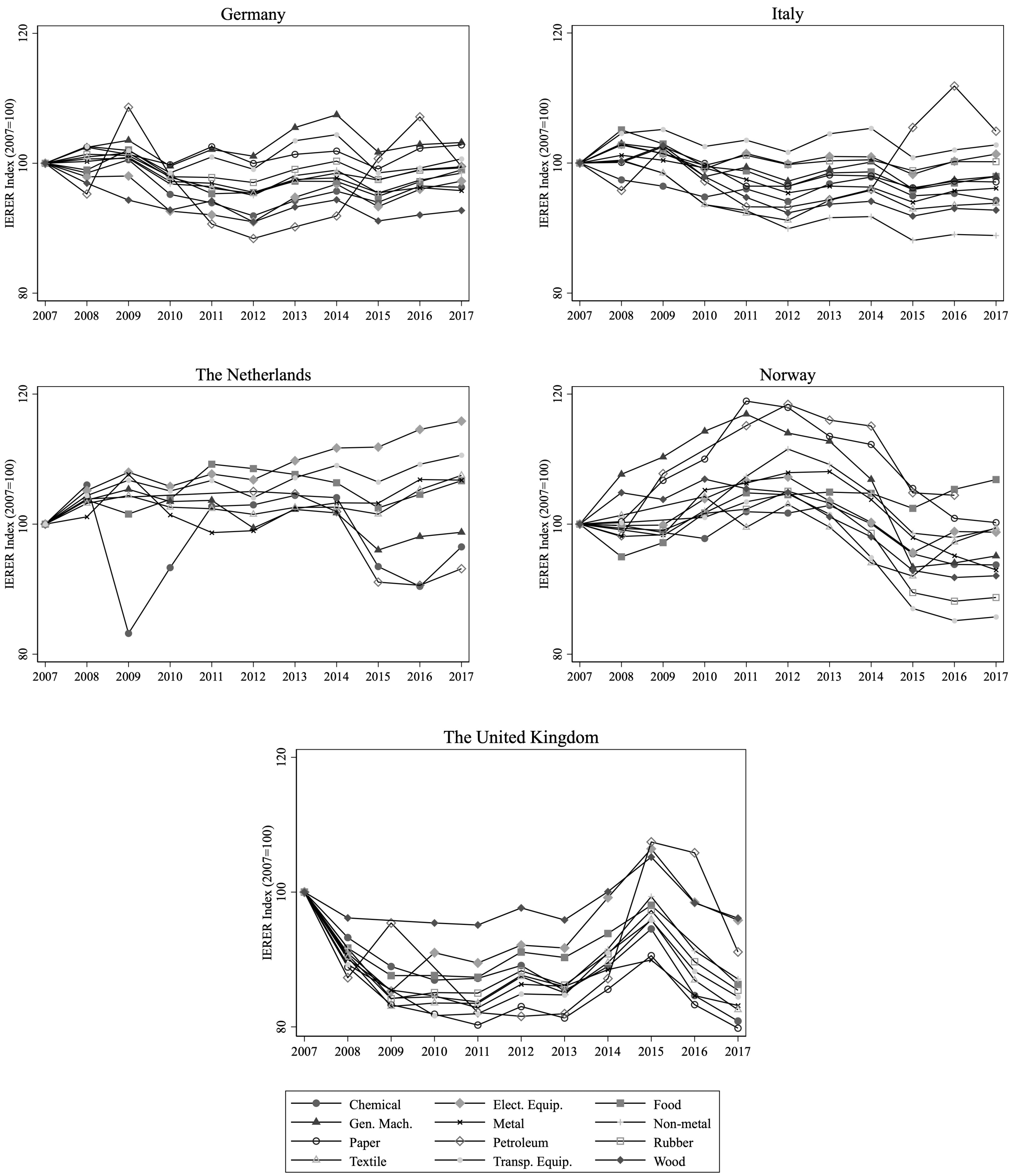
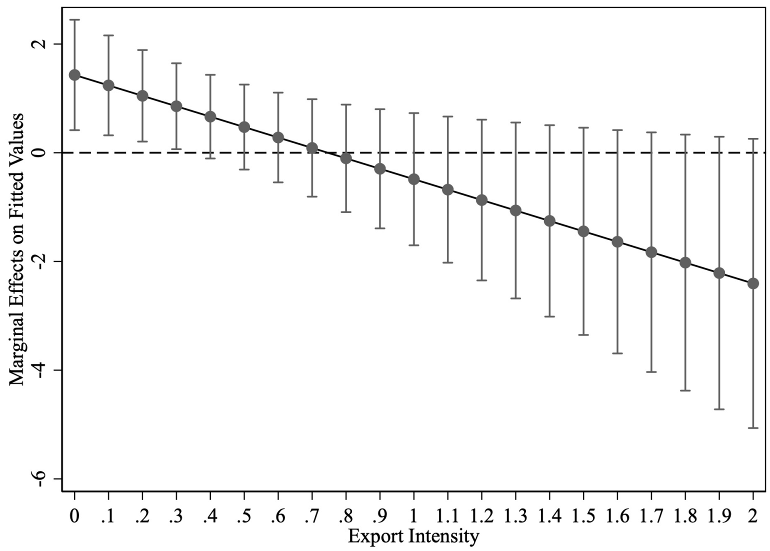
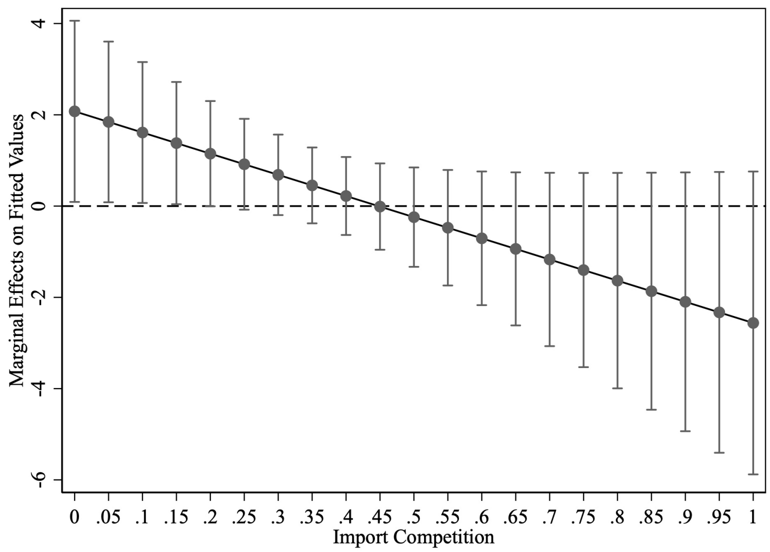


Figure 6: Marginal Effects of IERER on Total Investments at Varying Levels of Export Intensity



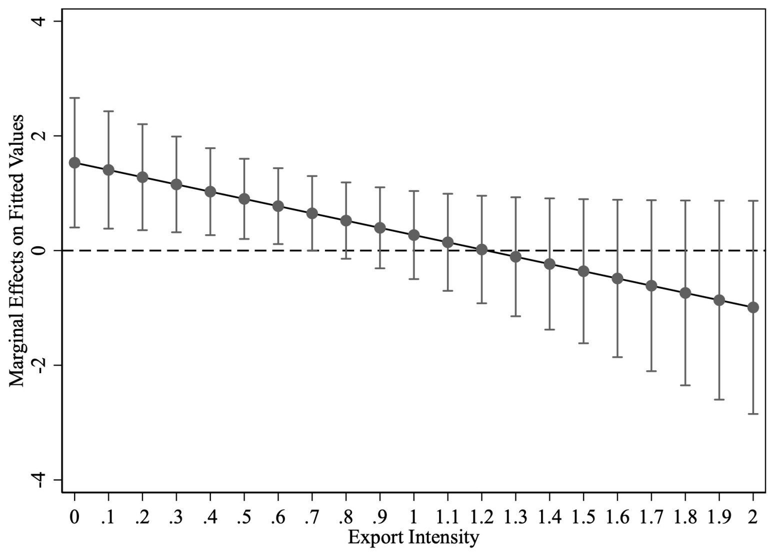
Note: The marginal effects in this figure are based on the estimation results reported in column *III* in Table 3. They are plotted over a large portion of variations in lagged export intensity using 95% confidence interval estimations.

Figure 7: Marginal Effects of IERER on Total Investments at Varying Levels of Import Competition



Note: The marginal effects in this figure are based on the estimation results reported in column *V* in Table 3. They are plotted over the range of variations in lagged import competition using 95% confidence interval estimations.

Figure 8: Marginal Effects of IERER on Tangible Investments at Varying Levels of Export Intensity



Note: The marginal effects in this figure are based on the estimation results reported in column *III* in Table 4. They are plotted over a large portion of variations in lagged export intensity using 95% confidence interval estimations.

Table 43: Industry Codes and Names

ISIC-4Code	Name	Description
10-12	Food	Food, Beverage, and Tobacco Products
13-15	Textile	Textile, Wearing Apparel, Leather, and Related Products
16	Wood	Wood and Products of Wood and Cork, Except Furniture
17-18	Paper	Paper, Paper Products, Printing, and Reproduction of Recorded Media
19	Petroleum	Coke and Refined Petroleum Products
20-21	Chemical	Chemical and Pharmaceutical Products
22	Rubber	Rubber and Plastic Products
23	Non-metal	Non-metallic Mineral Products
24-25	Metal	Basic Metals and Fabricated Metal Products, Except Machinery and Equipment
26-27	Electrical Machinery	Electrical, Electronic, and Optical Equipment
28	General Machinery	Machinery and Equipment N.E.C.
29-30	Transport Equipment	Transportation Equipment

Table 44: Summary Statistics

Variable	Mean	SD	Min	Max
Log(Inv): Total Inv.	21.29	1.53	16.88	24.66
Log(Inv): Tangible Inv.	21.06	1.53	16.34	23.81
Log(IERER)	4.59	0.09	4.32	4.81
Log(Y)	24.37	1.33	20.49	26.94
Log(r)	0.93	0.44	0.38	1.91
ExpInt	0.59	0.57	0.04	4.88
ImpComp	0.36	0.17	0.07	0.85

Table 45: Total Investments

	I	II	III	IV	V
	$\Delta Log(Inv_{ci,t})$	$\Delta Log(Inv_{ci,t})$	$\Delta Log(Inv_{ci,t})$	$\Delta Log(Inv_{ci,t})$	$\Delta Log(Inv_{ci,t})$
$Log(Inv_{ci,t-1})$	-0.652***	-0.706***	-0.648***	-0.643***	-0.650***
	(0.129)	(0.131)	(0.114)	(0.114)	(0.104)
$Log(IERER_{ci,t-1})$	0.480	1.542***	1.431***	1.711*	2.076**
	(0.414)	(0.590)	(0.518)	(1.033)	(1.013)
$Log(IERER_{ci,t-1}) \times ExpInt_{ci,t-1}$		-1.754**	-1.918**		
		(0.757)	(0.819)		
$ExpInt_{ci,t-1}$		8.097**	8.838**		0.0310
		(3.494)	(3.780)		(0.0900)
$Log(IERER_{ci,t-1}) \times ImpComp_{ci,t-1}$				-3.703	-4.637*
				(2.476)	(2.560)
$ImpComp_{ci,t-1}$			-0.922	16.50	20.53*
			(1.160)	(10.99)	(11.23)
$Log(Y_{ci,t-1})$	0.727***	0.852***	0.649***	0.701***	0.718***
	(0.188)	(0.193)	(0.128)	(0.152)	(0.138)
$Log(r_{c,t-1})$	-0.0537	-0.143	-0.0714	0.0156	0.0206
	(0.198)	(0.198)	(0.180)	(0.169)	(0.173)
$\Delta Log(Y_{ci,t})$	0.774***	0.812***	0.683***	0.727***	0.726***
	(0.159)	(0.146)	(0.154)	(0.161)	(0.153)
$\Delta Log(r_{c,t})$	0.174	0.0515	0.0847	0.211	0.205
	(0.167)	(0.167)	(0.163)	(0.150)	(0.151)
$\Delta ExpInt_{ci,t}$					-0.0426
					(0.106)
$\Delta ImpComp_{ci,t}$			-0.232		
			(0.771)		
Constant	Yes	Yes	Yes	Yes	Yes
Time Trend	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes	Yes
No. Obs.	536	536	536	536	536
No. Cross Sec.	56	56	56	56	56
No. Inst.	37	41	45	41	45
AB AR(1) P-val.	0	0	0	0	0
AB AR(2) P-val.	0.286	0.313	0.299	0.283	0.295
Hansen P-val.	0.569	0.599	0.432	0.686	0.835

Notes: Robust standard errors are reported in parentheses. AB AR(1) and AB AR(2) P-val. report the p-values for the test developed by Arellano and Bond (1991). Hansen P-val. reports the p-value for the test developed by Hansen (1982). *** P-val. <0.01, ** P-val.<0.05, * P-val.<0.1

Table 46: Tangible Investments

	I	II	III	IV	V
	$\Delta Log(Inv_{ci,t})$	$\Delta Log(Inv_{ci,t})$	$\Delta Log(Inv_{ci,t})$	$\Delta Log(Inv_{ci,t})$	$\Delta Log(Inv_{ci,t})$
$Log(Inv_{ci,t-1})$	-0.614***	-0.638***	-0.627***	-0.634***	-0.658***
	(0.143)	(0.154)	(0.150)	(0.141)	(0.137)
$Log(IERER_{ci,t-1})$	0.822**	1.321**	1.532***	1.635	1.754
	(0.360)	(0.601)	(0.576)	(1.035)	(1.098)
$Log(IERER_{ci,t-1}) \times ExpInt_{ci,t-1}$		-0.916	-1.262*		
		(0.778)	(0.680)		
$ExpInt_{ci,t-1}$		4.242	5.825*		0.0608
		(3.567)	(3.110)		(0.0981)
$Log(IERER_{ci,t-1}) \times ImpComp_{ci,t-1}$				-2.455	-2.322
				(2.827)	(2.900)
$ImpComp_{ci,t-1}$			-0.191	11.56	11.26
			(1.380)	(12.35)	(12.75)
$Log(Y_{ci,t-1})$	0.762***	0.754***	0.645***	0.745***	0.841***
	(0.208)	(0.201)	(0.225)	(0.233)	(0.215)
$Log(r_{c,t-1})$	-0.243	-0.268	-0.203	-0.138	-0.233
	(0.252)	(0.229)	(0.231)	(0.262)	(0.265)
$\Delta Log(Y_{ci,t})$	0.881***	0.860***	0.856***	0.811***	0.890***
	(0.231)	(0.199)	(0.197)	(0.227)	(0.215)
$\Delta Log(r_{c,t})$	0.108	0.0604	0.0639	0.158	0.0995
	(0.232)	(0.223)	(0.223)	(0.238)	(0.246)
$\Delta ExpInt_{ci,t}$					0.0489
					(0.114)
$\Delta ImpComp_{ci,t}$			1.188		
			(1.000)		
Constant	Yes	Yes	Yes	Yes	Yes
Time Trend	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes	Yes
No. Obs.	477	477	477	477	477
No. Cross Sec.	56	56	56	56	56
No. Inst.	37	41	45	41	45
AB AR(1) P-val.	0	0	0	0	0
AB AR(2) P-val.	0.614	0.501	0.500	0.572	0.557
Hansen P-val.	0.242	0.302	0.202	0.195	0.174

See the notes in Table 3.

Chapter 3

Bayesian Variable Selection for Regime Switching Models: the UIP Puzzle and Currency Carry Trade Dynamics

3.1 Introduction

A key puzzle in international macroeconomics is the consistent failure of the theory of uncovered interest rate parity (UIP). According to UIP, a currency with a higher interest rate should depreciate against one with a lower interest rate. Essentially, any interest rate differential between two countries should be entirely offset by either the expected depreciation of the high interest rate currency or the anticipated appreciation of the currency with the lower interest rate. However, empirical findings contradict this, indicating that currencies with high interest rates often appreciate, while those with low interest rates tend to depreciate. This is commonly referred to as a violation of UIP. Consequently, the carry trade has emerged as an investment strategy. In this approach, an investor borrows in a currency with a low interest rate, known as the funding currency, and invests in another currency with a higher interest rate, termed the target currency.[19] Those who engage in carry trades are essentially speculating on the violation of UIP, highlighting the existence of the forward premium anomaly (Backus et al. (2001); Brunnermeier et al. (2008); Burnside et al. (2011a); Christiansen et al. (2011); Fama (1984); Hansen and Hodrick (1980, 1983); Lustig et al. (2011); Lustig and Verdelhan (2007); Menkhoff et al. (2012)).[20]

While identifying the primary factors behind the UIP puzzle and the associated excess

[19] Comprehensive surveys of the literature can be found in Burnside (2012); Engel (1996, 2014); Hodrick (2014); Jordà and Taylor (2012); Sarno (2005), which offer a detailed exploration of determinants of the carry trade.

[20] The carry trade strategy has yielded considerable excess returns, with a Sharpe ratio that is more than double that of the US stock market Burnside et al. (2011b). Consequently, the substantial attention it has received in the financial literature is well justified.

returns from currency carry trade strategies remains a persistent challenge, the finance literature has documented several characteristics that appear to be relevant predictors. Among the critical factors are the sizable interest rate differential, as highlighted by Fama (1984); Lustig et al. (2011); Mulder and Tims (2018), and foreign exchange (FX) market volatility,[21] which has been noted by Baillie and Chang (2011); Cho et al. (2019); Christiansen et al. (2011); Ichiue and Koyama (2011). In addition to these, momentum, as explored by Burnside et al. (2011a); Menkhoff et al. (2012), plays a significant role. Furthermore, funding liquidity, discussed by Brunnermeier et al. (2008); Brunnermeier and Pedersen (2009), and the influence of commodity indices, as documented by Bakshi and Panayotov (2013), are also crucial in shaping these dynamics. Finally, macroeconomic indicators such as unemployment and inflation rates have been analyzed for their influence on UIP violations by Colacito et al. (2020); Dahlquist and Hasseltoft (2020). To accurately model these potentially important variables, we implement a variable selection approach aimed at isolating the most significant predictors contributing to UIP violations. Our goal is to refine the precision of economic models and deepen our understanding of the dynamics involved in UIP violations.

In this paper, we analyze the dollar carry trade using the framework proposed by Lustig et al. (2014), which conditions the dollar factor on the global interest rate differential. According to this strategy, investors tend to hold long positions in a basket of foreign currencies and short positions in the U.S. dollar when the average foreign interest rate exceeds the U.S. rate, with these positions reversed when the situation is the opposite. We employ a regime switching model to determine whether the currency market is in a state where UIP fails and carry trades yield profits. Our objective is to identify macroeconomic variables that explain these regime transitions. By applying a horseshoe prior for variable selection to

[21] Financial theory indicates that investors focus on the factors that dictate the trajectory of investment opportunities and aim to protect their investments against unexpected shifts in market volatility. This behavior leads risk-averse individuals to prefer currencies that act as hedges against risk. Additionally, assets that perform poorly during times of increased market turbulence contribute to a portfolio's negative skewness. If investors have a preference for skewness, it follows that assets sensitive to volatility spikes would, in equilibrium, necessitate a premium return to compensate for their higher perceived risk Menkhoff et al. (2012).

the macroeconomic determinants and channeling them through the transition probabilities in a Markovian process, we seek to isolate the macroeconomic variables that significantly influence UIP violations.

As highlighted in Ichiue and Koyama (2011) and Cho et al. (2019), the application of regime switching models to analyze exchange rates is not a novel approach. The Markov regime switching methodology, in which regime shifts depend on an unobserved Markov process, was introduced by Goldfeld and Quandt (1973). Hamilton (1989) later extended this framework by incorporating an autoregressive process and an iterative algorithm similar to the Kalman filter. Following Hamilton's seminal work, Markov regime switching models have been extensively applied in economics and finance.[22]

However, a common criticism of Hamilton's Markov regime-switching model is its assumption of constant state transition probabilities. Research by Diebold et al. (1993); Filardo (1994); Peria (2002) and more recently Bazzi et al. (2017) indicates that the constant transition probability matrix in the Markov switching model might be too restrictive. To address this, they have expanded upon the fixed transition probability Markov switching model to incorporate time-varying transition probabilities, taking into account observable covariates. This includes both strictly exogenous variables and the lagged values of the dependent variable. Although this approach can be practical, it comes with some drawbacks. The choice of information variables or functional specification to describe transition probability dynamics is non-trivial, especially in a data-rich context (Filardo et al. (1998); Kaufmann (2015); Kim et al. (2008)). Determining the right variables for the regime switching framework is challenging. A regime switching model with few variables in its switching probability may miss out vital information, as indicated by Bernanke et al. (2005). Incorrect variable selection can bias estimates or weaken the model's efficacy. To address this challenge, based on Wand et al. (2011) and Makalic and Schmidt (2015), we suggest a Gibbs sampling algorithm incorporating a horseshoe prior. This approach, a variable selection method using shrinkage

[22] See Hamilton and Raj (2002) and Piger (2009) for a survey of the literature.

priors, has been notably recognized in high-dimensional models for effectively isolating key predictors.

This paper contributes to the literature in two significant ways. Firstly, given the challenges in identifying the most influential variables for switching behavior in a Markov switching setting, we introduce a novel econometric approach. By employing a horseshoe prior (a type of shrinkage prior) in the estimation of the time-varying transition probability, our method effectively selects the key predictors for regime changes. This model serves as a valuable reference in scenarios where multiple variables impact the transition probabilities in a regime switching model. Secondly, we apply our methodology to address the uncovered interest rate parity puzzle and its implications on carry trade returns. Through our analysis, we identify three principal predictors for the UIP violation: the TED spread, Term spread and consumption growth of the U.S. economy. Understanding these predictors provides a deeper insight into the mechanics underlying carry trade returns, thereby enriching our comprehension of financial dynamics.

The remainder of the paper is organized as follows. Section 3.2 revisits the concept of uncovered interest rate parity. Section 3.3 offers a review of the literature pertaining to the empirical findings of UIP. In Section 3.4 and Section 3.5, we engage in a concise discussion about model specification and estimation techniques. Section 3.6 details the model framework and the data utilized in our analysis. Section 3.7 presents the results derived from applying a Markov switching regression model to UIP. The final Section summarizes the main findings and provides concluding insights.

3.2 The Uncovered Interest Parity and Carry Trade

This section investigates the concept of uncovered interest rate parity (UIP) and the conditions under which it may be violated, providing a foundation for understanding the potential profitability of exploiting interest rate differentials. Many previous studies empirically demonstrate that substantial profitability exists in a carry trade strategy. The return of the carry trade[23] that takes a long position on a foreign risk-free asset and at the same time takes a short position on a domestic risk-free asset is given by:

$$r_{t+1} = (i_t - i_t^*) - \Delta s_{t+1} \tag{29}$$

where r_{t+1} is the excess return, i_t^* is the one-period foreign risk-free interest rate, i_t is the one-period domestic risk-free interest rate, s_t is the logarithm of the spot exchange rate at time t, and $\Delta s_{t+1} = s_{t+1} - s_t$. The spot exchange rate represents the price of foreign currency in terms of the home currency, which in this case is the U.S. dollar, or the amount of U.S. dollars required to purchase one unit of foreign currency. An increase in s_t indicates an appreciation of the foreign currency and a depreciation of the U.S. dollar.

The return equation indicates that carry trade profitability increases when a currency with a higher interest rate appreciates, or conversely, when a currency with a lower interest rate depreciates, between time t and $t+1$. UIP indicates that the change in s_t should be equal to the interest rate differential:[24]

$$\Delta s_{t+1} = (i_t - i_t^*) \approx (f_t - s_t) \tag{30}$$

where f_t is the logarithm of the one-period forward exchange rate and $(f_t - s_t)$ is the forward premium. The relation between $(i_t - i_t^*)$ and $(f_t - s_t)$ in Equation 30 is based on the covered interest rate parity (CIP), which is shown to be empirically valid at short and long time horizons by Akram et al. (2008).

To test whether UIP holds in the long-run, Fama (1984) employs the linear regression model given below:

$$\Delta s_{t+1} = \beta_0 + \beta_1(f_t - s_t) + \varepsilon_{t+1} \tag{31}$$

[23]The return equation also holds ex-ante as $E[r_{t+1}|I_t] = (i_t - i_t^*) - E[\Delta s_{t+1}|I_t]$ where $E[.|I_t]$ is the conditional expectation given the information set I_t available upto time t.

[24]If $E[r_{t+1}|I_t] > 0$, financial arbitrageurs would create relatively strong demand for the foreign asset and currency at time t. This high demand induces the appreciation of the foreign currency, which reduces s_t and increases $E[\Delta s_{t+1}|I_t] = E[s_{t+1}|I_t] - s_t$ accordingly.

and performs statistical inference under the null hypothesis that $\beta_0 = 0$ and $\beta_1 = 1$. Under the uncovered interest parity hypothesis, if the return on a domestic n-period zero-coupon bond exceeds that of a foreign bond by one percentage point per annum, one would expect the foreign currency to appreciate by one percent over the following n periods. However, in practice, this hypothesis is frequently violated (Fama (1984); Hansen and Hodrick (1980); Lustig and Verdelhan (2007)). Most notably, the estimate of β_1 is often found to be negative, indicating the existence of the forward premium anomaly, where high interest rate currencies tend to further appreciate at time $t+1$ rather than depreciate when $(i_t - i_t^*) \approx (f_t - s_t)$ is very high, making the carry trade a profitable investment strategy in international finance.

3.3 Literature Review

The unresolved puzzle of uncovered interest rate parity and its connection to the significant returns of currency carry trade strategies remain a persistent challenge in financial econometrics. When Uncovered Interest Rate Parity (UIP) is maintained and the foreign exchange market is in equilibrium, under the assumption of risk-neutrality and rational expectations, the expected returns on domestic assets should be consistent with returns on foreign assets, after accounting for currency exchange fluctuations. In theory, this should eliminate any chance for arbitrage. However, in practice, such profitable opportunities are frequently detected and leveraged in large-scale trading strategies.

In international economics literature, numerous explanations have been proposed to clarify the empirical failure of UIP. However, a consensus on this puzzle remains elusive, with ongoing research efforts aimed at resolving it. One perspective indicates that market participants tend to be risk-averse rather than risk-neutral, and the violation of UIP might stem from a non-zero and time-varying risk premium. This suggests that positive carry trade returns are perceived as compensation for the risks undertaken.Accordingly, a particular focus has been dedicated to identifying the risk factors associated with carry trade returns, as demonstrated in the investigations conducted by (Bansal and Shaliastovich (2013); Burnside (2012); Burnside et al. (2011a,b); Engel (1984); Fama (1984); Hansen and Hodrick (1980); Lustig et al. (2011); Lustig and Verdelhan (2007, 2012); Menkhoff et al. (2012); Mueller et al. (2017)). In their analysis of currency returns, Lustig et al. (2011) employed a common factor model, identifying two primary factors that account for the fluctuations observed in global exchange rates. The first factor, known as the "dollar risk factor"captures the average change in value of a basket of foreign currencies relative to the dollar. The second factor, the "high-minus-low risk factor"delineates the market-driven appreciation or depreciation of currencies based on their interest rate difference with a benchmark currency, notably the USD. Their analysis highlights that currencies with higher interest rates generally align more with this $\mathrm{HML}_{\mathrm{FX}}$ factor compared to their low-interest counterparts. Furthermore, this $\mathrm{HML}_{\mathrm{FX}}$ factor provides a robust explanation for the periodic variations in average excess returns between high and low-interest rate currencies. Building on the foundational work of Lustig et al. (2011), Menkhoff et al. (2012) pursued a related approach founded on factors asset pricing model. However, in their work, the $\mathrm{HML}_{\mathrm{FX}}$ factor is substituted with innovations in global foreign exchange volatility. Menkhoff et al. (2012) investigate the relationship between global FX volatility risk and the returns derived from carry trades. Their findings indicate that currencies with high interest rates exhibit an inverse correlation with innovations in global FX volatility, resulting in diminished returns during unexpected volatility spikes. The research further demonstrates that the spread of foreign exchange excess returns is predominantly governed by global foreign exchange volatility. Christiansen et al. (2011) further demonstrated that the level of foreign exchange volatility significantly impacts the risk exposure of carry trade returns to stock and bond markets. This research highlighted a heightened susceptibility to stock market fluctuations during periods of high FX volatility, as shown through the application of a regime-dependent pricing model. Ichiue and Koyama (2011) employs a regime-switching model to investigate the link between exchange rate volatilities and uncovered interest rate parity (UIP) failure. It reveals that exchange rate returns are notably affected by regime shifts. During periods of low volatility, there is a tendency for low-interest-rate currencies to depreciate, mainly due to decreased margins facilitating increased carry trade positions. In essence, stability hinges on the coexistence of a low-volatility setting and the depreciation of low-interest-rate currencies.

Another hypothesis that seeks to explain the failure of uncovered interest rate parity (UIP) points to the significant involvement of carry trade investors in the foreign exchange market, coupled with the associated crash risk (Ames et al. (2017); Baillie and Chang (2011); Brunnermeier et al. (2008); Brunnermeier and Pedersen (2009); Chernov et al. (2018); Cho et al. (2019); Farhi et al. (2009); Jurek (2014)). Brunnermeier et al. (2008) show that carry trade returns tend to be negatively skewed, and are prone to crash risks[25], particularly during periods of reduced market liquidity and increased volatility[26]. This is evidenced through the abrupt unwinding of speculative positions, a finding that is further corroborated by Ames et al. (2017), who explore the influence of highly leveraged speculator behavior on the structure of currency returns. The study concludes that speculative volumes in carry trades play a significant role in determining the movements of high and low interest rate currency returns in both high and low-risk scenarios. In their study, Ichiue and Koyama (2011) discuss how the depreciation of low-interest-rate currencies usually maintains low volatility levels until the unwinding of carry trades takes place. This unwinding process, when combined with speculators' limited ability to invest and ensure market liquidity, significantly increases the volatility of exchange rate returns. Supporting this notion, Brunnermeier and Pedersen (2009) point out that liquidity is important for understanding the risk premiums in foreign exchange. .In a related finding, Menkhoff et al. (2012) also acknowledge the importance of liquidity, albeit noting that global FX volatility has a more dominant effect on exchange rate variations, thereby illustrating that liquidity plays a critical, yet comparatively secondary

[25] The observation aligns with a prevalent saying among currency traders, "exchange rates go up by stairs and down by the elevator", the concept conveys that carry traders accrue minor gains while navigating upward trends, only to face substantial losses when currencies with high interest rates experience abrupt depreciation. Building on this, Ichiue and Koyama (2011) point out that such pronounced appreciations in low-interest rate currencies may arise when speculators are forced to quickly unwind their carry trade positions to meet margin requirements.

[26] Brunnermeier et al. (2008) demonstrates that, with an increase in the VIX—a measure for stock market volatility—currencies with lower interest rates are prone to experiencing notable appreciation. Essentially, a spike in market volatility is frequently associated with a rapid reversion to Uncovered Interest Parity (UIP).

role in the cross-sectional variance of foreign exchange excess returns. Baillie and Chang (2011) [27] posits that the forward premium anomaly could stem from an increase in carry trade activity. This leads to increased demand and subsequent appreciation of high-yielding currencies compared to low-yielding ones, a phenomenon that contradicts the UIP theory but benefits carry trade speculators. Nevertheless, this trend is observed to reverse in the foreign exchange market during a financial crisis. The unwinding of carry trade results in the appreciation of low-yielding currencies and the depreciation of high-yielding ones, aligning with UIP. In a study conducted by Cho et al. (2019), similar results were obtained, revealing findings that align with the theory that carry trade activity can, to some extent, elucidate the forward premium anomaly. The study associates an increase in speculator involvement in carry trade with the failure of Uncovered Interest Parity (UIP). The research employed a regime-switching model to investigate the profitability of carry trade, where the regime shifts were determined endogenously. During periods of turbulence, tighter funding and liquidity constraints compel investors to unwind carry trade positions, leading to depreciations of the target currencies and increasing their volatility. Conversely, in more stable periods, investors are inclined to engage in carry trades, which are subsequently associated with the appreciation of target currencies. The findings indicated that while carry trades are profitable in a regime characterized by low exchange rate volatility—signifying a failure of UIP—they yield losses in a high-volatility regime, pointing to a reversion to UIP.

The literature also explores the relationship between currency returns and macroeconomic fundamentals, emphasizing a growing link between carry trade returns and various broader economic indicators and risk factors, including aggregate consumption, unemployment, output gaps, and macroeconomic uncertainty (Berg and Mark (2018); Colacito et al. (2020); Dahlquist and Hasseltoft (2020); Della Corte and Krecetovs (2019); Della Corte et al. (2022); Engel and West (2005); Hoffmann and Studer-Suter (2017); Lustig and Verdelhan (2007);

[27] The analysis is based on limits to speculation of Lyons et al. (2001), wherein the presence of unusually high profit opportunities from conducting carry trades draws in speculative capital and encourages agents to trade away these opportunities. Conversely, when the prospects of carry trade profits are diminished or turn negative, the forward bias persists, as it remains unexploited.

Nucera (2017); Sarno and Schmeling (2014); Zviadadze (2017)). Dahlquist and Hasseltoft (2020) introduce a currency investment strategy centered on economic momentum, using indicators such as interest rates, consumer and producer prices, retail sales, industrial production, and unemployment data. This approach, which involves taking long positions in currencies from countries with stronger economic growth and short positions in those with weaker growth based on historical trends of up to sixty months, not only yields substantial risk-adjusted returns but also outperforms typical carry trade strategies. Similarly, Colacito et al. (2020) focus specifically on output gaps as a singular measure of business cycles, finding them crucial in shaping expected currency returns. Currencies from economies with higher output gaps tend to provide greater returns, and a strategy that ranks currencies based on these gaps leads to significant risk-adjusted returns. Moreover, the study underscores the impact of a business cycle risk factor on currency excess returns across various investment strategies, thereby contributing to a deeper understanding of currency risk premia.

We contribute to the growing body of research focused on identifying risk factors associated with the violation of Uncovered Interest Parity (UIP) and the profitability of carry trade strategies. While there is no consensus in the existing literature regarding these risk factors, a variety of them have been explored in numerous studies analyzing carry trade profitability. Our primary goal is to shed light on which of these suggested factors are critically important. To achieve this, we utilize a variable selection model within a time-varying Markov switching framework, which helps in more clearly elucidating these relationships.

3.4 Model Specification

This section proposes a general modeling framework applicable to selecting meaningful predictors for a regime switching process. To this end, we consider the regime switching regression model with time-varying transition probabilities:[28]

$$y_t = \mathbf{x}_t'\beta_{s_t} + \varepsilon_t, \quad \varepsilon_t \sim \mathrm{N}(0, \sigma_{s_t}^2), \tag{32}$$

where $\mathbf{x}_t = \{x_{0,t} = 1, x_{1,t}, ..., x_{K,t}\}$; $s_t = 0$ if $s_t^* \leq 0$ and $s_t = 1$ otherwise; and

$$s_t^* = \theta_0 + \theta_1 s_{t-1} + \alpha_1 z_{1,t-1} + \alpha_2 z_{2,t-1} + ... + \alpha_L z_{L,t-1} + u_t, \quad u_t \sim \mathrm{N}(0, 1). \tag{33}$$

We use $\beta = \{\beta_0, \beta_1\}$ and $\sigma^2 = \{\sigma_0^2, \sigma_1^2\}$ to denote the regime dependent model parameters. Our proposed method to select meaningful predictors can be easily extended to other model classes such as linear/non-linear state space models and linear/non-linear multivariate regression models. The continuous latent variable s_t^* determines the time-varying transition probability at time t as:

$$pr(s_t = 0|s_{t-1}, \mathbf{z}_{t-1}) = pr(s_t^* \leq 0|s_{t-1}, \mathbf{z}_{t-1}) = \Phi(-E[s_t^*|s_{t-1}, \mathbf{z}_{t-1}]) \tag{34}$$

$$pr(s_t = 1|s_{t-1}, \mathbf{z}_{t-1}) = 1 - \Phi(-E[s_t^*|s_{t-1}, \mathbf{z}_{t-1}]) \tag{35}$$

where $\mathbf{z}_{t-1} = [z_{1,t-1}, z_{2,t-1}, \ldots, z_{L,t-1}]'$; $E[s_t^*|s_{t-1}, \mathbf{z}_{t-1}] = \theta_0 + \theta_1 s_{t-1} + \alpha_1 z_{1,t-1} + \alpha_2 z_{2,t-1} + ... + \alpha_L z_{L,t-1}$; and $\Phi(.)$ is the standard normal CDF. For notational simplicity, we use $\Theta = \{\theta_0, \theta_1, \alpha_1, ..., \alpha_L\}$. In the case of $\alpha_1 = \alpha_2 = \ldots = \alpha_L = 0$, the model is reduced to a conventional Markov switching model in which the current regime s_t only depends on the previous regime s_{t-1}. Our model specification is designed to select only those variables that possess predictive power for forecasting the subsequent regime, beyond the current regime. This mechanism is essential for accurately predicting regime shifts in the following period.

We impose the horseshoe prior developed by Carvalho et al. (2009) and Carvalho et al.

[28]Markov switching models are widely recognized and frequently used in applied econometric research. For an in-depth introduction and discussion, refer to the textbooks by Chan et al. (2019); Frühwirth-Schnatter (2006); Gary (2003).

(2010) over $\alpha = [\alpha_1, \alpha_2, \ldots, \alpha_L]'$ in equation (33)

$$\alpha_\ell|\lambda_\ell \sim \mathcal{N}(0, \lambda_\ell^2), \qquad \lambda_\ell|\tau \sim \mathcal{C}^+(0, \tau), \qquad \tau \sim \mathcal{C}^+(0, \tau_0) \tag{36}$$

where $\mathcal{C}^+(a, b)$ is a half-Cauchy distribution with location parameter a and scale parameter b. The overall level of shrinkage in the model is determined by the parameter τ. By defining $\lambda_\ell = \delta_\ell \tau$, the above prior can be rewritten as:[29]

$$\alpha_\ell|\lambda_\ell \sim \mathcal{N}(0, \delta_\ell^2 \tau^2), \qquad \delta_\ell \sim \mathcal{C}^+(0, 1), \qquad \tau \sim \mathcal{C}^+(0, \tau_0). \tag{37}$$

For the efficient implementation of a Bayesian estimation algorithm, we employ the scale mixture representation of the half-Cauchy distributions for δ_ℓ and τ in equation (37):

$$\delta_\ell^2|\nu_\ell \sim \mathcal{IG}(\frac{1}{2}, \frac{1}{\nu_\ell}), \qquad \nu_\ell \sim \mathcal{IG}(\frac{1}{2}, 1) \tag{38}$$

$$\tau^2|\xi \sim \mathcal{IG}(\frac{1}{2}, \frac{1}{\xi}), \qquad \xi \sim \mathcal{IG}(\frac{1}{2}, \frac{1}{\tau_0}). \tag{39}$$

It can be shown that the half-Cauchy distributions of δ_ℓ and τ emerge by integrating out the auxiliary variables ν_ℓ and ξ. The prior-hyperparameter τ_0 plays an important role. To induce the strong shrinkage prior, a small value of τ_0 should be imposed. The horseshoe prior automatically shrink the proposed model with time-varying transition probabilities toward a standard Markov switching model with constant transition probabilities.

3.5 Estimation

The estimation of the model is performed via the Markov Chain Monte Carlo (MCMC) method. The most commonly used MCMC algorithm is Gibbs sampling, introduced by Geman and Geman (1984) and Gelfand and Smith (1990). Gibbs sampling is a method that combines the likelihood and proposed priors to construct the posterior density for all param-

[29]Suppose that $\gamma \sim \mathcal{C}^+(a, b)$. Then, $c\gamma \sim \mathcal{C}^+(a, cb)$.

eters and produces a sequence of random samples by iteratively drawing from the posterior conditional distribution. The Gibbs sampling algorithm for this model can proceed as follows.

MCMC Algorithm for model estimation

We start the algorithm with arbitrary initial values $(\beta^{(0)}, \sigma^{2(0)}, \alpha^{(0)} ...)$.

Step 1: Draw a posterior sample of $\tilde{S} = \{s_1, s_2, ..., s_T\}$ sequentially from conditional density $p(s_t|s_{t+1}, \beta, \sigma^2, \Theta, D)$ backward in time for $t = T, T-1, ..., 1$ where D denotes the entire dataset. The sampler uses the following target posterior density:

$$p(\tilde{S}|\beta, \sigma^2, \Theta, D) = p(s_T|\beta, \sigma^2, \Theta, D) \prod_{t=1}^{T-1} p(s_t|s_{t+1}, \beta, \sigma^2, \Theta, D), \tag{40}$$

where $\tilde{S} = \{s_1, s_2, ..., s_T\}$. The target conditional density of s_t is proportional to the filtered regime probability and the transition probability at time t+1 as

$$p(s_t|s_{t+1}, \beta, \sigma^2, \Theta, D) \propto \pi_{t+1}\ p(s_t|\beta, \sigma^2, \Theta, \tilde{D}_t) \tag{41}$$

where $\pi_{t+1} = p(s_{t+1}|s_t, \Theta, z_t)$ and $\tilde{D}_t$ is the data available up to time t. We obtain the filtered regime probability $p(s_t|\beta, \sigma^2, \Theta, \tilde{D}_t)$ with the time-varying transition probabilities using the forward filtering algorithm proposed by Hamilton (1989).[30]

Step 2: Draw a posterior sample of $\tilde{S}^* = \{s_1, s_2, ..., s_T\}$ from conditional posterior distribution $p(s_t^*|s_t, s_{t-1}, \beta, \sigma^2, \Theta, D)$. Because given the current and past states s_t, s_{t-1}, all other information in Y is irrelevant, we can draw s^* from the simple truncated normal distribution given below:

$$s_t^* = \begin{cases} TN_{(-\infty,0)}(m_t, 1) & \text{if } s_t = 0 \\ TN_{(0,\infty)}(m_t, 1) & \text{if } s_t = 1 \end{cases} \tag{42}$$

where $TN_{[a,b]}(\mu, \sigma^2)$ denotes a normal distribution with mean μ and variance σ^2 trun-

[30]The Hamilton filter is described in Appendix A.

cated to interval $[a, b]$. The mean function is given by $m_t = \theta_0 + \theta_1 s_{t-1} + \alpha_1 z_{1,t-1} + \alpha_2 z_{2,t-1} ... + \alpha_L z_{L,t-1}$.

Step 3: Draw a posterior sample of Θ from the conditional posterior distribution $p(\Theta|\tilde{S}^*, \tilde{S})$. Under the horseshoe prior on Θ, the conditional posterior distribution is given as:

$$\Theta|. \sim \mathcal{N}(M_\Theta, V_\Theta) \tag{43}$$

where $V_\Theta = (\Omega^{-1} + \tilde{Z}'\tilde{Z})^{-1}$; $M_\Theta = V_\Theta(\Omega^{-1}\underline{M}_\Theta + Z'S^*)$; the prior covariance matrix is $\Omega = diag(\underline{v}_{\theta_0}, \underline{v}_{\theta_1}, \delta_1^2\tau^2, \delta_2^2\tau^2, ..., \delta_L^2\tau^2)$; $\tilde{Z} = [\tilde{\mathbf{z}}_0, \tilde{\mathbf{z}}_1, ..., \tilde{\mathbf{z}}_{T-1}]'$; $\tilde{\mathbf{z}}_t = [1, I_1(s_{t-1}), \mathbf{z}_t']'$; $I_1(s_{t-1})$ is the indicator function that takes one if $s_{t-1} = 1$ and 0 otherwise; and the prior mean is $\underline{M}_\Theta = [\underline{\mu_{\theta_0}}, \underline{\mu_{\theta_1}}, 0, 0, ..., 0]'$; $\underline{\mu_{\theta_0}}$ and $\underline{v}_{\theta_1}$ are the prior mean and variance of θ_i for $i = 0, 1$. For the sake of notational simplicity, we abbreviate the conditioning information in the target posterior distribution above.

Step 4: Draw a posterior sample of δ_ℓ^2 conditional on α_ℓ, v_ℓ and τ for $\ell = 1, 2, ..., L$. The target conditional posterior distribution is given by:

$$\delta_\ell^2|. \sim \mathcal{IG}(1, \frac{1}{\nu_\ell} + \frac{\alpha_\ell^2}{2\tau^2}). \tag{44}$$

Step 5: Draw a posterior sample of ν_ℓ conditional on δ_ℓ^2 for $\ell = 1, 2, ..., L$. The target conditional posterior distribution is given by:

$$\nu_\ell|. \sim \mathcal{IG}(1, 1 + \frac{1}{\delta_\ell^2}). \tag{45}$$

Step 6: Draw a posterior sample of τ^2 conditional on $\{\alpha_1^2, ..., \alpha_L^2\}$, $\{\delta_1^2, ..., \delta_L^2\}$ and ξ. The target conditional posterior distribution is given by:

$$\tau^2|. \sim \mathcal{IG}(\frac{1+L}{2}, \frac{1}{\xi} + \sum_{\ell=1}^{L} \frac{\alpha_\ell^2}{2\delta_\ell^2}) \tag{46}$$

Step 7: Draw a posterior sample of ξ conditional on τ^2. The target conditional posterior distribution is given by:

$$\xi|. \sim \mathcal{IG}(1, \frac{1}{\tau_0^2} + \frac{1}{\tau^2}) \tag{47}$$

Step 8: Draw a posterior sample of β_s from $p(\beta_s|\sigma^2, \tilde{S}, D)$ for $s = 0, 1$. The targe posterior conditional distribution is the normal distribution $\mathcal{N}(M_{\beta_s}, V_{\beta_s})$, where $V_{\beta_s} = (\underline{V}_{\beta_s}^{-1} + X_s' X_s/\sigma_s^2)$ and $M_{\beta_s} = V_{\beta_s}(\underline{V}_{\beta_s}^{-1}\underline{M}_{\beta_s} + X_s' Y_s/\sigma_s^2)$; $\underline{V}_{\beta_s}$ and $\underline{M}_{\beta_s}$ are the prior covariance and mean of β_s; X_s and Y_s are the matrices of x_t and y_t corresponding to regime s.

Step 9: Draw a posterior sample of σ_s^2 from $p(\sigma_s^2|\beta, \tilde{S}, D)$ for $s = 0, 1$. The posterior distribution of σ_s^2 is the inverse-Gamma distribution $\mathcal{IG}(\frac{d_s}{2}, \frac{\kappa_s}{2})$ where $d_s = \underline{d}_s + T$ and $\kappa = \underline{\kappa}_s + (Y_s - X_s\beta_s)'(Y_s - X_s\beta_s)$.

The above estimation procedure is repeated a large number of times to ensure that the MCMC chain converges to the stationary posterior distribution. We discard the first 10,000 posterior samples to eliminate the effect of initial parameter values among total 20,000 posterior samples.

3.6 Data and Empirical Analysis

In this section, we outline the data and empirical model applied in our study to identify key economic variables that predict regime changes in the UIP equation.

3.6.1 Data

In our empirical analysis, we utilize data from monthly forward and spot exchange rates, along with interbank borrowing rates, for 44 countries, spanning the period from January 1985 to April 2019.[31] The currency data are collected from Barclays and Reuters via Datas-

[31]The countries included are: Australia, Belgium, Bulgaria, Canada, Chile, China, Colombia,Cyprus, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indone-

tream. The countries we have chosen for this analysis align with those considered in the research conducted by Dahlquist and Hasseltoft (2020); Lustig and Verdelhan (2007); Menkhoff et al. (2012).

We adopt the methodology of Lustig et al. (2014) by employing a dollar carry trade strategy that focuses on investing in a basket of foreign currencies, rather than individual currency pairs as is common in much of the literature. To calculate the dollar factor, we take the cross-sectional average of the currency returns of all countries each month. Additionally, the global interest rate differential (GIRD) is computed as the average interest rate differential between the U.S. and other countries. Lustig et al. (2014) demonstrate that an excess return can be achieved by taking a long position on the U.S. dollar when the U.S. interest rate exceeds the global interest rate, and vice versa. This finding suggests that the violation of uncovered interest parity (UIP) occurs at a global level. In this study, we further investigate this global phenomenon using the proposed regime-switching model. Figure 9 plots the time series observations of the dollar factor and the global interest rate differential. The interest rate differential was relatively low during the late 1990 and early 1994 but increased after 1995. Overall, the interest rates exhibit a relatively smooth pattern with slight fluctuations, while the dollar factor is characterized by greater volatility,exhibiting significant movements over time.This highlights its dynamic nature compared to the relatively stable interest rate differential.

In this paper, we explore eight economic variables that are consistent across all countries as potential drivers of carry trade returns. Our objective is to identify which of these factors has the greatest influence on carry trade returns. To assess the liquidity of the FX market, our analysis relies on two key indicators: the TED spread[32] and the rate of change in the aggregate capital ratio of financial intermediaries, denoted as (Δcr). The importance of the

sia, Ireland, Israel, Italy, Japan, Kuwait, Lithuania, Malaysia, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Russia , Saudi Arabia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Sweden, Switzerland, Thailand, United Kingdom, and Vietnam.

[32]The TED spread is defined as the difference between the London Interbank Offered Rate (LIBOR) and the risk-free rate offered by U.S. Treasury bills.

TED spread in explaining currency returns has been notably emphasized by Brunnermeier et al. (2008).[33] Further, Brunnermeier and Pedersen (2009); Doukas and Zhang (2013) have pointed out that an increase in the TED spread typically tightens funding liquidity, leading to a reduction in carry trade positions and consequently a decline in carry trade returns. The importance of (Δcr) is emphasized by He et al. (2017), who associate it with fluctuations in equity excess returns. We also consider the U.S. term spread (TS)[34] as an aggregate predictor, reflecting the state of the U.S. economy, as noted by Estrella and Mishkin (1998); Rudebusch and Williams (2009). In addition, in line with Burnside (2012), we incorporate measures of consumption growth and stock market excess returns into our analysis. These factors have been recognized for their significant explanatory power on currency returns. Further,Christiansen et al. (2012) underscore the importance of including dividend yield (DY) due to its notable impact on exchange rate return volatility and its correlation with slow mean reversion in stock returns across economic cycles. Lastly, we include lagged values of the dollar factor (represented as DF_{t-1}) and carry factors (denoted as CF_{t-1}) to capture the persistence in risk factors. The carry factor is calculated each month by determining the difference in average returns between the portfolio with the highest interest rate differential (IRD) and the one with the lowest IRD,providing insights into the dynamics of interest rate impacts on currency values.

3.6.2 Empirical Implementation

This section investigates how and when the uncovered interest parity (UIP) is systematically violated by employing the proposed regime switching model. In recent years, the use of nonlinear models has become increasingly prevalent among researchers seeking to understand how changes in exchange rates correlate with interest rate differentials (Chen (2006); Cho et al. (2019); Ichiue and Koyama (2011)). It is recognized that the behavior of economic

[33] This perspective is reinforced by studies such as Creal and Kim (2021); Karnaukh et al. (2015); Mancini et al. (2013), which consider the TED spread as a reflection of the FX market's liquidity.

[34] The term spread is calculated by taking the difference between the average yields on 10-year Treasury bonds and those of three-month Treasury bills.

variables is influenced by the current global state, which in turn affects the characteristics of foreign exchange time series in different regimes. We attempt to identify predictors for the forward premium anomaly by using our proposed regime switching model. The paper employs a Markov switching model, as shown in Equation 48, for analyzing the relationship between the interest rate differential and exchange rate returns.

$$\Delta S_{t+1} = \beta_0 + \beta_{1,s_{t+1}}(f_t - S_t) + \varepsilon_{t+1}, \qquad \varepsilon_{t+1} \sim N(0, \sigma^2_{s_{t+1}}), \tag{48}$$

$$\beta_{1,s_{t+1}} = \beta_{1,0}(1 - s_{t+1}) + \beta_{1,1}s_{t+1} \tag{49}$$

$$\sigma^2_{s_{t+1}} = \sigma^2_0(1 - s_{t+1}) + \sigma^2_1 s_{t+1} \tag{50}$$

$$s_{t+1} = 0 \ \text{ if } s^*_{t+1} \leq 0, \qquad s_{t+1} = 1 \ \text{ if } s^*_{t+1} > 0, \tag{51}$$

$$s^*_{t+1} = \theta_0 + \theta_1 s_t + \boldsymbol{\alpha}'\boldsymbol{z}_t + u_{t+1}, \quad u_{t+1} \sim \mathrm{N}(0, 1). \tag{52}$$

where $s_t \in \{0, 1\}$ indicates regime indicator variable, S_t represents the spot nominal exchange rate, defined as the amount of U.S. dollars required to purchase one unit of foreign currency, and f_t denotes the forward exchange rate, also expressed in U.S. dollars per unit of foreign currency. An increase in S_t indicates an appreciation of the foreign currency. The variable $\boldsymbol{z}_t$ is an$(L \times 1)$ vector of regime predictors, with $\boldsymbol{\alpha}$ as the corresponding $(L \times 1)$ vector of coefficients. Equation 48 assumes simultaneous switches in both the slope coefficient (β) and the volatility parameter (σ^2). Regarding the intercept, we hold it constant ($\beta_0 = \beta_{00} = \beta_{01}$), a decision based on Ichiue and Koyama (2011), who notes that allowing the intercept to vary does not significantly enhance the explanatory power of the model for exchange rate returns. Furthermore, Ichiue and Koyama (2011) indicates that regime changes in exchange rate returns are more accurately characterized by shifts in the dynamics between these returns and interest rate differentials, or by variations in speculators' behaviors, particularly in relation to carry trades and their unwinding. Consequently, we interpret regime shifts in exchange rate returns as indicative of changes in their relationship with interest rate differentials, rather than just switches in the intercept.

For identification of the two regimes, we assume $\beta_{10} < 0$ and $\beta_{11} > 0$. This approach allows us to determine the prevailing market regime: in one, the forward premium anomaly is present, marked by persistent deviations from UIP and signaling opportunities for profitable carry trades. In contrast, the alternate regime typically shows a reversion to UIP. The model includes several parameters:β_0,β_{10}, β_{11}, σ_0, σ_1, and a $2*2$ transition matrix P. Additionally, we need to estimate the unobservable state variable s_t.To estimate these parameters and the state variable, we utilize a Bayesian Gibbs sampling approach, as detailed in Section 3.5. The initial values of the parameters are determined by replicating a traditional regression to test UIP with our data,using OLS regression on Equation 31. Also, to make the shrinkage prior uniformly applied to all coefficients in $\boldsymbol{\alpha}$, we normalize $\boldsymbol{z}_t$ such that all predictors have mean zero and variance one prior to estimation.

3.7 Empirical Results

We begin our empirical analysis by examining Equation 48 with constant coefficients as a baseline case, aiming to uncover basic empirical facts about the relationship between exchange rate returns and interest rate differentials. The results are presented in Table 47, where the intercept (β_0) is estimated at 0.061 and is statistically insignificant, while the slope coefficient (β_1), which is our primary focus, is -1.964 with a standard error of 0.754.[35] This negative and significant estimate for β_1 provides initial evidence of the forward premium anomaly, indicating that on average, currencies with lower interest rates tend to depreciate against the dollar, contrary to UIP predictions.

Building on these baseline findings,we next apply a regime-switching model to account for possible shifts in the relationship dynamics over time, allowing the parameters to vary across different states of the regime. In this model, we set the total number of MCMC iterations

[35]If UIP holds, the null hypothesis to be tested is that $\beta_0 = 0$ and $\beta_1 = 1$. Although the estimated β_1 is significantly different from zero at conventional significance levels, the primary focus is on testing the hypothesis that $\beta = 1$. Imposing this theoretical restriction results in a t-statistic of -3.933 and a corresponding p-value of 0.000, indicating that we can reject the null hypothesis of $\beta = 1$ at the 95% confidence level, which suggests that UIP does not hold.

to be 20,000, discarding the first 10,000 posterior samples as a burn-in period to mitigate the influence of initial values. Our inference is then based on the analysis of the remaining 10,000 draws. Through successive iterations, we simulate draws from the joint distribution of the state variable and the model parameters, given the data.

3.7.1 Regime Probabilities and Transition Matrix

In Figure 10, we present the time-varying transition probability estimates for remaining in regime one (S==1), where several regime switches are evident. Notably, there is substantial persistence within these regimes, with a significant shift to regime one occurring during the late 2007 and 2008 periods. This transition aligns with the onset of the global financial crisis, which was characterized by massive losses across financial institutions. Following the 2008 crisis, there is a discernible increase in the tendency for currencies to remain in regime one, where uncovered interest parity holds. In the subsequent post-crisis period, we witness a resurgence in carry trade activity. It became apparent that the financial crisis had altered the relationship between interest rate differentials and dollar carry trade returns, leading to a reinforcement of UIP during the turmoil of 2008 Baillie and Cho (2014).[36]

3.7.2 Parameter Estimates

The Primary objective of Markov Chain Monte Carlo (MCMC) methods is to approximate posterior distributions through stochastic sampling, enabling robust inference on parameter values. Table 48 provides a summary of the posterior estimates for the model parameters, including the posterior mean, standard deviation, and the 90% credible interval. For β_1 in regime 0 (β_{10}), the posterior mean is -4.221 with a standard deviation of 0.951, and the 90% band ranges from -5.791 to -2.672, indicating a high degree of confidence that the true parameter value lies within this interval. This negative coefficient suggests that, under normal conditions, the forward premium anomaly or the failure of UIP persists, making carry

[36] As noted by Brunnermeier and Pedersen (2009), during turbulent periods, increased risk aversion among investors can lead to a substantial unwinding of carry trade positions, causing rapid reversals in exchange rates. Consequently, low-interest-rate currencies may appreciate more than what UIP would predict.

trades profitable on average by exploiting this anomaly. In regime 1, the posterior mean for β_1 (β_{11}) is 1.173 with a standard deviation of 1.052, and the 90% band spans from 0.077 to 3.203, showing a wider spread compared to β_{10}. A positive value exceeding unity indicates a reversal of the forward premium anomaly, signaling a collapse in potential carry trade gains. For σ_{10}^2, the posterior mean is 529.099 with a standard deviation of 53.201. In contrast, σ_{11}^2 has a posterior mean of 1458.262 with a standard deviation of 247.299, indicating that the level of volatility in regime 1 is substantially larger than in regime 0.[37] The wider interval for σ_{11}^2 reflects greater variability in regime 1. This is consistent with Baillie and Chang (2011), who found that UIP is more likely to hold in high-volatility regimes, implying that carry trade strategies tend to incur losses as market volatility increases.

Figure 11 presents the estimated posterior distributions of the β_1 parameters across two regimes, based on 20,000 MCMC iterations. To ensure convergence, the first 10,000 iterations are discarded as a burn-in to promote stability and minimize the influence of initial, arbitrary starting values. This practice is critical as it allows the converge to their posterior distributions, minimizing the influence of initial, arbitrary starting values. As indicated in the Figure 11, after the burn-in period, the samples exhibit characteristics of convergence, with the posterior distributions of β_{10} and β_{11} stabilizing around their respective mean values. The consistent fluctuation around the means further suggests that the chains have converged adequately, reinforcing the reliability of these posterior estimates for subsequent inference.

As illustrated in Figure 12, we present predictors related to the forward premium anomaly, using the horseshoe prior to identify which variables most strongly influence the dynamics of the foreign exchange market in the context of UIP. These predictors are: 'lagged Dollar Factor', 'lagged Carry Factor', 'TED spread', 'Capital ratio growth', 'Term spread', 'market excess return', 'consumption growth of the U.S, economy', and 'Dividend yield'. Figure 12 suggests that three variables—"TED spread", "Term spread", and "Consumption growth of

[37] Kernel density estimates of the posterior distributions for β_1 and σ_1^2 are provided in the Appendix C for a detailed view of their distributional characteristics.

the U.S, economy"—have a particularly strong influence on carry trade returns. In contrast, the remaining 5 variables cluster near zero with narrow error bars, implying they are likely insignificant in the model and exhibit minimal effect. The influence of the horseshoe shrinkage prior is evident, as it shrinks most coefficients toward zero, emphasizing only the most relevant predictors of UIP violation within the regime-switching model.

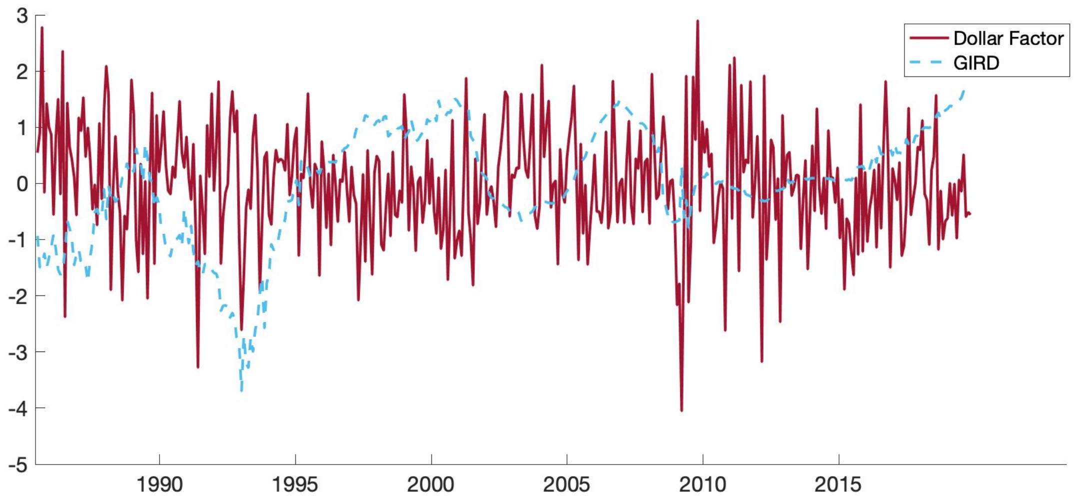
3.8 Conclusion

This article sheds light on an important topic that has long been debated in economic and financial literature which is the uncovered interest rate parity. Empirical evidence has shown that currency markets often do not conform to this key financial principle, which connects exchange rates to the interest rates of two distinct countries. This phenomenon has led to the emergence of the carry trade, a strategy that has gained widespread popularity among a growing number of speculators.

In this paper, we apply the dollar carry strategy, as outlined by Lustig et al. (2014), to calculate carry returns. This strategy is based on the average interest rates of foreign currencies. Specifically, when the average interest rate of these currencies is higher than that of the U.S. dollar, we take a long position in the foreign currencies and a short position in the U.S. dollar. The reverse strategy is employed when the U.S. dollar's interest rate is higher. We focus on understanding and measuring the influence of macroeconomic factors on expected currency returns. The primary contribution of this study is to address the complexities of various variables that influence the violation of uncovered interest parity and to identify specific variables that affect this phenomenon. We examine eight factors suggested by the literature to assess their impact on carry trade returns.

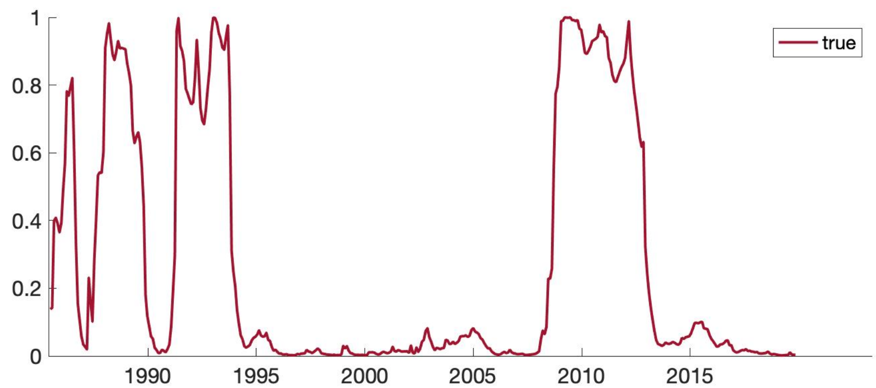
To this end, we employ a novel regime switching model. A key innovation in our approach is the incorporation of the horseshoe prior, which allows us to perform variable selection and identify the most important factors influencing the transition probabilities. A shrinkage prior is applied to perform variable selection, especially when certain variables may not influence the model's regime-switching behavior. The goal is to accurately estimate the transition probabilities within a regime-switching framework, where a wide array of potential covariates influences these probabilities. By applying the horseshoe prior for variable selection, we aim to pinpoint the key variables that explain these transition probabilities. We document in this paper that TED spread, term spread and U.S. consumption growth are powerful predictors of expected currency returns.

Figure 9: Dollar factor and global interest rate differential



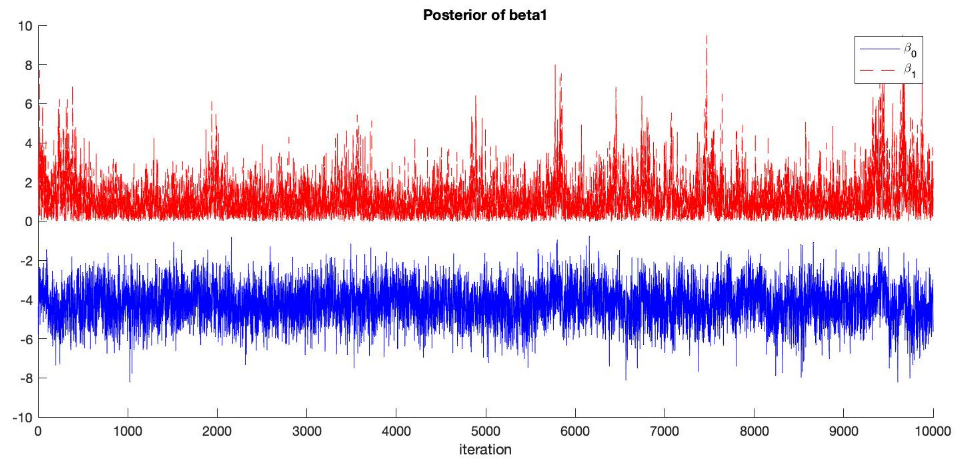
Note: The red lines represent the Dollar factor, and the blue dashed lines denote the global interest rate differential

Figure 10: Regime probabilities



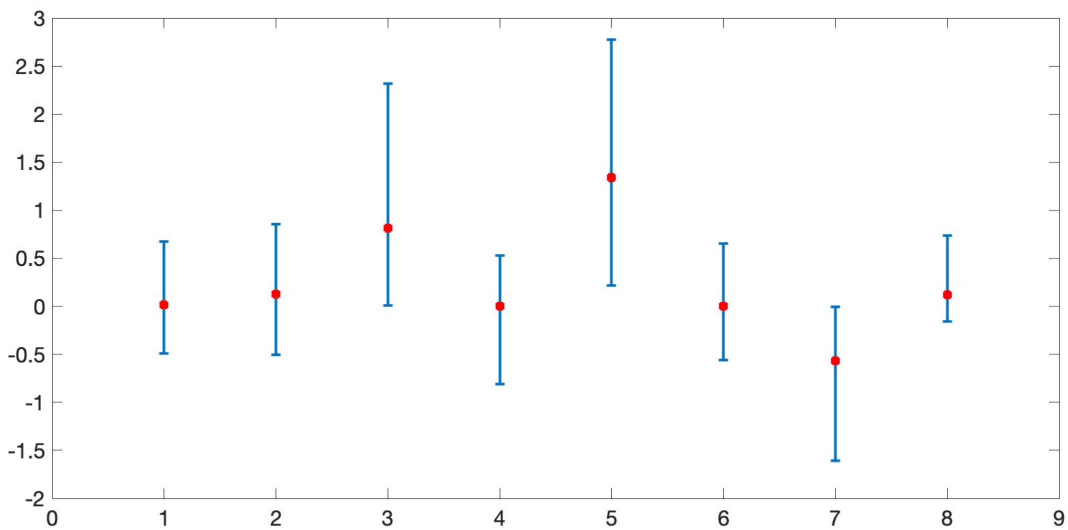
Note: Estimated transition probabilities from the Markov switching model

Figure 11: Posterior distributions of β in a regime-switching model



Note: Posterior distributions of β over 10,000 iterations using Gibbs sampling in a time-varying regime-switching model. The red curve represents the posterior of β in regime 1, while the blue curve delineates the posterior in regime 0.

Figure 12: Variable Selection using the Horseshoe Prior



Note: Parameters of z correspond to the following variables: (1) 'Lagged DF', (2) 'Lagged CF', (3) 'TED Spread', (4) 'Capital Ratio Growth', (5) 'Term Spread', (6) 'Market Excess Return', (7) 'Consumption Growth (3 months)', and (8) 'Dividend Yield'. The red dot represents the posterior median, and the blue lines depict the 90% credible interval.

Table 47: Baseline model estimation without regime-switching dynamics

Parameter	Estimate	Std. Error	t-statistics	p-value
β_0	0.061	1.573	0.039	0.969
β_1	-1.964	0.754	-2.606	0.010

Note: This table presents the results of the baseline model, as specified in Equation 48, estimated without regime-switching dynamics. Here, β_0 represents the intercept, and β_1 denotes the coefficient on the global interest rate differential.

Table 48: Parameter estimates of the regime-switching model

Parameter	Posterior mean	Posterior std. dev	[5% 95%]
β_{10}	-4.221	0.951	[-5.791, -2.672]
β_{11}	1.173	1.052	[0.077, 3.203]
σ^2_{10}	529.099	53.201	[447.297, 621.249]
σ^2_{11}	1458.262	247.299	[1123.384, 1891.044]

Note: This table reports the posterior mean, standard deviation, and 90% highest posterior density interval of the parameters of the regime-switching model.

Bibliography

Abel, A. B. (1983). Optimal investment under uncertainty. *The American Economic Review*, 73(1):228–233.

Aghion, P., Bacchetta, P., Ranciere, R., and Rogoff, K. (2009). Exchange rate volatility and productivity growth: The role of financial development. *Journal of Monetary Economics*, 56(4):494–513.

Aguirre, A. and Calderón, C. (2005). Real exchange rate misalignments and economic performance. *Documentos de Trabajo (Banco Central de Chile)*, (315):1–49.

Akram, Q. F., Rime, D., and Sarno, L. (2008). Arbitrage in the foreign exchange market: Turning on the microscope. *Journal of International Economics*, 76(2):237–253.

Alfaro, I., Bloom, N., and Lin, X. (2016). The real and financial impact of uncertainty shocks. In *Stanford Institute for Theoretical Economics (SITE) 2016 Workshop. Retrieved from https://site. stanford. edu/sites/default/files/alfaro. pdf.*

Alfaro, L., Cunat, A., Fadinger, H., and Liu, Y. (2023). The real exchange rate, innovation, and productivity. *Journal of the European Economic Association*, 21(2):637–689.

Ames, M., Bagnarosa, G., and Peters, G. W. (2017). Violations of uncovered interest rate parity and international exchange rate dependences. *Journal of International Money and Finance*, 73:162–187.

Arellano, M. and Bond, S. (1991). Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. *The Review of Economic Studies*, 58(2):277–297.

Arellano, M. and Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68(1):29–51.

Arnold, J., Bassanini, A., and Scarpetta, S. (2011). Solow or lucas? testing speed of convergence on a panel of oecd countries. *Research in Economics*, 65(2):110–123.

Atella, V., Atzeni, G. E., and Belvisi, P. L. (2003). Investment and exchange rate uncertainty. *Journal of Policy Modeling*, 25(8):811–824.

Avdjiev, S., Bruno, V., Koch, C., and Shin, H. S. (2019). The dollar exchange rate as a global risk factor: evidence from investment. *IMF Economic Review*, 67(1):151–173.

Backus, D. K., Foresi, S., and Telmer, C. I. (2001). Affine term structure models and the forward premium anomaly. *The Journal of Finance*, 56(1):279–304.

Baillie, R. T. and Chang, S. S. (2011). Carry trades, momentum trading and the forward premium anomaly. *Journal of Financial Markets*, 14(3):441–464.

Baillie, R. T. and Cho, D. (2014). When carry trades in currency markets are not profitable. *Review of Development Economics*, 18(4):794–803.

Bakshi, G. and Panayotov, G. (2013). Predictability of currency carry trades and asset pricing implications. *Journal of financial economics*, 110(1):139–163.

Balassa, B. (1964). The purchasing-power parity doctrine: a reappraisal. *Journal of Political Economy*, 72(6):584–596.

Baltar, C. T., Hiratuka, C., and Lima, G. T. (2016). Real exchange rate and investment in the Brazilian manufacturing industry. *Journal of Economic Studies*, 43(2):288–308.

Banerjee, R., Hofmann, B., and Mehrotra, A. N. (2020). Corporate investment and the exchange rate: The financial channel.

Bansal, R. and Shaliastovich, I. (2013). A long-run risks explanation of predictability puzzles in bond and currency markets. *The Review of Financial Studies*, 26(1):1–33.

Bazzi, M., Blasques, F., Koopman, S. J., and Lucas, A. (2017). Time-varying transition probabilities for markov regime switching models. *Journal of Time Series Analysis*, 38(3):458–478.

Béreau, S., Villavicencio, A. L., and Mignon, V. (2012). Currency misalignments and growth: a new look using nonlinear panel data methods. *Applied Economics*, 44(27):3503–3511.

Berg, A., Ostry, J. D., and Zettelmeyer, J. (2012). What makes growth sustained? *Journal of Development Economics*, 98(2):149–166.

Berg, K. A. and Mark, N. C. (2018). Global macro risks in currency excess returns. *Journal of Empirical Finance*, 45:300–315.

Berg, M. A. and Miao, Y. (2010). *The real exchange rate and growth revisited: The Washington Consensus strikes back?* Number 10-58. International Monetary Fund.

Berman, N., Martin, P., and Mayer, T. (2012). How do different exporters react to exchange rate changes? *The Quarterly Journal of Economics*, 127(1):437–492.

Bernanke, B. S. (1983). Irreversibility, uncertainty, and cyclical investment. *The quarterly journal of economics*, 98(1):85–106.

Bernanke, B. S., Boivin, J., and Eliasz, P. (2005). Measuring the effects of monetary policy: a factor-augmented vector autoregressive (favar) approach. *The Quarterly journal of economics*, 120(1):387–422.

Binding, G. and Dibiasi, A. (2017). Exchange rate uncertainty and firm investment plans evidence from swiss survey data. *Journal of Macroeconomics*, 51:1–27.

Blanchard, O., Amighini, A., and Giavazzi, F. (2010). *Macroeconomics: a European perspective*. Pearson.

Blecker, R. A. (2016). The debate over 'thirlwall's law': balance-of-payments-constrained growth reconsidered. *European Journal of Economics and Economic Policies: Intervention*, 13(3):275–290.

Bloom, N., Bond, S., and Van Reenen, J. (2007). Uncertainty and investment dynamics. *The Review of Economic Studies*, 74(2):391–415.

Blundell, R. and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1):115–143.

Bøler, E. A., Moxnes, A., and Ulltveit-Moe, K. H. (2015). R&d, international sourcing, and the joint impact on firm performance. *American Economic Review*, 105(12):3704–39.

Breitenbach, M. C., Tipoy, C. K., and Zerihun, M. F. (2017). Equilibrium exchange rates and misalignments: The case of homogenous emerging countries. *Economic Research Southern Africa (ERSA) Working Paper*, (713).

Bresser-Pereira, L. C., Oreiro, J. L., and Marconi, N. (2014). *Developmental Macroeconomics: new developmentalism as a growth strategy.* Routledge.

Brito, S., Magud, M. N. E., and Sosa, M. S. (2018). *Real exchange rates, economic complexity, and investment.* International Monetary Fund.

Brunnermeier, M. K., Nagel, S., and Pedersen, L. H. (2008). Carry trades and currency crashes. *NBER macroeconomics annual*, 23(1):313–348.

Brunnermeier, M. K. and Pedersen, L. H. (2009). Market liquidity and funding liquidity. *The review of financial studies*, 22(6):2201–2238.

Bruno, V. and Shin, H. S. (2019). Dollar exchange rate as a credit supply factor–evidence from firm-level exports.

Bruno, V. and Shin, H. S. (2020). Currency depreciation and emerging market corporate distress. *Management Science*, 66(5):1935–1961.

Buera, F. J. and Kaboski, J. P. (2009). Can traditional theories of structural change fit the data? *Journal of the European Economic Association*, 7(2-3):469–477.

Burnside, C. (2012). Carry trades and risk. *Handbook of exchange rates*, pages 283–312.

Burnside, C., Eichenbaum, M., Kleshchelski, I., and Rebelo, S. (2011a). Do peso problems explain the returns to the carry trade? *The Review of Financial Studies*, 24(3):853–891.

Burnside, C., Eichenbaum, M., and Rebelo, S. (2011b). Carry trade and momentum in currency markets. *Annu. Rev. Financ. Econ.*, 3(1):511–535.

Caballero, R. J. (1991). On the sign of the investment-uncertainty relationship. *The American Economic Review*, 81(1):279–288.

Caglayan, M. and Demir, F. (2019). Exchange rate movements, export sophistication and direction of trade: the development channel and north–south trade flows. *Cambridge Journal of Economics*, 43(6):1623–1652.

Caglayan, M. and Torres, R. I. M. (2011). The effect of the exchange rates on investment in Mexican manufacturing industry. *Open Economies Review*, 22(4):669–683.

Campa, J. M. and Goldberg, L. S. (1995). Investment in manufacturing, exchange rates and external exposure. *Journal of International Economics*, 38(3-4):297–320.

Campa, J. M. and Goldberg, L. S. (1999). Investment, pass-through, and exchange rates: a cross-country comparison. *International Economic Review*, 40(2):287–314.

Carvalho, C. M., Polson, N. G., and Scott, J. G. (2009). Handling sparsity via the horseshoe. In *Artificial Intelligence and Statistics*, pages 73–80. PMLR.

Carvalho, C. M., Polson, N. G., and Scott, J. G. (2010). The horseshoe estimator for sparse signals. *Biometrika*, 97(2):465–480.

Cassel, G. (1918). Abnormal deviations in international exchanges. *The Economic Journal*, 28(112):413–415.

Cassel, G. (1925). *Money and foreign exchange after 1914*. New York: MacMillan Company.

Chan, J., Koop, G., Poirier, D. J., and Tobias, J. L. (2019). *Bayesian econometric methods*, volume 7. Cambridge University Press.

Chatterjee, A., Dix-Carneiro, R., and Vichyanond, J. (2013). Multi-product firms and exchange rate fluctuations. *American Economic Journal: Economic Policy*, 5(2):77–110.

Chen, S.-S. (2006). Revisiting the interest rate–exchange rate nexus: a markov-switching approach. *Journal of Development Economics*, 79(1):208–224.

Chen, S.-S. (2017). Exchange rate undervaluation and R&D activity. *Journal of International Money and Finance*, 72:148–160.

Chenery, H. B. and Taylor, L. (1968). Development patterns: among countries and over time. *The Review of Economics and Statistics*, 50(4):391–416.

Chernov, M., Graveline, J., and Zviadadze, I. (2018). Crash risk in currency returns. *Journal of Financial and Quantitative Analysis*, 53(1):137–170.

Chinn, M. D. (2006). A primer on real effective exchange rates: determinants, overvaluation, trade flows and competitive devaluation. *Open Economies Review*, 17(1):115–143.

Cho, D., Han, H., and Lee, N. K. (2019). Carry trades and endogenous regime switches in exchange rate volatility. *Journal of International Financial Markets, Institutions and Money*, 58:255–268.

Christiansen, C., Ranaldo, A., and Söderlind, P. (2011). The time-varying systematic risk of carry trade strategies. *Journal of Financial and Quantitative Analysis*, 46(4):1107–1125.

Christiansen, C., Schmeling, M., and Schrimpf, A. (2012). A comprehensive look at financial volatility prediction by economic variables. *Journal of Applied Econometrics*, 27(6):956–977.

Chudik, A., Mohaddes, K., Pesaran, M. H., and Raissi, M. (2016). *Long-run effects in large heterogeneous panel data models with cross-sectionally correlated errors*. Emerald Group Publishing Limited.

Chudik, A. and Pesaran, M. H. (2013). Large panel data models with cross-sectional dependence: a survey. *CAFE Research Paper*, (13.15).

Chudik, A. and Pesaran, M. H. (2015). Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. *Journal of Econometrics*, 188(2):393–420.

Cimoli, M., Fleitas, S., and Porcile, G. (2013). Technological intensity of the export structure and the real exchange rate. *Economics of Innovation and New Technology*, 22(4):353–372.

Clark, P. B. and MacDonald, R. (1998). Exchange rates and economic fundamentals: A methodological comparison of beers and feers.

Cline, W. (2008). Estimating consistent fundamental equilibrium exchange rates. *Peterson Institute for International Economics Working Paper*, (08-6).

Cline, W. R., Williamson, J., et al. (2010). Estimates of fundamental equilibrium exchange rates, may 2010. Technical report, Peterson Institute for International Economics.

Colacito, R., Riddiough, S. J., and Sarno, L. (2020). Business cycles and currency returns. *Journal of Financial Economics*, 137(3):659–678.

Cottani, J. A., Cavallo, D. F., and Khan, M. S. (1990). Real exchange rate behavior and economic performance in ldcs. *Economic Development and Cultural Change*, 39(1):61–76.

Creal, D. and Kim, J. (2021). Empirical asset pricing with bayesian regression trees. Technical report, Working Paper University of Notre Dame, Department of Economics.

Dahlquist, M. and Hasseltoft, H. (2020). Economic momentum and currency returns. *Journal of Financial Economics*, 136(1):152–167.

Dao, M. C., Minoiu, C., and Ostry, J. D. (2021). Corporate investment and the real exchange rate. *Journal of International Economics*, 131:103437.

Darby, J., Hallett, A. H., Ireland, J., and Piscitelli, L. (1999). The impact of exchange rate uncertainty on the level of investment. *The Economic Journal*, 109(454):55–67.

De Gregorio, J. and Wolf, H. C. (1994). Terms of trade, productivity, and the real exchange rate. *NBER working paper*, (w4807).

De V. Cavalcanti, T. V., Mohaddes, K., and Raissi, M. (2015). Commodity price volatility and the sources of growth. *Journal of Applied Econometrics*, 30(6):857–873.

De Vries, G., Arfelt, L., Drees, D., Godemann, M., Hamilton, C., Jessen-Thiesen, B., Kaya, A. I., Kruse, H., Mensah, E., and Woltjer, P. (2021). The economic transformation database (etd): content, sources, and methods. *Technical Note, WIDER.*

De Vries, G., Timmer, M., and De Vries, K. (2015). Structural transformation in africa: Static gains, dynamic losses. *The Journal of Development Studies*, 51(6):674–688.

De Vries, G. J., Erumban, A. A., Timmer, M. P., Voskoboynikov, I., and Wu, H. X. (2012). Deconstructing the brics: Structural transformation and aggregate productivity growth. *Journal of Comparative Economics*, 40(2):211–227.

Della Corte, P. and Krecetovs, A. (2019). *Macro uncertainty and currency premia*. SSRN.

Della Corte, P., Sarno, L., Schmeling, M., and Wagner, C. (2022). Exchange rates and sovereign risk. *Management Science*, 68(8):5591–5617.

Demir, F. (2009). Macroeconomic uncertainty and private investment in Argentina, Mexico and Turkey. *Applied Economics Letters*, 16(6):567–571.

Demir, F. and Razmi, A. (2022). The real exchange rate and development theory, evidence, issues and challenges. *Journal of Economic Surveys*, 36(2):386–428.

Demir, F. and Tabrizy, S. S. (2022). Gendered effects of sanctions on manufacturing employment: Evidence from iran. *Review of Development Economics*, 26(4):2040–2069.

Di Nino, V., Eichengreen, B., and Sbracia, M. (2011). Real exchange rates, trade, and growth: Italy 1861-2011. *Bank of Italy Economic History Working Paper*, (10).

Diao, X., Harttgen, K., and McMillan, M. (2017). The changing structure of africa's economies. *The World Bank Economic Review*, 31(2):412–433.

Diao, X., McMillan, M., and Rodrik, D. (2019). *The recent growth boom in developing economies: A structural-change perspective*. Springer.

Diaz-Alejandro, C. F. (1965). *Exchange-rate devaluation in a semi-industrialized country: the experience of Argentina, 1955-1961*. Massachusetts institute of technology.

Diebold, F. X., Lee, J.-H., Weinbach, G. C., et al. (1993). Regime switching with time-varying transition probabilities.

Dixit, A. K. and Pindyck, R. S. (1994). *Investment under uncertainty*. Princeton university press.

Dollar, D. (1992). Outward-oriented developing economies really do grow more rapidly: evidence from 95 ldcs, 1976-1985. *Economic Development and Cultural Change*, 40(3):523–544.

Domac, I. and Shabsigh, G. (1999). Real exchange rate behavior and economic growth: Evidence from egypt, jordan, morocco, and tunisia. *IMF Working Paper*.

Doukas, J. A. and Zhang, H. (2013). The performance of ndf carry trades. *Journal of International Money and Finance*, 36:172–190.

Driver, R. L. and Westaway, P. F. (2003). Concepts of equilibrium exchange rates. *Exchange rates, capital flows and policy*, pages 98–124.

Duarte, M. and Restuccia, D. (2010). The role of the structural transformation in aggregate productivity. *The Quarterly Journal of Economics*, 125(1):129–173.

Eberhardt, M. and Teal, F. (2013). Structural change and cross-country growth empirics. *The World Bank Economic Review*, 27(2):229–271.

Eichengreen, B. (2007). The real exchange rate and economic growth. *Social and Economic Studies*, 56(4):7–20.

Elbadawi, I. A., Kaltani, L., and Soto, R. (2012). Aid, real exchange rate misalignment, and economic growth in sub-saharan africa. *World Development*, 40(4):681–700.

Engel, C. (1996). The forward discount anomaly and the risk premium: A survey of recent evidence. *Journal of empirical finance*, 3(2):123–192.

Engel, C. (2014). Exchange rates and interest parity. *Handbook of international economics*, 4:453–522.

Engel, C. and West, K. D. (2005). Exchange rates and fundamentals. *Journal of political Economy*, 113(3):485–517.

Engel, C. M. (1984). Testing for the absence of expected real profits from forward market speculation. *Journal of International Economics*, 17(3-4):299–308.

Estrella, A. and Mishkin, F. S. (1998). Predicting us recessions: Financial variables as leading indicators. *Review of Economics and Statistics*, 80(1):45–61.

Fama, E. F. (1984). Forward and spot exchange rates. *Journal of monetary economics*, 14(3):319–338.

Farhi, E., Fraiberger, S. P., Gabaix, X., Ranciere, R., and Verdelhan, A. (2009). Crash risk in currency markets. Technical report, National Bureau of Economic Research.

Filardo, A. J. (1994). Business-cycle phases and their transitional dynamics. *Journal of Business & Economic Statistics*, 12(3):299–308.

Filardo, A. J. et al. (1998). Choosing information variables for transition probabilities in a time-varying transition probability markov switching model. Technical report, Federal Reserve Bank of Kansas City.

Freund, C. and Pierola, M. D. (2012). Export surges. *Journal of Development Economics*, 97(2):387–395.

Froot, K. A. and Rogoff, K. (1995). Perspectives on ppp and long-run real exchange rates. *Handbook of International Economics*, 3:1647–1688.

Frühwirth-Schnatter, S. (2006). *Finite mixture and Markov switching models*. Springer Science & Business Media.

Funk, M. (2003). The effects of trade on research and development. *Open economies review*, 14(1):29–42.

Gala, P. (2007). Real exchange rate levels and economic development: theoretical analysis and econometric evidence. *Cambridge Journal of Economics*, 32(2):273–288.

Gala, P. and Libanio, G. (2010). Exchange rate policies, patterns of specialization and economic development: theory and evidence in developing countries.

Gala, P. and Lucinda, C. R. (2006). Exchange rate misalignment and growth: old and new econometric evidence. *Revista Economia*, 7(4):165–187.

Gary, K. (2003). Bayesian econometrics.

Gelfand, A. E. and Smith, A. F. (1990). Sampling-based approaches to calculating marginal densities. *Journal of the American statistical association*, 85(410):398–409.

Geman, S. and Geman, D. (1984). Stochastic relaxation, gibbs distributions, and the bayesian restoration of images. *IEEE Transactions on pattern analysis and machine intelligence*, (6):721–741.

Ghura, D. and Grennes, T. J. (1993). The real exchange rate and macroeconomic performance in sub-saharan africa. *Journal of Development Economics*, 42(1):155–174.

Glüzmann, P. A., Levy-Yeyati, E., and Sturzenegger, F. (2012). Exchange rate undervaluation and economic growth: Díaz alejandro (1965) revisited. *Economics Letters*, 117(3):666–672.

Goldberg, L. S. (1993). Exchange rates and investment in united states industry. *The review of economics and statistics*, pages 575–588.

Goldfeld, S. M. and Quandt, R. E. (1973). A markov model for switching regressions. *Journal of Econometrics*, 1(1):3–15.

Goya, D. (2020). The exchange rate and export variety: A cross-country analysis with long panel estimators. *International Review of Economics & Finance*, 70:649–665.

Guzman, M., Ocampo, J. A., and Stiglitz, J. E. (2018). Real exchange rate policies for economic development. *World Development*, 110:51–62.

Habib, M. M., Mileva, E., and Stracca, L. (2017). The real exchange rate and economic growth: Revisiting the case using external instruments. *Journal of International Money and Finance*, 73:386–398.

Hamilton, C. and de Vries, G. J. (2023). *The Structural Transformation of Transition Economies*. University of Groningen, Groningen Growth and Development Centre.

Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica: Journal of the Econometric Society*, pages 357–384.

Hamilton, J. D. (2016). Macroeconomic regimes and regime shifts. *Handbook of macroeconomics*, 2:163–201.

Hamilton, J. D. and Raj, B. (2002). New directions in business cycle research and financial analysis. *Empirical Economics*, 27(2):149–162.

Hansen, L. P. (1982). Large sample properties of generalized method of moments estimators. *Econometrica: Journal of the econometric society*, pages 1029–1054.

Hansen, L. P. and Hodrick, R. J. (1980). Forward exchange rates as optimal predictors of future spot rates: An econometric analysis. *Journal of political economy*, 88(5):829–853.

Hansen, L. P. and Hodrick, R. J. (1983). Risk averse speculation in the forward foreign exchange market: An econometric analysis of linear models. In *Exchange rates and international macroeconomics*, pages 113–152. University of Chicago Press.

Harchaoui, T., Tarkhani, F., and Yuen, T. (2005). *The effects of the exchange rate on investment: Evidence from Canadian manufacturing industries*. Bank of Canada.

Hartman, R. (1972). The effects of price and cost uncertainty on investment. *Journal of economic theory*, 5(2):258–266.

Hausmann, R. and Hidalgo, C. A. (2011). The network structure of economic output. *Journal of Economic Growth*, 16:309–342.

Hausmann, R., Pritchett, L., and Rodrik, D. (2005). Growth accelerations. *Journal of Economic Growth*, 10(4):303–329.

He, Z., Kelly, B., and Manela, A. (2017). Intermediary asset pricing: New evidence from many asset classes. *Journal of Financial Economics*, 126(1):1–35.

Herrendorf, B., Rogerson, R., and Valentinyi, A. (2014). Growth and structural transformation. In *Handbook of Economic Growth*, volume 2, pages 855–941. Elsevier.

Herrendorf, B., Rogerson, R., and Valentinyi, A. (2022). New evidence on sectoral labor productivity: Implications for industrialization and development. Technical report, National Bureau of Economic Research.

Herrendorf, B. and Valentinyi, A. (2012). Which sectors make poor countries so unproductive? *Journal of the European Economic Association*, 10(2):323–341.

Hinkle, L. E. and Montiel, P. J. (1999). Exchange rate misalignment: Concepts and measurement for developing countries. Technical report, The World Bank.

Hodrick, R. (2014). *The empirical evidence on the efficiency of forward and futures foreign exchange markets*. Routledge.

Hodrick, R. J. and Prescott, E. C. (1997). Postwar us business cycles: an empirical investigation. *Journal of Money, Credit, and Banking*, pages 1–16.

Hoffmann, M. and Studer-Suter, R. (2017). Systematic consumption risk in currency returns. *Journal of International Money and Finance*, 74:187–208.

Ibarra, C. A. and Blecker, R. A. (2016). Structural change, the real exchange rate and the balance of payments in mexico, 1960–2012. *Cambridge Journal of Economics*, 40(2):507–539.

Ichiue, H. and Koyama, K. (2011). Regime switches in exchange rate volatility and uncovered interest parity. *Journal of International Money and Finance*, 30(7):1436–1450.

IMF (2021). International financial statistics. https://data.imf.org/IFS.

Inklaar, R., Marapin, R., and Gräler, K. (2023). Tradability and sectoral productivity differences across countries. *GGDC Research Nemorandum*, 195.

Isard, P. (2007). Equilibrium exchange rates: assessment methodologies. *IMF Working Papers*, pages 1–48.

Jordà, Ò. and Taylor, A. M. (2012). The carry trade and fundamentals: Nothing to fear but feer itself. *Journal of International Economics*, 88(1):74–90.

Jurek, J. W. (2014). Crash-neutral currency carry trades. *Journal of Financial Economics*, 113(3):325–347.

Kaiser, B., Siegenthaler, M., Spescha, A., and Wörter, M. (2018). The impact of real exchange rates on swiss firms: Innovation, investment, productivity and business demography. study on behalf of the state secretariat for economic affairs seco. Technical report, KOF Studien.

Kaldor, N. (1966). *Causes of the slow rate of economic growth of the United Kingdom: an inaugural lecture*. London: Cambridge UP.

Kamar, B. and Ben Naceur, S. (2007). Gcc monetary union and the degree of macroeconomic policy coordination.

Kandilov, I. T. and Leblebicioğlu, A. (2011). The impact of exchange rate volatility on plant-level investment: Evidence from Colombia. *Journal of Development Economics*, 94(2):220–230.

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics*, 90(1):1–44.

Karnaukh, N., Ranaldo, A., and Söderlind, P. (2015). Understanding fx liquidity. *The Review of Financial Studies*, 28(11):3073–3108.

Kaufmann, S. (2015). K-state switching models with time-varying transition distributions—does loan growth signal stronger effects of variables on inflation? *Journal of Econometrics*, 187(1):82–94.

Kim, C.-J., Piger, J., and Startz, R. (2008). Estimation of markov regime-switching regression models with endogenous switching. *Journal of Econometrics*, 143(2):263–273.

Korinek, A. and Serven, L. (2016). Undervaluation through foreign reserve accumulation: Static losses, dynamic gains. *Journal of International Money and Finance*, 64:104–136.

Krugman, P. (1999). Balance sheets, the transfer problem, and financial crises. *International Tax and Public Finance*, 6:459–472.

Kruse, H., Mensah, E., Sen, K., and de Vries, G. (2023). A manufacturing (re) naissance? industrialization in the developing world. *IMF Economic Review*, 71(2):439–473.

Kuznets, S. S. (1966). *Modern Economic Growth*. Yale University Press.

Lane, M. P. R. and Milesi-Ferretti, M. G. M. (2017). *International financial integration in the aftermath of the global financial crisis*. International Monetary Fund.

Lane, P. R. and Milesi-Ferretti, G. M. (2002). External wealth, the trade balance, and the real exchange rate. *European Economic Review*, 46(6):1049–1071.

Lee, J. and Shin, K. (2000). The role of a variable input in the relationship between investment and uncertainty. *American Economic Review*, 90(3):667–680.

Levy-Yeyati, E., Sturzenegger, F., and Gluzmann, P. (2013). Fear of appreciation. *Journal of Development Economics*, 101(C):233–247.

Lewis, W. A. (1954). Economic development with unlimited supplies of labour. *The Manchester School*, 22(2):139–191.

Li, G., Li, J., and Wu, Y. (2019). Exchange rate uncertainty and firm-level investment: Finding the hartman–abel effect. *Journal of Comparative Economics*, 47(2):441–457.

Libman, E., Montecino, J. A., and Razmi, A. (2019). Sustained investment surges. *Oxford Economic Papers*, 71(4):1071–1095.

Lustig, H., Roussanov, N., and Verdelhan, A. (2011). Common risk factors in currency markets. *The Review of Financial Studies*, 24(11):3731–3777.

Lustig, H., Roussanov, N., and Verdelhan, A. (2014). Countercyclical currency risk premia. *Journal of Financial Economics*, 111(3):527–553.

Lustig, H. and Verdelhan, A. (2007). The cross section of foreign currency risk premia and consumption growth risk. *American Economic Review*, 97(1):89–117.

Lustig, H. and Verdelhan, A. (2012). Exchange rates in a stochastic discount factor framework. *Handbook of exchange rates*, pages 391–420.

Lyons, R. K. et al. (2001). *The microstructure approach to exchange rates*, volume 333. Citeseer.

MacDonald, R. (2000). Concepts to calculate equilibrium exchange rates: an overview. *Bundesbank Series 1 Discussion Paper*.

MacDonald, R. and Vieira, F. V. (2010). A panel data investigation of real exchange rate misalignment and growth. *CESifo Working Paper Series*.

Makalic, E. and Schmidt, D. F. (2015). A simple sampler for the horseshoe estimator. *IEEE Signal Processing Letters*, 23(1):179–182.

Mancini, L., Ranaldo, A., and Wrampelmeyer, J. (2013). Liquidity in the foreign exchange market: Measurement, commonality, and risk premiums. *The Journal of Finance*, 68(5):1805–1841.

Martins, P. M. (2019). Structural change: Pace, patterns and determinants. *Review of Development Economics*, 23(1):1–32.

McMillan, M., Rodrik, D., and Sepulveda, C. (2017). Structural change, fundamentals and growth: A framework and case studies. Technical report, National Bureau of Economic Research.

McMillan, M., Rodrik, D., and Verduzco-Gallo, Í. (2014). Globalization, structural change, and productivity growth, with an update on africa. *World Development*, 63:11–32.

McMillan, M. S. and Rodrik, D. (2011). Globalization, structural change and productivity growth. Technical report, National Bureau of Economic Research.

Meleckỳ, M. and Komárek, L. (2007). The behavioral equilibrium exchange rate of the czech koruna. *Transition Studies Review*, 14(1):105–121.

Melitz, M. J. and Ottaviano, G. I. (2008). Market size, trade, and productivity. *The Review of Economic Studies*, 75(1):295–316.

Menkhoff, L., Sarno, L., Schmeling, M., and Schrimpf, A. (2012). Carry trades and global foreign exchange volatility. *The Journal of Finance*, 67(2):681–718.

Mueller, P., Stathopoulos, A., and Vedolin, A. (2017). International correlation risk. *Journal of Financial Economics*, 126(2):270–299.

Mulder, A. and Tims, B. (2018). Conditioning carry trades: Less risk, more return. *Journal of International Money and Finance*, 85:1–19.

Neumann, R. and Tabrizy, S. S. (2021). Exchange rates and trade balances: Effects of intra-industry trade and vertical specialization. *Open Economies Review*, 32(3):613–647.

Nouira, R. and Sekkat, K. (2012). Desperately seeking the positive impact of undervaluation on growth. *Journal of Macroeconomics*, 34(2):537–552.

Nucci, F. and Pozzolo, A. F. (2001). Investment and the exchange rate: An analysis with firm-level panel data. *European Economic Review*, 45(2):259–283.

Nucera, F. (2017). Unemployment fluctuations and the predictability of currency returns. *Journal of Banking & Finance*, 84:88–106.

Nurkse, R. (1945). *Conditions of International Monetary Equilibrium*. Dept. of Economics and Social Institutions, Princeton University, Princeton, N.J.

Obstfeld, M., Rogoff, K. S., and Rogoff, K. (1996). *Foundations of International Macroeconomics*. MIT press.

OECD (2021a). Business enterprise R&D expenditures. https://stats.oecd.org/Index.aspx?DataSetCode=BERD_INDU.

OECD (2021b). Structural analysis database. https://www.oecd.org/industry/ind/stanstructuralanalysisdatabase.htm.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, 61(S1):653–670.

Pedroni, P. (2004). Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the ppp hypothesis. *Econometric Theory*, pages 597–625.

Peria, M. S. M. (2002). A regime-switching approach to the study of speculative attacks: A focus on ems crises. In *Advances in Markov-Switching Models*, pages 159–194. Springer.

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2):265–312.

Pesaran, M. H. (2015). Testing weak cross-sectional dependence in large panels. *Econometric reviews*, 34(6-10):1089–1117.

Pesaran, M. H., Shin, Y., and Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3):289–326.

Pesaran, M. H., Shin, Y., and Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94(446):621–634.

Pesaran, M. H. and Smith, R. (1995). Estimating long-run relationships from dynamic heterogeneous panels. *Journal of Econometrics*, 68(1):79–113.

Piger, J. (2009). Econometrics: Models of regime changes.

Porcile, G. and Lima, G. T. (2010). Real exchange rate and elasticity of labour supply in a balance-of-payments-constrained macrodynamics. *Cambridge Journal of Economics*, 34(6):1019–1039.

Prasad, E., Rajan, R., and Subramanian, A. (2007). Foreign capital and economic growth. *Brookings Papers on Economic Activity*, 38(1):153–230.

Rapetti, M. (2011). Macroeconomic policy coordination in a competitive real exchange rate strategy for development. Technical report, Working Paper.

Rapetti, M. (2013a). Macroeconomic Policy Coordination in a Competitive Real Exchange Rate Strategy for Development. *Journal of Globalization and Development*, 3(2):1–31.

Rapetti, M. (2013b). The real exchange rate and economic growth: some observations on the possible channels. Technical report, Working Paper.

Rapetti, M. (2020). The real exchange rate and economic growth: A survey. *Journal of Globalization and Development*, 11(2):20190024.

Ravn, M. O., Schmitt-Grohé, S., and Uribe, M. (2012). Consumption, government spending, and the real exchange rate. *Journal of Monetary Economics*, 59(3):215–234.

Razin, O. and Collins, S. M. (1997). Real exchange rate misalignments and growth. *NBER Working Paper No 6174*.

Razmi, A. (2016). Correctly analysing the balance-of-payments constraint on growth. *Cambridge Journal of Economics*, 40(6):1581–1608.

Razmi, A., Rapetti, M., and Skott, P. (2012). The real exchange rate and economic development. *Structural Change and Economic Dynamics*, 23(2):151–169.

RIETI (2021). Industry-specific nominal and real effective exchange rates of 25 countries worldwide. https://www.rieti.go.jp/users/eeri/en/index.html.

Rodrik, D. (2008). The real exchange rate and economic growth. *Brookings papers on economic activity*, 2008(2):365–412.

Rodrik, D. (2013). Unconditional convergence in manufacturing. *The Quarterly Journal of Economics*, 128(1):165–204.

Rodrik, D. (2016). Premature deindustrialization. *Journal of economic growth*, 21(1):1–33.

Rodrik, D. (2018). An african growth miracle? *Journal of African Economies*, 27(1):10–27.

Rogoff, K. (1996). The purchasing power parity puzzle. *Journal of Economic Literature*, 34(2):647–668.

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal*, 9(1):86–136.

Roodman, D. et al. (2006). How to do xtabond2. In *North American Stata Users' Group Meetings 2006*, number 8. Stata Users Group.

Rudebusch, G. D. and Williams, J. C. (2009). Forecasting recessions: the puzzle of the enduring power of the yield curve. *Journal of Business & Economic Statistics*, 27(4):492–503.

Samuelson, P. A. (1964). Theoretical notes on trade problems. *The Review of Economics and Statistics*, pages 145–154.

Sarno, L. (2005). Towards a solution to the puzzles in exchange rate economics: Where do we stand? *Canadian Journal of Economics/Revue canadienne d'économique*, 38(3):673–708.

Sarno, L. and Schmeling, M. (2014). Which fundamentals drive exchange rates? a cross-sectional perspective. *Journal of Money, Credit and Banking*, 46(2-3):267–292.

Sarno, L. and Taylor, M. P. (2002). Purchasing power parity and the real exchange rate. *IMFs Staff Papers*, 49(1):65–105.

Sato, K., Shimizu, J., Shrestha, N., and Zhang, S. (2015). Industry-specific real effective exchange rates in Asia. *RIETI Discussion Papers*.

Sato, K., Shimizu, J., Shrestha, N., and Zhang, S. (2020). New empirical assessment of export price competitiveness: Industry-specific real effective exchange rates in Asia. *The North American Journal of Economics and Finance*, 54:101262.

Schröder, M. (2013). Should developing countries undervalue their currencies? *Journal of Development Economics*, 105:140–151.

Servén, L. (2003). Real-exchange-rate uncertainty and private investment in LDCs. *Review of Economics and Statistics*, 85(1):212–218.

Stein, J. (1995). The natrex model, appendix: international finance theory and empirical reality. *Fundamental Determinants of Exchange Rates*.

Stein, J. L. (1999). The evolution of the real value of the us dollar relative to the g7 currencies. In *Equilibrium Exchange Rates*, pages 67–101. Springer.

Tabrizy, S. S. (2020). Industrial research and development and real exchange rate depreciation in a small open economy. *The World Economy*, 43(9):2490–2523.

Taylor, A. M. and Taylor, M. P. (2004). The purchasing power parity debate. *Journal of Economic Perspectives*, 18(4):135–158.

Taylor, M. P. (2006). Real exchange rates and purchasing power parity: mean-reversion in economic thought. *Applied Financial Economics*, 16(1-2):1–17.

Thirlwall, A. P. (1979). The balance of payments constraint as an explanation of the international growth rate differences. *PSL Quarterly Review*, 32(128).

Timmer, M., de Vries, G. J., and De Vries, K. (2015). Patterns of structural change in developing countries. In *Routledge Handbook of Industry and Development*, pages 79–97. Routledge.

Tipoy, C. K., Breitenbach, M. C., and Zerihun, M. F. (2016). Equilibrium exchange rates and misalignments: The case of homogenous emerging countries. *SPOUDAI-Journal of Economics and Business*, 66(4):3–25.

Üngör, M. (2017). Productivity growth and labor reallocation: Latin america versus east asia. *Review of Economic Dynamics*, 24:25–42.

Vaz, P. H. and Baer, W. (2014). Real exchange rate and manufacturing growth in latin america. *Latin American Economic Review*, 23(1):1–17.

Verdelhan, A. (2018). The share of systematic variation in bilateral exchange rates. *The Journal of Finance*, 73(1):375–418.

Vieira, F. V. and MacDonald, R. (2012). A panel data investigation of real exchange rate misalignment and growth. *Estudos Econômicos (São Paulo)*, 42(3):433–456.

Wand, M. P., Ormerod, J. T., Padoan, S. A., Frühwirth, R., et al. (2011). Mean field variational bayes for elaborate distributions. *Bayesian Analysis*, 6(4):847–900.

Williamson, J. (1983). *The exchange rate system*. Number 332.45/W73e.

Williamson, J. (1990). The washington consensus. *Washington, DC*.

Williamson, J. (1994). *Estimating equilibrium exchange rates*. Peterson Institute.

Wooldridge, J. M. (2002). Econometric analysis of cross section and panel data mit press. *Cambridge, MA*, 108.

World Bank (2021). World integrated trade solution. https://wits.worldbank.org.

Zeira, J. (1990). Cost uncertainty and the rate of investment. *Journal of Economic Dynamics and Control*, 14(1):53–63.

Zviadadze, I. (2017). Term structure of consumption risk premia in the cross section of currency returns. *The Journal of Finance*, 72(4):1529–1566.

Appendices

Appendix for Chapter 1

Figure A1: Distribution of the Misalignment (m4)

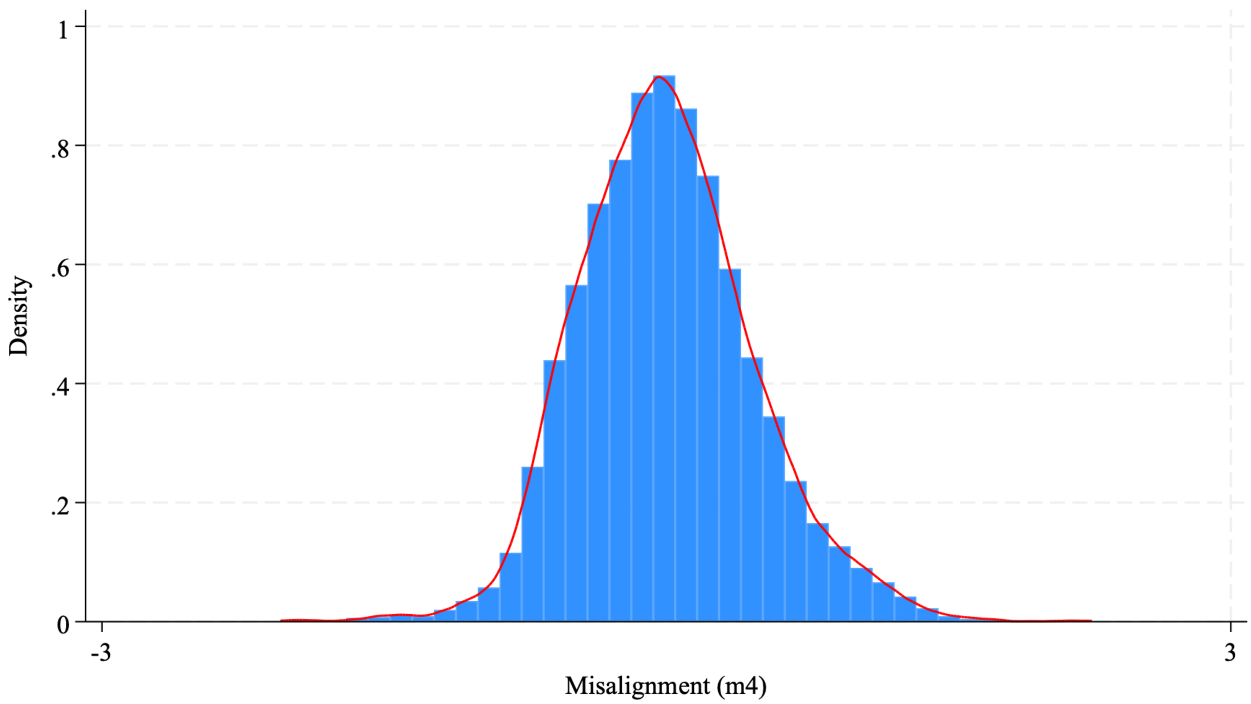


Figure A2: Distribution of the Misalignment (pmg)

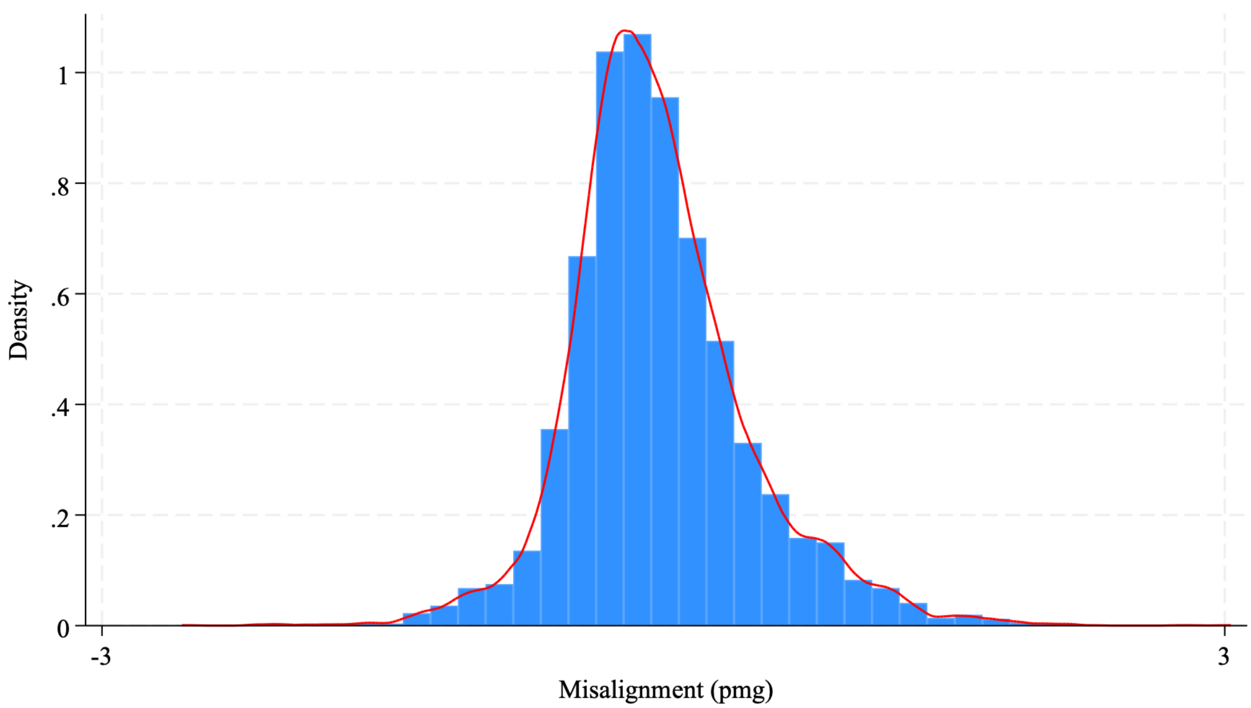


Figure A3: Distribution of the Misalignment (csardl)

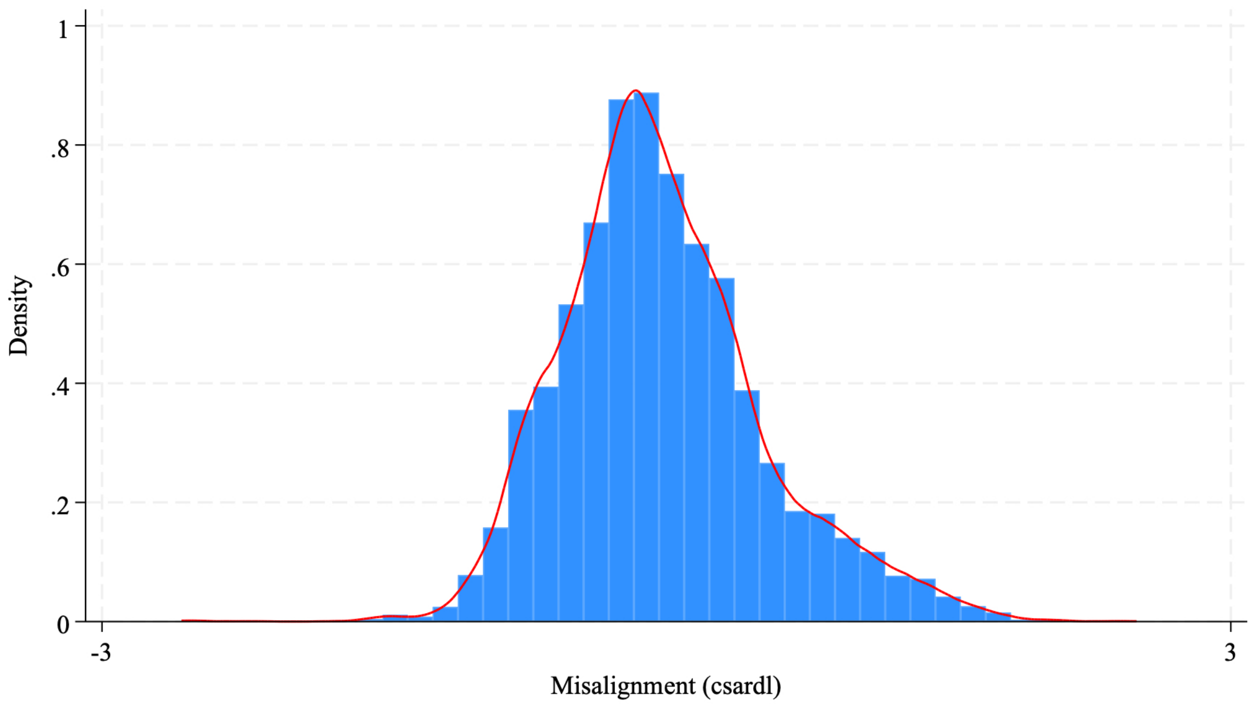


Table A1: List of Countries in the Sample

Region of the World	Country
GGDC 10 Countries	
Sub-Saharan Africa	Botswana, Ethiopia, Ghana, Kenya, Malawi, Mauritius, Nigeria, Senegal, South Africa, Tanzania, Zambia
North Africa	Egypt, Morocco
Asia	China, Hong Kong, India, Indonesia, Japan, South Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand
Latin America	Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru, Venezuela
North America	United States of America
Europe	West Germany, Denmark, Spain, France, United Kingdom, Italy, The Netherlands, Sweden
GGDC/UNU-WIDER Countries	
Developing Asia (14)	Bangladesh, Cambodia, China, India, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Viet Nam
Advanced Asia (6)	Chinese Taipei, Hong Kong (China), Israel, Japan, Korea (Rep. of), Singapore
Latin America (9)	Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru
Middle East and North Africa (4)	Egypt, Morocco, Tunisia, Turkey
Sub-Saharan Africa (18)	Botswana, Burkina Faso, Cameroon, Ethiopia, Ghana, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Uganda, Zambia
GGDC-ETD-TE Countries	
Middle East and Central Asia	Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan
Developing Europe	Belarus, Georgia, Moldova, Russian Federation, Ukraine
Advanced Europe	Estonia, Latvia, Lithuania

Table A2: Classification of Countries by Economic Development: A List of Advanced, Emerging, and Low-Income Countries

Category	Countries
Advanced Economies (AEs)	Estonia, Chinese Taipei, Hong Kong, Israel, Japan, Republic of Korea, Singapore, Latvia, Lithuania
Emerging Markets and Developing Economies (EMDEs)	Argentina, Armenia, Azerbaijan, Belarus, Bolivia, Botswana, Brazil, Chile, China, Colombia, Costa Rica, Ecuador, Egypt, Georgia, India, Indonesia, Kazakhstan, Malaysia, Mauritius, Mexico, Morocco, Namibia, Pakistan, Peru, Philippines, Russia, South Africa, Sri Lanka, Thailand, Tunisia, Türkiye, Ukraine
Low-Income Countries (LICs)	Bangladesh, Burkina Faso, Cambodia, Cameroon, Ethiopia, Ghana, Kenya, Kyrgyzstan, Laos, Lesotho, Malawi, Moldova, Mozambique, Myanmar, Nepal, Nigeria, Rwanda, Senegal, Tajikistan, Tanzania, Uganda, Uzbekistan, Viet Nam, Zambia

Note: The classification of countries into advanced economies, emerging markets, and low-income developing countries is based on the classifications provided by the International Monetary Fund (IMF).
Source: GGDC/UNU-WIDER

Table A3: List of Countries and Classification by Economic Development: Advanced, Emerging, and Low-Income Countries (UNIDO Data Set)

Category	Countries
Advanced Economies (AEs)	Australia, Austria, Belgium, Canada, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, Taiwan Province of China, United Kingdom, United States of America
Emerging Markets and Developing Economies (EMDEs)	Albania, Algeria, Angola, Argentina, Armenia, Aruba, Azerbaijan, Bahamas, Bahrain, Barbados, Belarus, Belize, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Cabo Verde, Chile, China, Colombia, Costa Rica, Dominican Republic, Ecuador, Egypt, El Salvador, Eswatini, Fiji, Gabon, Georgia, Guatemala, Hungary, India, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kuwait, Lebanon, Malaysia, Maldives, Mauritius, Mexico, Mongolia, Montenegro, Morocco, Namibia, North Macedonia, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Qatar, Romania, Russian Federation, Saint Lucia, Saudi Arabia, Serbia, South Africa, Sri Lanka, Suriname, Thailand, Trinidad and Tobago, Tunisia, Turkey, Ukraine, United Arab Emirates, Uruguay, Venezuela
Low-Income Countries (LICs)	Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Republic, Congo, Côte d'Ivoire, Ethiopia, Gambia, Ghana, Haiti, Honduras, Kenya, Kyrgyzstan, Lao People's Dem Rep, Lesotho, Liberia, Madagascar, Malawi, Moldova, Mozambique, Myanmar, Nepal, Nicaragua, Niger, Nigeria, Rwanda, Senegal, Sudan (including South Sudan), Tajikistan, Tanzania, Uganda, Viet Nam, Yemen, Zambia, Zimbabwe

Note: The classification of countries into advanced economies, emerging markets, and low-income developing countries is based on the classifications provided by the International Monetary Fund (IMF).
Source: UNIDO

Table A4: Summary Statistics for Selected Variables

	Observations	Mean	Standard Deviation	Minimum	Maximum
Terms of Trade	2018	0.007	0.225	-1.675	2.071
Net Foreign Assets	1541	-0.332	1.311	-20.161	12.905
Government expenditure	1492	2.724	0.382	0.000	4.257
Investment	1275	3.174	1.164	-5.349	6.242
GDP per Capita	2018	8.644	1.182	5.908	12.228
Human Capital	1727	0.668	0.359	0.007	1.337
Growth rate	1843	0.022	0.042	-0.244	0.312
Misalignment (m1)	2018	-0.014	0.673	-1.977	2.611
Misalignment (m4)	1304	-0.013	0.450	-1.849	1.900
Misalignment (pmg)	1527	-0.046	0.464	-1.641	2.088
Misalignment (csardl)	1527	-0.027	0.509	-1.760	1.711

Source: Authors' calculations
Note: The summary statistics are based on 5-year average data used in the regression analysis. All variables, except Net foreign assets, are presented in logarithmic form. The growth rate variable is reported in decimal form.

Table A5: Summary Statistics

Country	Economy-wide Productivity	Sector with Highest Labor Productivity		Sector with Lowest Labor Productivity	
		Sector	Productivity	Sector	Productivity
Advanced economies					
Hong Kong	74.388	Utilities	531.433	Agriculture	22.500
Denmark	38.799	Mining	1862.567	Business svc	18.284
France	40.777	Utilities	156.811	Business svc	20.485
Italy	39.667	Utilities	231.668	Business svc	5.598
Japan	53.682	Utilities	203.070	Agriculture	16.768
Netherlands	45.891	Mining	1822.944	Personal svc	29.798
Republic of Korea	42.628	Utilities	314.956	Agriculture	18.498
Singapore	77.607	Utilities	258.622	Agriculture	12.353
Spain	39.312	Utilities	251.879	Business svc	18.646
Sweden	39.665	Utilities	228.379	Agriculture	31.838
Taiwan	60.286	Mining	640.894	Construction	19.405
United Kingdom	42.566	Mining	597.060	Agriculture	25.766
United States	83.496	Utilities	367.212	Personal svc	52.366
Emerging markets and developing economies					
Argentina	21.337	Mining	343.479	Personal svc	8.756
Bolivia	6.242	Utilities	56.023	Construction	2.242
Botswana	29.365	Mining	426.987	Agriculture	1.828
Brazil	12.972	Utilities	131.420	Agriculture	4.196
Chile	26.072	Mining	256.056	Agriculture	12.054
China	8.495	Utilities	61.282	Personal svc	1.813
Colombia	14.515	Utilities	222.554	Agriculture	5.820
Costa Rica	17.801	Transport	27.869	Agriculture	10.861
Egypt	17.067	Mining	1364.491	Government	6.730
India	6.172	Utilities	45.276	Agriculture	1.945
Indonesia	7.418	Mining	112.043	Agriculture	2.413
Malaysia	30.557	Mining	1100.251	Construction	11.258
Mauritius	24.930	Mining	95.909	Personal svc	13.960
Mexico	23.488	Mining	409.012	Agriculture	5.826
Morocco	12.808	Business svc	133.572	Agriculture	5.824
Peru	12.325	Mining	97.594	Agriculture	3.429
Philippines	9.722	Utilities	99.684	Personal svc	3.156
South Africa	23.947	Utilities	99.309	Agriculture	4.309
Thailand	12.972	Mining	335.711	Government	2.972
Venezuela	25.988	Mining	536.533	Agriculture	11.257
Low-income developing countries					
Ethiopia	1.146	Utilities	27.437	Agriculture	0.668
Ghana	5.654	Utilities	30.996	Trade svc	3.542
Kenya	3.393	Utilities	34.876	Agriculture	1.778
Malawi	1.895	Mining	39.672	Agriculture	0.882
Nigeria	4.536	Mining	1323.536	Personal svc	0.730
Senegal	4.160	Utilities	129.390	Agriculture	1.348
Tanzania	2.025	Business svc	26.515	Personal svc	0.848
Zambia	6.234	Business svc	62.276	Personal svc	0.636

All data presented in this table are derived from the GGDC 10-sector database. The productivity figures represent averages for the period 2000–2010 and are expressed in terms of 2005 purchasing power parity (PPP) $1,000.
Source: Authors' calculations

Table A6: Summary Statistics

Country	Economy-wide Productivity	Sector with Highest Productivity		Sector with Lowest Productivity	
		Sector	Productivity	Sector	Productivity
Advanced Economies (AEs)					
Estonia	36.049	Realestate	213.690	Other	20.549
Hong Kong	84.326	Other	1098.128	Agriculture	28.903
Israel	55.640	Realestate	1286.544	Other	21.707
Japan	68.925	Realestate	510.248	Agriculture	18.121
Republic of Korea	55.383	Realestate	244.174	Agriculture	22.077
Singapore	84.027	Utilities	495.766	Mining	3.170
Chinese Taipei	75.801	Realestate	1029.708	Agriculture	25.523
Latvia	32.735	Realestate	169.078	Agriculture	15.850
Lithuania	36.201	Realestate	305.152	Agriculture	15.320
Emerging Markets and Developing Economies (EMDEs)					
Argentina	53.399	Mining	769.129	Other	16.742
Armenia	16.319	Realestate	634.085	Agriculture	8.815
Azerbaijan	18.576	Mining	852.843	Agriculture	3.477
Belarus	24.563	Realestate	75.730	Other	12.543
Bolivia	7.849	Realestate	525.431	Agriculture	3.286
Brazil	22.144	Realestate	538.673	Other	4.546
Botswana	28.700	Realestate	572.188	Agriculture	2.237
Chile	36.306	Realestate	500.935	Government	11.229
China	14.067	Realestate	101.307	Agriculture	4.224
Colombia	21.164	Utilities	266.947	Other	4.203
Costa Rica	24.459	Realestate	441.193	Other	9.938
Ecuador	17.186	Mining	294.730	Other	5.734
Egypt	28.763	Mining	2327.208	Other	9.341
Georgia	19.817	Realestate	1964.960	Agriculture	4.899
India	9.118	Utilities	98.915	Agriculture	3.721
Indonesia	13.881	Realestate	317.813	Other	4.732
Kazakhstan	30.941	Realestate	228.005	Agriculture	6.620
Malaysia	41.134	Mining	1006.197	Construction	18.051
Mauritius	33.158	Realestate	904.109	Construction	19.678
Mexico	33.856	Realestate	773.790	Agriculture	8.549
Morocco	15.660	Realestate	929.624	Other	5.641
Namibia	27.713	Realestate	970.309	Other	7.663
Pakistan	11.799	Mining	347.778	Construction	4.033
Peru	15.078	Realestate	481.624	Agriculture	5.754
Philippines	13.317	Realestate	266.191	Other	4.072
Russia	31.968	Mining	197.261	Agriculture	13.875
South Africa	29.638	Realestate	342.221	Agriculture	5.528
Sri Lanka	18.539	Realestate	1751.152	Agriculture	5.649
Thailand	20.108	Mining	419.870	Agriculture	5.639
Türkiye	46.732	Realestate	1360.281	Agriculture	18.682
Tunisia	29.872	Mining	307.985	Construction	10.835
Ukraine	38.565	Manufacturing	106.239	Other	11.957
Uzbekistan	14.601	Realestate	105.212	Other	2.143
Low-Income Countries (LICs)					
Bangladesh	5.869	Realestate	421.403	Agriculture	2.318
Burkina Faso	3.638	Realestate	4120.139	Agriculture	1.465
Cambodia	4.002	Realestate	519.602	Agriculture	1.978
Cameroon	6.291	Realestate	5095.604	Agriculture	1.735
Ethiopia	2.097	Realestate	1815.863	Agriculture	1.239
Ghana	10.017	Mining	62.645	Other	2.627
Kenya	5.022	Realestate	1315.931	Other	1.130
Kyrgyzstan	9.116	Realestate	100.874	Other	4.599

Continued on next page

Table A6: Summary Statistics (Continued)

Country	Economy-wide Productivity	Sector with Highest Productivity		Sector with Lowest Productivity	
		Sector	Productivity	Sector	Productivity
Laos	7.035	Realestate	3530.482	Agriculture	2.686
Lesotho	12.015	Realestate	13324.620	Other	1.569
Malawi	2.655	Realestate	329.637	Agriculture	1.318
Moldova	13.174	Realestate	409.905	Agriculture	6.332
Mozambique	2.642	Realestate	1289.706	Agriculture	0.968
Myanmar	7.280	Realestate	45.692	Other	0.609
Nepal	3.674	Business	50.539	Agriculture	1.883
Nigeria	11.391	Realestate	1187.163	Other	4.065
Rwanda	3.121	Realestate	5948.447	Agriculture	1.394
Senegal	6.681	Business	375.585	Other	2.206
Tanzania	4.276	Realestate	946.414	Agriculture	1.692
Uganda	4.248	Realestate	410.142	Agriculture	1.837
Uzbekistan	14.601	Realestate	105.212	Other	2.143
Viet Nam	6.853	Realestate	577.907	Agriculture	2.813
Zambia	8.233	Realestate	193.743	Agriculture	1.304

Note: All data presented in this table are derived from the GGDC/UNU-WIDER database. The productivity figures represent averages for the period 2000–2018 and are expressed in terms of 2011 purchasing power parity (PPP) $1,000.
Source: Authors' calculations

Table A7: Panel Unit Root Test

	CIPS		Im-Pesaran-Shin		PP-Fisher		ADF-Fisher	
	No trend	With trend	No trend	With trend	No trend	With trend	No trend	With trend
Real exchange rate(log)	-2.233	-2.218	-3.734	11.900	427.973	260.017	433.308	282.177
	(-2.140)	(-2.620)	(0.000)	(1.000)	(0.002)	(0.999)	(0.001)	(0.996)
GDP per capita(log)	-1.982	-2.314	9.569	0.125	271.496	429.345	261.476	319.411
	(-2.140)	(-2.620)	(1.000)	(0.549)	(0.999)	(0.002)	(0.999)	(0.878)
Net foreign asset	-3. 037	-3.131	-8.099	-8.099	933.441	602.244	905.543	593.020
	(-2.140)	(-2.620)	(0.000)	(0.000)	(0.005)	(0.000)	(0.000)	(0.000)
Terms of Trade(log)	-3.230	-3.695	-24.025	-20.575	1417.221	1661.836	514.998	460.860
	(-2.140)	(-2.620)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Government expenditure(log)	-2.581	-2.761	-23.115	-17.766	476.282	998.672	1081.979	823.355
	(-2.140)	(-2.620)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: Levin-Lin-Chu (Null Hypothesis: Panels contain unit roots - common process).
Im-Pesaran-Shin; ADF-Fisher and PP-Fisher(Null Hypothesis: all panels contain unit roots- individual process).
Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.
p-values in parentheses.
Automatic lag length selection based on AIC with a max lag of 4.
Source: Authors' calculations

Table A8: Panel Cointegration Tests:Pedroni and Kao

Panel A: lRER, lGDPC, NFA, lTOT and lGOV	Pedroni	Statistic	Prob
	Modified Philllips-Perron t	0.408	0.341
	Phillips-Perron t	1.464	0.071
	Augmented Dicky-Fuller t	3.368	0.000
Panel B: lRER, lGDPC, NFA, lTOT and lGOV	Kao	Statistic	Prob
	Modified Dickey-Fuller t	-3.398	0.000
	Dickey-Fuller t	-6.416	0.000
	Augmented Dickey-Fuller t	-5.768	0.000
	Unadjusted Modified Dickey-Fuller t	-2.040	0.020
	Unadjusted Dickey-Fuller t	-5.664	0.000

Notes: Null Hypothesis: No Cointegration.
Source: Authors' calculations

Table A9: Correlation Analysis of RER Misalignment Measures

Method	Misalignment(m1)	Misalignment(m4)	Misalignment(pmg)	Misalignment(csardl)
Misalignment(m1)	1.000			
Misalignment(m4)	0.978***	1.000		
Misalignment(pmg)	0.788***	0.802***	1.000	
Misalignment(csardl)	0.762***	0.735***	0.851***	1.000

Notes: Simple correlation coefficient among four misalignment measures.

Table A10: Growth and RER Misalignment(m4)

	Fixed-Effects			GMM-Diff			GMM-Sys		
	I	II	III	IV	V	VI	VII	VIII	IX
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Initial income	-0.064***	-0.081***	-0.082***	-0.304***	-0.178***	-0.075	-0.039*	-0.158***	-0.037*
	(0.004)	(0.006)	(0.006)	(0.076)	(0.043)	(0.053)	(0.023)	(0.042)	(0.022)
Misalignment(m4)	0.059***	0.079***	0.035***	0.066**	0.095**	0.100*	-0.027	0.126***	0.098*
	(0.005)	(0.008)	(0.008)	(0.032)	(0.045)	(0.055)	(0.043)	(0.047)	(0.058)
Investment	0.007***	0.005**	0.004	-0.006	0.005	-0.006	0.004	-0.002	0.007
	(0.002)	(0.002)	(0.003)	(0.023)	(0.014)	(0.017)	(0.025)	(0.010)	(0.009)
Government expenditure	-0.005	0.008	-0.067***	0.006	0.014	-0.041	-0.131***	-0.023	-0.060
	(0.005)	(0.006)	(0.009)	(0.049)	(0.036)	(0.055)	(0.045)	(0.037)	(0.057)
Human capital	0.034*	0.122***	-0.006	0.185	0.576	0.800	0.250***	0.552***	0.298**
	(0.019)	(0.035)	(0.023)	(0.453)	(0.497)	(0.503)	(0.089)	(0.199)	(0.147)
Terms of trade	-0.034***	-0.018	-0.059***	0.228	0.182	-0.201**	-0.118	-0.168	-0.274*
	(0.010)	(0.013)	(0.016)	(0.190)	(0.136)	(0.092)	(0.146)	(0.154)	(0.156)
Constant	0.574***	0.561***	1.026***				0.512***	1.025***	0.270
	(0.039)	(0.056)	(0.069)				(0.148)	(0.286)	(0.231)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	900	425	475	757	351	406	900	425	475
R-squared	0.422	0.493	0.557						
Instruments				21	25	21	33	26	26
AR2 (p-value)				0.229	0.865	0.859	0.437	0.553	0.129
Hansen-J (p-value)				0.244	0.207	0.253	0.294	0.215	0.725

Source: Authors' calculation
Observations are averages over a 5-year period. The misalignment measure is estimated using GDP per capita, net foreign assets (NFA), terms of trade (TOT), and government expenditure (GOV).
Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).
We have collapsed the instruments in order to restrict the number of instruments Roodman et al. (2006).
In both GMM-diff and -system only time dummies are assumed exogenous and used as instruments.
The Hansen test: the null hypothesis is that instruments are not correlated with the residuals.
The Arellano-Bond test, for AR(2) in first difference: the null hypothesis is that the errors in the first difference regression have no second order serial correlation.
Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively.

Table A11: Growth and RER Misalignment(pmg)

	Fixed-Effects			GMM-Diff			GMM-Sys		
	I	II	III	IV	V	VI	VII	VIII	IX
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Initial income	-0.061***	-0.075***	-0.080***	-0.139***	-0.151***	-0.101**	-0.043**	-0.140***	-0.024
	(0.004)	(0.006)	(0.006)	(0.030)	(0.031)	(0.045)	(0.017)	(0.033)	(0.023)
Misalignment(pmg)	0.054***	0.075***	0.020**	0.055**	0.181***	0.029	0.035	0.134***	0.012
	(0.005)	(0.008)	(0.008)	(0.022)	(0.050)	(0.059)	(0.046)	(0.040)	(0.063)
Investment	0.007***	0.006***	0.003	0.040**	-0.050	-0.019	0.012	-0.001	-0.016
	(0.002)	(0.002)	(0.003)	(0.016)	(0.051)	(0.034)	(0.022)	(0.017)	(0.034)
Government expenditure	-0.001	0.020***	-0.073***	-0.075**	0.090*	-0.006	-0.127**	0.032	-0.165***
	(0.006)	(0.007)	(0.009)	(0.033)	(0.051)	(0.106)	(0.052)	(0.042)	(0.062)
Human capital	0.034*	0.124***	-0.002	0.158	0.058	0.313	0.254***	0.580***	0.259*
	(0.019)	(0.035)	(0.023)	(0.250)	(0.293)	(0.438)	(0.058)	(0.225)	(0.149)
Terms of trade	-0.050***	-0.041***	-0.067***	0.002	-0.140	-0.084	-0.300*	-0.058	-0.292
	(0.010)	(0.013)	(0.016)	(0.064)	(0.127)	(0.132)	(0.178)	(0.086)	(0.224)
Constant	0.550***	0.507***	1.029***				0.523***	0.730***	0.529***
	(0.040)	(0.057)	(0.070)				(0.176)	(0.272)	(0.201)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	905	430	475	760	353	407	905	430	475
R-squared	0.399	0.468	0.541						
Instruments				33	17	21	33	26	22
AR2 (p-value)				0.121	0.874	0.156	0.125	0.304	0.200
Hansen-J (p-value)				0.144	0.783	0.110	0.163	0.708	0.689

Source: Authors' calculation
Observations are averages over a 5-year period. The misalignment measure is based on a pooled mean group (PMG) approach, where the equilibrium real exchange rate is estimated using GDP per capita, net foreign assets (NFA), terms of trade (TOT), and government expenditure (GOV).
Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000).
We have collapsed the instruments in order to restrict the number of instruments Roodman et al. (2006).
In both GMM-diff and -system only time dummies are assumed exogenous and used as instruments.
The Hansen test: the null hypothesis is that instruments are not correlated with the residuals.
The Arellano-Bond test, for AR(2) in first difference: the null hypothesis is that the errors in the first difference regression have no second order serial correlation.
Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively.

Table A12: Growth and RER Misalignment(csardl)

	Fixed-Effects			GMM-Diff			GMM-Sys		
	I	II	III	IV	V	VI	VII	VIII	IX
	Full	Developing	Developed	Full	Developing	Developed	Full	Developing	Developed
Initial income	-0.053***	-0.056***	-0.084***	-0.074*	-0.146***	-0.149**	-0.040**	-0.098	-0.020
	(0.004)	(0.007)	(0.006)	(0.041)	(0.055)	(0.061)	(0.019)	(0.073)	(0.032)
Misalignment(csardl)	0.007	0.027***	-0.023***	-0.016	0.030	-0.078	-0.002	0.117*	-0.051
	(0.006)	(0.010)	(0.007)	(0.022)	(0.061)	(0.060)	(0.056)	(0.065)	(0.061)
Investment	0.006***	0.006**	0.002	0.012	0.041	0.017	0.011	0.004	-0.022
	(0.002)	(0.002)	(0.003)	(0.012)	(0.041)	(0.030)	(0.022)	(0.030)	(0.034)
Government expenditure	-0.007	0.018**	-0.080***	-0.053	0.017	-0.177***	-0.127***	0.028	-0.170**
	(0.006)	(0.008)	(0.009)	(0.034)	(0.061)	(0.062)	(0.048)	(0.053)	(0.086)
Human capital	0.061***	0.128***	0.025	0.450**	0.032	-0.053	0.246***	0.471	0.236
	(0.020)	(0.039)	(0.023)	(0.210)	(0.563)	(0.189)	(0.071)	(0.381)	(0.234)
Terms of trade	-0.027**	-0.015	-0.059***	-0.029	-0.018	0.135	-0.313*	-0.097	-0.242
	(0.011)	(0.014)	(0.016)	(0.076)	(0.133)	(0.134)	(0.173)	(0.190)	(0.336)
Constant	0.433***	0.316***	1.049***				0.508***	0.467	0.544**
	(0.041)	(0.059)	(0.071)				(0.159)	(0.494)	(0.223)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	905	430	475	760	353	407	905	430	475
R-squared	0.316	0.348	0.546						
Instruments				33	21	25	33	26	33
AR2 (p-value)				0.119	0.412	0.0986	0.113	0.366	0.349
Hansen-J (p-value)				0.204	0.215	0.560	0.205	0.634	0.162

Source: Authors' calculation
Observations are averages over a 5-year period. The misalignment measure is based on a cross-sectionally augmented autoregressive distributed lag (CS-ARDL) approach, where the equilibrium real exchange rate is estimated using GDP per capita, net foreign assets (NFA), terms of trade (TOT), and government expenditure (GOV). Developing countries are identified by the threshold in per capita GDP used by Rodrik (2008) ($6000). We have collapsed the instruments in order to restrict the number of instruments Roodman et al. (2006).
In both GMM-diff and -system only time dummies are assumed exogenous and used as instruments.
The Hansen test: the null hypothesis is that instruments are not correlated with the residuals.
The Arellano-Bond test, for AR(2) in first difference: the null hypothesis is that the errors in the first difference regression have no second order serial correlation.
Standard errors in parentheses, *, **, *** represents the level of statistical significance at 10%, 5% and 1 %, respectively.

Appendix for Chapter 2

Figure A4: Density Plots

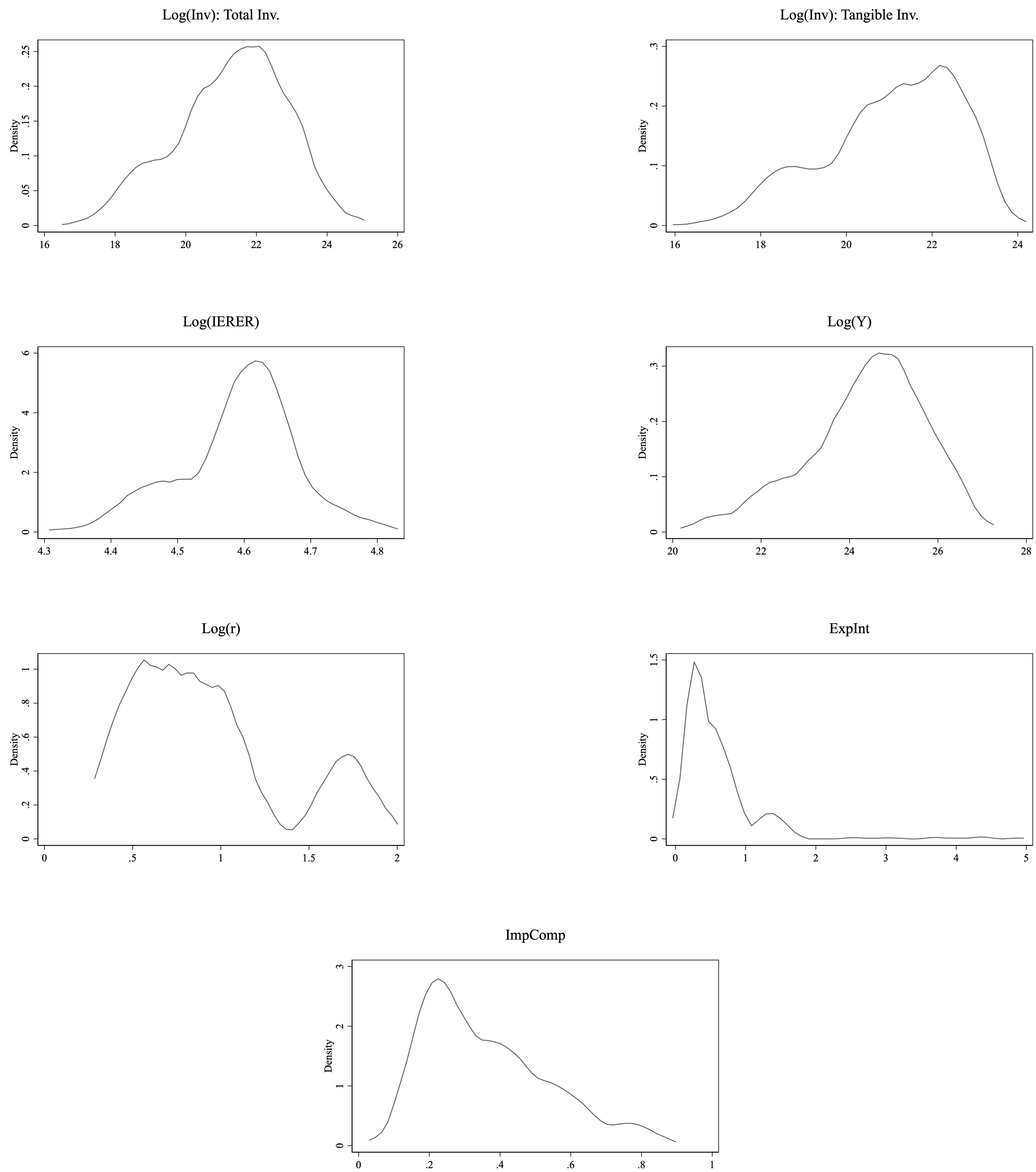


Table A13: Industry Matching

OECD STAN Data	OECD BERD Data	RIETI Data
Food Products and Beverages	Food, Beverage, and Tobacco Products	Food, Beverage, and Tobacco
Tobacco Products	Food, Beverage, and Tobacco Products	Food, Beverage, and Tobacco
Textile, Wearing Apparel, Leather, and Related Products	Textile, Wearing Apparel, Leather, and Related Products	Textile, Textile Products, Leather, and Footwear
Wood and Products of Wood and Cork, Except Furniture	Wood and Products of Wood and Cork, Except Furniture	Wood Products (Excl. Furniture)
Paper and Paper Products	Paper and Paper Products	Paper, Paper Products, Printing, and Publishing
Printing and Reproduction of Recorded Media	Printing and Reproduction of Recorded Media	Paper, Paper Products, Printing, and Publishing
Coke and Refined Petroleum Products	Coke and Refined Petroleum Products	Coke, Refined Petroleum Products, and Nuclear Fuel
Chemical and Pharmaceutical Products	Chemical and Chemical Products	Chemical and Chemical Products
Chemical and Pharmaceutical Products	Basic Pharmaceutical Products	Chemical and Chemical Products
Rubber and Plastic Products	Rubber and Plastic Products	Rubber and Plastic Products
Non-metallic Mineral Products	Non-metallic Mineral Products	Non-metallic Mineral Products
Basic Metals and Fabricated Metal Products, Except Machinery and Equipment	Basic Metals	Basic Metals and Fabricated Metal Products
Basic Metals and Fabricated Metal Products, Except Machinery and Equipment	Fabricated Metal Products, Except Machinery and Equipment	Basic Metals and Fabricated Metal Products
Electrical, Electronic, and Optical Equipment	Computer, Electronic, and Optical Products	Electrical Machinery and Apparatus N.E.C.
Electrical, Electronic, and Optical Equipment	Electrical Equipment	Electrical Machinery and Apparatus N.E.C.
Machinery and Equipment N.E.C.	Machinery and Equipment N.E.C.	Machinery and Equipment N.E.C.
Transport Equipment	Motor Vehicles, Trailers, and Semi-trailers	Transport Equipment
Transport Equipment	Other Transport Equipment	Transport Equipment

Note: We use the OECD's Structural Analysis (STAN) and Business Enterprise R&D (BERD) datasets to obtain the data for industry-level investments, R&D, and output. We also use the data published by the Research Institute of Economy, Trade, and Industry (RIETI) to obtain the industry-specific effective real exchange rate measures.

Appendix for Chapter 3

Appendix A: Hamilton filter

A.1 Hamilton Filter

In this section, we describe the forward-backward algorithm, also known as the Hamilton filter. For a detailed explanation see, Hamilton (1989) and Hamilton (2016). The Hamilton filter proceeds in two steps:

- Prediction Step: The state variable is predicted one period forward

$$\hat{\xi}_{t|t-1} = P\hat{\xi}_{t-1|t-1} \tag{53}$$

where P is the transition probabilities and $\xi_{t|t-1}$ is an estimate of $p(s_t = i|I_{t-1}, \theta)$ where

$$p(s_t = i|I_{t-1,}\theta) = \sum_{j=0}^{1} p(s_t = i|s_{t-1} = j, I_{t-1}, \theta)p(s_{t-1} = j|I_{t-1}, \theta) \tag{54}$$

- Update Step: Update the predicted estimate with information in the data at time t, This can be obtained via:

$$\hat{\xi}_{t|t} = \frac{(\hat{\xi}_{t|t-1} \odot \eta_t)}{1'(\hat{\xi}_{t|t-1} \odot \eta_t)} \tag{55}$$

$$\eta_t = p(y_t|s_t = i, I_{t-1}, \theta) = \frac{1}{\sqrt{2\pi\sigma^2_{s_t}}} exp[\,-\frac{(y_t - x_t\beta_{s_t})(y_t - x_t\beta_{s_t})'}{2\sigma^2_{s_t}}] \tag{56}$$

where $\odot$ indicates element by element multiplication,each element of $\hat{\xi}_{t|t}$ is equal to the normalized $p(s_t|I_t)$. Applying these two steps provides the likelihood function of the model $p(y_t|I_{t-1})$ and $\xi_{t|t}$ or $p(s_t|I_{t-1}, y_t)$.

To start Hamilton filter, we need to specify initial $\xi_{1|0}$. It can be set equal to the unconditional probabilities or can be treated as a separate parameter to be estimated. For the two regime case considered here these unconditional probabilities are given by:

$$p(s_0 = 0) = \frac{1 - p_{11}}{2 - p_{00} - p_{11}} \tag{57}$$

$$p(s_0 = 1) = 1 - p(s_0 = 0) \tag{58}$$

A.2 Sampling $\tilde{s}$

We want to derive the conditional distribution $p(\tilde{S}_t|\sigma^2_{s_t}, \beta_{s_t}, P, \tilde{Y}_t)$ where $\tilde{S}_t = [s_1, ..., s_t]$, $\tilde{Y}_t = [y_1, x_1, ..., y_1, x_1]$. The joint density $p(s_1, s_2, ..., s_t|\tilde{Y}_t)$ can be factored as

$$\begin{aligned}
&p(s_1, s_2, ..., s_t|\tilde{Y}_t) \\
&= p(s_t|\tilde{Y}_t)p(s_1, s_2, ...s_{t-1}|\tilde{Y}_t, s_t) \\
&= p(s_t|\tilde{Y}_t)p(s_{t-1}|s_t, \tilde{Y}_t)p(s_1, s_2, ...s_{t-2}|\tilde{Y}_t, s_t, s_{t-1}) \\
&= p(s_t|\tilde{Y}_t)p(s_{t-1}|s_t, \tilde{Y}_t)p(s_{t-2}|s_t, s_{t-1}, \tilde{Y}_t)...p(s_1|s_2, ..., s_{t-1}, s_t, \tilde{Y}_t)
\end{aligned} \tag{59}$$

The last line can be written as:

$$H(s_t|\tilde{Y}_t)H(s_{t-1}|s_t, \tilde{Y}_{t-1})H(s_{t-2}|s_{t-1}, \tilde{Y}_{t-2})...H(s_1|s_2, \tilde{Y}_1) \tag{60}$$

$$= H(s_t|\tilde{Y}_t) \prod_{t=1}^{t-1} H(s_t|s_{t+1}, \tilde{Y}_t) \tag{61}$$

Hence, the conditional posterior for the state variable to sample from is given by:

$$H(\tilde{s}_t|\sigma^2_{s_t}, \beta_{s_t}, P, \tilde{Y}_t) = H(s_t|\tilde{Y}_t) \prod_{t=1}^{t-1} H(s_t|s_{t+1}, \tilde{Y}_t) \tag{62}$$

Appendix B: Data construction

In this section, we describe the process of our data construction and the definition of variables. We assign $s_{it} = \ln(S_{it})$ and $fr_{it} = \ln(FR_{it})$ to represent the logarithmic nominal spot exchange and logarithmic nominal forward spot exchange rate in terms of U.S dollars per foreign currency, respectively. In this appendix, we mark foreign variables with an asterisk, x_t^*, while U.S variables are denoted without an asterisk, x_t. The conventional time series difference operator is represented as $\Delta x_t = x_t - x_{t-1}$.

Data on daily spot and one-month forward exchange rates are sourced from Barclays and Reuters through Datastream. We utilize this daily data to formulate monthly variables. We define a monthly excess return for a U.S. investor, who borrows in U.S. dollars at the U.S. risk-free rate and purchases a foreign one-month risk-free asset, as $r_{i,t+1} = s_{i,t+1} - (i_t - i_t^*)$. To calculate the cross-country interest rate differential, we employ Thomson's interbank rates. If any observations are missing, we fill them in using $r_{i,t+1} = s_{i,t+1} - f_{i,t}$, following the practice of previous studies like Lustig et al. (2011, 2014); Mueller et al. (2017).This excess return can be seen as the return from purchasing a foreign currency in the forward market in month t and selling it in the spot market in month $t + 1$. This approximation is feasible because, under covered interest parity $(CIP), (i_t - i_t^*) \approx (f_{i,t} - s_{i,t})$. Akram et al. (2008) empirically affirm that CIP is valid over short and long durations.

The interest rate differential is characterized by $i_{i,t} - i_t^*$ .To substitute for missing observations for $\Delta_c i_{it} = i_t - i_{it}^*$, we use the forward discount $f_{i,t} - s_{i,t}$. Following the methodology of Lustig et al. (2011) we eliminate some forward discount observations due to significant failure of Covered Interest Parity (CIP). These include data from South Africa from July to December 1985, Indonesia up to July 2007, and Malaysia from August 1998 to June 2007.

The real exchange rate is defined by e_{it}, which represents the logarithm of the real exchange rate for the i-th country, given by:

$$e_{it} = s_{it} - (p_t - p_{it}^*) \tag{63}$$

This equation implies that a higher value of eit corresponds to a depreciation of the U.S. dollar.

The studies conducted by Lustig et al. (2011); Verdelhan (2018) reveal that the variations observed in currency excess returns across different assets can be effectively explained by two factors, namely the carry and dollar factors.

$$CF_t = \frac{1}{n_{H,t}} \sum_{i \in H} r_{it} - \frac{1}{n_{L,t}} \sum_{i \in L} r_{it} \tag{64}$$

The notation $n_{H,t}$ and $n_{L,t}$ represents the number of currencies with high (low) interest rates in month t. The dollar factor, on the other hand, is derived by taking the average of all currency returns.

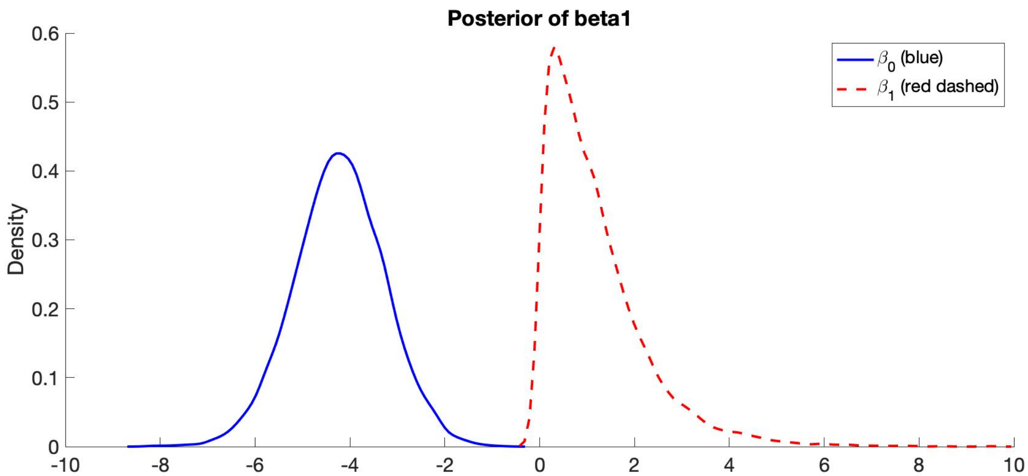
$$DF_t = \frac{1}{n_t} \sum_{i} r_{it} \tag{65}$$

where n_t denotes the number of all currencies in month t.

Data on the aggregate capital ratio of financial intermediaries can be found on Zhiguo He's personal homepage. `https://voices.uchicago.edu/zhiguohe/data-and-empirical-patterns`. The capital ratio is determined by dividing the total market equity by the sum of the market equity and book debt.

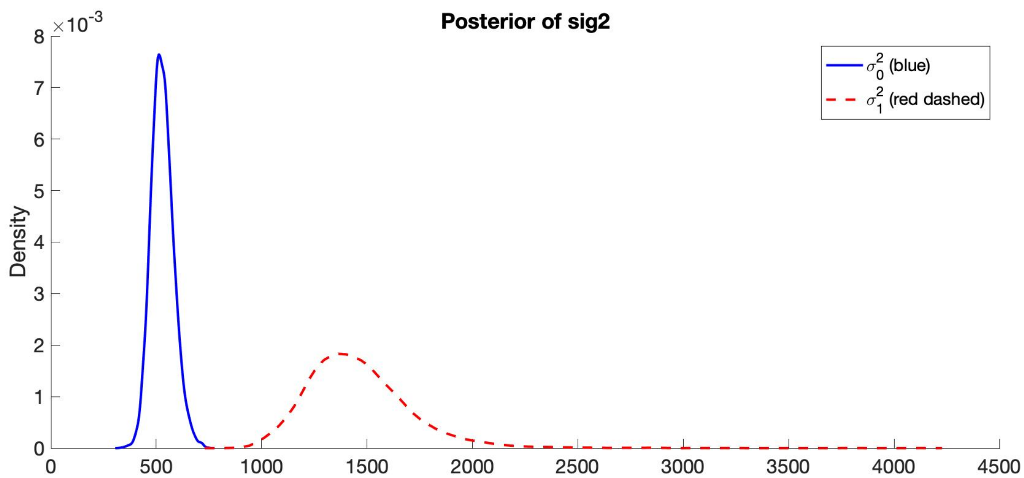
Appendix C: Density Plots

Figure A5: Kernel density estimates of β_1 coefficient



Note:Kernel density estimates of β_1: tthe blue curve represents β_{10}, and the red curve represents β_{11}.

Figure A6: Kernel density estimates of σ_1^2



Note: Kernel density estimates of σ_1^2: the blue curve represents σ_{10}^2 and the red curve represents σ_{11}^2.