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Titel | Title

Substitute or Complement? The Impact of Cryptocurrency Adoption on Remittance Flows in European Economies.

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Arina Riabykh

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Zusammenfassung

Diese Masterarbeit untersucht, ob die Verbreitung von Kryptowährungen traditionelle Kanäle für Auslandsüberweisungen in zehn europäischen Volkswirtschaften ergänzt oder ersetzt. Auf Grundlage von Fixed-Effects-Panelregressionen mit Jahres- und Quartalsdaten für den Zeitraum von 2018 bis 2024 zeigt die Analyse, dass eine verstärkte Nutzung von Kryptowährungen – gemessen an nationalen Kryptoeinnahmen und der Anzahl der MetaMask-Downloads – positiv mit den Auslandsüberweisungen korreliert. Der Zusammenhang ist in Ländern mit hoher systemischer Krypto-Adoption besonders ausgeprägt. Die Ergebnisse deuten darauf hin, dass Überweisungsströme empfindlich auf Transaktionskosten, institutionelle Rahmenbedingungen und den Zugang zu Finanzdienstleistungen reagieren. Insgesamt stützen die Befunde die Komplementaritätshypothese: Kryptowährungen stärken bestehende Überweisungssysteme, anstatt sie zu verdrängen – mit Implikationen für finanzielle Inklusion, die Ausgestaltung politischer Maßnahmen und den Ausbau digitaler Infrastrukturen.

Abstract

This thesis investigates whether cryptocurrency adoption complements or substitutes traditional remittance channels across ten European economies. Using annual and quarterly fixed-effects panel regressions from 2018 to 2024, the study finds that increased crypto usage, proxied by national crypto revenue and MetaMask downloads, is positively associated with remittance outflows. The effect is strongest in countries with high systemic crypto adoption. Results indicate that remittance flows are sensitive to transaction costs, institutional readiness, and financial access. Overall, the findings support the complementarity hypothesis: cryptocurrencies enhance rather than replace conventional remittance systems, with implications for financial inclusion, policy design, and digital infrastructure development.

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1 Introduction

The central objective of this thesis is to investigate how the adoption of cryptocurrencies interacts with traditional financial services, with a particular focus on remittance behavior. Specifically, it explores whether increased cryptocurrency usage serves as a substitute for or a complement to conventional remittance channels in European economies. The broader question underpinning this inquiry is not just *what* is happening in the relationship between crypto and remittances, but *why these dynamics vary across countries*: What macroeconomic, institutional, and technological conditions appear to shape the interaction between cryptocurrency adoption and remittance behavior? And under which circumstances do decentralized financial technologies coexist with (or displace) conventional financial systems at the national level? Although individual motivations are not directly modeled, this thesis draws on behavioral insights from adoption literature and cross-country differences to interpret patterns in remittance flows and crypto engagement.

To address these questions, this thesis undertakes a comparative analysis of ten countries in Western and Eastern Europe. These include high- and moderate-adoption countries, such as Ukraine, the United Kingdom, France, Russia, and Germany, as well as lower-adoption ones like Belgium, Sweden, Norway, Austria, and Portugal. By analyzing this diverse panel, the research seeks to determine whether the growth of crypto adoption displaces traditional remittance services or instead functions in parallel with them, and critically, what economic, behavioral, or institutional drivers underlie this relationship.

The selection of the ten countries was guided by both theoretical relevance and empirical diversity. These countries represent a balanced mix of high, moderate, and low cryptocurrency adoption levels based on their rankings in the Global Crypto Adoption Index from 2020 to 2024 (Chainalysis, 2020–2024). This heterogeneity is essential for capturing cross-country variation in digital finance behavior and allows for the construction of a high-vs-low adoption classification used in interaction analysis. Importantly, the divergence in adoption levels also reflects deeper structural and behavioral contrasts, such as differences in remittance costs, levels of digital literacy, banking access, which may influence whether cryptocurrencies are used as alternatives to or complements of conventional remittance channels.

Geographically, the sample comprises ten European countries: Austria, Belgium, Sweden, Norway, Portugal, the United Kingdom, France, Germany, Ukraine, and Russia[1], selected for their empirical feasibility, regional comparability, and diversity in cryptocurrency adoption levels. This geographic focus ensures consistency in macroeconomic structure and financial infrastructure while allowing for meaningful cross-country contrasts in digital readiness, regulation, and user behavior.

The sample spans both advanced economies with established financial systems (e.g., UK, Germany, Sweden) and more transitional or emerging ones (e.g., Ukraine, Russia), enabling the analysis to assess

[1] Data from Ukraine and Russia were available for core indicators but excluded from demographic tables due to incomplete consumer lifestyle data

whether cryptocurrencies act as complements or substitutes depending on local institutional contexts. Adoption intensity varies widely across the sample, as captured by the Chainalysis Crypto Adoption Index, facilitating structured subgroup comparisons. In addition to macro-level indicators, the availability of detailed demographic and behavioral data further enriches the interpretation of crypto engagement across different adoption environments.

The subject of this research is of growing importance for macroeconomic policy, financial development, and regulatory strategy. As financial systems become increasingly digitalized, emerging technologies such as cryptocurrencies are beginning to reshape the institutional foundations of financial intermediation. Remittances, a crucial and recurring financial behavior, are particularly susceptible to disruption by faster, lower-cost crypto channels that bypass traditional infrastructure. The decision to use cryptocurrency for remittances may be influenced by multiple factors: the desire to avoid fees, long processing times, institutional distrust, or the ability to access decentralized apps via mobile devices. From a macroeconomic perspective, widespread crypto adoption could affect the transmission of monetary policy, broaden financial inclusion, and reduce dependency on traditional banking systems. Understanding these dynamics is especially critical for European countries at various stages of digital financial development, where cryptocurrencies may either challenge or reinforce established remittance channels depending on user behavior and institutional readiness.

To address these questions, the thesis applies a panel data methodology using annual observations from 2018 to 2024 across the ten selected countries. The empirical analysis is based on fixed-effects panel regressions that link remittance outflows to national cryptocurrency revenue, while controlling for macroeconomic and digital infrastructure variables. Among the controls, particular attention is paid to the average cost of sending remittances and the proportion of international migrants in the population, both of which are key structural drivers of remittance behavior. This cross-country panel structure enhances statistical power and generalizability while allowing for heterogeneity in institutional settings and behavioral responses.

In addition to the annual model, this thesis incorporates a quarterly panel regression for the period 2020 Q3 to 2024 Q4. This high-frequency model uses MetaMask wallet downloads as a behavioral proxy for crypto adoption, alongside remittance costs, GDP per capita, and adoption tier classifications - a categoric classification of countries into high, medium, and low crypto adoption groups, informed by Global Crypto Adoption Index rankings. The use of MetaMask data allows for deeper analysis of short-term shifts in user engagement, capturing dynamics that annual data may overlook.

To better understand whether the impact of cryptocurrency usage differs by national context, the quarterly model also introduces an interaction term between MetaMask downloads and cryptocurrency adoption tiers. This interaction enables the testing of whether the relationship between crypto usage and remittance behavior is conditional on the country's systemic level of adoption. This is particularly impor-

tant for distinguishing whether complementary effects are uniform across countries or vary with crypto adoption levels.

To contextualize these macro-level differences and complement the interaction analysis, it is useful to examine the demographic and behavioral characteristics of cryptocurrency users across adoption tiers. Despite differences in adoption levels, several cross-cutting patterns emerge: in both high- and low-adoption countries, cryptocurrency users are predominantly male (65–78%) and younger, particularly among Millennial and Gen Z cohorts. Educational attainment is high across the board, with over half of users in most countries holding a university degree or higher. High-income representation varies more widely: over 50% of users in the UK, Germany, and Norway fall into the high-income category, compared to lower figures in countries like Belgium (35%) and Sweden (42%).

Interest in technology, science, and finance appears as a common behavioral trait among crypto users. Many report digital-first habits, including online banking, gaming, and e-commerce. While these characteristics are not modeled econometrically, they help explain why crypto adoption may be more pronounced in some countries than others. They also shed light on the type of user likely to view crypto as either an extension of their digital financial habits or as an alternative to existing systems.

Finally, country-specific traits remain important. For instance, UK users exhibit strong DeFi participation alongside urban tech engagement, while Portuguese users report the highest willingness to pay for digital services. Austrian and Norwegian users display higher interest in finance and politics, even at lower adoption levels. These national patterns enrich the comparative framework by highlighting how local cultural, economic, and behavioral factors may influence the relationship between cryptocurrency use and financial behavior. For a comparative and detailed overview of user demographics and behavioral profiles across high- and low-adoption countries, see Tables 10 and 11 in the Appendix.

Taken together, these ten countries offer a representative and behaviorally varied empirical base for examining the conditions under which cryptocurrency adoption interacts with traditional financial systems across Europe.

Research Gaps and Contributions. This thesis addresses a significant gap in the prior research by empirically investigating the direct impact of cryptocurrency adoption on remittance outflows using econometric methods. While much of the existing studies focus on emerging markets or descriptive, single-country case studies, particularly in the Global South, there is a notable absence of cross-country panel analyses focused on high-income or digitally mature European economies. Furthermore, prior work has seldom quantified how behavioral and systemic adoption of cryptocurrencies may influence formal remittance channels.

To fill this gap, this research uses both annual and quarterly fixed-effects panel models across ten European countries, capturing the temporal and institutional heterogeneity of the crypto–remittance relation-

ship. It introduces novel proxies for adoption, such as MetaMask downloads, national crypto revenues, and categorical adoption tiers, that reflect everyday usage patterns and structural integration. Interaction terms between behavioral proxies and systemic adoption levels allow the analysis to explore whether the relationship between crypto usage and remittance behavior is conditional on a country's institutional context.

By taking this comprehensive approach, the thesis offers original empirical evidence to ongoing debates about financial innovation, digital inclusion, and the evolving role of decentralized technologies in high-income settings. The findings suggest that cryptocurrencies may enhance, rather than displace, conventional remittance systems, though their effects are mediated by regulatory maturity, financial infrastructure, and user demographics. These insights hold practical implications for policymakers, financial institutions, and fintech developers aiming to balance innovation with financial stability and inclusion.

The remainder of this thesis is structured as follows. Chapter 2 reviews the relevant literature. Chapter 3 describes the data sources, variables, and country selection criteria, while Chapter 4 outlines the empirical methodology and model specifications used in the panel regressions. Chapter 5 presents the estimation results from both quarterly and annual models, followed by Chapter 6, which includes robustness checks to validate the findings. Chapter 7 discusses the implications of the results, linking them to broader policy and financial inclusion debates. Finally, Chapter 8 concludes the thesis and suggests avenues for future research.

2 Literature Review

2.1 Key Concepts and Definitions

To clearly understand the dynamics examined in this thesis, it is important to first define core concepts such as cryptocurrencies, blockchain technology, decentralized finance (DeFi), and traditional banking services. These definitions not only provide technical clarity but also frame the behavioral and institutional contrasts that underlie the substitution and complementarity hypotheses central to this research. *Cryptocurrencies* are decentralized digital assets that utilize blockchain technology to enable secure, transparent peer-to-peer transactions without the need for central intermediaries (Nakamoto, 2008; Härdle et al., 2020). Introduced with the launch of Bitcoin, cryptocurrencies are powered by distributed ledger technology (DLT), cryptographic hashing, and consensus mechanisms such as proof-of-work (PoW) and proof-of-stake (PoS), ensuring data immutability and trustless verification. Their core appeal lies in their ability to facilitate borderless, low-cost transactions, which has made them particularly attractive in contexts where traditional financial systems are expensive, slow, or inaccessible.

Blockchain refers to the decentralized, append-only database architecture that underpins cryptocurrencies. Transactions are recorded across a distributed network of nodes, ensuring transparency and resilience. Beyond cryptocurrencies, blockchain has broader applications in digital identity, supply chain management, and programmable finance through smart contracts (Kumari & Devi, 2022).

Decentralized Finance (DeFi) describes a rapidly evolving ecosystem of blockchain-based protocols that replicate or extend traditional financial services, such as lending, trading, or saving, without relying on centralized institutions. Built predominantly on public blockchains like Ethereum, DeFi allows users to interact directly with financial applications through smart contracts (Zetzsche et al., 2020; Bech & Garratt, 2017). DeFi activity, often measured by protocol transaction volumes, serves as a leading indicator of advanced crypto adoption. Its rise reflects a broader trend toward disintermediation, financial self-custody, and user-driven innovation, particularly among digitally literate and risk-tolerant populations.

Traditional banking services, in contrast, are centralized financial systems operated by regulated institutions offering core functions such as deposits, lending, and remittance transfers. These institutions rely on a high degree of regulatory oversight, institutional reputation, and client trust (Frost et al., 2019; Kumari & Devi, 2022). Their accessibility, speed, and cost can vary widely across countries, which partly explains why users in some settings may turn to decentralized alternatives.

Remittances refer to cross-border personal transfers made by individuals residing abroad to recipients in their country of origin. According to the International Monetary Fund (IMF), remittances typically comprise two components: personal transfers and compensation of employees, both reflecting non-commercial, household-level financial flows (IMF, 2009). Remittances play a crucial role in supporting household consumption, education, and healthcare, and they contribute significantly to financial inclusion in both sending and receiving economies. Because they represent recurring, purpose-driven transactions, remittances provide a particularly useful behavioral lens through which to examine whether individuals are turning to cryptocurrencies out of necessity, convenience, or due to structural inefficiencies in traditional financial systems.

This structural distinction between centralized and decentralized finance is essential for understanding the behavioral mechanisms behind cryptocurrency adoption. Users may adopt crypto technologies either out of necessity (e.g., to bypass remittance fees or banking restrictions) or opportunity (e.g., for portfolio diversification or faster settlement). These underlying motivations help explain whether cryptocurrencies function as substitutes for, or complements to, traditional banking systems.

2.2 Cryptocurrency Adoption and Banking: Disruption or Complementarity?

The academic literature offers divergent perspectives on whether the rise of cryptocurrencies represents a disruptive threat to traditional banking services or a complementary extension of them. This distinction is central to understanding how digital assets interact with conventional financial intermediation, especially in the domain of remittance transfers, which is the core focus of this thesis.

Several researchers emphasize the disintermediating nature of cryptocurrency systems. Zetzsche et al. (2019) highlight that private digital currencies, such as the formerly proposed Libra (now Diem), challenge monetary sovereignty by creating synthetic currencies outside the purview of domestic regulators. Similarly, Hileman and Rauchs (2017) argue that cryptocurrencies facilitate financial transactions without reliance on commercial banks, thereby eroding the traditional banking role in payments, savings, and cross-border money transfers. These views frame crypto as a disruptive innovation, capable of bypassing formal financial institutions and weakening the infrastructure of centralised finance.

Conversely, a growing body of research conceptualizes cryptocurrencies as part of a broader financial evolution, capable of coexisting with existing systems. Bech and Garratt (2017) outline a two-tier model in which central bank digital currencies (CBDCs) and commercial banks can function in parallel, with blockchain-based tools improving payment speed and transparency. Waller (2024) emphasizes that the relationship between crypto and banking depends on contextual variables, such as regulatory frameworks, financial maturity, and digital access, while Kumari and Devi (2022) highlight that blockchain technologies can enhance transparency and efficiency in financial transactions. However, their analysis does not take a direct position on the substitutive or complementary role of crypto, instead identifying potential sectoral applications that may align with either outcome depending on institutional context.

Cross-country empirical studies also indicate that the motivations for cryptocurrency adoption are highly context-specific. In low-income and financially underserved economies, uptake is often driven by high remittance costs, inflation, or limited access to formal financial systems (IMF, 2021; Guo et al., 2025). In contrast, research by Auer and Tercero-Lucas (2021) and Chainalysis (2024) finds that in high-income settings, adoption tends to be driven by investment motives, digital convenience, and increasing participation in decentralized finance (DeFi). While this thesis does not directly test adoption motivations, such evidence provides useful background to interpret observed differences in adoption outcomes across countries.

Frost et al. (2019) further contribute to this discussion by examining the rise of "alternative financial rails" created by BigTech firms. These platform-based systems, which include digital wallets and integrated financial services, offer infrastructures that parallel traditional banking. Although not limited to cryptocurrencies, their findings underline how emerging technologies can reshape financial access, with implications for competition, trust, and the regulatory role of central banks.

Taken together, the literature underscores that the effects of cryptocurrency adoption on banking, and remittance behavior in particular, are not universal but dependent on national context. This reinforces the need for empirical studies that apply cross-country panel analysis to investigate whether higher levels of crypto usage are associated with a reduction or intensification of remittance flows through traditional channels. By employing indicators such as MetaMask downloads, crypto revenue, and adoption tiers, this thesis contributes to a more structured understanding of how digital financial behavior interacts with conventional financial systems across the European region.

2.3 Adoption Patterns

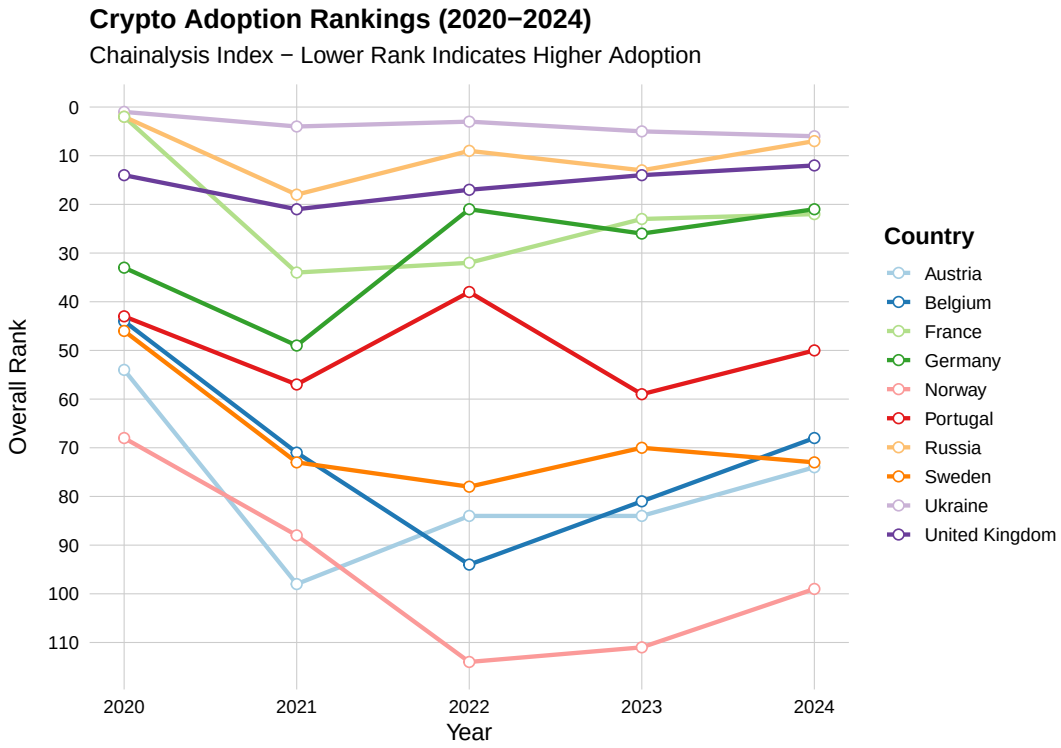

Figure 1: Fluctuations in Overall Crypto Adoption Rankings (2020–2024) across 10 Selected Countries. Based on Chainalysis Global Crypto Adoption Index. Lower rank indicates higher adoption.

Figure 1 shows how overall cryptocurrency adoption rankings have evolved between 2020 and 2024 across the ten countries included in this study. The graph makes it clear that adoption levels differ significantly across countries, and in many cases, these levels also change over time. Since a lower ranking in the Chainalysis Index corresponds to higher adoption, countries near the top of the figure, such as Ukraine, Russia, and the United Kingdom, can be seen as leading adopters. Their high ranking reflects stronger engagement with cryptocurrency platforms, whether through peer-to-peer transfers, investment, or decentralized finance (DeFi) activity.

In 2024, five countries, Ukraine (6^{th}), Russia (7^{th}), United Kingdom (12^{th}), Germany (21^{st}), and France

(22^{nd}), are positioned within or near the top 20 globally. These countries form the high adoption tier used in the panel regression models. While Ukraine and Russia are typically associated with informal, peer-driven use due to financial instability or restricted banking access, countries like the UK, Germany, and France have developed more regulated ecosystems involving exchanges, digital wallets, and DeFi tools. This shows that crypto adoption can emerge under very different conditions, either as a way to avoid weak financial systems or as part of digital investment behavior in advanced economies.

The other five countries, Austria (74^{th}), Belgium (68^{th}), Sweden (73^{rd}), Norway (99^{th}), and Portugal (50^{th}), belong to the medium and low adoption tiers. These countries tend to have fewer users engaging with cryptocurrency services. In some cases, this may reflect strong trust in existing financial institutions or limited interest in alternatives. Norway's especially low rank in 2024 could be explained by its high digital banking usage and relatively low remittance dependency. On the other hand, Portugal, while not among the top performers, has improved steadily over time and may be undergoing a shift toward more active adoption.

The graph also reveals that rankings are not static. For instance, France experienced a sharp drop in its rank in 2021, followed by a recovery in later years. This fluctuation suggests that adoption can be sensitive to regulatory changes, global crypto trends, or national economic conditions. These patterns justify using both cross-sectional and temporal dimensions in the analysis and support the decision to group countries by adoption tier in the econometric model.

Overall, this variation across and within countries highlights why a comparative approach is important. Grouping countries into high, medium, and low adoption tiers based on their overall position in the index provides a meaningful way to analyze how differences in digital adoption relate to traditional financial outcomes such as remittance behavior.

Further breakdowns of DeFi value received and user motivation indices are presented in the Appendix.

2.4 Remittances as a Key Channel

Remittance flows offer one of the clearest real-world applications of blockchain technology in the financial sector. Cross-border money transfers are often slow, costly, and heavily reliant on traditional financial intermediaries. By enabling direct peer-to-peer transactions, distributed ledger technologies have shown promise in improving the efficiency, speed, and transparency of international remittances (Rella, 2019). This potential has made remittances a high-priority use case for both private innovation and public policy reform in financial technology.

The relevance of remittances extends beyond technical improvements. For many migrant-sending households, remittances are not optional, they are regular, purpose-driven financial flows that often serve as a lifeline. While Maurer (2015) does not focus on cryptocurrency specifically, his analysis of remittances as structurally embedded and behaviorally grounded transactions supports the use of remittance flows

as a stable lens through which to evaluate financial behavior. Especially in countries with high remittance costs or limited access to formal banking, crypto-based remittance solutions may emerge as viable alternatives.

This thesis positions remittances as a key channel through which to assess the interaction between cryptocurrency adoption and traditional banking services. Unlike other crypto activities that are investment-led or volatile, remittances provide a stable and policy-relevant dependent variable.

This logic is included in the empirical design of the thesis: quarterly and annual remittance outflows serve as the main outcome variable in panel regression models, with varying crypto adoption indicators used as key predictors. By focusing on 10 European countries with diverse adoption levels and financial infrastructures, the analysis captures both cross-country variation and temporal dynamics. The aim is not simply to measure correlation, but to identify patterns that suggest underlying behavioral shifts in financial access and usage.

In doing so, the study moves beyond conceptual debates to offer a more grounded and testable framework for understanding how cryptocurrencies are integrated (or not) into everyday financial practices.

2.5 Conceptual Pathways: How Crypto May Influence Remittance Behavior

To understand how cryptocurrencies interact with traditional financial systems, particularly in the domain of remittance transfers, it is essential to examine the underlying behavioral and institutional mechanisms that shape user decisions. These mechanisms can operate in different directions, depending on the context in which cryptocurrency adoption occurs.

In some cases, the adoption of cryptocurrencies may lead users to shift away from conventional remittance providers toward decentralized alternatives. This behavioral shift is often motivated by structural inefficiencies in the traditional system, such as high transaction costs, long processing times, or limited accessibility, especially in regions where banking infrastructure is underdeveloped or trust in financial institutions is low. Under such conditions, users may find blockchain-based solutions, including peer-to-peer transfers and mobile wallet applications, to be more efficient, affordable, and transparent. The increasing availability of decentralized applications (dApps) and smartphone-based wallets further lowers entry barriers, making it easier for individuals to send funds internationally without relying on banks or money transfer operators.

However, in other settings, cryptocurrency usage may evolve alongside or even enhance existing financial behaviors. Rather than replacing banks, digital assets may be used in parallel with formal remittance systems, either as a secondary channel or as part of an integrated financial strategy. In countries with high levels of digital literacy and robust financial infrastructure, users might turn to cryptocurrencies not out of necessity, but for convenience, speed, or diversification. Some remittance providers already incorporate blockchain technologies to reduce settlement costs while maintaining fiat-based interfaces,

indicating a growing compatibility between centralized and decentralized systems. Moreover, exposure to crypto services may stimulate broader financial participation, leading to increased engagement with fintech platforms or online banking.

These divergent pathways show the need to analyze financial innovation within its broader context. Whether crypto usage emerges as an alternative or a complement depends on a range of factors, including regulatory frameworks, remittance pricing, financial access, and the cultural perceptions of digital trust. This conceptual framing informs the cross-country analysis that follows, providing a basis for interpreting how different adoption environments shape remittance behavior over time.

3 Data and Design

3.1 Cryptocurrency Data

3.1.1 Annual Data

This subsection introduces the annual cryptocurrency-related indicators used in this study, spanning the period from 2018 to 2024. These variables are drawn from the Statista Market Insights database, which provides harmonized, country-level metrics on digital asset markets. The inclusion of a seven-year period enables panel data analysis that captures both cross-sectional variation and temporal dynamics in cryptocurrency adoption and usage across advanced and developing financial ecosystems.

For clarity, the key indicators used in the dataset are summarized in Table 1.

Table 1: Description of Annual Cryptocurrency Data (2018–2024)

Variable Name	Definition and Description
Crypto Revenue	Total annual revenue generated from cryptocurrency-related services, including transaction fees, commissions from trading activities, and income from crypto-enabled financial products. Reflects the total monetary volume associated with digital asset usage.
Average Crypto Revenue per User	The average annual revenue generated per active user. This metric offers insight into how effectively crypto platforms monetize their user base across countries.
Number of Crypto Users	The estimated number of individuals participating in cryptocurrency ecosystems annually, including users of exchanges, DeFi applications, NFT platforms, and neobanks.
Crypto Penetration Rate	The share of the national population that engages with cryptocurrency products or services, expressed as a percentage. It is used to assess the relative level of adoption.

All indicators are sourced from Statista's Digital Assets module, which provides standardized data through a top-down modeling approach. The estimates are constructed using financial disclosures from leading industry players, user survey data (e.g. Statista Consumer Insights), and country-level macroeconomic indicators. The modeling process accounts for GDP, population, internet penetration, online banking rates, and app usage to generate harmonized market size approximations. Only B2C market participants are included in scope.

The inclusion of this dataset enables detailed analysis of how national market structures differ in their adoption of digital assets.

Figures 2 and 3 show the annual change of total cryptocurrency revenue across the selected sample of countries from 2018 to 2024. The upper panel illustrates the trajectory for high-revenue countries - Russia, Germany, France, and the United Kingdom - while the lower panel focuses on the remaining countries with lower market volumes: Austria, Belgium, Norway, Portugal, Sweden, and Ukraine.

In the high-revenue group, a sharp acceleration in crypto revenue is evident between 2020 and 2021. Russia and Germany exhibit the highest peaks, with Russia reaching over USD 3.5 billion in 2024. Although all four countries experienced a revenue dip in 2022–2023, a strong rebound occurred by 2024, suggesting the resilience of crypto platforms in mature financial systems. This revenue surge aligns with increased trading volumes, institutional interest, and the rise of decentralized finance (DeFi) in advanced markets.

In contrast, the lower-revenue countries, displayed in Figure 3, show a more modest yet steady increase in crypto revenues over the same period. Notably, Austria, Belgium, and Sweden experienced significant gains in 2024, approaching the USD 600 million mark, while Ukraine and Portugal remained below USD 400 million. These countries demonstrate consistent growth without the same level of volatility as high-revenue counterparts.

From an empirical perspective, this divergence between high- and low-revenue countries provides an important foundation for analyzing heterogeneity in crypto adoption. The revenue differences not only reflect varying levels of digital financial infrastructure and user maturity but also inform the explanatory power of adoption intensity in the panel regression models. By disaggregating countries based on their market size, this study can better isolate the substitution or complementarity effects between cryptocurrency activity and traditional banking indicators such as remittances.

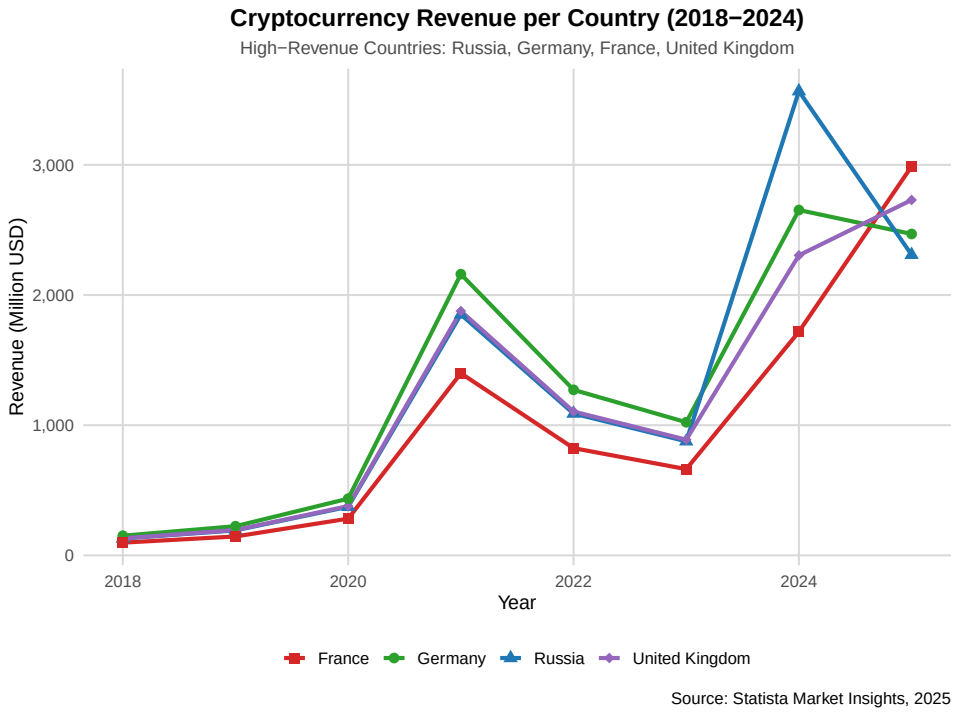

Figure 2: Cryptocurrency Revenue in High-Revenue Countries (2018–2024).

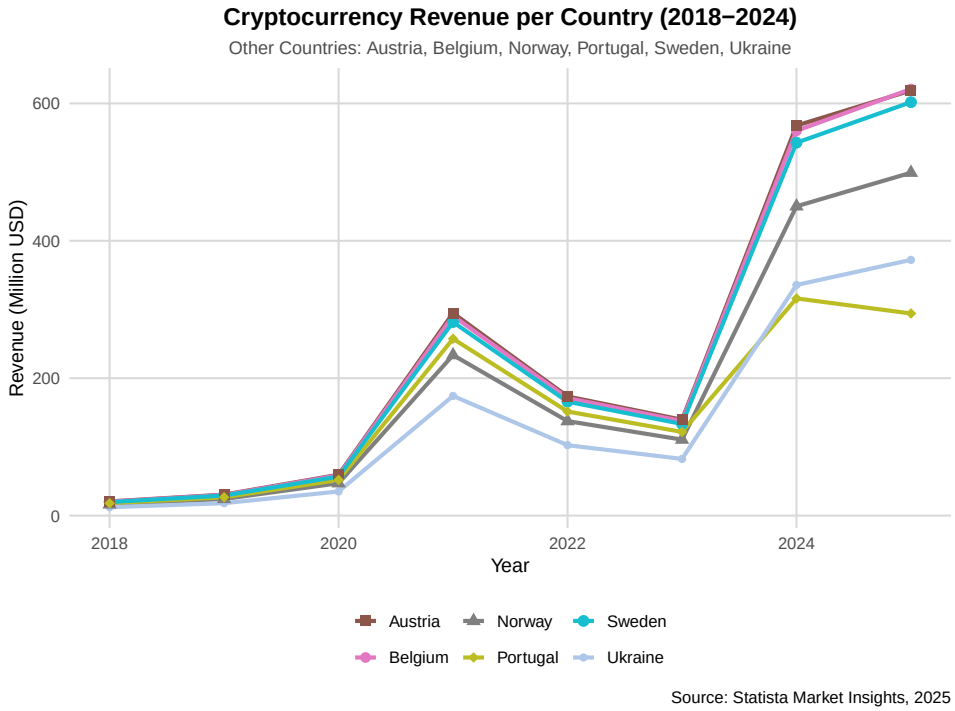

Figure 3: Cryptocurrency Revenue in Low-Revenue Countries (2018–2024).

A crucial proxy for crypto adoption is the penetration rate, reflecting the share of the population using crypto services. As seen in Figure 4, countries like Norway and Austria exhibit remarkably high levels of penetration by 2024, while Ukraine and Russia still lag behind, even though based on the Chainalysis

reports general level of crypto adoption in these 2 countries is amoung the top. These patterns offer empirical motivation for treating adoption intensity as a heterogeneous explanatory factor in the panel regression models.

While total revenue reflects market size, the revenue per user and number of users (shown in the appendix) illustrate differences in user monetization and scale. These indicators jointly help capture whether growth in digital asset markets is driven by adoption volume or user intensity. Together, these annual indicators form the foundation of the econometric models explored in the next section.

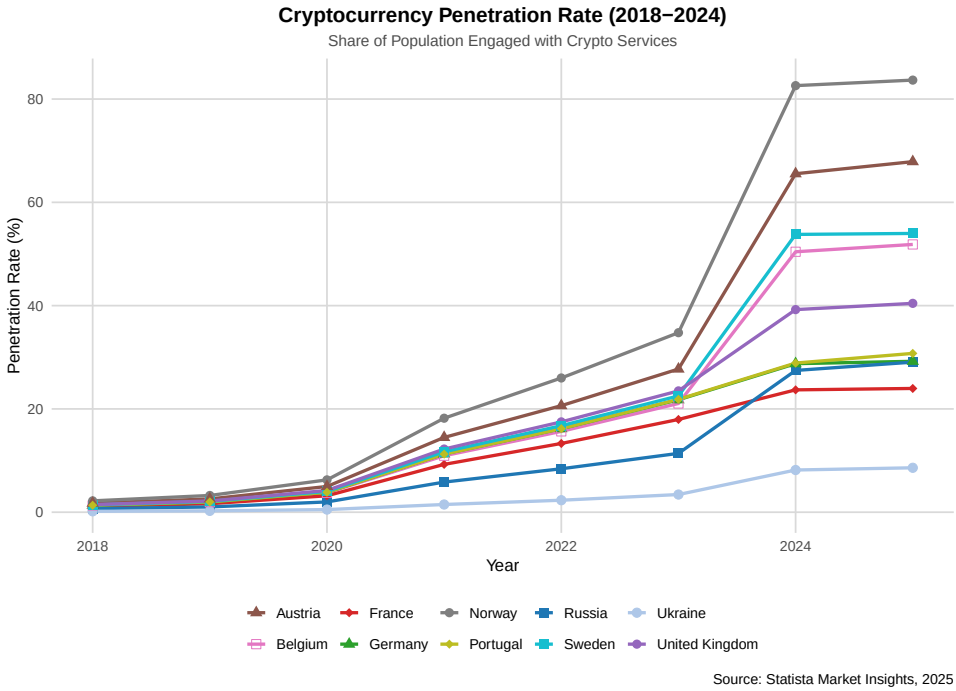

Figure 4: Cryptocurrency Penetration Rate by Country (2018–2024)

In addition to the core cryptocurrency usage metrics, this study incorporates a specifically constructed measure of national adoption intensity using the Chainalysis Global Crypto Adoption Index. This index is used to classify countries into three distinct adoption tiers: high, medium, and low and included as a categorical control variable in the regression models.

As provided by the authors of the respective reports, the Chainalysis index is built upon four sub-indexes, each representing a different aspect of crypto-related activity: on-chain retail value received, on-chain retail transfers, peer-to-peer (P2P) exchange trade volume, and decentralized finance (DeFi) protocol usage. For each sub-index, countries are ranked based on estimated transaction volumes derived from web traffic data associated with crypto services and platforms. The final index score for each country is the geometric mean of its normalized sub-index rankings, scaled from 0 to 1. A value closer to 1 indicates higher relative adoption.

While Chainalysis acknowledges the limitations of web traffic data, they note that the dataset is drawn

from over 13 billion visits and hundreds of millions of transactions. Further validation is conducted by cross-referencing with insights from regional experts and local market operators.

For the purposes of this thesis, countries are categorized into three adoption groups based on their overall Chainalysis ranking as follows:

Table 2: Country Grouping by Crypto Adoption Intensity (Based on Chainalysis Ranking)

Adoption Group	**Chainalysis Ranking Criteria**
High adoption	Countries ranked in the global **top 30**
Medium adoption	Countries ranked between **31 and 70**
Low adoption	Countries ranked **below 70**

This classification provides a discrete proxy for national adoption intensity and helps account for differences in technological engagement across countries. The categorical variable Adoption Tier is subsequently included as a control in the annual panel regression to test whether the level of crypto adoption moderates the relationship between cryptocurrency use and traditional banking behavior.

3.1.2 Quarterly Data

To complement the annual adoption indicators, this study incorporates higher-frequency data on cryptocurrency engagement by tracking MetaMask wallet downloads at the quarterly level for the period Q3 2020 to Q4 2024. MetaMask is one of the most widely used decentralized wallet applications, as such, download data for MetaMask provides a behaviorally grounded proxy for quarterly cryptocurrency adoption across countries.

The dataset used records the number of new MetaMask wallet installations by country and quarter. While the variable MetaMask Downloads does not directly capture transaction volumes or user account activity, it offers a valid approximation of user onboarding intensity, particularly for technologically engaged retail users. MetaMask adoption patterns have been shown to correspond closely with major ecosystem trends such as DeFi booms and market cycles.

Figure 5 presents a stacked area chart of MetaMask downloads over time across the ten countries in this study. The surge during 2021, particularly in Russia, Ukraine, and the United Kingdom, reflects increased global interest in decentralized technologies during the DeFi expansion wave. A notable dip occurred during 2022, coinciding with the broader crypto market contraction. Subsequently, partial recovery is observed in 2023–2024, with renewed uptake in key markets such as Germany and France.

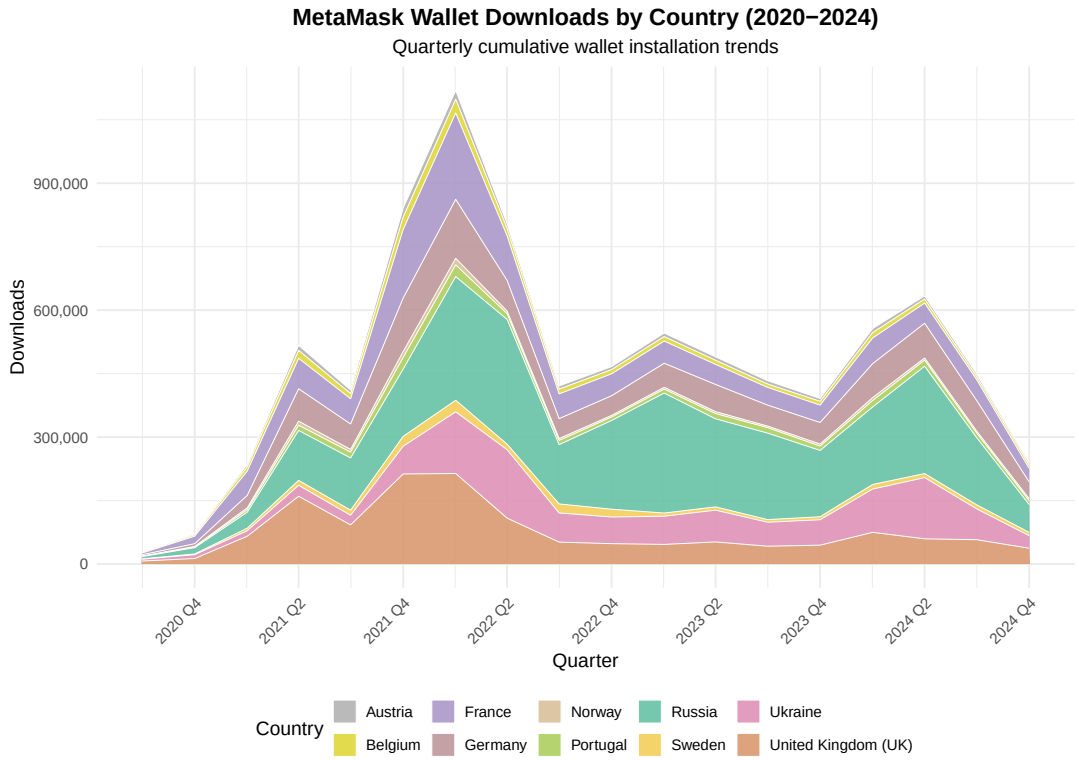

Figure 5: MetaMask Wallet Downloads by Country (2020–2024): Quarterly cumulative wallet installation trends; Statista

The MetaMask variable is included in the quarterly panel regressions as a time-varying proxy for crypto adoption. The use of quarterly data significantly increases the number of observations available for estimation compared to annual models, thereby enhancing statistical power and the robustness of the results. This higher frequency enables a more specific analysis of the relationship between cryptocurrency engagement and traditional financial behavior, including remittance outflows. Moreover, the expanded time resolution allows for the modeling of short-term dynamics, which are often obscured in annual datasets.

Nevertheless, the use of MetaMask downloads as a proxy comes with limitations. First, the variable reflects app installations rather than unique users or active usage. Second, it captures only one specific access point to the crypto ecosystem and excludes centralized exchange activity. Despite these limitations, the variable remains a valuable behavioral signal, especially in the absence of more exact on-chain user data at the country level.

3.2 Traditional Banking Data

This thesis focuses on remittance outflows as the primary dependent variable when analyzing the relationship between cryptocurrency adoption and traditional banking services. This decision is grounded in the remittance profile of the selected countries, the majority of which are net senders of remittances.

These countries host large migrant populations who regularly transfer money to their countries of origin, making outflows a more relevant and representative metric of traditional cross-border financial behavior. In contrast, remittance inflows are generally less significant in these economies and may not accurately reflect domestic engagement with international transfer systems. Additionally, the theoretical motivation of this research lies in examining whether the increasing use of cryptocurrencies (often promoted as a faster and cheaper alternative) serves as a substitute or complement to traditional remittance channels. This substitution effect is more likely to manifest on the sending side, where users choose between bank-based and crypto-based transfer mechanisms.

The data on remittance outflows are obtained from the International Monetary Fund's Balance of Payments (BoP) statistics and cover the period from the first quarter of 2016 (2016 Q1) to the fourth quarter of 2024 (2024 Q4). This dataset provides quarterly values in current U.S. dollars for the relevant remittance-related components, allowing for both high-frequency panel analysis and annual aggregation.

To construct the total outflow of remittances, this thesis follows the methodology outlined by the World Bank, which defines personal remittances as the sum of two components: personal transfers and compensation of employees. Personal transfers include all current transfers in cash or in kind made by resident households to nonresident households. This captures a wide range of international transfers between individuals, including support sent to family members abroad. Compensation of employees, on the other hand, refers to the income earned by border, seasonal, or short-term workers employed in economies where they are not considered residents, as well as by residents working for nonresident employers.

According to the IMF's Balance of Payments Manual (sixth edition), these two components are reported separately as standard items. For the purpose of this study, both components are taken from the debit side of the BoP accounts, representing money sent out of the reporting country. These values are summed to calculate the total quarterly remittance outflow per country. For the annual analysis, the quarterly values are aggregated to generate yearly totals.

This procedure was undertaken because the World Bank only reports personal remittances on an annual basis, whereas this thesis requires quarterly-level data to perform high-frequency panel analysis. To address this gap, quarterly data on personal transfers and compensation of employees were obtained separately and aggregated in accordance with the World Bank's definition. After calculating total remittance outflows using this method, the resulting annual aggregates were compared to the officially reported values by the World Bank. The comparison showed that the computed annual figures matched the World Bank data exactly, which validates the accuracy and reliability of the methodology used.

This consistent construction ensures comparability across countries and time periods, aligning with global standards for measuring remittance flows while capturing the full spectrum of traditional remittance activity.

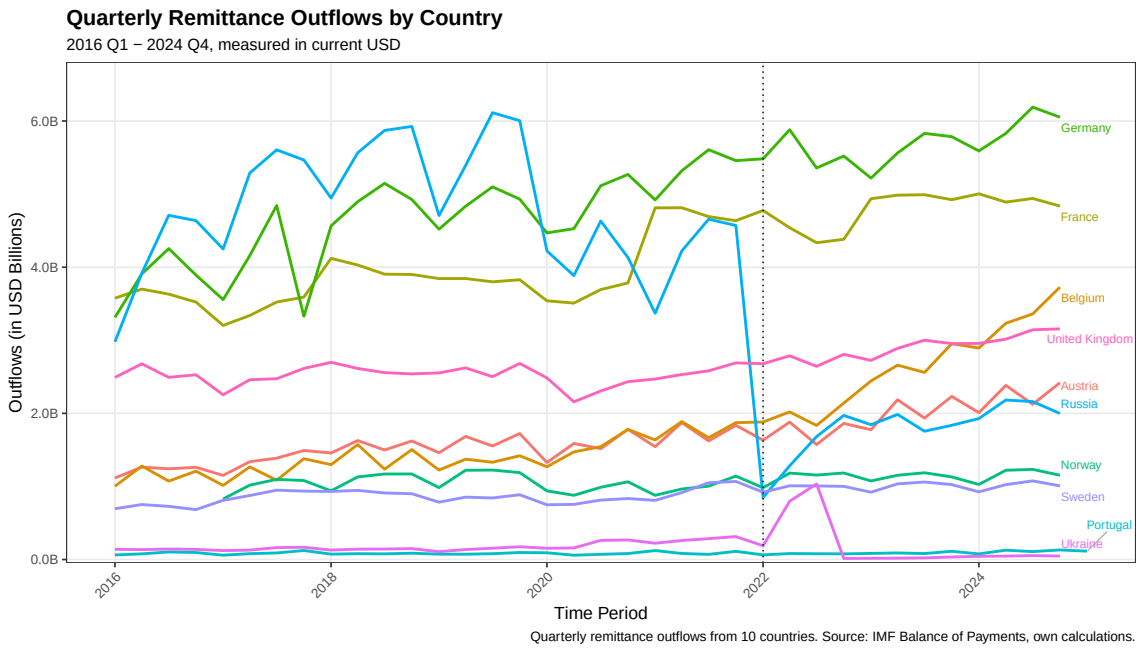

Figure 6: Quarterly remittance outflows from 10 countries. Source: IMF Balance of Payments, own calculations.

Figure 6 illustrates the evolution of quarterly remittance outflows between 2016 Q1 and 2024 Q4 across the ten countries included in this study. Several key patterns are observable. First, Germany, France, and Russia consistently record the highest outflows, reflecting their status as major migrant destination countries. The United Kingdom, Belgium, and Austria follow with medium levels of outbound remittances, while countries such as Norway, Sweden, and Portugal exhibit lower but steady trends. Ukraine, which is primarily a remittance-receiving country, registers negligible outflows, with a temporary spike in 2022 likely due to geopolitical disruptions.

A vertical dotted line marks the beginning of 2022, providing a reference for interpreting potential structural changes. Notably, sharp discontinuities are visible for Russia and Ukraine around this period, corresponding to international sanctions and conflict-induced migration dynamics.

The variation in levels and volatility of outflows across countries justifies the inclusion of country fixed effects and time-varying controls in the empirical strategy. Furthermore, the quarterly resolution of the data enables the identification of short-term behavioral shifts, which are particularly relevant for analyzing substitution or complementarity between traditional and crypto-based remittance mechanisms. The next subsection outlines the control variables included in the regression models, capturing macroeconomic and financial factors that may influence remittance behavior alongside cryptocurrency adoption.

3.3 Control Metrics

To ensure robust estimation of the impact of cryptocurrency adoption on traditional remittance behavior, several control variables are included in the empirical models. These controls account for country-

level differences in financial infrastructure, macroeconomic context, and remittance-related transaction costs. The specification of control metrics differs slightly between the annual and quarterly models, depending on data availability. Accordingly, the control variables are grouped into three categories: Annual Controls, Quarterly Controls, and Controls Included in Both Models.

Annual Controls

The annual panel regression models include two key country-level control variables.

First, Bank Account Penetration, measured as the percentage of adults holding a bank account, serves as a proxy for access to formal financial services. Countries with higher penetration are expected to rely more on conventional banking channels, potentially reducing the demand for cryptocurrency-based alternatives. This variable is sourced from Statista Market Insights and is available for the period 2018 to 2024.

Second, the annual model includes Migrant Stock as a Percentage of Population, which captures structural differences in remittance incentives. Countries with a larger share of international migrants tend to exhibit higher outbound remittances. This variable was constructed by the author based on data from the United Nations Department of Economic and Social Affairs, Population Division (2024), International Migrant Stock, which reports migrant stock figures for the years 2005, 2010, 2015, 2020, and 2024. Linear interpolation was used to estimate annual values between 2018 and 2024. These interpolated estimates were then divided by national population figures to obtain percentage shares. While interpolation introduces approximation, it provides a consistent proxy for migration-driven remittance behavior across countries.

Although the dataset does not specify the origin countries of the migrant populations, further insight is provided in the following subsection, where Table 3 presents the most common remittance destinations by sending country. These destinations, such as Nigeria, India, Morocco, and Turkey, indicate that a significant portion of remittance-sending migrants likely originate from non-EU countries. This reinforces the relevance of migrant stock as a control, as it reflects the demographic structures most likely to engage in outbound remittance activity.

GDP per capita is not included in the annual specification due to its high collinearity with Bank Account Penetration. Since both variables are correlated with financial development, only one is retained to avoid multicollinearity. Bank Account Penetration is selected as the more directly relevant indicator of financial inclusion.

Quarterly Controls

In the quarterly regressions, GDP per capita is introduced as a macroeconomic control variable, serving as a proxy for income levels. Higher GDP per capita is associated with greater remittance-sending

capacity and possibly lower sensitivity to transaction costs. Quarterly GDP per capita data are sourced from the OECD and reported in US dollars using the expenditure approach. The dataset spans from 2016 Q1 to 2025 Q1.

Controls Included in Both Models

Two control variables are consistently included in both annual and quarterly specifications:

(1) Average Cost of Sending a Remittance: This variable captures the total cost of sending a standard USD 200 transfer from a given country, including both the explicit transaction fee and the foreign exchange margin, in accordance with the methodology developed by the World Bank Remittance Prices Worldwide (RPW) database. [2]

The RPW defines this total cost as the percentage markup over the principal amount transferred, standardizing all corridor-specific observations to allow for consistent international comparison.

The RPW dataset reports these costs quarterly and disaggregates them by sending country and destination corridor. For the purposes of this thesis, the data were first filtered to include only sending countries from the European region included in the analysis. The corridor-level data were then aggregated to obtain the simple average total cost of sending USD 200 from each country across all destinations in a given quarter. This average was constructed using all available remittance service providers (RSPs) that disclose both their fees and applicable exchange rates, in accordance with RPW transparency criteria.

To generate a consistent panel, these quarterly figures were then averaged to obtain annual values for use in the annual model specifications. In the quarterly regressions, the original quarterly values are retained. The variable is expressed as a percentage of the USD 200 amount and reflects structural differences in the remittance pricing environment across countries and over time.

Inclusion of the remittance cost variable serves both theoretical and empirical purposes. From a theoretical standpoint, transaction costs are a key determinant of remittance behavior: higher costs may deter the use of formal financial channels and increase the appeal of alternative mechanisms, such as cryptocurrencies. Empirically, the variable helps isolate the effect of crypto adoption by adjusting for cross-country and temporal variation in traditional remittance channel costs, thereby mitigating omitted variable bias in the estimation of substitution or complementarity effects.

[2] For detailed methodology, see: World Bank SmaRT Methodology PDF.

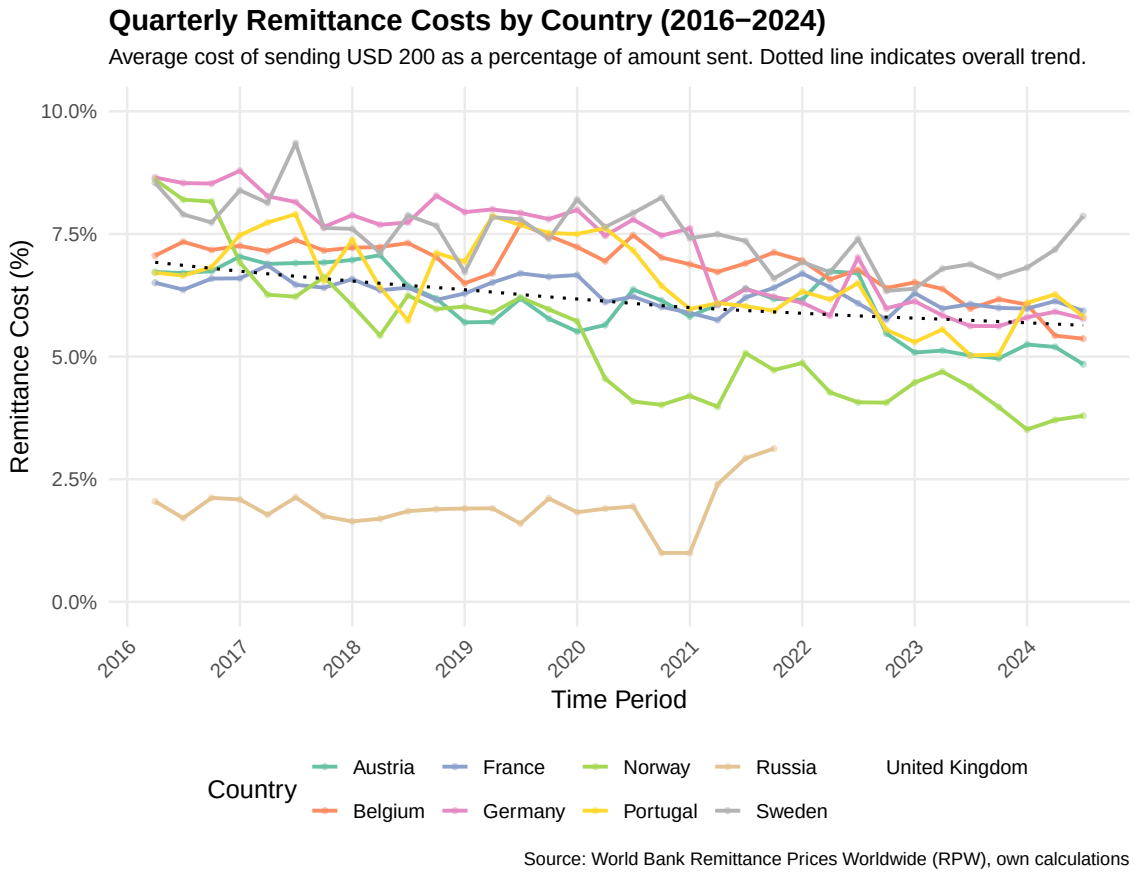

Figure 7: Quarterly Remittance Costs by Country (2016–2024).

Figure 7 shows the evolution of quarterly remittance costs across countries in the sample. A general downward trend is visible from 2016 to 2024, though cross-country variation remains notable. Russia consistently exhibits the lowest costs, while countries like the United Kingdom, Sweden, and France remain above the UN Sustainable Development Goal target of 5%. Portugal, Germany, and Austria show moderate declines. The dotted trend line represents the average cost across all countries and highlights a significant drop after 2018, justifying the inclusion of this variable as a control.

Notably, Ukraine is not included in the RPW database. To preserve Ukraine in the panel and still assess the role of remittance costs, two versions of the model are estimated: one excluding Ukraine but including the cost variable, and one that omits this control to retain Ukraine in the main sample.

To further contextualize the significance of remittance cost as a control, Table 3 provides an overview of the top remittance destinations by sending country, based on the World Bank's Remittance Prices Worldwide (RPW) database.

Table 3: Top Remittance Destinations by Sending Country (Based on RPW Data)

Sending Country	**Top Remittance Destinations**
Austria	Croatia, Hungary, Turkey, Kosovo, Serbia
Belgium	Morocco, Congo (Dem. Rep.), Turkey, Algeria
France	Morocco, Senegal, Côte d'Ivoire, India, Cameroon
Germany	Romania, Ghana, India, Morocco, Nigeria
Norway	Pakistan, Poland
Portugal	Angola, Mozambique, Brazil, Cape Verde, Guinea-Bissau
Russia	Uzbekistan, Tajikistan, Kyrgyzstan, Armenia, Azerbaijan
Sweden	Somalia, Iraq, Lebanon, Syria, Turkey
United Kingdom	Nigeria, India, Pakistan, Ghana, Bangladesh

Note: The destinations listed are those most frequently recorded for each sender in the World Bank Remittance Prices Worldwide (RPW) database. Ukraine is not included in the original RPW dataset as a sending country and is therefore absent from this table.

This table highlights the geographic diversity of destination countries and underscores the importance of accounting for remittance cost heterogeneity in the analysis. The listed destinations vary widely in terms of financial infrastructure, corridor competition, and geopolitical risk, all of which directly influence the cost of sending funds. For example, corridors from EU countries to sub-Saharan Africa or South Asia tend to be more expensive due to higher regulatory and compliance costs. In contrast, remittances sent to Central Asia from Russia often benefit from regional proximity, lower costs, and established payment mechanisms.

Including this contextual information enhances the methodological robustness of this research: by including average remittance costs as a control, the model adjusts for country-specific remittance patterns and corridor-level pricing dynamics. This ensures that the estimated effects of cryptocurrency adoption are not merely capturing differences in traditional remittance infrastructure or pricing barriers but instead reflect genuine changes in financial behavior.

(2) Cryptocurrency Adoption Tier: Derived from the Chainalysis Global Crypto Adoption Index, this categorical variable, introduced in the earlier section of this research, classifies countries into:

- High adoption: Countries ranked in the global top 30
- Medium adoption: Countries ranked 31–70
- Low adoption: Countries ranked below 70

This classification accounts for differences in baseline crypto engagement. Including adoption tiers ensures that observed effects of MetaMask downloads or crypto transaction proxies are not simply driven

by pre-existing national differences in adoption rates.

Overall, these controls collectively strengthen the causal interpretation of the results by adjusting for critical variables that influence both remittance behavior and crypto uptake. Their selection was not only theoretically grounded, but also shaped by practical considerations of data availability. Only variables that could be consistently measured across most countries and over a sufficient time period were included to maintain panel balance and ensure model comparability. This dual emphasis on theoretical relevance and empirical feasibility enhances the robustness and generalizability of the regression findings.

4 Methodology

4.1 Research Hypotheses

This study investigates the evolving relationship between cryptocurrency adoption and traditional remittance behavior in European economies. To guide the analysis, it poses the following key research questions:

1. Does increased cryptocurrency adoption influence the volume of remittance outflows in European countries?
2. Do these effects vary depending on the country's level of cryptocurrency adoption?
3. What role do structural factors, such as banking access, remittance costs, and migrant stock, play in shaping this relationship?

These questions reflect the core aim of the thesis: to evaluate how decentralized financial technologies interact with existing remittance systems under varying macroeconomic and institutional conditions. The analysis centers on remittance outflows, which are particularly relevant in the European context given the prevalence of net sending countries in the sample. Two primary measures of cryptocurrency engagement are used: (i) MetaMask wallet downloads at the quarterly level, and (ii) national crypto revenue at the annual level. The empirical strategy is guided by the following hypotheses:

- H1 (Substitution Hypothesis): Higher cryptocurrency adoption is associated with lower volumes of traditional remittance outflows. This hypothesis reflects the idea that users may switch from conventional remittance services to blockchain-based alternatives due to lower transaction costs, faster transfers, and greater accessibility.
- H2 (Complementarity Hypothesis): Higher cryptocurrency adoption is associated with higher volumes of traditional remittance outflows. This hypothesis posits that cryptocurrency use may

enhance rather than replace traditional banking activity. For instance, by increasing financial literacy, expanding digital financial inclusion, or facilitating hybrid remittance methods involving both crypto and fiat channels.

By testing these hypotheses, the study contributes to understanding whether cryptocurrencies act as disruptive substitutes to traditional financial services or simply complement existing remittance infrastructure in digitally evolving economies.

4.2 Estimation Methods

This study employs fixed-effects panel regression models to estimate the impact of cryptocurrency adoption on traditional remittance outflows. The fixed-effects approach is implemented using the `plm` package in R, which allows for panel-specific modeling while accounting for unobserved heterogeneity across countries.

The general fixed-effects specification is given by:

$$y_{it} = \alpha_i + \beta X_{it} + \varepsilon_{it} \tag{1}$$

where y_{it} is the dependent variable (remittance outflows), X_{it} is a vector of independent variables including proxies for cryptocurrency adoption and relevant control variables, α_i captures country-specific fixed effects, and ε_{it} is the idiosyncratic error term.

The models are estimated separately on annual and quarterly datasets to capture both long-term trends and short-term fluctuations.

Robust standard errors are applied in all specifications to correct for heteroskedasticity and potential serial correlation within country panels. These are computed using the default variance-covariance estimators in the `plm` framework, which are clustered at the country level to ensure consistent inference.

To assess multicollinearity among regressors, a linear model equivalent of the main specification is estimated using the `lm()` function, and variance inflation factors (VIFs) are calculated using the `car` package. Variables showing high multicollinearity (e.g., GDP per capita and bank account penetration) are not included in the same specification to avoid distortions in coefficient interpretation.

Overall, the estimation strategy is designed to ensure internal validity, mitigate omitted variable bias, and isolate the dynamic relationship between cryptocurrency adoption and remittance behavior across a diverse set of countries.

4.3 Model Specifications

As mentioned, to empirically test the proposed hypotheses, this study employs fixed-effects panel regression models using both annual and quarterly datasets. This method is appropriate for isolating the

impact of within-country changes over time while controlling for unobserved, time-invariant country-specific factors that might otherwise bias the estimates. By focusing on temporal variation within each country, the model captures how shifts in cryptocurrency adoption relate to corresponding changes in remittance outflows, independent of stable cross-country differences. The fixed-effects approach is a widely accepted strategy in panel data econometrics for addressing omitted variable bias in such settings (Wooldridge, 2010).

Two separate model frameworks are used to capture both long-term structural patterns (annual model) and short-term behavioral shifts (quarterly model). Together, these specifications provide complementary perspectives on the evolving relationship between crypto adoption and traditional remittance behavior.

Annual Model

The fixed-effects model estimated using annual country-level data from 2018 to 2024 is specified as:

$$y_{it} = \alpha_i + \beta_1 \, \mathrm{x}_{it} + \boldsymbol{\beta_2}' z_{it} + \varepsilon_{it} \tag{2}$$

In this specification, y_{it} denotes remittance outflows from country i at time t, serving as the dependent variable. The term $\mathbf{x}_{it}$ captures the main explanatory variable of interest, a proxy for cryptocurrency adoption, which is crypto revenue, while $\mathbf{z}_{it}$ represents a vector of control variables. These controls include the share of adults with access to a bank account (a measure of financial inclusion), the country's crypto adoption tier (a categorical indicator of systemic adoption environment), the migrant stock as a percentage of the population, and the average cost of sending remittances, expressed as a percentage of the amount sent. Country-specific fixed effects are captured by α_i, accounting for time-invariant heterogeneity across countries, and ε_{it} is the idiosyncratic error term.

This structure allows for isolating the impact of cryptocurrency adoption on remittance behavior, while accounting for cross-country differences in financial access, migration dynamics, and transaction costs.

Quarterly Models

Two fixed-effects panel specifications are estimated using quarterly country-level data from 2020 Q3 to 2024 Q4. The goal is to assess how the relationship between cryptocurrency adoption and remittance outflows varies across different levels of systemic adoption.

Model 1: Baseline Specification (No Interaction Term)

$$y_{it} = \alpha_i + \beta_1 \, x_{it} + \beta_2 \, a_{it} + \beta_3 \, c_{it} + \beta_4 \, g_{it} + \varepsilon_{it} \tag{3}$$

In this specification:

- y_{it} denotes quarterly remittance outflows from country i at time t.

- x_{it} is MetaMask wallet downloads, capturing short-term behavioral crypto adoption.
- a_{it} is a categorical variable indicating the systemic cryptocurrency adoption tier (low, medium, or high).
- c_{it} represents the average cost of sending remittances as a percentage of the transfer amount.
- g_{it} denotes GDP per capita in USD.

The term α_i captures unobserved, time-invariant country-specific effects, and ε_{it} is the idiosyncratic error term. This model tests whether crypto adoption has a direct association with remittance behavior across different countries, controlling for structural factors.

Model 2: Interaction Specification

$$y_{it} = \alpha_i + \beta_1 x_{it} + \beta_2 a_{it} + \beta_3 (x_{it} \times a_{it}) + \beta_4 c_{it} + \beta_5 g_{it} + \varepsilon_{it} \tag{4}$$

This extended specification introduces an interaction term between MetaMask downloads (x_{it}) and the adoption tier (a_{it}), allowing the effect of crypto usage on remittance outflows to vary depending on the country's level of systemic adoption. This structure enables the identification of heterogeneous effects, where β_3 captures how the marginal impact of crypto adoption shifts in low- and medium-adoption countries relative to the high-adoption baseline.

The interaction model is particularly useful in capturing context-dependent dynamics of financial innovation, where structural readiness may condition the extent to which decentralized technologies influence remittance behavior.

Both models are estimated using the within transformation to eliminate country fixed effects. Robust standard errors clustered at the country level are used to address heteroskedasticity and potential autocorrelation. Employing different time frequencies and combinations of variables allows for more comprehensive use of the available data and strengthens the reliability of the empirical results.

5 Estimation Results

5.1 Quarterly Panel Analysis

The quarterly panel regression analysis investigates the short-run association between cryptocurrency adoption and traditional financial behavior, proxied by remittance outflows. Table 4 presents the results of the fixed-effects models that incorporate both macroeconomic controls and institutional context, namely GDP per capita, average remittance cost, and adoption tier.

Table 4: Fixed Effects Quarterly Panel Regression Results

Variable	**Model 1**	**Model 2**
MetaMask Downloads (k)	1.92*	4.39**
Avg. Remittance Cost (%, million USD)	-182.15***	-184.23***
GDP per capita (USD)	0.08***	0.07***
Adoption Tier: Low (million USD)	-323.40**	35.07
Adoption Tier: Medium (million USD)	-117.16	91.55
MetaMask × Low (k)	–	-13.97**
MetaMask × Medium (k)	–	-3.51
Observations	124	124
R^2	0.327	0.361
Adjusted R^2	0.254	0.278
F-statistic	10.77	8.78

Note: Dependent variable - Outflows of Remittances. All coefficients are scaled: remittance values in millions USD, MetaMask downloads in thousands. Reference group for adoption tier is *High*.

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$

The quarterly fixed-effects regressions in Table 4 examine the relationship between cryptocurrency usage and traditional remittance outflows across European countries from 2020 Q3 to 2024 Q4. Both models offer robust insights into this dynamic.

Model 1, which includes MetaMask downloads, GDP per capita, remittance cost, and adoption tier dummies, shows that MetaMask wallet downloads are positively associated with remittance outflows, with statistical significance at the 10% level. Numerically, an increase of 1,000 MetaMask downloads is associated with an increase of approximately 1.92 million USD in remittance outflows. This suggests that increased user engagement with decentralized financial tools is correlated with greater formal remittance activity. Such a result supports the complementarity hypothesis, suggesting that cryptocurrencies may facilitate, rather than replace, conventional remittance channels.

The coefficient for average remittance cost is negative and highly significant ($p < 0.01$), indicating that a one-percentage-point increase in the average remittance cost is associated with a decline of approximately 182 million USD in remittance outflows per quarter. This is a substantial economic effect, underscoring the strong sensitivity of remittance behavior to transaction costs. Put simply, the more expensive it becomes to send money across borders, the less of it is sent. This finding is consistent with economic theory and reinforces previous empirical evidence on the cost-elasticity of remittance flows, particularly in contexts where senders are highly responsive to price signals.

GDP per capita exhibits a positive and statistically significant effect ($p < 0.01$), with a one-dollar increase in GDP per capita corresponding to an average increase of 0.08 USD in remittance outflows. While the

per-unit effect appears small, aggregated across GDP levels in the thousands or tens of thousands, this becomes economically meaningful, supporting the view that wealthier economies remit more due to stronger transnational financial ties.

With respect to adoption tiers, countries classified as low adoption are associated with significantly lower remittance outflows relative to the high adoption reference category, with an estimated difference of approximately 323.4 million USD ($p < 0.05$). The coefficient for medium adoption is also negative (-117.16), though statistically insignificant, suggesting weaker crypto–remittance linkages in these countries, although with higher uncertainty.

Model 2 extends the baseline specification by including interaction terms between MetaMask downloads and adoption tiers. The main effect of MetaMask Downloads increases in magnitude and significance, from 1.92 ($p < 0.10$) in Model 1 to 4.39 ($p < 0.05$) in Model 2. This implies that in high-adoption countries (the reference group), an increase of 1,000 MetaMask downloads is associated with an increase of 4.39 million USD in remittance outflows. This suggests a stronger and more direct relationship between crypto engagement and cross-border transfers in environments where crypto adoption is already higher. The increase in the coefficient reflects the model's re-specification: in Model 2, the MetaMask Downloads coefficient captures the effect specifically in high adoption countries. This clarifies that the positive relationship between cryptocurrency usage and remittance flows is most pronounced where systemic adoption is high.

Among the interaction terms, MetaMask × Low is negative and statistically significant at the 5% level (-13.97). This implies that the marginal effect of 1,000 MetaMask downloads on remittance outflows is 13.97 million USD lower in low-adoption countries compared to high-adoption ones. In practical terms, the net effect of MetaMask downloads in low-adoption contexts is reduced to about -9.58 million USD (4.39 - 13.97), potentially even reversing the expected positive relationship. This may reflect regulatory frictions, infrastructural gaps, or limited public trust.

The MetaMask × Medium interaction is also negative (-3.51), though not statistically significant, indicating a weaker and less consistent dampening effect in medium-adoption contexts.

Notably, once interaction terms are introduced, the standalone coefficients for adoption tiers lose statistical significance, which is an expected outcome, as their marginal effects are now captured under the interaction terms.

The negative effect of remittance costs and the positive effect of GDP per capita persist across both models, reinforcing their role as structural drivers of remittance behavior. The size and consistency of these effects highlight the continuing importance of both institutional frictions and economic capacity in shaping remittance flows.

Overall, the quarterly panel results indicate that cryptocurrency usage, proxied by MetaMask downloads, is positively associated with formal remittance outflows. However, this relationship is not uniform: it

is significantly stronger in countries with high levels of systemic crypto adoption. The inclusion of interaction terms reveals that in lower-adoption environments, the impact of crypto engagement on remittance behavior is substantially weakened. These findings support a complementarity perspective, where the effectiveness of crypto tools in facilitating remittances is mediated by national-level of crypto adoption.

5.2 Annual Panel Analysis

To evaluate the relationship between cryptocurrency adoption and traditional financial flows in the long run, two fixed-effects panel regressions were estimated using annual country-level data from 2018 to 2024. The dependent variable is remittance outflows in USD.

Model 1 excludes remittance cost due to missing values for Ukraine, allowing for a larger sample of 10 countries. Model 2 includes the average cost of sending remittances, reducing the sample to 9 countries but incorporating a potentially influential control. Both models control for cryptocurrency revenue, bank account penetration, cryptocurrency adoption tier, and migrant stock as a percentage of population. The variables were selected based on theoretical considerations and data availability.

Table 5: Fixed Effects Annual Panel Regression Results

Variable	**Model 1** (w/o Remit. Cost)	**Model 2** (w/ Remit. Cost)
Crypto Revenue (in millions)	0.843*	0.869**
Bank Account Penetration (%)	-952.69***	-792.17*
Adoption Tier: Medium	-149.62	33.97
Adoption Tier: Low	-1369.10	-670.17
Migrant Stock (%)	1219.62***	628.15**
Avg. Remittance Cost (%)	–	-930.60*
Observations	50	42
Countries	10	9
R^2	0.525	0.621
Adjusted R^2	0.335	0.424
F-statistic (p-value)	7.73 (< 0.001)	7.37 (< 0.001)

Notes: Dependent variable - Outflows of Remittances. All coefficients are scaled: remittance values in millions USD. Reference group for adoption tier is *High*.
Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$

Both annual model specifications reinforce the evidence from quarterly regressions, demonstrating a statistically significant and positive association between national cryptocurrency revenue and remittance

outflows. In Model 1 (without remittance cost), the coefficient for Crypto Revenue is significant at the 10% level, while in Model 2 (with remittance cost), its significance increases to the 5% level. Numerically, a one-million USD increase in crypto revenue is associated with an increase in annual remittance outflows of approximately 0.84 to 0.87 million USD, depending on specification. This progression strengthens the argument that higher crypto-related activity may enhance rather than replace formal remittance flows, a pattern also observed in the quarterly MetaMask-based models.

The persistence of a stable and significant Crypto Revenue coefficient across specifications, even after controlling for remittance cost, suggests that digital financial tools can complement rather than disrupt the infrastructure of existing remittance systems. In particular, increased engagement with crypto may help offset inefficiencies in traditional channels, especially in costly or institutionally weaker corridors. This complements the quarterly finding where MetaMask downloads had a consistently positive relationship with remittance outflows, particularly among countries with higher crypto adoption readiness.

Bank account penetration is negatively associated with remittance outflows in both annual models. The effect is highly significant at the 1% level in Model 1 and remains marginally significant at the 10% level in Model 2. Although this may seem counterintuitive since broader financial access is often linked with formal money transfers, it could suggest that in more financially inclusive countries, there may be less need for international transfers, or that migrants utilize domestic support systems more intensively. It may also reflect differences in remittance motivations across financially integrated versus underserved populations.

Migrant stock percentage emerges as a consistently strong structural determinant. In Model 1, a one-percentage-point increase in the migrant population share is associated with an increase of 1.22 billion USD in remittance outflows; in Model 2, the magnitude is slightly lower but still substantial at 628 million USD. These results, significant at the 1% and 5% levels respectively, confirm that countries with larger migrant populations abroad receive greater remittance inflows, which is on of the central findings consistent with both theory and quarterly results.

Average remittance cost, included only in Model 2, is negatively associated with remittance outflows and statistically significant at the 10% level. A one-percentage-point increase in the cost of sending remittances is associated with a decrease of approximately 931 million USD in annual outflows. This is a very substantial economic effect, highlighting the strong cost-sensitivity of remittance behavior: as it was mentioned before, the more expensive it is to send money abroad, the less is sent through formal channels. This complements the even stronger result found in the quarterly model, where cost was significant at the 1% level.

The adoption tier coefficients in both models are not statistically significant, but their signs suggest that countries with lower crypto adoption may exhibit reduced remittance flows, repeating the pattern seen in the quarterly models. However, without statistical significance, these effects should be interpreted

cautiously.

To summarize, these annual results both validate and expand upon the quarterly model findings: cryptocurrency usage, whether proxied through MetaMask activity or national crypto revenue, is positively associated with formal remittance outflows. Moreover, structural drivers such as migrant stock and transaction costs remain central in understanding the scale and variability of these flows. Overall, the evidence supports the notion that crypto adoption complements, rather than competes with, formal financial channels, particularly in countries where cryptocurrency usage is already more established.

5.3 Summary of Empirical Results

The combined results from the quarterly and annual panel analyses offer strong support for the view that cryptocurrency adoption is closely intertwined with traditional financial behavior, particularly the dynamics of remittance flows, over both short- and long-term horizons.

At the quarterly level, the use of MetaMask downloads as a high-frequency proxy for crypto engagement reveals a statistically significant and positive relationship with remittance outflows. In Model 1, an increase of 1,000 MetaMask downloads is associated with approximately 1.92 million USD in additional remittance outflows per quarter ($p < 0.10$). In Model 2, where MetaMask is interacted with crypto adoption tier, this effect rises to 4.39 million USD and becomes significant at the 5% level. This progression supports the hypothesis that decentralized financial tools may not only operate in parallel to traditional systems but actively facilitate and expand cross-border transfers. Additionally, both remittance cost and GDP per capita are highly significant in all specifications, indicating that economic capacity and price frictions strongly shape remittance behavior.

In contrast, the annual models rely on lower-frequency structural indicators such as bank account penetration and national crypto revenue. The coefficient for Crypto Revenue remains consistently positive and statistically significant across both specifications, rising from 0.84 ($p < 0.10$) in Model 1 to 0.87 ($p < 0.05$) in Model 2. This implies that a one-million USD increase in national crypto revenue is associated with 840,000–870,000 USD in additional remittance outflows per year. The inclusion of remittance cost strengthens this relationship and mirrors the pattern observed in the quarterly models, reinforcing the interpretation that crypto activity complements rather than substitutes formal remittance channels.

Structural variables such as migrant stock percentage are highly significant across both annual models. A one-percentage-point increase in migrant stock is associated with 1.22 billion USD more in remittance outflows in Model 1 ($p < 0.01$), and 628 million USD in Model 2 ($p < 0.05$). These results confirm that the size of the migrant population abroad is a key determinant of remittance volumes.

Average remittance cost also emerges as a significant negative predictor of remittance flows in both quarterly and annual models. These findings provide robust evidence that high transaction costs discourage the use of formal remittance channel either by reducing transfer frequency and volume, or by

incentivizing the use of informal alternatives.

Notably, the effects of crypto adoption tiers vary across timeframes. In the quarterly interaction model, the low adoption tier significantly weakens the effect of MetaMask usage: the interaction term is negative and significant at the 5% level, suggesting that in low-adoption environments, the impact of crypto engagement on remittances is not only diminished but potentially reversed. In contrast, in the annual models, neither the medium nor low adoption tier indicators are statistically significant. This divergence highlights the importance of measurement resolution and model specification in capturing the conditional effects of systemic crypto readiness on remittance behavior.

Taken together, these findings converge on a central insight: cryptocurrency usage is positively associated with remittance outflows and appears to function as a complement, not a substitute, to existing financial infrastructure. This effect is particularly pronounced in countries with higher levels of crypto adoption and digital readiness, where crypto-based solutions may offer speed, affordability, or access advantages. The results carry practical implications for financial inclusion strategies and regulatory design, suggesting that carefully integrating cryptocurrency tools into the broader financial ecosystem could enhance the efficiency and reach of international money transfers.

These conclusions directly support the central objective of this thesis: to determine whether cryptocurrency adoption acts as a substitute for or a complement to traditional banking systems in the context of remittance behavior. The weight of evidence across models, datasets, and timescales points decisively toward the latter.

6 Robustness Checks

To ensure the stability and reliability of the main empirical findings, several robustness checks were conducted for both the quarterly and annual model specifications. These checks were designed to address potential concerns related to model specification, omitted variable bias, endogeneity, and sensitivity to functional form. Specifically, the analysis evaluates how the estimated effects of cryptocurrency adoption (proxied by MetaMask wallet downloads and crypto revenue metrics) on remittance outflows hold under alternative econometric treatments.

6.1 Quarterly Models

A series of alternative quarterly panel regression models were estimated. These include pooled OLS, fixed-effects with country-clustered standard errors, and a model with lagged independent variables. All coefficient estimates are scaled and presented in Table 6.

Table 6: Robustness Checks — Quarterly Panel Regression Models (Scaled Coefficients with Standard Errors)

Variable	**FE Model**	**FE + Interaction**	**Pooled OLS**	**Clustered SEs**	**Lagged Effects***
MetaMask Downloads (k)	1.92* (1.04)	4.39** (1.76)	4.39** (1.76)	4.39* (2.34)	4.85*** (1.27)
MetaMask × Tier Low (k)		-13.97** (6.55)	-13.97** (6.55)	-13.97*** (3.36)	-18.23*** (4.53)
MetaMask × Tier Medium (k)		-3.51 (2.32)	-3.51 (2.32)	-3.51* (2.00)	-3.99*** (1.23)
Remittance Cost (%, million USD)	-182.15*** (47.77)	-184.23*** (48.33)	-184.23*** (48.33)	-184.23** (87.10)	-176.78*** (45.63)
GDP per Capita (USD)	0.08*** (0.02)	0.07*** (0.02)	0.07*** (0.02)	0.07* (0.04)	0.07*** (0.02)
Tier Low (million USD)	-323.40** (132.92)	35.07 (208.99)	35.07 (208.99)	35.07 (132.15)	
Tier Medium (million USD)	-117.16 (100.47)	91.55 (177.39)	91.55 (177.39)	91.55 (138.73)	
Observations (N)	124	124	124	124	116
R^2	0.327	0.361	0.982	0.361	0.397
Adj. R^2	0.254	0.278	0.980	0.278	0.327

Notes: Dependent variable - Outflows of Remittances. All coefficients are scaled: remittance values in millions USD, MetaMask downloads in thousands. Robust standard errors clustered at country level in Model 4. Standard errors are shown in parentheses.

* Variables "MetaMask Downloads", "MetaMask × Tier Low" and "MetaMask × Tier Medium" are lagged in this model specification. Significance codes: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

The baseline fixed-effects models (Models 1 and 2) provide initial support for the complementarity hypothesis, showing a consistently positive association between MetaMask downloads and remittance outflows. When interaction terms with adoption tiers are included, the strength of the relationship increases, and a significant negative interaction with the Low Adoption Tier emerges. This suggests that the positive influence of crypto usage on remittance flows is weaker, or even reversed, in countries with low institutional readiness, while the effect in medium-tier countries remains statistically inconclusive.

To assess the sensitivity of the results to the fixed-effects structure, a pooled OLS model was estimated using the same variables as in Model 2. The results mirror those of the interaction model in both magnitude and significance, with the MetaMask coefficient at 4.39 and the Low Tier interaction again negative and significant. This consistency increases confidence that the observed relationships are not artifacts of the fixed-effects framework alone.

To account for potential within-country correlation of the residuals, Model 4 repeats the interaction model but reports country-clustered standard errors. Although the standard errors increase, the key coefficients, including MetaMask downloads (4.39, $p < 0.1$) and the Low Tier interaction (-13.97, $p < 0.01$), remain statistically significant. This provides further reassurance that the results are robust to heteroskedasticity and intra-group correlation.

Finally, Model 5 introduces a one-period lag of MetaMask downloads to address potential simultaneity and endogeneity concerns. The coefficient on lagged MetaMask is positive (4.85) and statistically significant at the 1% level, suggesting that increased wallet adoption in the previous quarter predicts higher

remittance outflows in the current period. The interaction with the Low Adoption Tier is also negative and significant (-18.23, $p < 0.01$), reinforcing the earlier finding that crypto's effect is contingent on local adoption capacity. Additionally, the lagged interaction with the Medium Tier remains negative but is not statistically significant.

Across all specifications, control variables behave as expected. Remittance cost shows a consistently strong and negative effect, indicating that lower transaction costs are associated with greater remittance activity. GDP per capita maintains a small but statistically significant positive effect, likely reflecting income-driven remittance capacity. The standalone coefficients for the adoption tiers vary and are not robust across specifications, which further validates the inclusion of interaction terms.

These robustness checks confirm that the positive relationship between cryptocurrency adoption and remittance outflows is not dependent on a single estimation strategy. The results remain consistent across fixed-effects, pooled, clustered, and lagged models. Notably, the lag structure strengthens causal interpretation by addressing reverse causality concerns. Moreover, the interaction effects highlight that the complementarity between crypto adoption and remittance behavior is stronger in countries with favorable adoption infrastructure. Together, these results offer compelling evidence that cryptocurrency use, when supported by sufficient institutional and technological readiness, can enhance rather than substitute formal remittance systems.

Stationarity and Cointegration Checks. To ensure the reliability of the panel regression estimates and avoid spurious correlations that may arise due to trending variables, panel unit root and cointegration diagnostics were carried out. Specifically, the Im-Pesaran-Shin (IPS) test was applied to assess the stationarity of the main time series variables. The test results indicate that MetaMask Downloads and GDP per Capita are stationary at level, while Remittance Outflows and Remittance Cost are non-stationary. In the presence of such mixed integration orders, standard inference may be compromised unless the variables exhibit a long-run equilibrium relationship.

Given the presence of non-stationary variables, a Pedroni panel cointegration test was subsequently performed to examine whether a stable long-run relationship exists among the variables. The test strongly rejected the null hypothesis of no cointegration (with a highly significant p-value < 0.01), suggesting that despite non-stationarity in some variables, the panel regression captures a meaningful and consistent long-run equilibrium This finding supports the use of level-form variables in the main specifications, as cointegration implies that short-term deviations from equilibrium are bounded and do not invalidate the estimated relationships (Pedroni, 1999).

6.2 Annual Models

To assess the robustness of the annual panel regression findings, several alternative model specifications are employed. These include models incorporating robust standard errors clustered at the country level, and a pooled OLS specification with country dummies to account for unobserved heterogeneity. The consistency of coefficient signs and significance across these models supports the stability of the core relationships. Moreover, to ensure that the long-run associations among remittance outflows, cryptocurrency adoption, and macroeconomic variables are not spurious, a Pedroni cointegration test was also conducted.

Table 7: Robustness Checks — Annual Panel Regression Models (Scaled Coefficients with Standard Errors)

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Crypto Revenue (million USD)	0.84* (0.39)	0.87** (0.40)	0.84** (0.39)	0.87** (0.40)	0.87** (0.38)
Bank Account (%)	-952.69*** (396.47)	-792.17* (373.63)	-952.69** (396.47)	-792.17** (373.63)	-792.17* (420.72)
Adoption Tier Medium	-149.62 (633.56)	33.97 (516.37)	-149.62 (633.56)	33.97 (516.37)	33.97 (692.07)
Adoption Tier Low	-1369.10 (639.38)	-670.17 (428.70)	-1369.10** (639.38)	-670.17 (428.70)	-670.17 (889.81)
Migrant Stock (%)	1219.62*** (421.74)	628.15** (215.86)	1219.62*** (421.74)	628.15*** (215.86)	628.15** (272.35)
Remittance Cost (%)		-930.60* (451.33)		-930.60** (451.33)	-930.60* (472.22)
Observations (N)	50	42	50	42	42
R^2	0.525	0.621	0.525	0.621	0.986
Adj. R^2	0.335	0.424	0.335	0.424	0.979

Notes: Dependent variable - Outflows of Remittances. All coefficients are scaled: remittance values in millions USD.

Standard errors in parentheses.

Model 1: FE without remittance cost.

Model 2: FE with remittance cost.

Model 3: FE without cost + clustered SEs (country).

Model 4: FE with cost + clustered SEs (country).

Model 5: Pooled OLS with country dummies.

Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

The first two specifications in Table 7 (Model 1 and Model 2) represent the primary fixed-effects regressions introduced earlier, estimated respectively without and with the Remittance Cost variable. To test the robustness of these results, three additional model variations were included: fixed-effects models using robust standard errors clustered at the country level (Models 3 and 4), and a pooled OLS model with country dummies (Model 5), allowing for heterogeneity across countries.

Across all specifications, several core patterns hold. The coefficient for Crypto Revenue remains positive and statistically significant in all models, confirming a robust association between increased cryptocurrency adoption and higher remittance outflows. Similarly, the effect of Migrant Stock is consistently positive and significant, underscoring the structural role of migrant population shares in shaping re-

mittance dynamics. The variable Bank Account (%) also retains a stable and statistically significant negative effect in every model.

In contrast, the coefficient for Adoption Tier Low is not robust to alternative specifications. While it is significantly negative in the fixed-effects model without cost (Model 3), its statistical significance disappears in all other models that include cost, clustered standard errors, or adopt pooled estimation (Models 2, 4, and 5). This inconsistency suggests that the role of lower-tier adoption environments may be context-dependent and influenced by sample composition or omitted variable bias.

Altogether, the results from these robustness checks reinforce the main findings of the annual analysis. The stable directionalities and significance of Crypto Revenue, Bank Account, and Migrant Stock across diverse specifications point to a consistent underlying relationship.

Due to the limited time dimension of the annual panel dataset ($T = 5$), formal panel unit root tests such as Levin–Lin–Chu or Im–Pesaran–Shin are not appropriate, as they require a larger number of time periods to yield reliable results. To nevertheless assess the long-run equilibrium properties of the model, a Pedroni-type panel cointegration test was conducted using the Durbin–Watson (DW) framework. The test, applied to the key explanatory variables in Model 2, yielded a DW statistic of 0.835 and a highly significant p-value ($p < 0.001$), indicating strong evidence of cointegration. This result supports the assumption of a stable long-term relationship between remittance outflows, crypto adoption, financial access, and transaction costs, thereby mitigating concerns over non-stationarity in the annual specification.

Taken together, the robustness checks presented in this section reinforce the validity of the main empirical findings. Across alternative specifications, whether through the inclusion or exclusion of remittance costs, the application of clustered standard errors, or pooled estimation with country dummies, the direction and significance of core predictors such as Crypto Revenue, Migrant Stock, and Bank Account remain largely consistent. The strong statistical support for cointegration further proves the presence of a meaningful long-run relationship between cryptocurrency adoption and remittance outflows. Altogether, the findings are robust to multiple estimation strategies and assumptions, lending credibility to the underlying complementarity hypothesis.

7 Discussion

The empirical results presented in this thesis offer a detailed understanding of how cryptocurrency adoption interacts with traditional remittance flows across European economies. The evidence consistently points toward a complementary relationship, whereby increased crypto engagement, rather than displacing conventional financial channels, enhances or reinforces them, particularly in already advanced crypto environments.

The quarterly panel models reveal that MetaMask downloads, as a proxy for behavioral crypto adoption, are positively and significantly associated with remittance outflows. Notably, the effect becomes stronger and more statistically significant when accounting for adoption tiers. In countries with high systemic adoption, an increase of 1,000 downloads corresponds to an average increase of 4.39 million USD in remittances, suggesting that decentralized tools function more effectively in mature digital environments. Conversely, interaction terms indicate that the marginal effect of crypto adoption is significantly weakened in low-adoption countries. This conditional complementarity aligns with the broader literature on digital finance diffusion and underlines the importance of institutional context in shaping adoption outcomes.

The annual models reinforce these findings using structural proxies, with national crypto revenue emerging as a strong and consistent predictor of remittance outflows. Even after controlling for banking access, remittance cost, and migrant stock, a one-million USD increase in crypto revenue is associated with approximately 0.87 million USD in additional remittances. This lends support to the idea that cryptocurrency ecosystems can scale in ways that benefit cross-border financial activity.

Crucially, structural variables also play a significant role. The average cost of remittances is consistently negative and economically large across models, confirming that users are highly sensitive to transaction costs. Similarly, migrant stock remains a robust and positive determinant, validating remittances as a demographically driven behavior. The negative coefficient for bank account penetration in annual regressions, although initially counterintuitive, may reflect reduced dependence on cross-border transfers in financially inclusive societies.

Taken together, the results suggest that cryptocurrencies function not as disruptive alternatives, but as strategic complements to traditional remittance systems, especially in environments characterized by high crypto adoption. This supports a more integrative perspective on financial innovation, where decentralized and centralized systems can coexist and co-evolve.

Nonetheless, certain limitations should be acknowledged. The analysis relies on proxy variables, namely MetaMask downloads and national crypto revenue, which may not fully capture actual usage intensity or transaction-level behavior. The absence of corridor-specific or micro-level remittance data constrains deeper exploration of heterogeneity, while cross-country differences in crypto regulation and informal usage remain unobserved. Lastly, the fixed-effects approach, while controlling for unobserved heterogeneity, does not account for dynamic feedback effects or policy endogeneity, which may influence both adoption and remittance behavior over time.

A further limitation concerns the geographical scope. While the focus on ten European countries ensures comparability in macroeconomic structure, these countries vary widely in regulatory environments and institutional maturity. Eastern nations like Ukraine and Russia show high peer-to-peer activity under weaker institutions, whereas Western countries favor regulated, exchange-based use. These contextual differences, though not directly modeled, shape adoption patterns and limit the generalizability of findings

to regions with different remittance dynamics or financial ecosystems.

8 Conclusion

This thesis set out to examine whether cryptocurrency adoption acts as a substitute for or a complement to traditional remittance outflows in European economies. Employing both annual and quarterly fixed-effects panel regressions from 2018 to 2024 across ten countries, the study provides consistent empirical support for the complementarity hypothesis. The results suggest that increased crypto usage proxied by national cryptocurrency revenue and MetaMask wallet downloads is positively associated with formal remittance outflows, especially in countries exhibiting high systemic levels of crypto adoption.

Crucially, the quarterly model reveals that the relationship between crypto adoption and remittance behavior is not uniform across all countries but conditional on adoption intensity. In high-adoption environments, behavioral proxies such as MetaMask downloads are significantly and positively correlated with remittance outflows. This suggests that decentralized financial tools are used more effectively in contexts where digital literacy, infrastructure, and user engagement are already strong. Conversely, in low-adoption countries, the interaction terms show that the marginal effect of crypto usage is significantly diminished, highlighting the importance of national context in shaping financial innovation outcomes.

These findings collectively challenge the notion of cryptocurrency as an inherently disruptive force to traditional finance. Instead, they suggest a more detailed conclusion: decentralized technologies coexist with and may even reinforce formal financial behaviors under the right conditions. Structural variables such as remittance cost, migrant stock, GDP per capita, and banking access continue to exert significant influence, underscoring that technological adoption alone does not determine financial behavior. Rather, the interaction between infrastructure, cost-efficiency, and behavioral incentives is what shapes outcomes.

Methodologically, the inclusion of both annual and high-frequency quarterly data allows the analysis to capture both structural patterns and short-term behavioral shifts. The use of MetaMask downloads as a behavioral proxy complements structural indicators like crypto revenue and adoption tiers. Moreover, the robustness checks and interaction models provide additional confidence that the results are driven by meaningful relationships and reflect underlying behavioral and institutional dynamics.

From a policy perspective, the results highlight that the integration of decentralized finance into formal financial ecosystems requires more than just technological diffusion. Regulatory clarity, digital infrastructure, and user education are essential to ensure that cryptocurrencies contribute positively to financial inclusion and cross-border financial flows. The findings suggest that rather than resisting crypto adoption, policymakers in advanced economies should explore hybrid solutions that allow formal remittance systems to benefit from the efficiencies of blockchain-based alternatives.

In sum, this thesis contributes to the growing body of empirical research on digital financial innovation

by offering structured, cross-country evidence from a European context. It shows that the effects of cryptocurrency adoption are mediated by adoption tier and national readiness, reinforcing the need for context-aware financial policies. Future research could build on this work by incorporating individual-level behavioral data, testing the effect of specific policy interventions, or exploring hybrid remittance systems that combine fiat and crypto-based mechanisms. As digital finance continues to evolve, understanding these dynamics will be essential for designing inclusive, efficient, and resilient financial systems.

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10 Appendix

Table 8: Crypto Adoption Rankings (2020 – 2024) – Moderate to High Adoption Countries

Country	Metric	2020	2021	2022	2023	2024
Ukraine	Overall ranking (out of 146)	1	4	3	5	6
	Index score (0–1)	1	0.29	–	–	–
	Centralized exchange activity (rank)	4	6	6	5	7
	Retail activity at centralized exchanges (rank)	4	5	6	3	5
	P2P trade volume (rank)	11	40	39	11	–
	DeFi value received (rank)	–	–	10	10	5
Russia	Overall ranking (out of 146)	2	18	9	13	7
	Index score (0–1)	0.931	0.14	–	–	–
	Centralized exchange activity (rank)	7	8	8	12	11
	Retail activity at centralized exchanges (rank)	8	6	8	10	7
	P2P trade volume (rank)	9	122	109	36	–
	DeFi value received (rank)	–	–	11	9	7
United Kingdom	Overall ranking (out of 146)	14	21	17	14	12
	Index score (0–1)	0.33	0.13	–	–	–
	Centralized exchange activity (rank)	15	12	14	15	12
	Retail activity at centralized exchanges (rank)	19	15	14	20	21
	P2P trade volume (rank)	7	94	71	38	–
	DeFi value received (rank)	–	–	12	8	9
France	Overall ranking (out of 146)	2	34	32	23	22
	Index score (0–1)	0.208	0.08	–	–	–
	Centralized exchange activity (rank)	18	17	26	26	26
	Retail activity at centralized exchanges (rank)	25	18	26	28	33
	P2P trade volume (rank)	55	123	101	55	–
	DeFi value received (rank)	–	–	16	21	21
Germany	Overall ranking (out of 146)	33	49	21	26	21
	Index score (0–1)	0.147	0.06	–	–	–
	Centralized exchange activity (rank)	21	20	22	23	21
	Retail activity at centralized exchanges (rank)	24	24	22	26	30
	P2P trade volume (rank)	79	143	114	60	–
	DeFi value received (rank)	–	–	15	25	23

Table 9: Crypto Adoption Rankings (2020 – 2024) – Low Adoption Countries

Country	Metric	2020	2021	2022	2023	2024
Belgium	Overall ranking (out of 146)	44	71	94	81	68
	Index score (0–1)	0.125	0.04	–	–	–
	Centralized exchange activity (rank)	51	56	74	74	77
	Retail activity at centralized exchanges (rank)	55	52	74	82	83
	P2P trade volume (rank)	47	100	128	105	–
	DeFi value received (rank)	–	–	58	75	63
Sweden	Overall ranking (out of 146)	46	73	78	70	73
	Index score (0–1)	0.117	0.04	–	–	–
	Centralized exchange activity (rank)	70	78	85	68	76
	Retail activity at centralized exchanges (rank)	67	73	85	68	90
	P2P trade volume (rank)	28	66	44	79	–
	DeFi value received (rank)	–	–	62	67	68
Norway	Overall ranking (out of 146)	68	88	114	111	99
	Index score (0–1)	0.072	0.03	–	–	–
	Centralized exchange activity (rank)	90	71	108	116	101
	Retail activity at centralized exchanges (rank)	99	79	108	116	103
	P2P trade volume (rank)	63	93	83	124	–
	DeFi value received (rank)	–	–	85	102	99
Austria	Overall ranking (out of 146)	54	98	84	84	74
	Index score (0–1)	0.087	0.02	–	–	–
	Centralized exchange activity (rank)	58	67	73	73	84
	Retail activity at centralized exchanges (rank)	72	65	73	78	84
	P2P trade volume (rank)	67	130	127	127	–
	DeFi value received (rank)	–	–	56	65	71
Portugal	Overall ranking (out of 146)	43	57	38	59	50
	Index score (0–1)	0.126	0.05	–	–	–
	Centralized exchange activity (rank)	54	45	51	55	50
	Retail activity at centralized exchanges (rank)	59	47	51	66	60
	P2P trade volume (rank)	34	89	24	82	–
	DeFi value received (rank)	–	–	40	43	51

Table 10: Key Crypto User Characteristics: High-Adoption Countries (2025)

Indicator	**United Kingdom**	**France**	**Germany**
Chainalysis Crypto Adoption Index Rank	12th globally	22nd globally	21st globally
Predominant Crypto User Group	Millennials (45%)	Gen Z (41%)	Millennials (46%)
Gender Distribution	76% male	72% male	75% male
High Income Users	55%	49%	48%
Urban Users	67%	64%	66%
University Degree or Higher	52%	48%	60%
Own Accommodation	64%	51%	60%
Most Followed Sport	Soccer	Soccer	Soccer
Dominant Interests	Tech, Science	Finance, Economy	Tech, Science
Hobbies	Tech, Computers, Gaming	Cars, Tech, Travel	Gaming, Tech, Fitness
Willing to Pay Extra for Service	37%	41%	47%

Sources: Statista Consumer Insights Reports (2025) for UK, France, and Germany; Chainalysis Geography of Crypto Report (2024).

Statista base: n=543 (UK), n=187 (France), n=206 (Germany); all data February 2025.

Table 11: Key Crypto User Characteristics: Low-Adoption Countries (2023–2025)

Indicator	**Austria**	**Belgium**	**Sweden**	**Norway**	**Portugal**
Chainalysis Crypto Adoption Index Rank	74th globally	68th globally	73rd globally	99th globally	50th globally
Predominant Crypto User Group	Millennials (39%)	Millennials (43%)	Gen Z (29%)	Gen Z (29%)	Millennials (46%)
Gender Distribution	75% male	71% male	78% male	78% male	65% male
High Income Users	48%	35%	42%	51%	45%
Urban/Small Town Users	27% small town	29% small town	31% small town	25% small town	34% small town
University Degree or Higher	61%	58%	55%	62%	61%
Own Accommodation	61%	Not stated	60%	Not stated	Not stated
Most Followed Sport	Basketball	Soccer	Soccer	Soccer	Soccer
Dominant Interests	Tech, Finance	Finance, Economy	Tech, Finance	Finance, Politics	Tech, Science
Hobbies	Tech, Gaming, Fitness	Tech, Socializing, Gaming	Tech, Music, Travel	Gaming, Socializing	Sports, Fitness
Willing to Pay Extra for Service	47%	40%	44%	40%	68%

Sources: Statista Consumer Insights Reports (2023–2025) for Austria, Belgium, Sweden, Norway, and Portugal; Chainalysis Geography of Cryptocurrency Report (2024).
Statista base: n=290 (Austria), n=164 (Belgium), n=248 (Sweden), n=147 (Norway), n=154 (Portugal); all data from latest available year.

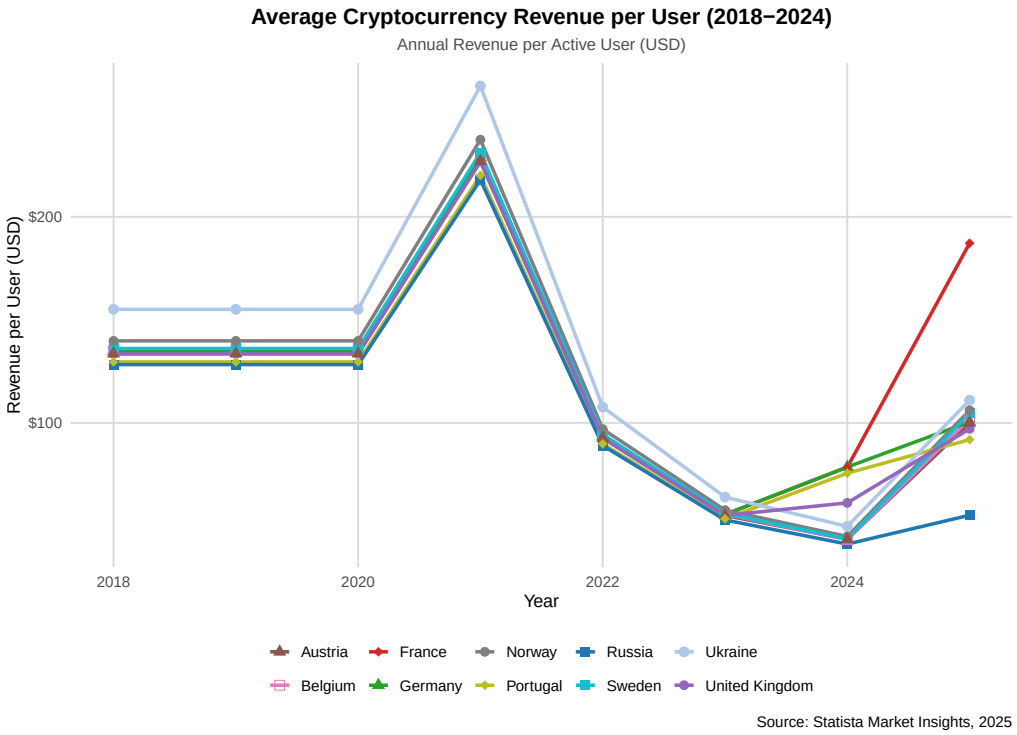

Figure 8: Average Cryptocurrency Revenue per User across 10 Countries (2018–2024)

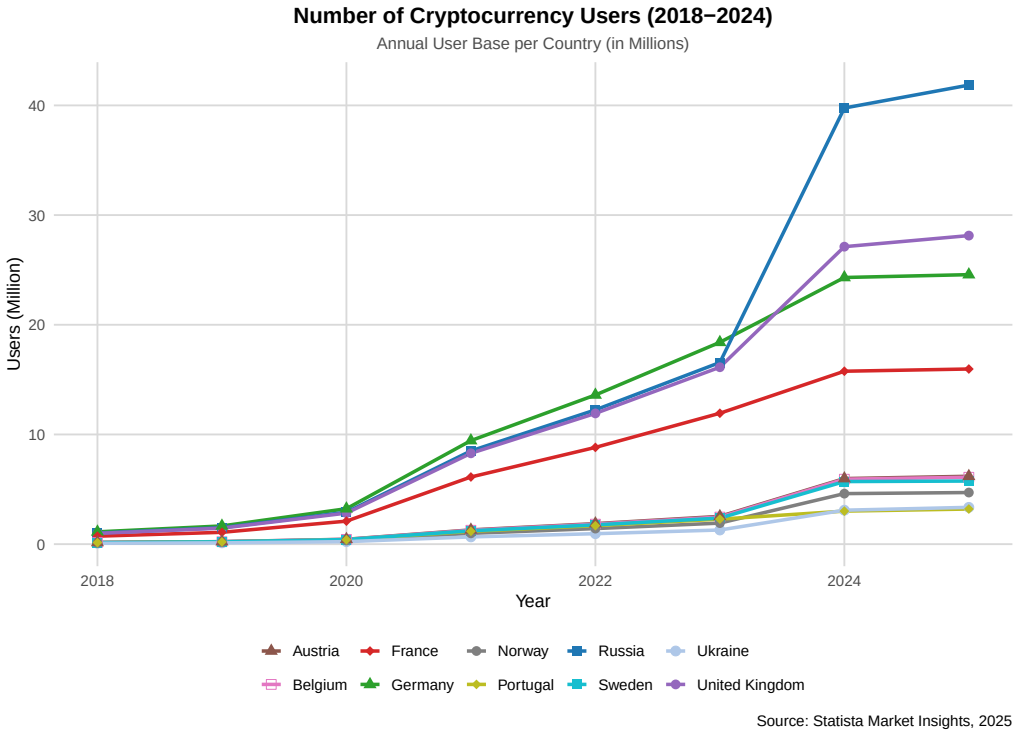

Figure 9: Number of Cryptocurrency Users by Country (2018–2024)