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The impact of using fintech applications in financial transactions on Gross Domestic Product: A Study of a Sample of Countries

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Abstract :

This study aims to highlight the impact of using fintech applications on GDP through their use in various financial transactions and the improvement of provided financial services. The study used the software program (Stata 15) to analyze data from a sample of countries included in the study.

The study's most important findings are that there is a significant relationship between fintech indicators and GDP, which indicates that the use of fintech has a positive impact on GDP.

Keywords: Fintech, financial transactions, GDP.

1. Introduction:

Fintech is experiencing a revolution in how financial transactions are conducted and money is managed through the use of several innovative applications such as artificial intelligence, blockchain, cryptocurrencies, and the Internet of Things. This helps facilitate access to financial services and increase transactions for customers, thus stimulating investments, enhancing economic growth, and increasing GDP. When using fintech applications, security aspects should be considered to ensure the protection of customers and enhance integrity and credibility. Alongside the benefits that fintech has achieved in the financial sector, countries are seeking to enact regulatory laws that allow for greater effectiveness to achieve better results.

Research Problem: Given the context, the main research question is:

How does the use of fintech applications in financial transactions affect GDP?

Subsidiary questions include:

- What are the concept and characteristics of fintech?
- What fintech applications are used in financial transactions?
- What are the impacts of fintech and its applications on GDP?

Study Hypotheses: To address the research questions, the following hypotheses are proposed:

- The use of fintech applications has contributed to the development of financial transactions.
- Fintech has an impact on the development and increase of GDP.
- There is a relationship between the use of fintech applications in financial transactions and GDP.

Importance of the study: The importance of the study lies in highlighting the impact of using fintech and its applications in financial transactions on the increase of GDP.

Study Objectives: This study aims to achieve the following:

- Identify fintech applications.
- Highlight the impact of using fintech applications in financial transactions on GDP through a study of a sample of countries.

Research Methodology: We relied on a descriptive approach (method) with analysis in this study, gathering and analyzing data using the Stata 15 software to study the topic and its various variables and relationships to reach results.

2. Previous Studies:

- **Study by Masmoudi Karima, Chetouane Sonia (2022):**

"Fintech Innovations and their Role in Enhancing Algeria's GDP - E-Payment as a Model" in the *Journal of Economic Integration*. This study aimed to highlight the importance of fintech in commercial banks and its contribution to enhancing financial inclusion in Algeria by adopting electronic payment methods to support GDP. Multiple regression analysis and the least squares method were used in the Eviews program to analyze annual financial data in Algeria from 2016 to 2021. The results showed that fintech innovations have statistical significance with GDP, indicating that Algeria should further pursue the use of fintech innovations to enhance financial inclusion.

- **Study by Zhiwei Ji (2023):**

"The Impact of Financial Technology on GDP and Home Prices: Evidence from China." This study examines the impact of financial technology on GDP and home prices in China. To study this impact, a comprehensive set of data was used and analyzed. The results indicated that financial technology has a positive and significant impact on GDP and home prices, which allows for economic growth and real estate market development, achieving sustainable economic development and real estate market stability.

- **Study by Mustafa Ahmed Hamid Radwan (2022):**

"The Impact of Digital Transformation on GDP." This study aimed to highlight the impact of applying digital transformation mechanisms on GDP by recognizing the importance of digital transformation as one of the innovations in information technology, and showing its key strategies

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and success determinants. According to the study results, digital transformation has a positive impact on the development of GDP, which is enhanced by providing human skills and competencies that improve the use of digital transformation techniques, in addition to attempting to overcome its obstacles by providing an investment climate conducive to the information technology sector.

Analysis of previous studies: From the previous studies discussed and in comparison to the current study, there are common points such as attempting to highlight the importance of fintech and its applications in the financial field. The points of difference are that the current study seeks to highlight the impact of fintech applications in financial transactions on GDP, a topic not directly addressed in previous studies. Some focused on studying the impact of digital transformation on GDP, while others focused on the impact of digital technology applications on financial inclusion. From the above, it is clear that previous studies have not directly addressed the impact of fintech on GDP."

3. Literature Review :

3.1 - Financial Technology

3.1.1 - Definition of Financial Technology: The Financial Stability Board (FSB) defines it as a technologically enabled financial innovation that may result in new business models, technology applications, operations, and products, which have a significant impact on financial markets, institutions, and the provision of financial services. (Sakhri, Ben Ali, 2021, p. 405)

It is also defined as a term that refers to any institution that intervenes in this field to offer its clients innovative or creative technological solutions. These are start-up companies that seek to gain market share at the expense of traditional actors in the financial services sector. (Alaqma and Sayhi, 2018, p. 89)

3.1.2 - Characteristics of Financial Technology: The key characteristics of financial technology can be summarized as follows: (Matai, 2013, pp. 23-30):

- Financial technology refers to the knowledge, skills, methods, and banking practices used to develop financial work in banks.
- Financial technology is a tool used in banks to achieve their set goals and facilitate their work.
- The application of financial technology is not limited to providing services but extends to the management methods adopted by the bank.

3.1.3 - Importance of Financial Technology: Financial technology has great importance, especially with the development witnessed in the world, as follows: (Masoudi and Qureshi, 2023, p. 425):

- Increasing economic growth and promoting financial inclusion, thanks to innovations that contribute to providing financial services to the unbanked.
- Striving to provide financing alternatives for small and medium-sized enterprises.
- Using financial technology helps maintain financial stability, ensure compliance with regulatory requirements, and manage risks.
- It helps develop foreign trade by providing mechanisms and methods for various financial transfers and reducing costs.
- The use of electronic payment methods helps the government monitor various financial operations, ensuring consumer protection and cybersecurity.

3.1.4 - Financial Technology Techniques: Financial technology relies on several financial technologies, including:

- Blockchain: A distributed database maintained in a decentralized manner, with secure encryption, unmodifiable data, and information stored in blocks using encryption processes. These blocks are linked sequentially to form a blockchain, offering features such as anonymity, decentralization, and a reliable database that is not subject to tampering. (Gai, Yue, and Jiaming, 2022, p. 2)
- Big Data: Large data sets that can be analyzed to uncover patterns and trends, especially concerning human behavior and interactions. These data sets have specific attributes, including volume, variety, and velocity, which are used to identify customer segments, detect financial fraud, and manage risks. (Gai, Yue, and Jiaming, 2022, p. 2)
- Cloud Computing: Defined as providing computing services (servers, storage, networks, software, analytics, and more) over the internet. This technology shifts processing and storage space from a computer to the cloud (a server accessed via the internet). It offers companies various tools to develop applications and provide quick, innovative solutions to the market, satisfying customer needs rapidly. (Hamdoch, Amani, and Ben Ali, 2021, p. 543)
- Artificial Intelligence: Defined as the ability to understand new and changing conditions. Generally, AI is a computer or machine created by humans to perform tasks that require intelligence. (Hamdoch, Amani, and Ben Ali, 2021, p. 544) Kurzweil, a prominent researcher in the field of AI, defines it as "the art of creating machines capable of performing tasks that require intelligence when done by humans." (Khawaled, 2019, pp. 12-13)
- Cryptocurrencies: A digital representation of virtual value that does not exist in the real world, with no issuer and not subject to regulation by any country. Cryptocurrencies are stored in electronic wallets and are traded among users due to their monetary functions. (Amal, 2020, p. 113)
- Internet of Things: An emerging global information engineering architecture based on the internet, aiming to provide an IT infrastructure to facilitate the exchange of goods and services in safe and reliable conditions. Its function is to bridge the gap between physical objects in the real world and their representation in information systems. (Mahidi and Farnan, 2021, p. 275)

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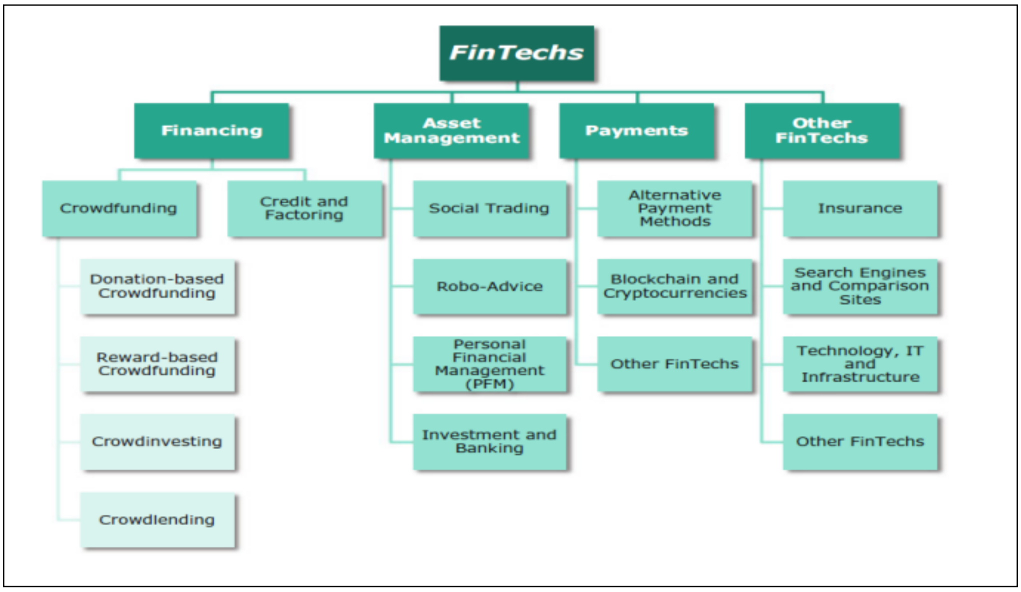
3.1.5 - Financial Technology Sectors : Some of the sectors of financial technology include:

- **Payments Sector**: The use of financial technology in this sector appears through bill payments and domestic and international money transfers, which has helped improve financial transaction services, reduce costs, and save time. Some of the tools used include mobile wallet applications on mobile phones instead of paper money and mobile payment operations such as the PayPal app. (Zouak, 2020, p. 342)
- **Insurance Sector**: Insurance prices are determined based on credit score or their profile on social media. However, with financial technology techniques, online applications can be used to compare prices and shop in the insurance sector. Some platforms in this sector include Money, Capital, and Uber. (Zouak, 2020, pp. 342-343)
- **Finance Sector**: Users, whether lenders or borrowers, can use financial technology applications, such as digital platforms that form direct financing circles (digital markets), to obtain crowdfunding, consisting of three parties: contributors, platforms, and the project entrepreneur. This also includes peer-to-peer lending, and these platforms provide information to individuals and companies for mutual lending at low rates. (Rabah, 2022-2023, p. 59)
- **Asset Management Sector**: Financial technology, through its applications, offers advice and guidance on asset management and helps make investment decisions without human intervention by analyzing data from various financial markets and comparing them with current market performance and future market predictions using algorithms designed for this purpose. (Rabah, 2022-2023, p. 59)

Figure 1: Financial Technology Sectors



Source: (Ajlouni & Monir, 2018, p. 04)

3.1.6 - Advantages of Financial Technology: Financial technology offers several advantages, including : (Alnajdawi and Ghassan, 2024, p. 16):

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- **Access to All Users**: This advantage is achieved through start-up companies capable of reaching all groups and classes by redesigning and adapting their products to match the customer's limited income, unlike traditional financial products that assess clients based on asset ownership.
- **High Flexibility and Affordability**: This is achieved through the ability of fintech start-up companies to develop multiple payment plans and goods and services suitable for customers.
- **Speed**: This advantage is demonstrated by shortening transaction time using financial technology, relying on various technologies such as big data and algorithms, compared to traditional financial transactions, which take longer.

3.1.7 - Definition of Financial Technology Companies: These are start-up companies with few shares but offer new and high-quality services. They help improve the financial sector and the services market. Due to the development experienced by these companies, they are increasingly expanding and rely on crowdfunding, which occurs through online platforms for financing. (Talba and Bouhnik, 2022, p. 5)

Table 1: Growth of Fintech Start-up Companies Worldwide from 2018 to 2021

Years	United States	Europe, Middle East & Africa	Asia-Pacific
2018	5,686	3,581	2,864
2019	5,779	3,583	2,849
2020	8,775	7,385	4,765
November 2021	10,755	9,323	6,286

Source: (Aman and Hebri, 2022, p. 20)

From Table 1, we observe that the growth in the number of fintech start-up companies in the United States, with 10,755 companies in November 2021, is higher than that in Europe, the Middle East & Africa, with 9,323 companies, and Asia-Pacific, with 6,286 companies.

3.1.8 - Features of Financial Technology Companies: Financial technology companies are characterized by the following: (Amani, 2017, p. 398)

- Providing Infrastructure for the Digital World;
- Offering Services Without Ownership;
- Providing Automated Assistance that exceeds customer service via phone;
- Offering Digital Services in Various Fields.

3.2 - Gross Domestic Product (GDP)

3.2.1 - Definition of Gross Domestic Product (GDP): This indicator was developed into its current form by economist Simon Kuznets in 1934 in a report presented to the U.S. Congress. It aimed to estimate the U.S. production of all goods and services, serving as an indicator of a country's economic performance. It rises during times of prosperity and falls during times of recession. (Magdy, 2021, p. 08)

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3.2.2 - Calculation of Gross Domestic Product (GDP):

GDP is calculated in several ways, including **the expenditure** method: GDP=C+G+I+N(E-I).
Gross Domestic Product = Consumer Expenditures + Government Spending + Gross Investment + Net Exports. (cibeg, 2020)

The method for calculating **total output** involves multiplying the quantities produced in each sector by the prices and then summing the results for all sectors. In other words, you can calculate the total output using the following equation:

GDP= ∑(Quantity produced in each sector × Price).

Difficulties in measuring GDP:

- Lack and unavailability of accurate statistical information and data for all economic sectors.
- The problem of double counting in accounting for certain products.
- Difficulty in measuring products and services consumed by their producers.
- Difficulty in estimating the imputed rent of owner-occupied houses.
- Difficulty in accounting for old and used goods included in the national income for the current year.
- Exclusion of a large portion of the labor force and not counting them in national income.
- Exclusion of hidden economic activities.

3.2.3 - Impact of Financial Technology on Gross Domestic Product (GDP): The impact of financial technology on Gross Domestic Product (GDP) is evident through significant shifts in production, consumption, and employment. Financial technology contributes to improving processes and production quality. The technology sector acts as a major driver of economic growth through its investments in research and development, the creation of digital infrastructure, and the stimulation of innovation across various sectors, as well as the development of advanced economic development strategies to achieve positive outcomes and increase GDP. (Al-Jubairi, 2024)

4. The Study Framework

4.1 - Methods and Tools : This section revolves around studying the impact of financial technology indicators represented by the total number of SWIFT messages, total users of the SWIFT system, and the number of credit cards on GDP for a sample of countries, including: (Argentina, Belgium, Canada, Germany, India, Indonesia, Italy, Mexico, Russia, Saudi Arabia, Sweden, Switzerland, Turkey). Based on the above, we can rely on panel models in this study to demonstrate this effect, which we will examine as follows:

4.1.1 - Identifying Study Variables: Based on the empirical results of previous studies, we will rely on three panel models (fixed effects, pooled, and random) to measure the effect of financial technology indicators on GDP. The following table represents the study variables.

Table 2: Standard Study Variables

Code	Indicator
Dependent Variable	
y	GDP
Independent Variables	
X 1	Total number of SWIFT messages (in thousands)
X 2	Total users of the SWIFT system (in thousands)
X 3	Number of credit cards (in thousands)

Source: Compiled by the researchers.

4.1.2 - Study Data and Tools : Through our review of statistics on the website of the Bank for International Settlements (BIS), data for the study were collected, spanning from 2012 to 2021, covering 13 countries (Argentina, Belgium, Canada, Germany, India, Indonesia, Italy, Mexico, Russia, Saudi Arabia, Sweden, Switzerland, Turkey). The data was then processed using the (Stata .15 software). Since the aim of the empirical study is to build a standard model that illustrates the nature of the relationship between study variables, we opted to use panel models, also known as cross-sectional time-series data, which combines the characteristics of cross-sectional and time-series data.

4.2 - Results and Discussion

4.2.1 - Comparison Between Panel Models

To compare panel models, we need to extract the results of each model, as illustrated in the following table.

Table 3 : Results of Panel Models Estimation Outputs.

Interpretive Variables	Aggregate Impact Model	Fixed Effects Model	Random Effects Model
X 1	0. 03635285 (0.227)	-0.072347 (0.168)	-0.0684726 (0.108)
X 2	0. 3317667 (0.000)	0. 1761367 (0.015)	0. 2230048 (0.000)
X 3	0. 3030834 (0.000)	0. 1376278 (0.005)	0. 150286 (0.000)
Constant	1.505714 (0.001)	5.385641 (0.000)	4.920092 (0.000)
Number of Observations	130	130	130
R-squared	0.6656	0.9754	-
Adjusted R-squared	0.6576	0.9721	-
Prob (F-Stat)	0.0000	0.002	0.0000

Source: Compiled by researchers based on the outputs of the (Stata 15) program (see Appendix 01)

To compare the three estimated models in Table 03, we perform the following tests:

- **Breusch and Pagan Test**: This test is used to differentiate between the Aggregate regression model and the random effects model. The hypothesis for this test is formulated as follows:

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$$\begin{cases} \mathbf{H_0}: \text{(Aggregate model) has no random effects} \\ \mathbf{H_1}: \text{has a random effects} \end{cases}$$

Table 4 : Breusch and Pagan Test Results

chibar2(01)	438.60
Prob > chibar2	0.0000

Source: Compiled by researchers based on the outputs of the (Stata 15) program (see Appendix 02)

From the table, we observe that the Prob > Chibar2 value is statistically significant, i.e., less than 5%. Therefore, we accept the alternative hypothesis (H1) indicating the presence of random effects. In other words, we choose the random effects model over the Aggregate impact model.

- The Hausman test : is employed to differentiate between the fixed effects model and the random effects model, within two hypothesis:

$$\begin{cases} \mathbf{H_0}: \text{Random Effects Model} \\ \mathbf{H_1}: \text{Fixed Effects Model} \end{cases}$$

This test relies on calculating both chi2 (10) and Prob>ch, and the results using Stata 15 are presented in the following table:

Table 5 : Hausman Test Results

chi2(3)	7.16
Prob>chi2	0.0671

Source: Compiled by researchers based on the outputs of the (Stata 15) program (see Appendix 03)

The Prob > Chi2 value in the above table indicates that the probability for the test is not statistically significant at the 5% level. This leads us to accept the null hypothesis (Ho). Therefore, we find that the random effects model is preferable compared to the fixed effects model.

- Fisher's Restricted Test : serves as a test for differentiation between the aggregate regression model and the fixed effects model, verifying the presence of individual effects within two given hypothesis:

$$\begin{cases} \mathbf{H_0}: \text{has no fixed impact (Aggregate model)} \\ \mathbf{H_1}: \text{has a fixed impact} \end{cases}$$

Table 6 : Fisher's Restricted Test Results

F(12, 114)	119.482
Prob> F	0.0000

Source: Compiled by researchers based on the outputs of the (Stata 15) program (see Appendix 01)

The results of this test indicate that the F-statistic (12, 114) with a value of 119.482 is statistically significant at a 5% level of significance (since Prob > F = 0.0000 < 0.05). Therefore, we accept the alternative hypothesis (H1), which suggests the presence of fixed effects in the model. Consequently, the preferred model within this test is the fixed effects model.

4.2.2- Estimation of the Optimal Model: Through our examination of the comparative tests, we find that the fixed effects model is the most suitable for the study. However, before relying on its results, it is crucial to ensure that this model does not suffer from standard problems, such as autocorrelation of errors and heteroscedasticity.

- Wooldridge Test: This test measures the autocorrelation of errors, which is the degree of correlation between the values of the same variable over a specified period, rather than between one or more variables. There are several tests to measure autocorrelation, with one of the most important being the Wooldridge test (Etoumi, 2018, p293). The test can be conducted using the command (xtserial) in the Stata 15 program. The results of this test were as follows:

```
. xtserial y x1 x2 x3
Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
F(  1,      12) =     21.930
Prob > F =      0.0005
```

Source: Compiled by researchers based on the outputs of the (xtserial) command in Stata 15.

The results of the Wooldridge test for detecting autocorrelation issues indicate that the probability value is less than 0.05. This allows us to accept the null hypothesis, suggesting the absence of autocorrelation problems.

- Modified Wald test: This test allows us to know the heterogeneity of the variance. The latter affects the estimates of the variance of the model's estimators. It is used to determine the presence of this problem or not by using the Modified Wald test within the property provided by the command (xttest3) in the program (stata.15). As indicated by the command results below:

```
. xttest3

Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (13)  =     288.77
Prob>chi2 =      0.0000
```

Source: Compiled by researchers based on the outputs of the (xttest3) command in Stata 15.

From the results of the Modified Wald test, it is concluded that the fixed effects model suffers from the problem of heteroscedasticity. This conclusion is drawn because the statistically significant probability value (Prob > F < 0.05) is less than 5%, leading to the rejection of the null hypothesis and acceptance of the alternative hypothesis.

4.2.3- Analysis of the Estimated Model: Based on the tests revealing the presence of econometric issues, it appears that the model suffers from heteroskedasticity. To address this problem, the method of correcting errors in panel time series data, also known as xtgls (Danie, 2007, p285), is employed. This method is resorted to when the cross-sectional dataset has fewer time periods available.

```
xtpcse y x1 x2 x3

Linear regression, correlated panels corrected standard errors (PCSEs)

Group variable:   ind                    Number of obs      =      130
Time variable:    year                   Number of groups   =       13
Panels:           correlated (balanced)  Obs per group:
Autocorrelation:  no autocorrelation                    min =       10
                                                        avg =       10
                                                        max =       10
Estimated covariances      =        91   R-squared          =   0.6656
Estimated autocorrelations =         0   Wald chi2(3)       =  3991.25
Estimated coefficients     =         4   Prob > chi2        =   0.0000


------------------------------------------------------------------------------
             |           Panel-corrected
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .0365285   .0203358     1.80   0.072     -.003329    .0763859
          x2 |   .3317667   .0316902    10.47   0.000      .269655    .3938784
          x3 |   .3030834   .0135154    22.42   0.000     .2765936    .3295732
       _cons |   1.505714   .2642263     5.70   0.000     .9878397    2.023588
------------------------------------------------------------------------------
```

Through the results of this method, the equation of the estimated optimal model can be written as follows:

Y=1.505714+0.0365285x1+0.3317667x2+0.3030834x3

Through these models, we observe that for every increase of one unit in the total number of SWIFT messages (x1) between banks and financial institutions in the studied sample countries, the gross domestic product (GDP) increases by 0.0365 units. This means that the number of messages via SWIFT reflects the number of financial transactions that take place through it, and therefore we can say that using the SWIFT system increases GDP. This is consistent with the leading supply theory. Furthermore, we observe that for every one unit increase in the total number of SWIFT system users (X2), GDP increases by 0.331 units. Similarly, it is clear that an increase in the number of credit cards (X3) by one unit also leads to an increase in GDP by 0.303 units. From this, we conclude that using financial technology applications in various financial transactions enhances and increases the value of GDP.

5. Conclusion:

The use of financial technology has become necessary in all sectors, especially the financial sector, which is considered the backbone of the global economy. The latter is characterized by its fast-paced financial transactions, which requires the use of modern and secure techniques such as financial technology applications that ensure speed and allow for cost reduction, leading to increased financial investments and enhanced GDP. The study concludes with the following findings:

- Financial technology applications have a positive effect on GDP according to the results of a study on a sample of countries.
- Financial technology contributes to the development of financial transactions.

- Financial technology faces several challenges that must be taken into account to ensure better results.

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7. Appendices:

Appendix 1: Estimation of the Three Panel Models:

- Aggregate Impact Model

```
reg y x1 x2 x3

      Source |       SS           df       MS      Number of obs   =       130
-------------+----------------------------------   F(3, 126)       =     83.59
       Model |  32.0556387         3  10.6852129   Prob > F        =    0.0000
    Residual |  16.1064311       126  .127828819   R-squared       =    0.6656
-------------+----------------------------------   Adj R-squared   =    0.6576
       Total |  48.1620698       129  .373349378   Root MSE        =    .35753

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .0365285   .0334281     1.09   0.277    -.0296247    .1026817
          x2 |   .3317667    .055161     6.01   0.000     .2226047    .4409288
          x3 |   .3030834   .0268097    11.31   0.000     .2500279    .3561389
       _cons |   1.505714   .4435841     3.39   0.001     .6278738    2.383554
------------------------------------------------------------------------------
```

- Fixed Effects Model

```
xtreg y x1 x2 x3 , fe

Fixed-effects (within) regression               Number of obs     =        130
Group variable: ind                             Number of groups  =         13

R-sq:                                           Obs per group:
     within  = 0.1214                                         min =         10
     between = 0.5389                                         avg =       10.0
     overall = 0.5242                                         max =         10

                                                F(3,114)          =       5.25
corr(u_i, Xb)  = 0.4611                         Prob > F          =     0.0020

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

```
          x1 |   -.072347   .0521229    -1.39   0.168    -.1756021    .0309082
          x2 |   .1761367   .0713704     2.47   0.015     .0347525    .3175208
          x3 |   .1376278   .0482075     2.85   0.005     .0421291    .2331265
       _cons |   5.385641   .4818324    11.18   0.000     4.431135    6.340148
-------------+----------------------------------------------------------------
     sigma_u |  .47957871
     sigma_e |  .10201022
         rho |  .95671378   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(12, 114) = 119.48                   Prob > F = 0.0000

. areg y x1 x2 x3 , absorb ( country )

Linear regression, absorbing indicators         Number of obs     =        130
                                                F(   3,    114)   =       5.25
                                                Prob > F          =     0.0020
                                                R-squared         =     0.9754
                                                Adj R-squared     =     0.9721
                                                Root MSE          =     0.1020

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   -.072347   .0521229    -1.39   0.168    -.1756021    .0309082
          x2 |   .1761367   .0713704     2.47   0.015     .0347525    .3175208
          x3 |   .1376278   .0482075     2.85   0.005     .0421291    .2331265
       _cons |   5.385641   .4818324    11.18   0.000     4.431135    6.340148
-------------+----------------------------------------------------------------
     country |        F(12, 114) =    119.482   0.000         (13 categories)
```

- Random Effects Model

```
xtreg y x1 x2 x3 , re

Random-effects GLS regression                   Number of obs     =        130
Group variable: ind                             Number of groups  =         13

R-sq:                                           Obs per group:
     within  = 0.1200                                         min =         10
     between = 0.6064                                         avg =       10.0
     overall = 0.5879                                         max =         10

                                                Wald chi2(3)      =      28.32
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |  -.0684726   .0426596    -1.61   0.108    -.1520839    .0151388
          x2 |   .2330048   .0664968     3.50   0.000     .1026734    .3633361
          x3 |    .150286   .0392456     3.83   0.000     .0733661    .2272059
       _cons |   4.920092   .4681414    10.51   0.000     4.002552    5.837632
-------------+----------------------------------------------------------------
     sigma_u |  .39396835
     sigma_e |  .10201022
         rho |  .93716783   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Appendix 2: Comparative Results between the Random Effects Model and the Aggregate Model:

```
xttest0

Breusch and Pagan Lagrangian multiplier test for random effects
```

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```
y[ind,t] = Xb + u[ind] + e[ind,t]

Estimated results:
                 |       Var     sd = sqrt(Var)
        ---------+-----------------------------
               y |   .3733494       .6110232
               e |   .0104061       .1020102
               u |   .1552111       .3939684

Test:   Var(u) = 0
                     chibar2(01) =   438.60
                  Prob > chibar2 =   0.0000
```

Appendix 3: Comparative Results between the Random Effects Model and the Fixed Effects Model:

```
. hausman fe re

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
          x1 |    -.072347    -.0684726       -.0038744        .0299492
          x2 |    .1761367     .2330048       -.0568681        .0259211
          x3 |    .1376278      .150286       -.0126582        .0279955
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =  -519.38    chi2<0 ==> model fitted on these
                                        data fails to meet the asymptotic
                                        assumptions of the Hausman test;
                                        see suest for a generalized test

. hausman fe re, sigmamore

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
          x1 |    -.072347    -.0684726       -.0038744        .0314955
          x2 |    .1761367     .2330048       -.0568681        .0291555
          x3 |    .1376278      .150286       -.0126582        .0294113
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        7.16
                Prob>chi2 =      0.0671
```