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Article

Macroeconomic determinants of financial fraud and identity theft

Determinantes macroeconómicos del fraude financiero y robo de identidad

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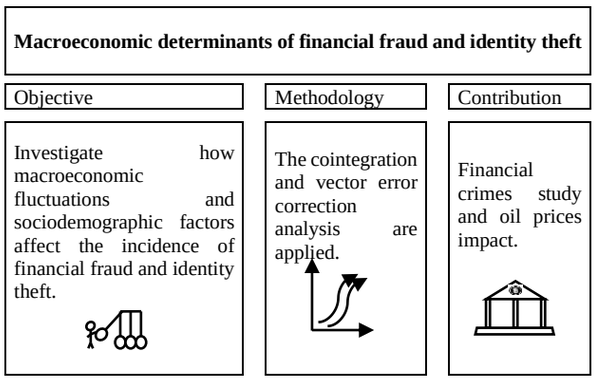
Abstract

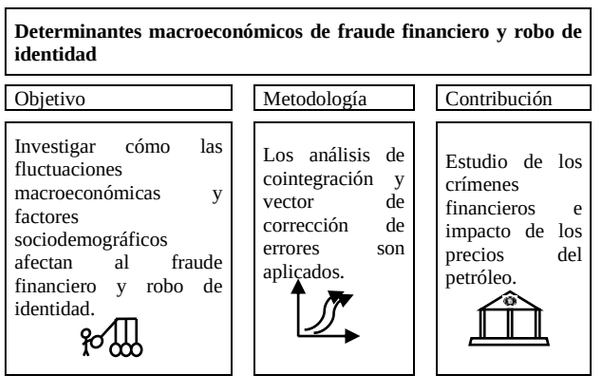
This study concentrates on the environment of financial institutions and investigates how macroeconomic fluctuations and sociodemographic factors affect the incidence of financial fraud and identity theft in the pre-covid era. Using quarterly records of the incidence of these variables provided by a major financial institution in Mexico from 1999 to 2019, we modelize financial crimes of fraud and identity theft. Macroeconomic and sociodemographic variables are employed. Oil prices are a new variable added to the analysis of financial crimes that have an impact on oil-exporting economies such as Mexico. The cointegration and vector error correction analysis is applied. Our findings show that the unemployment rate, oil prices, GDP per capita and gender have a significant impact in the short and long term on fraud and identity theft incidence. The Toda-Yamamoto test shows evidence of Granger-causality from inflation and the stock market towards these financial crimes.



Financial crime, macroeconomic, causality

Resumen

Este estudio se centra en el entorno de las instituciones financieras e investiga cómo las fluctuaciones macroeconómicas y los factores sociodemográficos afectan la incidencia del fraude financiero y el robo de identidad en la era pre-covid. Datos trimestrales de una importante institución financiera de 1999 a 2019 son utilizados. Los precios del petróleo son una nueva variable agregada al análisis de los delitos financieros que tienen un impacto en las economías exportadoras de petróleo como México. Se aplica el análisis de cointegración y corrección de errores vectoriales. Nuestros hallazgos muestran que la tasa de desempleo, los precios del petróleo, el PIB per cápita y el género tienen un impacto significativo en el corto y largo plazo en la incidencia del fraude y el robo de identidad. La prueba de Toda-Yamamoto muestra evidencia de causalidad de Granger de la inflación y el mercado de valores hacia estos delitos financieros.



Crimen financiero, macroeconómico, causalidad

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Introduction

Two main theoretical approaches explain the determinants of crime: the sociological and the economic. The sociological approach proposes that the criminal behavior of the individual is governed by individual characteristics, family factors and social structure (Butkus et al., 2019) or even when in the company of peers (Engel, 2023). The economic approach proposes that crime is the product of a utility maximization process where the individual chooses between committing a crime or a legitimate activity comparing its expected benefits with its costs as mentioned by Ehrlich (1973) and Becker (1968). This approach opens the door to the inclusion of macroeconomic factors that can modify benefits and opportunities in legal activities and maximize utility in the direction of illegal ones (Cerulli et al., 2018).

Fraud and identity theft crimes in financial institutions have not received attention in terms of their macroeconomic determinants in the literature review (Mangala and Soni, 2023). Fraud is considered any financial transaction not recognized by the customer made from their accounts in which identification is not necessary (Bolton and Hand, 2002). Identity theft occurs when one person obtains data or documents belonging to another (victim) and then passes himself off as the victim to steal money (Koops and Leenes, 2006). These crimes represent over 70% of total financial claims in countries such as Mexico causing monetary losses, investigation costs, external penalties, deterioration of institutional reputation and financial damage to clients. Knowledge of their determinants is crucial to mitigate these negative effects. Indeed, some authors hightlight that a type of crimes as corruption has a mixed effect into firm growth and innovation (Goedhuys et al., 2016; Sheng et al., 2019). It is well known in the literature that macroeconomic fluctuations and sociodemographic characteristics affect the incidence of non-financial crimes, but do these factors affect financial fraud and identity theft crimes? If so, does the impact contribute to increasing or reducing their incidence? The interest in the answers to these questions is heightened by the recession started in 2020 in different countries due to the SARS-Cov-2 pandemic, and the strong fluctuations in oil prices due to Russian-Saudi Arabian oil price war in 2020 and the recent Russo-Ukrainian war.

To answer the two questions above, data from a large financial institution in Mexico are taken to study the effects of macroeconomic fluctuations and sociodemographic characteristics on the incidence of financial fraud and identity theft per 100,000 individuals. The macroeconomic variables considered in the study are the unemployment rate, petroleum prices, inflation, GDP per capita, and economic growth. Petroleum prices are a new variable of interest as a determinant of financial crime, particularly in fraud and identity theft, that has not been deployed in previous analyses and is relevant in oil-exporting countries. Sociodemographic factors such as gender and level of urbanization are also considered in the study.

Using the cointegration and vector error correction analysis, our findings show that the unemployment rate and oil prices have a positive and negative impact on fraud and identity theft incidence, respectively, in the short and long term. The GDP per capita shows a negative impact on fraud and identity theft in the long term and a positive only for identity theft in the short term. Gender shows a significant negative impact on the incidence of both crimes in the short and long term. The Toda-Yamamoto test by its part shows evidence of Granger-causality from inflation and the stock market towards these financial crimes. Consequently, the contributions of this study are twofold: in a theoretical way, to show a new macroeconomic variable such as oil prices has an impact on fraud and identity theft incidence. In a practical way, the implementation of this methodology to real data works well in financial institutions to identify the increase of fraud and identity theft cases and apply mitigating measures to their determinants.

This article is organized as follows. In the “Literature review and hypotheses” section, we present the literature on determinant factors of financial and non-financial crimes, and hypotheses to prove. The "Data" section presents and describes the variables and sources of data. The "Methodology" section shows the econometric techniques implemented. The "Results and discussions" section describes the main results and findings. The article ends with the " Conclusions " section presenting the main findings.

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Literature review and hypotheses

As mentioned before, few articles study the determinant factors of crime in financial institutions. For example, Agarwal and Liu (2003) study how the unemployment rate affects credit card delinquency. They prove that the unemployment rate has a positive effect of between around 1.9 percentage points and 2.8 percentage points depending on the specification. Hartmann-Wendels et al. (2009) analyze the determining factors of the risk that a debt cannot be enforced because the identity of the person incurring the debt cannot be ascertained. They use individual features such as gender, nationality, marital status, telephone, age, occupation, overdraft and urban characteristics. The results of the regression suggest that fraud risk is sensitive to nationality, gender, marital status, age, occupation, and urbanization. Along the same lines, Reyns and Henson (2015) identify determinants for online identity theft and find that online banking, among others, is an important factor in exposure to this type of crime. In some cases, the crime does not come from external entities but can be caused internally by the institution. Avortri and Agbanyo (2020) prove that pressure on credit placement staff and poor remuneration have an impact on the incidence of financial fraud. Achim and Borlea (2020) study how cultural factors, religion, tax morale, trust in the state, or the happiness condition of individuals influence economic and financial crimes. This study is applied to European Union countries. A last related study is Mangala and Soni (2023) where the authors mention that pressure to sell products, the perceived opportunity to commit fraud and rationalization to justify offensive behavior can lead bank staff to commit financial fraud.

However, the literature on the determinants of non-financial crimes for different societies/countries is extensive. For example, a recent study by Gokmenoglu et al. (2022) shows that rapid urbanization and high-rate unemployment are influential factors in increasing crime rates. On the contrary, real GDP growth and progress in the rule of law reduce crime rates. The coming sections describe the most common non-financial crime determinants already studied in the literature that may explain the factors involved in financial fraud and identity theft crimes.

All existing empirical studies show that the determinants of crime can be classified into three main categories: economic, sociological and deterrence. These three categories are described below.

Economic approaches to the determinants of crime

The first group of determinants that could condition crimes are the economic ones. The main variables used are the following: unemployment, inflation, GDP/GDP per capita/economic growth and income inequality.

-*Unemployment*. By far the most widely used economic variable as a determinant of crime is the unemployment rate. Studies such as those of Cantor and Land (1985) have shown the positive and negative effects of the unemployment rate on crime (homicide, robbery, burglary, larceny, and motor vehicle theft). They argue that, on the one hand, the positive effect is because unemployed individuals look for alternatives to obtain income such as crime. On the other hand, the negative effect is due to a greater number of workers in the labor market with resources available to steal.

This ambiguity coincides with what was explained in Field (1990). This article states that wealth may be an incentive to crime simply because, with prosperity, there are more goods available to steal and at the same time, wealth may be a disincentive to crime because wealthy people have less need to steal. Cohen and Land (1987) report a negative effect of unemployment on motor vehicle theft rates and a positive effect on homicide rates. Studies such as those by Lee (2018) show that the unemployment rate can have an ambiguous (positive/negative) impact on crime depending on the apprehension rate. Nordin and Almén (2017) argue that property and violent crime are affected, in a different way, by the unemployment rate. On one hand, long-term unemployment has a strong positive effect on violent crime, while total unemployment affects only property crime.

Other studies such as Devine et al. (1988), Tang and Lean (2007), Tang (2009), Tang (2011) and Mittal et al. (2019) show evidence that the unemployment rate has only a positive impact on non-financial crimes as homicide, robbery and burglary, etc.

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In the context of economic crisis, Bell et al. (2015) use data from the US and UK to show evidence that recessions can lead to substantial and persistently higher rates of criminal behavior resulting from higher entry-level unemployment rates. In economic recessions with mass layoffs, Bennett and Ouazad (2018) suggest that, in transitions between employment and passive benefits and between active benefits and social assistance, crime spikes, and generates an associated social cost.

- *Inflation.*

Inflation is usually used as an indicator of good health in the economy. Consequently, high inflation is associated with difficult times in the economy that push people to perform criminal acts. Some of the first studies including inflation as a determinant of crime are carried out by Brenner (1976), Land and Felson (1976) and Devine et al. (1988) that prove a positive link between homicide rates, property (but not violent), robbery, burglary and inflation.

Allen (1996) argues that studies usually focus on the effect of the unemployment rate, ignoring the effects that inflation has on criminal activities. In the long term, inflation reduces the purchasing power of consumers and the cost of living increases. Consequently, individuals cannot maintain their lifestyle at the same level, opting, in some cases, for illegal activities to obtain resources (Tang and Lean, 2007). Tang (2009) includes the unemployment rate and inflation in the same model to investigate their effects on property and violent crimes. Using annual data from 1970 to 2006 in Malaysia, he finds that inflation has a positive effect on these types of crimes.

Teles (2004) and Gillani et al. (2009) point out that monetary and fiscal policies impact crime through inflation, specifically when prices increase, reducing the real income of individuals. Nunley et al. (2016) use annual data from 1950 to 2010 in the US and obtain a stable, positive impact of inflation on all forms of property crime (larceny, burglary, motor vehicle theft, and robbery). They deduce that this positive effect can be either via income, because inflation lowers the real income of thieves, or by raising the per-unit reward for theft. Rosenfeld and Levin (2016) link inflation to crimes committed for monetary gain through its effect on the market for stolen goods.

When prices of stolen merchandise increase due to inflation, they become more attractive to consumers and criminals, encouraging an increase in the theft of goods. The same results are obtained later when the same study is replicated in a sample of 17 U. S. cities between 1960 and 2013 (Rosenfeld et al., 2019). Other studies such as Adekoya and Abdul (2016) and Hazra and Cui (2018) also confirm the positive effect of inflation on crime. Recently, Rosenfeld and Vogel (2023) corroborate a significant association between inflation and homicide rates partially mediated by acquisitive crime.

- *GDP/GDP per capita/Economic growth*

GDP per capita is a common measure of economic affluence. It is also an indicator of economic development and conditions the context as social influence (Van Gelder and Nagin, 2023). This indicator can have two links to crime. If economic affluence increases as income disparity decreases, the incentive to commit a crime is likely to decrease. On the other hand, if the increase in economic affluence is accompanied by an unequal distribution of income, the incentive towards crime may emerge (Debnath and Das, 2017).

Rosenfeld and Fornango (2007) use GDP per capita as a measure of aggregate economic activity and find that GDP per capita has a significant negative impact on robbery and larceny crimes. Detotto and Otranto (2012) obtain a similar effect using the Gross Domestic Product (GDP) from Italy as a business cycle proxy proving the hypothesis that the crime rate follows a cycle. Especially, they show that a rise in economic performance is associated with a decrease in the total crime rate. Muloka et al. (2016) obtain a different result by taking economic growth as a determining variable.

They show that economic growth has a positive effect on the incidence of criminal activities in the short and long term. This study follows the economic reasoning that stable and growing economies tend to produce more crime since there is more wealth available to be stolen and vice versa. Kizilgol and Selim (2017) obtain results that also follow this logic but using GDP per capita and the crimes recorded by the police for the EU 28 and Turkey in 2001-2010.

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The effect of economic growth is not significant in this study. Kathena and Sheefeni (2017) use quarterly time series data over the period 2000Q1 to 2015Q4 in Namibia to show a bidirectional causality between crime rate and economic growth. They also prove that an increase in crime rates does indeed result in a decline in economic growth. The same positive effect between economic growth and criminal activities is obtained by Mulok et al. (2018) for Malaysia. Studies such as those of Latimaha et al. (2019) prove a negative relationship between the GDP per capita and all types of street crime (murder, rape, injuries and robbery) rates in Malaysia.

- *Income inequality*

Income inequality can be a catalyst for crime. Lower-income individuals may feel jealousy and envy and be pushed to acquire wealth from upper social classes in a criminal way. Kelly (2000) uses the ratio of mean to median households as a proxy of income inequality and data from 1991 FBI Uniform Crime Reports to prove that inequality has a strong positive and robust impact on violent crime and null on property crime. This article argues that individuals with economic disadvantages have more incentives to commit a crime in areas with high inequality.

Fajnzylber et al. (2000) introduce the Gini index as a measure of income inequality and obtain a positive significant effect on violent crime. Jennings et al. (2012) use statistics on recorded crime in England and Wales from 1961 to 2006 to confirm a null effect of income inequality on property crime. Later, Baharom et al. (2013) show a positive relationship between inequality and general crime by analyzing 21 countries, with data spanning from 1960 to 2001. Enamorado et al. (2016) estimate the effect of income inequality on crime in the context of Mexico's drug war. They prove that, for the period from 2007 to 2010, an increment of one percentage point in income inequality measured by the Gini index represents an increase of more than 6 homicides per 100,000 inhabitants in Mexican municipalities. Other more recent studies such as those of Kang (2016), Coccia (2017) and Buonanno and Vargas (2019) also show that socioeconomic inequality is one of the factors that generate high rates of property and violent crime.

From South Africa, Büttner (2022) find robust evidence for a significant and positive relationship between income inequality within precincts and local rates of violent crime. Moreover, education and housing inequality combined with racial heterogeneity are also positively correlated with crime.

Sociological approaches to the determinants of crime

Social and demographic characteristics of a population could affect the incidence of criminal activities. Age is a variable commonly related to crime. The pattern observed shows an increase in crime rates with age until a peak is reached in the teenage years, with a slow decline afterwards (Farrington, 1986). This is confirmed in the study by Nunley et al. (2011) which proves that the percentage of the young population is a robust predictor of the large swings observed in the U.S. murder rate for the period 1934–2006. Köber et al. (2022) find that younger people were almost as fearful as older people in the most disadvantaged neighbourhoods, but older people were considerably more fearful than younger ages in better-off neighbourhoods. Thus, age is a variable related to crime but mediated by other factors such as wealth.

Lafree et al. (1992) incorporate educational attainment and family stability in the study of rates of robbery, burglary, and homicide for blacks and whites. For white people, they found that crime rates declined as family income and educational attainment increased. In contrast, crime rates among black people showed a positive relationship with family stability and educational attainment. Igbinedion and Ebomoyi (2017) also find a negative relationship between education and crime rates. They suggest that education not only makes people risk-averse, but also indirectly alters an individual's decision to adopt criminal behavior. With the same arguments, Esedo et al. (2017) analyze white-collar crime in Nigeria to obtain a negative effect between education and crime rates. In Mexico, Gleditsch et al. (2022) corroborate that crime can be reduced by strengthening the education system.

Regarding gender, the universal belief held by criminologists is that women are less likely to commit a crime than men (Steffensmeier and Allan, 1996).

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Using an experiment, Reed and Rorie (2023) find that "gender identity influences the likelihood of crime perpetration even when one's opportunity to commit crime is held constant". Masih and Masih (1996) introduce urbanization as a determining variable of crime and find that burglary and vehicle theft are positively affected by the growth of urbanization. Other sociodemographic patterns related to crime are found by Gaviria and Pages (2002).

They explain that in Latin American countries the typical victims of property crime come from the middle and upper classes and live in large cities or with high population growth. In South Africa, Blackmore (2003) analyzes 15 crimes across the 9 provinces of South Africa over 8 years and finds that most crimes are positively affected by the degree of urbanization, the ratio of women to men, and drug possession offences. Haider and Ali (2015) examine the determinants of crime in Pakistan in the period 2010-2011. Their results suggest a positive and significant impact of population density on crime, meaning that dense and populated areas provide more chances for criminals to commit crimes. In contrast, they find that crime in Pakistan is negatively affected by education levels, suggesting that as education levels increase incentives to commit crimes decline.

The same result for population density is obtained by Anwa et al. (2015). Poverty is a variable that also has an impact on crime. Poverty is a denial of choices and opportunities, and a violation of human dignity. The poor lack of basic capacity to participate effectively in society. In this situation, individuals are more likely to opt for illegal activities than legal work (Kuhe et al., 2016).

Kuhe (2016) uses annual data from Nigeria for the period 1970-2015 to determine that the crime level is positively affected by the level of poverty. The same positive impact is obtained by Hassan et al. (2016) and Asghar et al. (2016) for Pakistan. Subsequently, Amin and Ahmad (2018) incorporate ethnic diversity and social exclusion in the analysis of determinants of crime in Pakistan in the period 1970-2015. Their results show a positive and significant impact on property, violent crime rates, and overall crimes in Pakistan.

Deterrence approaches to the determinants of crime

The deterrence factors are those aimed at containing criminal activities in society. These can be laws, police numbers, the number of arrests, etc. Meera and Jayakumar (1995) analyze the determinants of crime in developing countries, introducing as deterrence factors prison overcrowding, police development expenditure and size of the police force. They find that the first two are positively related to criminal activities while the size of the police force is not significant. Ralston (1999) also obtains positive effects by taking as a deterrent variable the white arrest rate. Imrohoroglu et al. (2000) introduce police expenditure to study its relationship to criminal activities using a general equilibrium model.

They show that increasing the level of expenditure on police protection reduces crime, although at a decreasing rate. In other articles such as those by Keshavarz and Markazi (2011), deterrent factors may not be significant for some crimes in the presence of certain sociodemographic and economic conditions. Frederick et al. (2016) use a balanced panel dataset of the 67 counties in Pennsylvania over the period from 1990 to 2009 to show that clearance and arrest rates contribute to criminal deterrence.

Adekoya and Abdul (2016) incorporate other interesting deterrent variables such as domestic investment, prosecution, and punishment in the analysis of determinants of crime for Nigeria in the period 1970-2013. Their results show that domestic investment and prosecution contribute to reducing criminal activity while punishment only causes a significant impact in the long term.

Recently, in many developed countries, the connection between crimes and immigration rates has been discussed. An empirical paper by Tufail et al. (2022) in the period 1988-2018 across 30 OECD countries show that no statistical evidence exists to relate an increase in the number of immigrants to the rise of any kind of crime. Curiously, an increase in foreign prisoners reduces all kinds of crimes.

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Developing hypotheses

The economic recession due to the SARS-Cov-2 pandemic, and the strong fluctuations in oil prices due to Russian-Saudi Arabian oil price war in 2020 and the recent Russo-Ukrainian war are three complex scenarios. Intuitively, you would think that the economic recession due to the coronavirus pandemic could be accompanied by high unemployment rates, a decrease in stock market, an economic slowdown, and higher levels of inflation that could increase the incidence of financial fraud and identity theft. This effect may be exacerbated by a reduction in GDP per capita and reductions in oil prices triggered by events such as the economic war between Russia and Saudi Arabia. On the other hand, the increase in oil prices due to events such as the war between Russia and Ukraine can mitigate the negative effects of the price decrease in oil-exporting countries (Neely, 2022).

From this scenario and the variables presented in the literature review of previous sections, we have decided to consider in the analysis the following economic and sociodemographic factors:

Unemployment rate: this is one of the most used in prior literature but also because this factor has an ambiguous (positive/negative) impact on non-financial crimes.

Inflation rate and GDP per capita: these factors are including as the purchasing power of clients.

Economic growth: this variable is considered as a measure of a country's wealth.

Oil prices: this is a new variable, never considered in analyzing the determinants of crimes.

Gender: this variable is used in prior literature and is incorporated in this study to confirm whether men are more likely to commit financial crimes as occurs in non-financial ones.

Urbanization level: this variable is a proxy of population density.

Bearing in mind all the above-mentioned literature, our hypotheses are as follows:

H1: Macroeconomic fluctuations in the unemployment rate, inflation, and economic growth positively affect the incidence of financial fraud and identity theft. This means that any increase of these variables in one unit may cause an increase in the incidence of fraud and identity theft and vice versa.

H2: Fluctuations in oil prices and GDP per capita negatively affect the incidence of financial fraud and identity theft. In other words, any increase of these variables in one unit may cause a decrease in the incidence of fraud and identity theft and vice versa.

H3: The level of urbanization is expected to have a positive effect on the incidence of these crimes and a negative one in terms of gender. That is to say, the higher the urbanization level the more likely the incidence of fraud and identity theft and vice versa. On the other side, is expected to see less crime when the proportion of women over men is small enough and vice versa.

Some or all the variables from the hypotheses mentioned are expected to be significant in the short and long term. The unemployment rate and inflation may produce short-term effects on the incidence of these crimes through direct interaction with the consumer. The same effect occurs in the long term. Economic growth, GDP per capita and oil prices may show effects that are more noticeable in the long term due to their indirect interaction with individuals. Regarding sociodemographic variables, their effects are expected to show in the long term, since social and demographic changes are slow and not as abrupt as some macroeconomic fluctuations.

Data

This study uses quarterly records of the incidence of these variables provided by a major financial institution in Mexico from 1999 to 2019 to model financial crimes of fraud and identity theft. The period was selected based on the information available on fraud and identity theft cases in the financial institution. Macroeconomic and sociodemographic variables are employed in the same periods and are taken from several sources. Moreover, we want to know the effect of the variables chosen on financial crimes during and before the effect of the coronavirus era.

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As the worldwide pandemic has been a rare effect on many macroeconomic variables (Wang et al., 2023), we have not considered more recent years.

Bank of Mexico provides statistics about the country's macroeconomic and financial indicators in daily, monthly, quarterly, or annual periods from Mexico. Time series of the unemployment rate, oil prices, stock market, GDP and inflation are taken from this source. The unemployment rate and GDP are available quarterly. The unemployment rate is included as an indicator of the level of legal activities performed by individuals in society. It is assumed that when an individual earns income from a non-legal activity, they may be performing informal work or illegal activities. GDP is expressed at 2013 prices and is used to obtain the GDP per capita and quarterly economic growth. GDP per capita is introduced as an indicator of individual wealth and economic growth as a measure of economic affluence. The quarterly inflation rate is obtained through the monthly series of the INPC (Consumer Price Index). This variable acts as the purchasing power of consumers and the cost of living. Oil prices are provided daily and in U.S. dollars. These prices are deflated using the U.S. consumer price index and the quarterly data is obtained as the average of the daily data. Oil prices are introduced as a measure of incoming wealth for the economy in the context of an oil-exporting country. Finally, the stock market is included also as a measure of wealth and is obtained on a monthly basis. The quarterly observations are calculated as the average of the monthly data.

Deterrent factors have a strong mitigating impact on crime incidence. In addition to the usual containment measures implemented by the government (police force, laws, regulations, etc.), financial crimes have internal mitigating factors aimed at minimizing the incidence of crime. Examples of these are requiring secret codes for any transaction, recognition of official identifications, fingerprints and digital signatures for transactions in a branch, restriction of operations with a certain amount and type of currency, asking questions in financial operations carried out by telephone, etc. In this study, governmental and internal deterrent factors are not considered due to the lack of available data for the period of analysis.

The data from the urbanization level was extracted from the National Survey on Occupation and Employment (ENOE) survey, carried out by the National Institute of Statistics and Geography (INEGI) every month in Mexico. From this source, the quarterly total population is used to express the incidence of fraud and identity theft per 100,000 individuals. The survey also provides the number of individuals in 4 levels of urbanization: rural, low urban, medium urban and more urbanized. The influence of urbanization is considered through the proportion of individuals in the more urbanized areas over the total population. The effect of gender is introduced as the proportion of women over men formed with the statistics reported by INEGI. Table 1 shows the initial variables contemplated for the study.

Box 1

Table 1

Explicative variables in the analysis

Unemployment rate	It is the number of unemployed individuals over the active total population.
Oil prices	Prices per barrel in US dollars.
Inflation	Inflation rate obtained through the Consumer Price Index.
GDP per capita	GDP of the country over total population.
Economic growth	Quarterly economic growth obtained with the GDP.
Gender	Proportion number of women over men.
Urbanization Level	Number of individuals in the more urbanized areas over the total population.

Source: Own elaboration

Methodology

We use cointegration theory to model the incidence of financial fraud and identity theft per 100,000 individuals, and the unemployment rate, petroleum prices, inflation, stock market, GDP per capita, economic growth, gender, age, and level of urbanization as explanatory variables.

To implement the mentioned theory, first, it is necessary to check whether the variables are stationary. For this, the Augmented Dickey-Fuller (ADF) stationarity test is implemented (Dickey and Fuller, 1981). We have chosen this method as it is currently used by the financial institution since 2020 for fraud prevention area.

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This test considered the following autoregressive model,

$$\Delta y_t = \alpha_0 + \delta y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t \quad [1]$$

Where $\delta = -(1 - \sum_{i=1}^{p} \alpha_i)$, $\beta_i = \sum_{i=1}^{p} \alpha_i$, y_t is the variable to be tested, Δ the difference operator and ε_t the error. The parameter of interest for the test is δ. The null hypothesis is to test whether $\delta = 0$. If the "t" statistic exceeds the critical Dickey-Fuller value, the null hypothesis is rejected indicating that the series is stationary. If the null hypothesis is not rejected, the series contains a unit root.

Second, if the series are not stationary, we proceed to check whether they are integrated of the same order "d". A time series is said to be integrated of order "d", denoted $I(d)$, if it becomes stationary after first being differentiated "d" times.

Third, once all the variables are integrated in the same order, the Johansen cointegration test is used to obtain long-term relationships among them (Johansen, 1991). The Johansen test considers the following vector autoregression model (VAR) of order "p", according to Enders (1995)

$$Y_t = \gamma + \theta_1 Y_{t-1} + \ldots + \theta_p Y_{t-p} + \varepsilon_t \quad [2]$$

Where Y_t is the $k-$ vector of non-stationary variables integrated of the same order $I(d)$, θ is a matrix of $k\ x\ k$ parameters and ε_t is a $k-$dimensional vector of white noise.

By rewriting equation 2, we obtain the following structure:

$$\Delta Y_t = \gamma + \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \quad [3]$$

The term ΠY_{t-1} is called the error correction term. The rank of Π is determined to obtain cointegration relationships in the long term. If the rank of Π is complete, any linear combination of the variables is stationary, and the model adjustment should be made with the variables in levels. If the rank of Π is null, then there is no cointegration relationship. If Π has a reduced rank, $r < k$, then there are r cointegration vectors, in which $0 < r < k$.

The Johansen cointegration test computes two statistics: trace and maximum eigenvalue statistics. The trace statistic for the null hypothesis of r cointegrating relationships is computed as:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{k} \ln(1 - \lambda_i) \quad [4]$$

The maximum eigenvalue test aims to test the null hypothesis that the number of vectors is r , $H_0: r$, against the alternative hypothesis of the existence of $r + 1$ cointegrating vectors, $H_1: r + 1$. The statistic is expressed as follows:

$$\lambda_{max}(r, r+1) = -T \sum_{i=r+1}^{k} \ln(1 - \lambda_{r+1}) \quad [5]$$

Once the existence of a long-run relationship among the variables is detected, the short-term effects of variables can be obtained by applying the Vector Error Correction Model (VECM). The VECM is a restricted VAR, where the restriction is on the existence of a long-run relation of the series and all endogenous variables that are used in the differenced form.

If some of the variables do not meet the requirements to be considered in the Johansen test, the Toda-Yamamoto (1995) method is applied to find out whether there is granger causality towards financial crimes.

Results and discussions

Johansen Cointegration Test and Vector Error Correction Model

When applying the Augmented-Dickey Fuller stationarity test at 0.05 significance level, it was found that incidence of identity theft and fraud, unemployment rate, oil prices, GDP per capita and gender were integrated of order 1, $I(1)$.

Conversely, the inflation, economic growth and urbanization level resulted stationary, $I(0)$. The results of the Augmented-Dickey Fuller test on the original time series and its first difference are shown in Table 2.

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Box 2

Table 2

Augmented Dickey-Fuller test (H0: Non-stationary, Ha: Stationary)

Variable	Original (p-value)	First differece (p-value)
Identity theft	0.1442	0.0100
Fraud	0.0794	0.0100
Unemployment rate	0.7429	0.0169
Oil Prices	0.7973	0.0100
GDP per capita	0.1297	0.0100
Gender	0.5594	0.0104
Economic growth	0.0178	0.0000
Urbanization level	0.0100	0.0000
Inflation	0.0300	0.0100

Source: Own elaboration with R software

From the above, it follows that the variables to be included in Johansen's cointegration test are the incidences of fraud and identity theft, unemployment rate, oil prices, GDP per capita and gender.

To identify the optimal lag length for our VAR specification the Schwarz information (SIC) criterion and the Hannan-Quinn (HQC) criterion are used. From the optimal lags obtained by the two criteria, the smallest lag is selected. According to Ventzislav and Lutz (2005), for quarterly VAR models, the Hannan-Quinn Criterion (HQC) appears to be the most accurate criterion with the exception of sample sizes smaller than 120, for which the Schwarz Information Criterion (SIC) is more accurate. The results are shown in Table 3.

Box 3

Table 3

Schwarz information (SIC) and Hannan-Quinn (HQC) criterion results. LR – Statistic of LR modified sequential test. *Indicates lag order selected by the criterion

VAR for fraud incidence and explanatory variables			LR	VAR for identity theft incidence and explanatory variables			LR
Lag	HQC	SIC		Lag	HQC	SIC	
0	11.30	11.39		0	0.139	0.2286	
1	4.98	5.51	579.4	1	-5.70	-5.17	541.71
2	3.974	4.95*	154.5	2	-6.68	-5.70*	152.13
3	3.61*	5.03	103.0	3	-6.84*	-5.41	86.59
4	3.86	5.74	53.2*	4	-6.77	-4.90	68.46*

Source: Own elaboration

In this way, the VAR is well specified so that the residuals do not have serial correlation at the selected lag length. Then, the Johansen cointegration test is applied to the variables to see if there is any cointegration relationship among them. As can be seen in Table 4, the trace and maximum eigenvalue tests reject the null hypothesis of non-integration among the variables at 5% significance for the cases that include fraud and identity theft. The trace tests indicate that there is at least one cointegration vector that defines the long-term relationship among the variables. This result is confirmed by the maximum eigenvalue test.

Box 4

Table 4

Trace and maximum eigenvalue tests for cointegration among variables. * denotes rejection of the null hypothesis at the level of 5%

Cointegration test with fraud incidence.				Cointegration tests with identity theft incidence.			
Trace Test				Trace Test			
Null	Alternative	Test statistic	Critical value (5%)	Null	Alternative	Test statistic	Critical value (5%)
r= 0	r>0	87.52*	76.07	r= 0	r>0	89.51*	76.07
r≤ 1	r>2	41.41	53.12	r≤ 1	r>1	39.35	53.12
r≤ 2	r>3	22.57	34.91	r≤ 2	r>2	21.13	34.91
r≤ 3	r>4	9.55	19.96	r≤ 3	r>3	8.25	19.96
r≤ 4	r>4	3.04	9.24	r≤ 4	r>4	2.73	9.24

Cointegration test with fraud incidence.				Cointegration tests with identity theft incidence.			
Maximum Eigenvalue Test				Maximum Eigenvalue Test			
Null	Alternative	Test statistic	Critical value (5%)	Null	Alternative	Test statistic	Critical value (5%)
r= 0	r=1	46.11*	34.4	r= 0	r=1	50.16*	34.4
r= 1	r=2	18.85	28.14	r= 1	r=2	18.22	28.14
r= 2	r=3	13.02	22	r= 2	r=3	12.88	22
r= 3	r=4	6.51	15.67	r= 3	r=4	5.52	15.67
r= 4	r=5	3.04	9.24	r= 4	r=5	2.73	9.24

Source: Own elaboration in R software

Table 5 shows the first cointegration vector, normalized to the financial crimes. Therefore, the coefficients should be interpreted with the opposite sign to that shown in the table.

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Box 5

Table 5

Cointegration vector normalized to the financial crimes. Estimations made in R software. The symbol "*" expresses that the coefficient is significant at 10%, "**" at 5% and "***" at 1%

Coefficient			Coefficient		
Financial Fraud	1	T-statistic	Identity Theft	1	T-statistic
Unemployment rate	-53.76***	-3.06	Unemployment rate	-0.24***	-3.65
Oil prices	18829.08***	7.71	Oil prices	0.02***	6.99
GDP per capita	4.63***	10.49	GDP per capita	25.77***	3.79
Gender	2261.27**	2.47	Gender	8.01**	2.30
Constant	-5437.18***	-6.31	Constant	-13.25***	-4.04

Source: Own elaboration

From Table 5 it is observed that in the long term, the unemployment rate has a significant positive impact (-53.76 it is observed in the cointegration vector but 53.76 is used for interpretation) on the incidence of financial fraud and identity theft. The result of the unemployment rate coincides with the positive effect on credit card delinquency obtained by Agarwal and Liu (2003). It also coincides with the positive effect obtained by Bell et al. (2015), Mittal et al. (2019) and Bennett and Ouazad (2018) on property and violent crime. This implies that in a period of recession when unemployment rates increase, individuals may find more benefit from carrying out illegal activities in financial institutions such as credit card cloning, identity theft, execution of transactions not recognized by clients and financial extortion.

The negative and significant effect of GDP per capita on financial fraud and identity theft is in line with that shown by Rosenfeld and Fornango (2007) in robbery and larceny crimes, and Latimaha et al. (2019) in all types of street crime (murder, rape, injuries and robbery). According to this, when the recession is accompanied by a decrease in GDP per capita, criminals may be more interested in committing fraud and identity theft crimes to get extra income due to a reduction of their personal income.

The same table shows that oil prices have a negative significant effect on the incidence of fraud and identity theft. In the oil price war between Russia and Saudi Arabi, drastic falls in oil prices were observed, even reaching negative numbers related to the low demand for oil caused by the sudden closure of companies. This drop-in price has a direct impact on the income of exporting countries such as Mexico, where oil sales represent about 33 per cent of its tax revenue.

When tax revenues are reduced, the government of the exporting country may experience a reduction in federal and sub-federal public spending, affecting investments in sectors such as education, health, social programs, public security, and business creation.

Thus, falls in oil prices may provoke an increase in financial crimes because individuals who do not see opportunities presented by the government in the sectors that previously existed may choose to carry out illegal activities, further aggravated by limited spending on public safety. The opposite effect will occur in the presence of events such as the war between Russia and Ukraine where rising prices are observed.

As for sociodemographic variables, in the long term, gender exhibits a negative effect as established in Steffensmeier and Allan (1996) about the involvement of males in most crimes.

Another visible result from Table 5 is that financial fraud and identity theft show similar reactions (same sign) to macroeconomic fluctuations and sociodemographic characteristics in the long term. These similarities may be justified by the fact that criminals in financial systems usually carry out several crimes at once.

In a few minutes, they may be performing card cloning, a transaction with a hacked account, transactions for the theft of app keys, or telephone extortion, without any physical exposure.

These offenders are not limited by physical effort, face-to-face action, or the time required to commit non-financial crimes such as assault with a weapon, car theft, or kidnapping.

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From the aforementioned, we have that hypothesis 1 is partially fulfilled by the positive significant effect of the unemployment rate and the absence of economic growth and inflation in the analysis. Hypothesis 2 is completely fulfilled by the negative effect of GDP per capita and oil prices. Hypothesis 3 is also partially fulfilled by the significant negative effect of gender, and the absence of the urbanization level in the analysis. The long-term impacts of macroeconomic variables are present as expected.

The long-term relationship among the variables, shown by the cointegration vector in Table 5 is used as an explanatory variable of the vector error correction representation. The vector error correction modelling allows us to identify the direction of Granger causality among variables and distinguish between "short-run" and "long-run" causality. The coefficients of the VECM for financial crimes in relation to the explanatory variables are shown in Tables 6 and 7. The coefficients are interpreted with the signs that appear in the following table.

Box 6

Table 6

VEC coefficients for fraud incidence**.** Estimations made in R software. The symbol "*" expresses that the coefficient is significant at 10%, “**” at 5% and "***" at 1%

Variable	Coefficient	Standard Error	T-statistic
ECT(-1)	-0.8569***	0.187	-4.573
ΔFraud (-1)	-0.74***	0.143	-5.172
ΔUnemployment Rate (-1)	96.66*	57.479	1.682
ΔOil Prices (-1)	-5.65***	1.796	-3.149
ΔGDP per capita (-1)	7134.94	5415.670	1.317
ΔGender (-1)	-7278.31**	3329.438	-2.186

Source: Own elaboration

Box 7

Table 7

VEC coefficients for identity theft. Estimations made in R software. The symbol "*" expresses that the coefficient is significant at 10%, “**” at 5% and "***" at 1%

Variable	Coefficient	Standard Error	T-statistic
ECT(-1)	-0.8477***	0.173	-4.88
ΔFraud (-1)	-0.79***	0.129	-6.151
ΔUnemployment Rate (-1)	0.42**	0.186	2.274
ΔOil Prices (-1)	-0.02***	0.006	-3.041
ΔGDP per capita (-1)	42.31**	17.596	2.405
ΔGender (-1)	-21.31*	12.436	-1.714

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Tables 6 and 7 show the adjustment degree of the error correction terms (ECT) that expresses how fast the variables converge in the long-term equilibrium. This value is -0.8569 and -0.8477 for fraud and identity theft, respectively, being negative and significant at a level of 1%. For fraud, the -0.8569 means that approximately 85.69% of the discrepancy between the current value and the long-term equilibrium is adjusted each quarter. For identity theft, the percentage of adjustment is 84.77%. Turning to details, it is observed that the unemployment rate, lagged in the first difference, has a significant positive impact on the incidence of fraud and identity theft in the short term, the same sign as that observed in the long term.

The positive and significant effect of GDP per capita on identity theft, lagged in the first difference, is opposite to the negative sign observed in the long term. This may indicate that in the short term, the impact of GDP per capita is in line with that established by Kizilgol and Selim (2017) in homicide, violence and other non-financial crimes. It also seems to follow what Debnath and Das (2017) set, an increase in economic affluence is accompanied by an unequal distribution of income that can incentive crime emergence. This dynamic would not be alien to an economy such as Mexico, which historically has been one of the most-unequal regions in the world and whose inequality has increased over the years (Reyes et al. 2017). According to this, when the recession is accompanied by a decrease in GDP per capita in the short-term, criminals may be less interested in committing identity theft crimes due to a reduction of assets in the victim's financial accounts. Faced with such an economic situation, delinquents might change their objective towards non-financial crimes according to what is shown by Rosenfeld and Fornango (2007) and Latimaha et al. (2019).

Finally, the oil prices and gender, lagged in first difference, show that same sign as that observed in the long term for both financial crimes.

Toda and Yamamoto Causality Testing

To explore whether there is a causal effect of the variables that were not incorporated in the Johansen test towards financial crimes, we implement the approach of Toda and Yamamoto (1995).

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The stock market will be added in this analysis, taking advantage that the GDP per capita with which it is highly correlated, is not present at this stage of the study. This method is appropriate when the series has a different order of integration or with an order of integration greater than 2. It also has the advantage of not requiring a Johansen cointegration pretesting to be applied.

This approach consists in estimating an augmented VAR of order "k" with "d" additional lags, where "d" is the maximum order of integration of the variables in the analysis. The "k" value is the optimal lag length of the VAR model determined by some measures such as the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Final Prediction Error (FPE) and Hannan-Quinn (HQC) Information Criterion.

For the present study, the specification of the increased VAR of order $(k+d)$ is the following,

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots + \beta_k Y_{t-k} + \ldots + \beta_{k+d} Y_{t-(k+d)}$$

$$\text{Where } Y_t = \begin{pmatrix} Fraud_t \\ Stock\ Market_t \\ Inflation_t \\ Economic\ Growth_t \\ Urbanization\ Level_t \end{pmatrix} \text{ or } Y_t = \begin{pmatrix} Identity\ Theft_t \\ Stock\ Market_t \\ Inflation_t \\ Economic\ Growth_t \\ Urbanization\ Level_t \end{pmatrix} \quad [6]$$

The null hypothesis of non-causality of any of the macroeconomic or sociodemographic variables towards financial crimes can be expressed as follows, $H_0: Y_{it}\ does\ not\ cause\ Y_{jt}, that\ is, \delta_{ij}^{p} = 0\ para\ p = 1,2,\ldots,k$. The Wald test statistic W with an asymptotic χ^2 distribution with k degrees of freedom is used to test this null hypothesis.

For the selected variables, an optimal lag of 2 was obtained following the Schwarz information (SIC) and Hannan-Quinn (HQC) criteria.

Given that the maximum order of integration obtained is 1, the augmented VAR to estimate is of order 3. See Table 8 for the results.

Box 8

Table 8

Toda-Yamamoto Causality (Wald Tet). "**" expresses rejection of null hypothesis at 5% and "***" at 1% of significance level

Null Hypothesis	Chi-sq	P-Value	Causality
Inflation does not Granger cause Fraud	21.8	0.0000***	Granger-Causality
Economic Growth does not Granger cause Fraud	0.29	0.8600	No Causality
Stock Market does not Granger cause Fraud	10.7	0.0047**	Granger-Causality
Urbanization Level does not Granger cause Fraud	1.60	0.4400	No Causality
Inflation does not Granger cause Identity Theft	6.4	0.04**	Granger-Causality
Economic Growth does not Granger cause Identity Theft	1.5	0.4800	No Causality
Stock Market does not Granger cause Identity Theft	2.40	0.3100	No Causality
Urbanization Level does not Granger cause Identity Theft	0.85	0.6500	No Causality

Source: Own elaboration

Table 8 shows that inflation and the stock market, granger cause financial fraud, and only inflation granger cause identity theft. When the economic slowdown is accompanied by a shortage of resources, the prices of goods and services can increase causing a decrease in purchasing power. This decrease in purchasing power can push individuals into alternative activities to obtain income that in many cases can be illegal.

Regarding the stock market, this variable can have a positive or negative effect on the incidence of fraud depending on whether the individuals are investors (hold stock) or non-investors. If the stock market increases, investors can see an increment in their wealth and a decrease in their propensity to crime. On the other hand, under these same conditions, non-inventors can observe how their wealth decreases concerning the wealth of investors, causing them feelings of envy, jealousy, or anger, increasing their propensity towards crime (Huck, 2018).

Finally, the null hypothesis of the non-causality of the economic growth and urbanization level towards financial crimes cannot be rejected, thus there is no evidence that these macroeconomic variables have a causal impact on financial crimes.

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Conclusions

The objective of this study is, concentrated on the environment of financial institutions, to investigate how macroeconomic fluctuations and sociological factors affect the incidence of financial fraud and identity theft. Our results show partial and complete compliance with the hypotheses priorly established in this study. The unemployment rate has a positive impact on the incidence of financial fraud and identity theft in the short and long term. Oil prices exhibit a significant negative effect on both crimes in the short and long term. Also, the GDP per capita shows a negative impact on fraud and identity theft in the long term and positive only for identity theft in the short term. Gender shows a significant negative impact on the incidence of both crimes in the short and long term. The patterns of reactions(signs) of financial fraud and identity theft to macroeconomic fluctuations and demographic characteristics were also shown to be similar.

The positive sign in the coefficients of the unemployment rate indicates that in the face of a recession, such as the one caused by the SARS-Cov-2 pandemic, the crimes of financial fraud and identity theft might increase in the long term. This effect may be intensified in exporting countries due to the drop-in oil prices by the sudden reduction in demand as that observed in the commercial war between Russia and Saudi Arabia. With these same conditions that can cause a decrease in GDP per capita, criminals in the short term may lose their interest in identity theft due to the reduction of victims' financial assets and turn towards non-financial crimes. Then, in the long term, the same decrease in GDP per capita may cause an increase in the incidence of both financial crimes. Regarding inflation and the stock market, the Toda-Yamamoto test shows the existence of Granger causality towards financial fraud and Granger causality from inflation to identity theft. The same test shows the absence of Granger causality from the economic growth and urbanization level towards financial crimes.

Given the results obtained by this study, it is recommended that the authorities of financial institutions reinforce their internal controls and mitigating actions to minimize the incidence of financial crimes when macroeconomic conditions fluctuate outside the normal range.

It is also important to note that the results produced by this study have the limitation of not considering deterrent factors, which play an important role in stopping financial crime. In addition to the laws and penalties imposed by the government, financial institutions have their internal policies, detection systems, customer authentication processes, and various controls that can produce different levels of impact depending on the institution.

Future research is aimed at studying how macroeconomic fluctuations affect the incidence of financial crimes in non-oil exporting countries. It will also study how changes in the stock market in a model without correlated variables affect the incidence of fraud and identity theft. Additionally, we will use data from 2020 onwards to analyse the impact of the covid pandemic on the incidence of financial fraud and identity theft as well.

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

Rocha-Salazar, José de Jesús: Writing - original draft, formal analysis, conceptualization, methodology, software.

Segovia-Vargas, María Jesús: Project administration, writing - review & editing, validation, funding acquisition.

Camacho-Miñano, María del Mar: Visualization, writing - review & editing, validation, resources.

Availability of data and materials

Data not available due to privacy policies of the institution. Data will be made available on request.

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Abbreviations

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
ECT	Error Correction Term
ENOE	Encuesta Nacional de Ocupación y Empleo
FPE	Final Prediction Error
GDP	Gross Domestic Product
HQC	Hannan Quinn Criterion
INEGI	Instituto Nacional de Estadística y Geografía
OECD	Organization for Economic Cooperation and Development
SARS-COV-2	The virus that causes coronavirus disease 19 (COVID-19)
SIC	Schwarz information Criterion
VAR	Vector autoregression
VECM	Vector Error Correction Model

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