Hacettepe University Graduate School of Social Sciences

Department of Economics

PREDICTING FINANCIAL STRESS IN EMERGING COUNTRIES

Eray SÖNMEZ

Ph.D. Dissertation

Ankara, 2023

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ACCEPTANCE AND APPROVAL

The jury finds that Eray Sönmez has on the date of December 27, 2022 successfully passed the defense examination and approves his Ph.D. dissertation titled “Predicting Financial Stress in Emerging Countries”.

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17/01/2023

Eray SÖNMEZ

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ABSTRACT

SONMEZ, Eray. *Predicting Financial Stress in Emerging Countries,* Ph.D. Dissertation, Ankara, 2023.

Economic policies are designed to eliminate vulnerabilities while also increasing the welfare of the citizens. Yet, some undesirable factors could hinder these goals by distorting the functioning of the financial system, and even leading the economy into a crisis. Being prepared for this kind of negativities stands out as one of the most important responsibilities of policy makers. For this reason, constructing early warning indicators that can capture business cycles has been studied for more than 40 years. However, progress in this field has remained limited; a great number of studies have focused only on building financial stress indices to foresee a crisis. Furthermore, although dynamic non-linear models promise high potential when used with early warning indicators, there is not enough work on this subject. Finally, carrying out a study in particular for developing countries was not popular in the business cycle literature, and the vast majority of the studies addressed advanced countries. Therefore, the aim of this thesis is to bring novelty by predicting financial stress turning points through a non-linear Markov regime switching model with time-varying transition probabilities, which has not been applied for a group of emerging countries before, and by using the "spread" variable of Sönmez and Kandemir Kocaaslan (2022) as an explanatory variable in predicting turning points. To this end, firstly, financial stress indices were constructed for each country. Evidence suggests that industrial production growth promotes a high financial stress period in all countries in the next few quarters. In Chile, South Africa and Türkiye, the CBOE Volatility Index gives signals up to four quarters before exiting from high financial stress period. In Chile and Poland, private sector credit growth predicts regime switches from high to low financial stress period up to eight quarters in advance. And finally, "spread" between business and mortgage credit interests predicts exit from tense state in all countries one to six quarters in advance, except Türkiye.

Keywords Markov Switching Model with Time-Varying Transition Probabilities, Financial Stress Index, Early Warning Models, Emerging Market Economies

ÖZET

SÖNMEZ, Eray. *Gelişmekte Olan Ülkelerde Finansal Stresin Öngörülmesi,* Doktora Tezi, Ankara, 2023.

İktisadi politikalar kırılganlıkları gidermek ve vatandaşların refahını artırmak üzere tasarlanmaktadır. Ancak istenmeyen bazı unsurlar finansal sistemin işleyişini bozarak bu hedeflere ulaşılmasını engelleyebilmekte ve hatta ekonomiyi krize sürükleyebilmektedir. Bu tür olumsuzluklara karşı hazırlıklı olmak, politika yapıcıların en önemli sorumluluklarından biri olarak öne çıkmaktadır. Bu nedenle, iş çevrimlerini yakalayabilen erken uyarı göstergelerinin oluşturulması 40 yılı aşkın bir süredir çalışılmaktadır. Ancak, bu alandaki ilerlemeler sınırlı bir alanda yoğunlaşmış; çok sayıda çalışma bir krizi öngörmek için sadece finansal stres endeksleri oluşturmaya odaklanmıştır. Ayrıca doğrusal olmayan dinamik modeller, erken uyarı göstergeleriyle kullanıldığında yüksek potansiyel vaat etse de bu konuda yeterli çalışma bulunmamaktadır. Son olarak, iş çevrimleri yazınında gelişmekte olan ülkeler özelinde oldukça az sayıda çalışma varken, çalışmaların büyük çoğunluğu gelişmiş ülkelere yöneliktir. Bu nedenle bu tezin amacı, daha önce bir grup gelişmekte olan ülke özelinde hiç uygulanmamış olan zamana bağlı geçiş olasılıklarına sahip Markov rejim değişimi modelini finansal stres dönüm noktalarını öngörmede kullanarak ve Sönmez ve Kandemir Kocaaslan (2022) tarafından türetilen "fark" değişkenini dönüm noktalarını tahmin etmede açıklayıcı değişken olarak belirleyerek yenilik getirmektir. Çalışmanın bulgularına göre, sanayi üretimi büyümesi tüm ülkelerde finansal stresin sonraki dönemlerde de yüksek bir rejimde bulunma olasılığını desteklemektedir. CBOE Oynaklık Endeksi; Şili, Güney Afrika ve Türkiye'de yüksek finansal stres dönemlerinden çıkışları dört çeyrek öncesinden, özel sektör kredi büyümesi ise yüksek finansal stres dönemlerinden düşük finansal stres dönemlerine geçişleri Şili ve Polonya'da sekiz çeyrek öncesinden haber verebilmektedir. Ticari ve konut kredileri faizleri arasındaki "fark", Türkiye hariç tüm ülkelerde bir ila altı çeyrek önceden yüksek finansal stres dönemlerinden çıkışları öngörebilmektedir.

Anahtar Sözcükler: Zamana-Bağlı Geçiş Olasılıkları ile Markov Rejim Değişim Modeli, Finansal Baskı Endeksi, Erken Uyarı Modelleri, Yükselen Piyasa Ekonomileri

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ABBREVIATIONS

AIC	: Akaike Information Criteria
BIS	: Bank for International Settlements
CAPM	: Capital Asset Pricing Model
CBOE	: Chicago Board Options Exchange
CLIFS	: Country Level Index of Financial Stress
ECB	: European Central Bank
EMBI	: Emerging Markets Bond Index
EME	: Emerging Market Economies
EMPI	: Exchange Market Pressure Index
FA	: Factor Analysis
Fed	: Federal Reserve
FSI	: Financial Stress Index
FTP	: Fixed Transition Probabilities
FX	: Foreign Exchange
GARCH	: Generalized Auto Regressive Conditional Heteroskedasticity
GDP	: Gross Domestic Product
IIF	: The Institute of International Finance
IMF	: International Monetary Fund
KF	: Kalman Filter
OECD	: The Organization for Economic Co-operation and Development
PCA	: Principal Component Analysis
TVTP	: Time-Varying Transition Probabilities
VAR	: Vector Auto Regression
VEW	: Variance Equal Weights
VIX	: CBOE Volatility Index
WB	: World Bank
WEO	: World Economic Outlook

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INTRODUCTION

The ultimate goal of economic policy is to achieve high aggregate demand and low unemployment, enable fairer distribution of national income, minimize the devastating effects of any shock that could threaten the economy, and to overcome possible economic problems before they turn into a crisis. Since predicting contraction and expansion periods of an economy will give policy makers room to maneuver, early warning systems, which provide signals prior to a crisis, are of interest to researchers and politicians (Sönmez and Kandemir Kocaaslan, 2022).

Rapid globalization and increasing economic activity in the past 30 years have taught the developing countries that fragilities in domestic market structures and macroeconomic fundamentals exacerbate the impact of shocks. The Mexican peso crisis in 1994, for example, is considered a financial crisis ignited by capital flight (Eun and Resnick, 2011). The economic crises in Brazil and Russia occurred in the late 1990s on account of similar problems, right after the 1997 Asian financial crisis. Argentina and Türkiye both experienced financial crisis in early 2000s, with Argentina experiencing a prolonged depression afterwards.

The global financial crisis had an unprecedented effect on the world economy. It is estimated that the 2008 global financial crisis caused a loss of 6 to 14 trillion dollars in output for the US economy alone (Atkinson et al., 2013). Governments launched exit strategies from the crisis, which drove them to dramatically intervene in the economy. While this situation negatively affected the efficient distribution of resources, the contribution of total factor productivity to economic growth decreased significantly among countries, regardless of the level of development (Levenko et al., 2019). Besides, the crisis decreased industrial production dramatically, which in turn accelerated job losses, especially amongst youth (Verick et al., 2013).

Such events led researchers to focus on early warning systems that can help foresee crises. A vast majority of the previous studies focused on building financial stress indexes for an economy or a group of countries. The main objective of these studies was to capture business cycles. Furthermore, as non-linear techniques have been developed, researchers were able to model data that displayed dynamic patterns over different time periods. Hamilton (1989) proposed a new approach in this context, namely "the Markov switching model", which contained a hidden structure that provided a way to examine expansion and contraction periods of an economy without making any a priori assumption. Shifts between these periods were determined by fixed transition probabilities. Diebold et al. (1994) and Filardo (1994) extended the model, which allowed the transition probabilities to vary over time.

Although there are a great number of studies on early warning systems, there is a gap between this field of interest and the literature on non-linear modelling of business cycles. This thesis aims to investigate potential indicators that can predict the cyclical movements of financial stress in a group of emerging countries by using a Markov switching model with time-varying transition probabilities. To this end, firstly, financial stress indices were constructed for Chile, Poland, South Africa and Türkiye. Using these indices as dependent variables, Markov switching models have been estimated to identify the determinants of regime switches between low financial stress periods, "tranquil states" and high financial stress periods, "tense states".

The contribution of this thesis to the existing literature is twofold. As far as is known, this study will be the first attempt to predict financial stress turning points in emerging countries via Markov switching model with time-varying transition probabilities. Furthermore, the "spread" between business and mortgage credit interest rates, derived by Sönmez and Kandemir Kocaaslan (2022), will be used for the first time as an explanatory variable to predict the turning points of financial stress episodes in emerging countries. And finally, the study intends to bridge the gap between the literature on traditional early warning systems and on predicting regime switches in a non-linear model framework.

The organization of the following chapters is as follows: Chapter 1 summarizes the existing literature on both measuring and predicting financial stress. Chapter 2 reviews the macroeconomic outlook of the selected countries. Chapter 3 shares the theoretical background of the study. Under this part, section 3.1. evaluates the generation process of the financial stress indices, which allows us to predict looming stress episodes in emerging countries. Section 3.2. gives the basic information on Markov regime switching models with time-varying transition probabilities. Section 3.3 introduces data, variables, and other features of the study. Finally, in Chapter 4, empirical findings will be given, and the results will be discussed in the conclusion.

1. LITERATURE REVIEW

This study consists of two stages. Firstly, it measures financial stress in a group of emerging countries with a dedicated financial stress index. Tracking and predicting cyclical movements of an economy through financial stress indices is a subject that is frequently studied by researchers, policy makers and institutions. Secondly, it estimates a non-linear model called "Markov switching model", which contains multiple structures (equations) that can characterize the time series behaviors in different regimes. By allowing switching between these structures with time-varying transition probabilities, this model is able to capture more complex dynamic patterns (Kuan, 2002). Hence, the study benefited from two different literatures, one on financial stress indices and the other one on predicting economic turning points and regime shifts by Markov regime switching models with time-varying transition probabilities.

1.1. LITERATURE ON FINANCIAL STRESS INDICES

The number of academic studies that develop early warning systems to capture financial shocks has increased significantly, particularly in the last decade. Before 2000, there was only one paper published per year in this field of study, while the numbers began to increase after 2008, with the majority of them concentrating between 2009 and 2016, with an average of nine papers published per year (Klopotan et al., 2018). These studies essentially focused on building financial stress indices, which are considered as instruments to monitor financial stability or as dependent variables in early warning models, which presumes that FSIs are related to financial crises (Kliesen et al., 2012).

Most of the previous studies focused on building country-specific financial stress indices, while a significant number of studies addressed multi-country cases. There are also several financial stress indices that were developed by institutions and central banks. Below, country-

specific studies will first be introduced in line with the selected countries for this study. Following that, multi-country studies and indices developed by institutions will be presented.

1.1.1. Country-Specific Financial Stress Indices

Although there are many studies that develop financial stress indices for a group of countries, the number of studies that develop financial stress indices specifically for a single country is limited in the literature. Among the selected countries of this thesis, only one study has been found for Chile. In this study, Alvarez, Fernandois and Sagner (2021) sought to quantify risks to Chilean economic growth. The authors applied the "Growth-at-Risk" method for the estimation of future growth rates conditional on the current economic conditions. In order to do this, they constructed a financial conditions index (FCI) using principal component analysis for a period of 1994 to 2020.

For Poland, three studies stand out in the literature with one thing in common: they were all conducted after the global financial crisis. Maliszewski (2009) built an index to measure financial system stability in Poland between 1998 and 2009. The method of this study is significantly different from past studies of financial stress indices. The author developed a synthetic index that decomposes individual macro prudential indicators with a taxonomic approach. According to his empirical analysis, the stability of the Polish financial sector has been found, surprisingly, to remain at a higher level during the global financial crisis than it was during the 1998-2003 period, which was the previous highest level.

Ho and Lu (2013) constructed a financial conditions index (FCI) for Poland by applying factor analysis (FA) and vector auto-regression (VAR) for the period of 2004-2012. They documented that the financial condition indices created by these two different approaches were highly correlated with each other; however, they suggested that the VAR approach had significant advantages over the FA approach. Their findings also put forward that the FCI was highly correlated with total output growth, and the main drivers of the index were global economic conditions and liquidity in the interbank market.

Kravchuk (2016) aimed to detect the signs of turbulence in the negotiable financial instruments market in Poland by means of a composite Financial Instruments Market Stress Index (FIMSI). The FIMSI contained indicators related to the stock market, the bond market, and the derivatives market. The index was designed to give an alarm when the index value exceeds the long-term trend by more than one standard deviation. The study's findings demonstrated that the index was effective in detecting turbulence in the financial conditions between 2007 and 2015.

Six studies were specifically investigated South Africa. Principal component analysis was the most used method in these studies, in line with the overall literature on early warning systems. One study, on the other hand, used factor-augmented VAR analysis with time-varying parameters, which is a relatively new-fangled approach.

Gumata, Klein and Ndou (2012) built a financial conditions index (FCI) for South Africa using two alternative approaches: Principal Component Analysis (PCA) and Kalman filter (KF). According to the analysis, the FCIs could forecast future GDP growth for up to four quarters in advance, and the PCA-based FCI seemed to have greater explanatory power over the KF approach, except for the pre-global crisis period.

The South African Reserve Bank published its Financial Stress Index (FSI) for South Africa in March 2015, which was designed specifically to assess financial stability risk. The FSI was derived from five sub-markets: credit, funding, equity, foreign exchange, and real estate. The index started in 2006 with a monthly frequency and was successful in capturing rising financial stress in 2014 (SARB, 2015-1).

Thompson, Van Eyden and Gupta (2015) constructed a financial conditions index (FCI) for South Africa using monthly data over the period of 1966 to 2011. They used principal component analysis (PCA) in a recursive way, a continuous iteration method to better understand the time-varying performance of the index. According to the in-sample causality

tests, the FCI was found to be highly correlated with industrial production and Treasury bill rates.

Similar to the study of Thompson, Van Eyden and Gupta (2015), Illesanmi and Tewari (2020) built a financial stress indicator (FSI) methodologically using the principal component analysis (PCA). According to their results obtained by a vector auto regression (VAR) model, financial stress negatively affected economic growth and investment in the medium to long run.

Kabundi and Mbelu (2020) estimated a financial conditions index (FCI) for South Africa by means of a factor-augmented vector auto regression model (FA-VAR) with time-varying parameters from January 2000 to April 2017. The FCI was constructed using principal component analysis and Kalman smoothing methods. The study found that the effects of the FCI on the real economy vary over time and that there are two different episodes of contraction of the real economy caused by tight financial conditions, namely, at the beginning of the sample and during the global financial crisis. A percentage rise in the FCI prior to the global financial crisis had limited effects on the real economy, while a percentage increase in the FCI had significant effects on the real economy, with the existing risks of the global financial crisis eventually leading the economy into a recession.

Kisten (2021) developed the South African Financial Stress Index (SAFSI) for a period of 1995 to 2017. Compared to the other stress indicators developed using principal component analysis and simple weighting of sub-indices, the SAFSI was claimed to be better at capturing the episodes of financial stress that affect the South African financial markets.

There are more than ten studies on measuring financial stress in Türkiye. In line with the general trend in this literature, the vast majority of these studies focused on the aftermath of the global financial crisis. The two most common methods used for developing financial stress indices were principal component analysis and variance equal weights. Furthermore,

vector auto regression models were mostly preferred. Cevik et al. (2013) developed a financial stress index for Türkiye by using principal component analysis for the period between 1997 and 2010. In addition to the traditional variables used in the financial stress index literature, the authors also inserted variables that were proxies for “trade credit”, “credit stress” and “liquidity”.

Ekinci (2013) developed a financial stress index for Türkiye by using the daily data from an indicator set of banking, the public sector, stock markets and exchange rate market. By using the index in the financial stress analysis, financial stress episodes were classified into six different periods between 2002 and 2013.

Öztürkler and Göksel (2013) developed a stress index capable of predicting financial stress in the Turkish economy in the period of 1998 to 2012. The emerging market bond index (EMBIG), the trade balance deficit, and the exchange rate volatility sub-indices were combined together in the financial stress index.

Aklan et al. (2015) developed the Financial Stress Index for Türkiye by using daily data for the period of January 2002 to October 2014. They implemented a vector auto regression model (VAR) and Granger causality methods to reveal the relation between financial stress and economic activity.

Camlica (2016) aimed to investigate whether the monetary policy response to financial systemic stress had really changed or not after 2010 by carrying out a subsample regression analysis. Instead of building a new financial stress index for Türkiye, Composite Indicator of Systemic Stress (CISS) was selected as the dependent variable in the analysis covering the period of 2005 to 2015.

Gunes and Camlica (2016) investigated how economic activity reacts to financial stress during different stress episodes in Türkiye by using monthly data for the period of 2002 to

2015. They estimated a threshold vector autoregression model (TVAR) with industrial production and a financial stress index for Türkiye as endogenous variables. They found that the relation between economic activity and financial stress is non-linear, and that in case of a shock, the economic activity loss in a high-stress regime is about five times larger than that in a normal-stress regime.

Chadwick and Öztürk (2019) analyzed financial stress using 15 different indices specific to Türkiye, covering the period between 2005 and 2016. They found that all the indices had different predictive powers, and they argued that there is no single financial stress index that can be considered the best for Türkiye.

Polat and Ozkan (2019) estimated a structural vector auto regression (SVAR) model in order to capture the dynamic relationship between the stress index, industrial production index and consumer price index for a period of January 2005 to November 2016. Following Hollo et al. (2012), they extended the Composite Indicator of Systemic Stress (CISS) for Türkiye.

Yildirim (2020) developed financial stress indices for Türkiye for a period of 2005 to 2017 in three different methodologies: principal components analysis (PCA), variance equal weight (VEW) and CISS approach. The indices were designed to measure the riskiness of the different segments of the economy such as financial markets, financial institutions and real sector. The empirical evidence of the study suggested that the CISS method captured systemic events better than the other two methods, however, the PCA and VEW methods were able to capture non-systemic events.

Sönmez and Kandemir Kocaaslan (2022) developed Türkiye Financial Stress Index (TR-FSI) for a period of 2006 to 2021 in both monthly and quarterly frequency. Using TR-FSI as the dependent variable, the authors investigated the predictive powers of candidate indicators on financial stress episodes in a non-linear Markov regime switching model with time-varying transition probabilities.

It has been observed that all these studies mentioned above, regardless of the country, developed indices that were better able to capture business cycles around the global financial crisis period.

1.1.2. Multiple-Country Financial Stress Indices

In addition to the single-country studies, there are also studies aimed to create financial stress indices for multiple countries. Just as with the single-country studies, the majority of research in this category was conducted after the global financial crisis. It is seen that the selected country groups are concentrated into two different bunches: as advance countries and emerging countries.

Cardarelli et al. (2009) analyzed the unwanted impacts of past financial stress episodes on economic activity in 17 advanced countries for a period of approximately 30 years since 1981. They developed financial stress indices for the selected countries by bringing together sub-indices proxied for banking sector, stock market and exchange rate volatility. The indices were constructed by the variance equal weighting method.

Balakrishnan et al. (2009-2011) developed Emerging Markets Financial Stress Indices (EM-FSI) in order to analyze the transition of financial stress from developed countries to the developing ones. The EM-FSI was constructed for 26 countries roughly for the period of 1997 to 2009. EM-FSI contained five components, namely, banking sector beta, stock market returns, time-varying stock market return volatility, sovereign debt spreads, and an exchange market pressure index (EMPI). The variance equal weighting method was used in the component aggregation process.

Grimaldi (2010) built a financial stress index for the Euro Area for the period between 1999 and 2009. They followed three phases in their analysis: first, they selected the financial stress

episodes, then they constructed the index, and finally they used a logit model for the econometric calculations.

Duca and Peltonen (2011) aimed to predict financial stress episodes with their financial stress index (FSI). The study covered 28 emerging market and advanced economies with quarterly data between 1990 and 2009.

Cevik et al. (2013) investigated the relation between financial stress and economic activity in five transition economies by means of a financial stress index specifically developed for the selected countries. The study covered the period from 1995 to 2010, and the FSIs were constructed by aggregating six components via principal component analysis.

Park and Mercado (2013) aimed to study the determinants of financial stress in 25 emerging market economies. They created Emerging Market Financial Stress Indices (EM-FSI) following Balakrishnan et al. (2009, 2011). Variance equal weights (VEW) and principal component analysis (PCA) were used in the study. The authors found that the VEW performed well in capturing episodes of high financial stress compared to the PCA.

Vermeulen et al. (2015) developed financial stress indices (FSI) for 28 OECD countries and examined the relation between financial crises and the FSIs for 30 years covering a period from 1980 to 2010. To understand how the crises broke out, they estimated multinomial logit regressions and univariate panel logit models. They advised policy-makers not to rely on stress indices in determining potential threats to financial stability because they were unable to identify any consistent temporal pattern between realized stress and the crises in the financial system.

Finally, Özçelebi (2020) aimed to find connections between the financial stress index (FSI) of advanced countries and the exchange market pressure index (EMPI) of developing countries, namely, Brazil, China, Mexico, Russia and South Korea using nonlinear vector

autoregression (VAR) model and quantile-based analysis. The study covered the period from 2010 to 2017. The quantile regression model, which considered the role of regime changes, showed that an increase in the FSI of developed countries may result in an increase in the EMPI of Brazil, China, Mexico, Russia, and South Korea during their high exchange market periods. This was confirmed by the nonlinear VAR, which found that increases or decreases in the FSI of developed countries will increase or decrease the EMPI in each emerging country.

1.1.3. Financial Stress Indices Developed by Institutions

Unlike the studies listed in the previous two categories, the common feature of the indices presented here is that they are mostly kept updated by institutions. To the best of our knowledge, most of the indices are designed for the US economy and the Euro Area countries, and an up-to-date index for either a group of countries or a single developing country does not exist.

Hakkio and Keeton (2009) developed a unique index for the US economy, namely, Kansas City Financial Stress Index (KCFSI). The index is mainly composed of financial indicators such as spreads between US bond rates, stock market returns, and other volatility indicators.

Oet et al. (2012) developed the Cleveland Financial Stress Index (CFSI) to identify financial risks and protect the stability of the financial system in the US economy. In order to aggregate an ultimate index, they brought data together from six markets: Funding, FX, Credit, Equity, Real Estate and Securitization.

Hollo et al. (2012) created the Composite Indicator of Systemic Stress (CISS) by combining 15 different indicators and five sub-indices specific to the Eurozone countries. These five sub-indices are financial intermediaries, money markets, equity markets, bond markets, and foreign exchange markets. In the making of the index, cross-correlation between all sub-

indices was considered and this cross-correlation was allowed to freely vary depending on time.

Duprey and Claus (2015) constructed a country-specific financial stress index, namely, Country-Level Index of Financial Stress (CLIFS) for 27 EU countries. The authors followed Hollo et al. (2012)'s work and they made extensions to improve the CISS.

Monin (2019) created a financial stress index that was developed by the Office of Financial Research, namely, OFR-FSI. Under the framework of OFR-FSI, three sub-indices were created for the regions: The United States, other advanced economies and emerging markets. The index used daily data from global financial markets. The index aggregated five different segments of the financial system, which are Credit, Equity Valuation, Funding, Safe Assets and Volatility.

1.1.4. Financial Stress Indices Developed for Other Countries

One of the most influential studies categorized under this title is Illing and Liu (2006). In order to measure financial stress in the Canadian financial markets, a financial stress index was developed with four different methods: factor analysis, variance equal weighting, weighting by credits, and cumulative distribution functions. They brought together four components in the making of index; banking sector, FX market, debt market and equity market. While selecting data and indicators for these components, they followed both the literature (standard measure) and their-own-expertise (refined measure).

Other studies of this category (Louzis and Vouldis (2013), Kota and Saqe (2013), Sinenko et al. (2013), Huotari (2015), Dahalan et al. (2016), Nagy et al. (2016), Chatterjee et al. (2017), Malega and Horwarth (2017), Tyschenko and Csajbok (2017), Ishrakieh et al. (2020) and Sahoo (2021)) aimed to develop single-country financial stress indices for Greece, Albania,

Latvia, Finland, Malaysia, Romania, United Kingdom, Czechia, Ukraine, Lebanon and India respectively.

1.2. LITERATURE ON PREDICTING FINANCIAL STRESS WITH MARKOV SWITCHING MODEL

Hamilton (1989) investigated whether the Gross National Product (GNP) of the US economy had followed discrete shifts between regimes of expansionary states and recessionary states. The Markov switching model was used to identify similarities between estimated expansion and contraction periods and the real business cycles in the US economy from 1951 to 1984. With this study, James Hamilton paved the way for new research on estimating business cycles. This initial model framework was based on constant transition probabilities between regimes, and regime durations were fixed as well.

With the advances in non-linear modelling techniques, researchers were able to present a more flexible approach. Diebold et al. (1994) proposed a Markov regime switching model with time varying transition probabilities. Following them, Filardo (1994) investigated the relation between leading indicators and the Gross Domestic Product (GDP) of the US economy with a Markov regime switching model with time-varying transition probabilities. Evidence from the study showed that the composite leading indicator variable had been giving signals before the exit from the contraction period. In other words, the leading indicator variable, which was built by aggregating various indicators, significantly increased the probability of an exit from a contraction period. The most novel aspect of this study, however, was the introduction of a structure in which the transition probabilities continuously change over time.

Abiad (2007) aimed to develop an early warning system for currency crises for five Asian countries including Indonesia, S. Korea, Malaysia, the Philippines and Thailand between 1972 and 1999. In the study, in which the explanatory variable set contained 21 indicators under the categories of Macroeconomic Imbalance, Capital Flows and Financial Fragility,

empirical analyses were carried out separately for each country. Thanks to the method used in the study, two-thirds of the observed crisis periods could be predicted successfully.

Duprey and Claus (2017) developed a financial stress index named the Country Level Index of Financial Stress (CLIFS). Using CLIFS as the dependent variable for a Markov regime switching model, they investigated whether a group of candidate indicators could predict regime switches from low to high financial stress episodes in the EU countries. Empirical findings showed that the majority of the credit-related variables were not successful in predicting regime transitions, while increases in the variables of debt service ratio of non-financial institutions and real property prices were found significant in predicting the transition to a high financial stress regime at a quarterly frequency. On the monthly basis, mortgage credits, bank leverage variable and mortgage interest rates could significantly predict the transition to a high financial stress regime. Signals for exits from high financial stress regimes came mainly from credit gap to GDP ratio variable at the quarterly basis and confidence indices variables at the monthly basis.

Finally, Sönmez and Kandemir Kocaaslan (2022) developed Financial Stress Index for Türkiye (TR-FSI) and used the same method in Duprey and Klaus (2017) in their analysis specifically for Türkiye between the year 2000 and 2021 for quarterly frequency and 2006 and 2021 for monthly frequency. According to their results, at monthly frequency, the spread between commercial and housing loan interest rates gave an early warning signal prior to transition from a low financial stress to a high financial stress regime. At quarterly frequency, industrial production produced signals before exiting from a high financial stress period.

Although all these studies above are directly related to the research area of this thesis, the studies of Filardo (1994) and Duprey and Claus (2017) stand out as the closest works to the subject area of this thesis in terms of the method and the purpose.

The importance of Filardo (1994)'s work is that it is a pioneering work in predicting business cycle turning points in the field of macroeconomics. Duprey and Claus (2017), on the other hand, comes forward for the reason that they create a new financial stress index for a group of countries such as EU member states, and it is the most comprehensive study that analyzes regime transitions with the Markov regime switching model with TVTP.

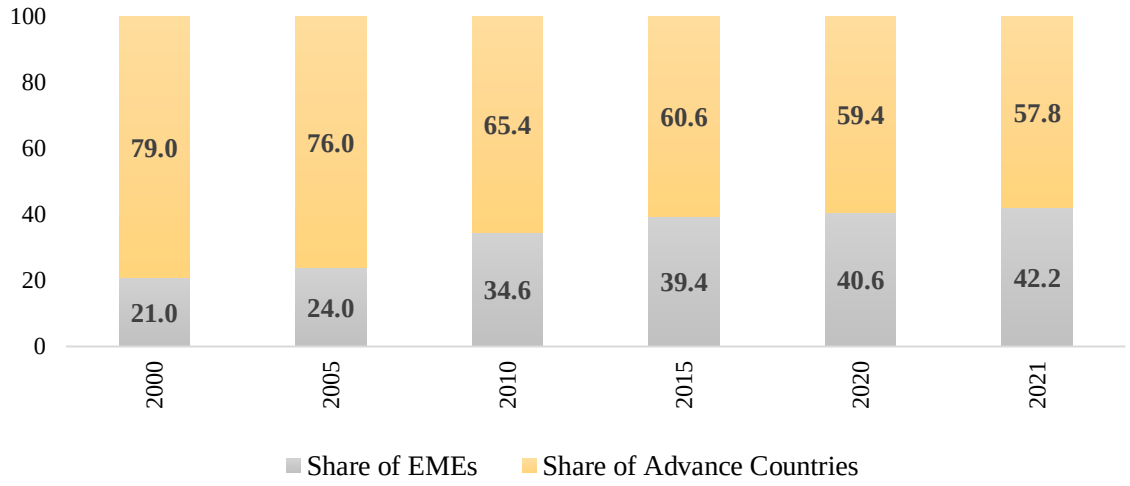
This thesis aims to improve the existing literature by working with a group of four emerging countries, which has some drawbacks compared to the developed countries in terms of data availability and data span. According to what is currently known, this study will be the first to use a Markov switching model with time-varying transition probabilities to predict financial stress turning points in emerging countries. Furthermore, the “spread” between business and mortgage credit interest rates, derived by Sönmez and Kandemir Kocaaslan (2022), will be used for the first time as an explanatory variable to predict the turning points of financial stress episodes in emerging countries. Last but not the least, the study intends to bridge the gap between the literature on traditional early warning systems and on predicting regime switches in a non-linear model framework.

2. MACROECONOMIC OUTLOOK OF THE SELECTED COUNTRIES

Although there is no official definition, the International Finance Corporation (IFC) of the World Bank Group used the term *Emerging Market Economies*[1] for the first time in the late 1980s (Rieffel, 2003). The concept of emerging market economies (or emerging countries) defines countries that are developing and that have rapid growth momentum, have made important progress in financial deepening and industrialization, and are able to attract foreign investment (Rieffel, 2003). Mody (2003) remarked that Emerging Market Economies (EMEs) are newly industrialized countries; on the one hand, EMEs offer high return opportunities for investors, on the other hand, they do not have a long history of foreign investment.

EMEs have made significant progress over the last two decades. As shown in Figure 1, the output of these countries has been increasing faster than that of developed countries, and their share in world output has doubled in the last 20 years. Chile and Poland increased their GDP by three times during this period, while South Africa and Türkiye increased their GDP by two times, in USD terms. Table 1 shows the GDP of the countries as well as their share in the total GDP of emerging market economies (excluding China), by year. Chilean economy slightly increased its share in the total GDP of EMEs (excluding China) from 1.3% in 2000 to 1.4% in 2021. South Africa and Türkiye lost their shares by 0.7 percentage points and by 1.1 percentage points, respectively, in the last 20 years.

[1] The terms “Emerging Market Economies” and “Emerging Countries” can be used interchangeably.



Source: IMF WEO, October 2022

Figure 1: Share of the Country Groups in the World Output

Although Poland had made a sharp upward movement between 2000 and 2008, its share stood at 2.9% as of 2021, the same level as in 2000.

Table 1: GDP of the Countries and Their Shares in the EMEs (excluding China) Group

(Billion USD)	**2000**	**2005**	**2010**	**2015**	**2020**	**2021**
EMEs GDP	7,156	11,453	23,021	29,528	34,657	40,926
EMEs (excl. China) GDP	5,951	9,163	16,987	18,414	19,794	23,181
Chile	78	122	217	243	252	317
Poland	172	306	480	477	600	679
South Africa	152	289	417	347	338	419
Türkiye	274	506	777	864	720	818
Share in EMEs (excl. China) GDP, %						
Chile	1.3	1.3	1.3	1.3	1.3	1.4
Poland	2.9	3.3	2.8	2.6	3.0	2.9
South Africa	2.6	3.2	2.5	1.9	1.7	1.8
Türkiye	4.6	5.5	4.6	4.7	3.6	3.5
Total Share of Four in EMEs (excl. China) GDP	11.4	13.4	11.1	10.5	9.6	9.6

Source: IMF WEO, October 2022

The data show that there are many countries that increased their GDP significantly apart from these four countries between the years 2000 and 2021. While Chile and Poland could at least maintain their shares in the EMEs, South Africa and Türkiye fell back. This might be due to the fact that the latter two countries lagged behind, especially in terms of productivity.

2.1. ECONOMY OF CHILE

Table 2 presents the main indicators of the Chilean economy. According to the classification of the World Bank, Chile is considered as a high-income country. Chile has significantly increased its GDP per capita in the last 20 years with a moderately growing population and stable economic growth. Credits to the private sector have been the iron horse of this performance. In the last two decades, the industry value-added increased its share in the GDP by almost 4 percentage points, while the share of the agriculture value-added decreased by 1.8 percentage points. Thanks to this, income inequality had room to improve. According to the World Bank data, the Gini index decreased by 0.08 point in this period and was realized as 0.449 in 2020.

Due to the negative effects of the pandemic, however, income inequality has deteriorated lately and is not expected to return to pre-pandemic levels in the medium term (World Bank, 2022). With the effects of the pandemic, general government gross debt to GDP increased sharply in 2020 and 2021. Although significant progress has been seen in product diversification, Chilean exports mainly rely on mine ores, copper and precious metals. While Chile has been a net exporter for the last two decades, the current account balance to GDP ratio of the country has not exhibited a stable pattern. Nevertheless, Chile has been attracting foreign investors successfully for the last 20 years and accumulating sufficient foreign capital in the country to spark green-field investments.

Table 2: Economic Indicators of Chile

	2000	2005	2010	2015	2020	2021
Population (million)	15.3	16.2	17.1	18.0	19.5	19.7
Urban population (% of total population)	86.1	86.8	87.1	87.4	87.7	87.8
GDP growth, constant prices, %	5.0	5.9	5.8	2.2	-6.1	11.7
GDP, current prices, billion USD	78.2	122.3	216.9	242.5	252.3	316.8
GDP per capita, current prices, USD	5,096	7,560	12,711	13,494	12,969	16,065
Agriculture, value added (% of GDP)	5.1	3.9	3.5	3.7	4.1	3.3
Industry (incl. construction), value added (% of GDP)	27.8	34.0	33.5	27.9	30.0	31.7
Credit to private non-financial sector (% of GDP)	109.4	90.4	102.7	145.3	159	146.8
Inflation, end of period consumer prices, %	4.6	3.7	2.9	4.4	2.9	7.1
Unemployment rate, %	9.7	9.3	8.3	6.3	10.8	8.9
General government gross debt (% of GDP)	13.2	7.0	8.6	17.4	32.6	36.3
Foreign direct investment, net inflows (% of GDP)	6.2	6.1	7.4	8.6	3.4	-
Exports of goods and services (% of GDP)	30.1	40.2	37.9	29.2	31.5	31.9
Imports of goods and services (% of GDP)	28.6	31.9	31.8	30.2	27.0	32.5
Current account balance to GDP, %	-1.0	2.2	0.9	-2.8	-1.7	-6.7

Source: IMF WEO October, 2022, WB, BIS

Chile has been developing policies to find ways to overcome stubborn unemployment, yet the job market has some rigidities. As a result, economic growth was not accompanied by sufficient job creation in the past. Inflation, on the other hand, is not a concern for Chile because the country has a well-established autonomous monetary policy framework. The relatively slow pace of urbanization might have contributed to the inflation outlook positively by lowering demand-side inflationary pressures.

2.2. ECONOMY OF POLAND

Table 3 gives the main economic indicators of Poland. According to the World Bank, Poland is defined as a high-income country, as is Chile. The country has been a member of the European Union since May 2004. It has quadrupled its GDP per capita in the last two decades

thanks to fast and stable economic growth. Sluggish population growth before the 2000s turned into steady losses between 2000 and 2021 due to an ageing population. The urbanization ratio also dropped by around 1.6 percentage points. The expansion of private sector credit supported Poland's strong growth performance, while general government debt to GDP remained relatively low during this period. Industry value-added has increased its share in the GDP only a small margin over the last 20 years, while the share of the agriculture value-added has decreased. Income inequality in Poland has been decreasing since 2004, Gini index of the World Bank improved by 0.08 point and was realized as 0.302 in 2018.

Table 3: Economic Indicators of Poland

	2000	**2005**	**2010**	**2015**	**2020**	**2021**
Population (million)	38.3	38.2	38.0	38.0	38.0	37.8
Urban population (% of total population)	61.7	61.5	60.9	60.3	60.0	60.1
GDP growth, constant prices, %	4.3	3.5	3.7	4.2	-2.2	5.9
GDP, current prices, billion USD	171.6	306.3	479.8	477.5	599.8	679.1
GDP per capita, current prices, USD	4,485	8,024	12,620	12,564	15,802	17,946
Agriculture, value added (% of GDP)	3.1	2.9	2.9	2.4	2.5	2.4
Industry (incl. construction), value added (% of GDP)	28.8	28.6	28.9	30.1	27.7	29.3
Credit to private non-financial sector (% of GDP)	39.6	43.3	72.7	83.6	80.5	76.3
Inflation, end of period consumer prices, %	8.5	0.7	3.1	-0.5	2.4	8.6
Unemployment rate, %	16.1	18.1	10.0	7.7	3.2	3.4
General government gross debt (% of GDP)	36.4	46.6	53.5	51.3	57.1	53.8
Foreign direct investment, net inflows (% of GDP)	5.4	3.6	3.8	3.2	2.9	-
Exports of goods and services (% of GDP)	27.2	34.6	39.9	49.1	56.2	60.9
Imports of goods and services (% of GDP)	33.7	35.9	42.1	46.3	49.4	56.7
Current account balance to GDP, %	-6.0	-2.9	-5.6	-0.9	2.9	-0.7

Source: IMF WEO October, 2022, WB, BIS

Although Poland has been attracting foreign direct investments, the current account balance has been in deficit for the last two decades, except for 2020. The main trade partners of the country are the neighboring and the other EU countries. Exports from Poland have relied mainly on vehicles and automobile parts, machinery-equipment as well as computer parts. Poland increased value-added production after the global financial crisis and has become a net exporter since the beginning of the second half of the 2010s. The job market reflected this positive outlook. Unemployment rate, which had been considerably high before 2010, has gradually decreased since then. Inflation rate, on the other hand, has been stable for 20 years, except for the last year.

2.3. ECONOMY OF SOUTH AFRICA

Table 4 presents the main indicators of the South African economy. The World Bank considers South Africa an upper-middle-income country. The population has increased by 34% in the last 20 years, and this outpaced the per capita GDP growth. Despite the remarkable leap seen in the 1990s in terms of well-being and infrastructure investments, the pace of progress has slowed down since the global financial crisis.

Since then, economic growth has been volatile, and the country's industrialization process has fallen short of the standards of upper-middle income countries. These factors have been hindering efforts to lower poverty and income inequality in the country for more than 20 years. Hence, according to the World Bank data, the Gini index has been fluctuating between 0.60 and 0.70 levels throughout the last two decades, indicating that South Africa has been one of the least successful countries in the world in terms of income distribution. High inequality indirectly indicates that the wealth and the origins of economic growth are not distributed homogeneously across the country, and this leads to low job creation and high unemployment figures in the next round.

Table 4: Economic Indicators of South Africa

	2000	**2005**	**2010**	**2015**	**2020**	**2021**
Population (million)	44.9	47.9	51.3	55.4	59.6	60.1
Urban population (% of total population)	56.9	59.5	62.2	64.8	67.4	67.8
GDP growth, constant prices, %	4.2	5.3	3.0	1.3	-6.3	4.9
GDP, current prices, billion USD	151.9	288.7	417.3	346.7	337.5	418.9
GDP per capita, current prices, USD	3,382	6,033	8,130	6,257	5,661	6,965
Agriculture, value added (% of GDP)	2.6	2.1	2.1	2.2	2.5	2.4
Industry (incl. construction), value added (% of GDP)	28.2	26.0	25.3	23.7	23.4	24.5
Credit to private non-financial sector (% of GDP)	58.6	64.9	72.9	75.8	73.2	66
Inflation, end of period consumer prices, %	6.5	3.5	3.6	5.2	3.2	5.4
Unemployment rate, %	23.0	24.7	24.9	25.4	29.2	34.3
General government gross debt (% of GDP)	37.9	29.6	31.2	45.2	69.0	69.0
Foreign direct investment, net inflows (% of GDP)	0.6	2.3	0.9	0.4	0.9	-
Exports of goods and services (% of GDP)	24.4	23.6	25.8	27.7	27.8	31.1
Imports of goods and services (% of GDP)	21.8	23.8	24.6	29.0	23.3	25.0
Current account balance to GDP, %	-0.1	-2.8	-1.3	-4.3	2.0	3.7

Source: IMF WEO October, 2022, WB, BIS

Furthermore, South Africa is a net exporter, with precious metals such as platinum, iron, gold and coal as well as vehicles being the main export items. The country has one of the largest coal reserves in the world, and the economy is heavily reliant on the coal-generated energy. Although the South African economy produces almost all of the energy it needs, crude oil imports have reached notable levels over the last two years. The country has been experiencing some difficulties attracting foreign investors for the last two decades. Furthermore, the current account balance has been negative except for the last two years. With the effects of the pandemic, the general government debt increased while the inflation rate, which had been under control prior the pandemic, has fallen remarkably but has become volatile since then.

2.4. ECONOMY OF TÜRKİYE

Table 5 presents the main economic indicators for Türkiye. Similar to South Africa, Türkiye is classified as an upper-middle-income country by the World Bank. The country has experienced rapid economic growth over the last two decades, with its GDP nearly doubling. During this time, industrialization progress accompanied GDP growth, and the share of agriculture in the economy nearly halved. The high pace of population growth and urbanization outshined the leap forward of the economy. Once GDP per capita, once it surpassed the 10,000 USD level, lost its momentum and could not increase further. Türkiye had made significant progress in income distribution between 2005 and 2010. The World Bank Gini index hit 0.384 in 2007 and has been rising since then realizing as 0.419 in 2019. Although rigidities in the labor market have been mostly eliminated in the last decade, unemployment is still a concern in Türkiye. Exports from the country consist of vehicles and automobile parts, machinery-equipment, textiles and clothing as well as processed iron and steel.

On the one hand, Türkiye is heavily reliant on energy imports, which exacerbates the country's persistent current account deficit. On the other hand, Türkiye is having difficulty attracting foreign investment. These two factors fuel the financing needs of the current account deficit. Besides, Türkiye has been negatively decoupling from the peer country group in currency depreciation for the last decade. All these factors deteriorate the country's inflation outlook. Nevertheless, Türkiye has a solid fiscal balance, and the general government debt level is relatively sustainable.

Table 5: Economic Indicators of Türkiye

	2000	**2005**	**2010**	**2015**	**2020**	**2021**
Population (million)	64.7	68.9	73.7	78.7	83.6	84.7
Urban population (% of total population)	64.7	67.8	70.8	73.6	76.1	76.6
GDP growth, constant prices, %	6.9	9.0	8.4	6.1	1.9	11.4
GDP, current prices, billion USD	274.3	506.2	776.6	864.1	720.1	817.5
GDP per capita, current prices, USD	4,238	7,351	10,533	10,974	8,612	9,654
Agriculture, value added (% of GDP)	10.0	9.2	9.0	6.9	6.7	5.6
Industry (incl. construction), value added (% of GDP)	26.8	25.2	24.5	27.8	28.0	31.1
Credit to private non-financial sector (% of GDP)	25.7	29.1	55.9	79.5	89.4	89.6
Inflation, end of period consumer prices, %	39.0	7.7	6.4	8.8	14.6	36.1
Unemployment rate, %	6.0	9.2	11.0	10.3	13.1	12.0
General government gross debt (% of GDP)	51.3	50.2	39.7	27.3	39.7	41.8
Foreign direct investment, net inflows (% of GDP)	0.4	2.0	1.2	2.2	1.1	-
Exports of goods and services (% of GDP)	19.9	21.9	21.2	24.5	28.7	35.4
Imports of goods and services (% of GDP)	22.5	24.3	25.5	26.6	32.5	35.8
Current account balance to GDP, %	-3.6	-4.1	-5.7	-3.2	-4.9	-1.7

Source: IMF WEO October, 2022, WB, BIS

3. EMPIRICAL METHODOLOGY AND DATA

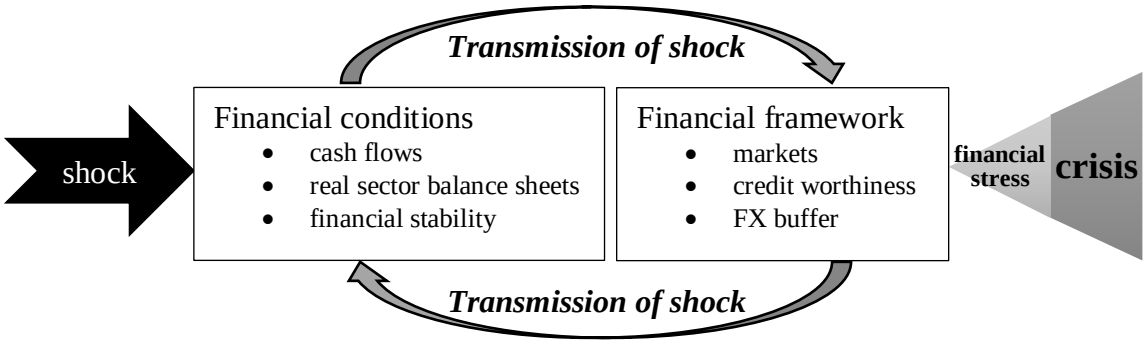
3.1. MEASURING FINANCIAL STRESS IN EMERGING COUNTRIES

Early warning systems have been mostly used in areas where "unwanted situations" interrupt economic and social development. By predicting these situations, which are better to avoid, early warning systems lower the possible damage, which can have unwanted consequences (Klopotan et al., 2018:3). In the first stage of this study, indices are constructed to capture "financial stress episodes", which can also be called "unwanted situations". At this point, sharing some further concepts related to financial stress and its measurement could be beneficial.

According to Balakrishnan et al. (2009), financial stress episodes emerge as a result of the factors that cause the financial system to fall short of its primary intermediary role. Significant increases in asset prices, abnormal increases in risk and/or uncertainty, emerging liquidity problems, and concerns about the health of the banking system are among these factors. In case such factors become evident, asymmetrical pressures may occur on supply and demand conditions in financial markets. This may eventually diffuse to the financial system and the economy as a whole, posing a risk to economic activity (Balakrishnan et al., 2009: 6). Financial stress is the outcome of a fragile financial system that is challenged by an exogenous shock. Fragility of financial system can be originated from weaknesses in financial conditions and/or in the framework of the financial system (Illing and Liu, 2006).

Diagram (1) illustrates how an external shock spreads through the financial system. A shock may diffuse if financial conditions in the economy are fragile. If the flow of funds (i.e., bank loans) diminishes rapidly and balance sheets are highly leveraged and/or lenders are more risk-averse, then financial stress might be elevated at a fast pace. Shocks may also spread due to the weaknesses in the framework of the financial system, such as when there are market

coordination failures, or credit worthiness of the system is questionable, and/or there is an inadequacy of foreign exchange reserves against capital outflows. The magnitude of the shock and its interaction with fragilities of the financial system determine how far financial stress can rise. In many cases, a shock is more likely to increase financial stress; in extreme cases, however, it could induce a financial crisis (Illing and Liu, 2006).



Reproduced from Illing and Liu (2006)

Diagram 1: Transmission of an external shock across the financial system

In this study, financial stress indices for each of the four emerging countries are developed following the methods used by Balakrishnan et al. (2009, 2011), Cardarelli et al. (2008, 2011), Yiu, Ho, and Jin (2010) and Park and Mercado (2014). As in previous studies, financial stress index for each economy contains five major components as shown in equation (1).

$$FSI = \beta + stock\ market\ returns + Stock\ market\ volatility + Sovereign\ debt\ spreads + EMPI \quad (1)$$

Banking sector beta, β, is a measure of the correlation between the total returns of the banking-sector stock index and the overall stock market index (Cardarelli, 2011). According to the standard capital asset pricing model (CAPM), if the beta is greater than one, the banking sector risk is accepted to be greater than the total market risk. Higher values of the beta are associated with higher banking sector riskiness, and in this case, it is considered that

the probability of a crisis in the banking sector rises (Balakrishnan et al 2011). In line with CAPM, the beta is calculated as follows:

$$\beta_t = \frac{COV(r_t^{MARKET}, r_t^{BANKS})}{VAR(r_t^{MARKET})} \quad (2)$$

In equation (2), r represents the year-over-year banking or stock market returns, computed over a 12-month rolling window. Stock market returns are computed as year-over-year change multiplied by minus one, in order to reverse the direction of the correlation between equity prices and securities-market–related stress. Stock Market Volatility is computed in line with Balakrishnan et al. (2011), month-over-month real returns are modeled as an autoregressive process with 12 lags in a GARCH (1,1) model framework. The standard GARCH (p, q) model can be shown as the following equation (3), where σ_t^2 is the conditional variance, ε_t is the residual returns as well as ω, α_i and β_j are the parameters of the model.

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \quad (3)$$

Through the estimation of eq. (3), the GARCH conditional variance series and thus stock market volatility itself are obtained.

By definition, Sovereign Debt Spread is calculated as the difference between government bond yield and the 10-year United States Treasury yield. In this study, the JP Morgan Emerging Markets Bond Index (EMBI) Global spread is chosen as the sovereign debt spread in line with the previous studies. Exchange Market Pressure Index (EMPI)[2] reflects

[2] Girton and Roper (1977) had first introduced foreign exchange market pressure index (EMPI). Thanks to the studies of Eichengreen et al. (1994 and 1995) and Weymark (1995), the index gained recognition and has been used in the literature.

depreciation of domestic currency against a major currency such as US dollar, and decreasing foreign exchange reserves.

$$EMPI_t = \frac{(\Delta e_t - \mu_{\Delta e})}{\sigma_{\Delta e}} - \frac{(\Delta RES_t - \mu_{\Delta RES})}{\sigma_{\Delta RES}} \quad (4)$$

In eq. (3), Δe and ΔRES are month-over-month change of currency and foreign exchange reserves (excluding gold), respectively. The mean is symbolized by μ and the standard deviation by σ. Variance-Equal Weighting (VEW) method is chosen to form the FSI by combining sub-indices. VEW is considered the simplest and most common weighting method in the literature. As indicated in Illing and Liu (2006), VEW performs very close to other methods such as Factor Analysis (FA) and Principal Component Analysis (PCA). Some studies in the literature, i.e., Illing and Liu, (2006), Park and Mercado Jr. (2014) and Öztürkler and Göksel (2013) use both PCA and VEW and assert that both methods produce very similar results. Following Cardarelli et al. (2011) and Balakrishnan et al. (2009 and 2011), sub-indices are demeaned and standardized in advance, and then the VEW process is used so as to calculate FSIs.

Figures 2a-2d shows the financial stress indices of the four countries analyzed in this study. Financial stress rose dramatically in all four countries due to the global financial crisis in late 2008. The Covid-19 pandemic outbreak hit South Africa and Chile the hardest; Poland, on the other hand, was able to unwind financial stress. In Türkiye, not only financial stress but also financial volatility became visible after second half of 2018. Financial stress in Türkiye ramped up several times after reaching one of the lowest levels seen in early 2018.

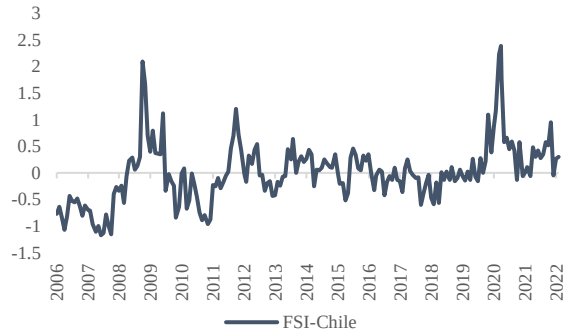


Figure 2- a: Chile

Figure 2- b: Poland

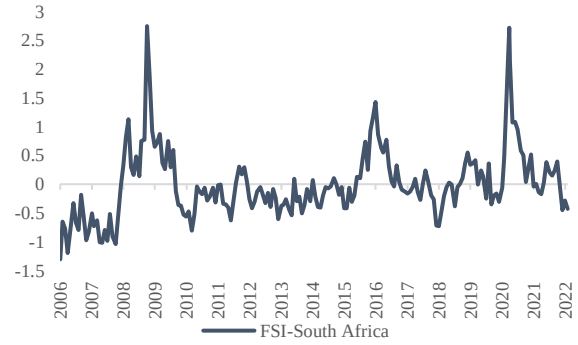


Figure 2- c: South Africa

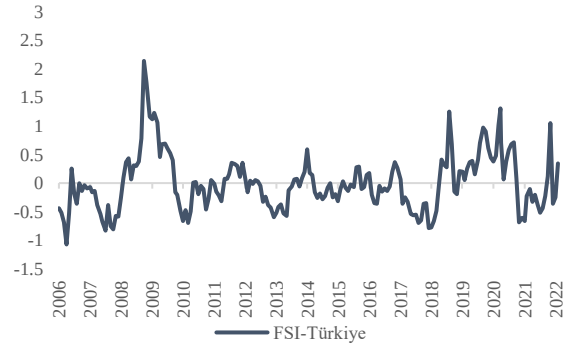


Figure 2- d: Türkiye

Figure 2: Financial Stress Indices of the Countries

Furthermore, Türkiye appears to be the country that reduced its financial stress level the most right after the pandemic outbreak. While Chile and Poland experienced similar stress peaks in late 2011, Türkiye and South Africa did not. Finally, due to rising domestic political uncertainty and emerging economic difficulties, financial stress levels in South Africa increased rapidly in early 2016 (Rosamond, 2016).

As seen in Figures 3a-3d, financial stress indices can successfully signal the most critical economic turning points. First, all of the FSIs captured the global financial crisis in late 2008, right before the economies started to contract in the first half of 2009. After the effects of the global crisis subsided, all countries except Türkiye experienced more volatile growth rates in comparison with the period prior to the crisis. Türkiye is the fastest-growing country of the sample, with an average growth rate of 5.9% in the 2010-21 period. During the same time period, Poland became the second fastest-growing country (with an average growth rate of

3.3%) and had the lowest volatility, while Chile is the third fastest-growing (with an average growth rate of 3.1%) and has the highest volatility. South Africa appears to have lost the momentum following the global crisis; its average growth rate fell by 2.9 percentage points in 2010-21 period when compared to the period preceding the global crisis. It is seen in all of four countries that financial stress indices have reacted quickly prior to the most significant fluctuations in the economic growth until the pandemic.

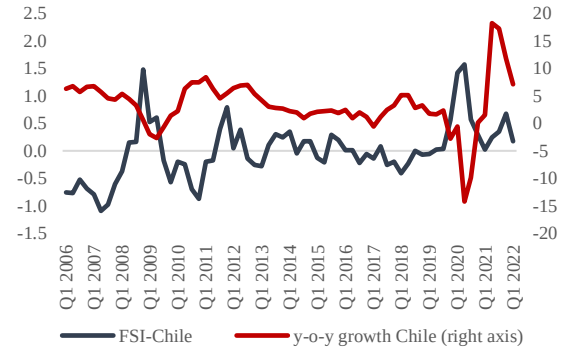


Figure 3- a: FSI of Chile and economic growth rate

Figure 3- b: FSI of Poland and economic growth rate

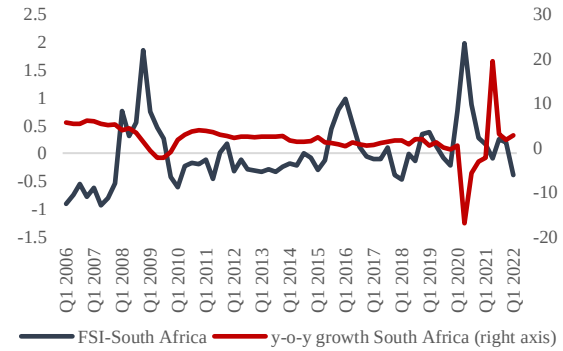


Figure 3- c: FSI of south Africa and economic growth rate

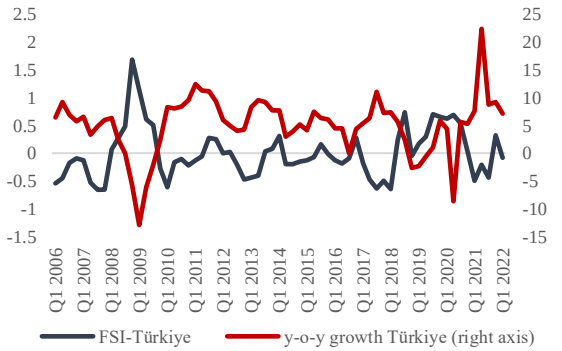


Figure 3- d: FSI of Türkiye and economic growth rate

Figure 3: Relation between Financial Stress Indices and Economic Activity

With the outbreak of the pandemic, FSIs rapidly signaled a contractionary period for all of the countries in the first quarter of 2020. In Chile, Poland and South Africa, the relationship between FSIs and growth rates is unambiguous. However, Türkiye, which had been struggling with already deteriorated financial conditions, took the wind on its back and, with measures taken to address the negative effects of the pandemic, managed to ease financial

stress. Except for Türkiye, all countries experienced negative growth rates in 2020. South Africa reacted the most to the pandemic outbreak in terms of both spikes in financial stress levels and contractions in GDP.

Figure 4 demonstrates the component breakdown of the unweighted average of FSIs for developing countries. It is seen that, except for the banking sector riskiness, equity, currency and debt markets all contributed to the rising financial stress in the 2008-09 period of the global financial crisis. This may imply that developing countries had solid banking sectors and financial conditions. In addition, banking sector riskiness had been increasingly contributing to the headline FSI aftermath of the global crisis until 2011. These two findings are consistent with the findings of Park and Mercado Jr., (2014). From 2011 to the Covid-19 outbreak, equity and currency markets were the main positive contributors to financial stress, while sovereign spreads pushed the stress level up in certain periods.

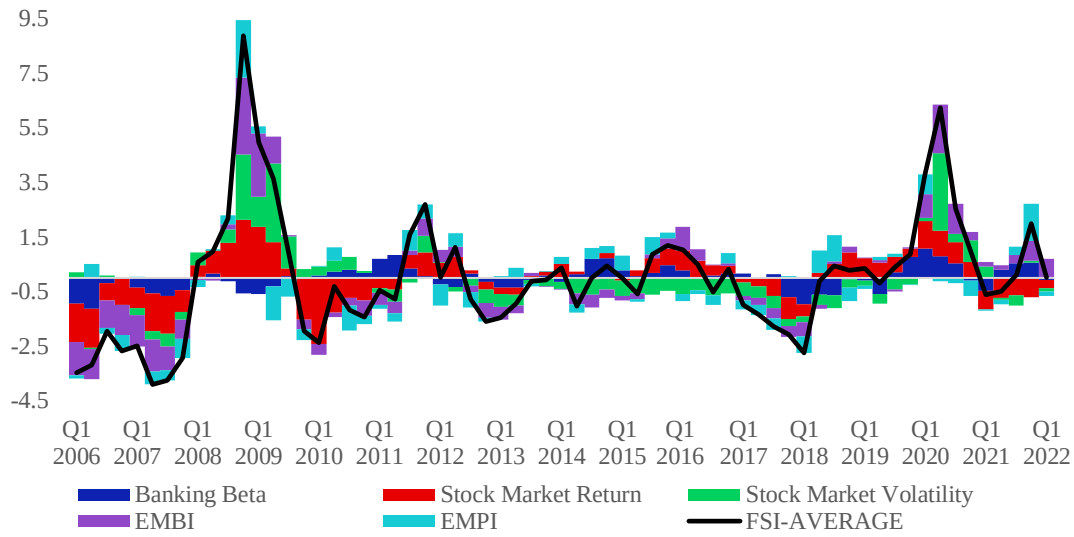


Figure 4: Component Breakdown of FSIs of Emerging Countries

The pandemic outbreak in the second quarter of 2020 caused a sharp increase in stock market volatility and had its biggest contribution to the FSI since the global financial crisis. However, unlike the 2008-09 financial crisis, stock market volatility was short-lived,

beginning to decline sharply in the following quarter and diminishing at a fast pace. In the first quarter of 2022, stock market returns and stock market volatility had a negative impact on the stress levels, yet, sovereign spreads continued to push the FSIs upwards due to the conflict between Russia and Ukraine. Overall, developing countries' FSIs are seen to capture the tough times and critical milestones.

3.2. MARKOV REGIME SWITCHING MODEL WITH TIME-VARYING TRANSITION PROBABILITIES

Total output generally goes through cycles such as expansion and contraction periods. As a result, total output, as measured by GDP, does not follow a linear pattern. Measuring GDP fluctuations with a simple linear model does not seem reasonable because it may contain non-linear behaviors, asymmetries and volatility clusters. For this reason, non-linear time series models have been developed for more than four decades. The Markov switching model of Hamilton (1989) has a strong reputation in this field as it can model data exhibiting dynamic patterns during different time periods (Kuan, 2002:1).

Hamilton (1989), in his pioneering study that introduced the Markov regime switching method, argued that there are significant asymmetries in the US economy due to the differences in the average growth rate of the three-month real gross national product. In this study, he uses a structure in which the transition between contraction and expansion periods is determined by fixed transition probabilities (FTP). Almost all of the early studies in the Markov regime-switching model literature used this structure. The Markov regime switching model allows us to analyze the movement of the economy between different regimes without making any a priori assumptions about the timing of the regime shifts. Furthermore, thanks to the transition probabilities matrix, which is the product of the hidden Markov chain structure, the model allows us to calculate the probability of being in a certain regime as well as the probability of transition from one regime to another (Duprey and Claus, 2017).

The studies of Filardo (1994) and Diebold et al. (1994) made an important contribution to Hamilton (1989), where the transition probabilities were assumed to be constant, by providing an extension that allows for the transition probabilities to vary over time. In addition, they also introduced a structure that allows the transition probabilities to be conditionally linked to a set of leading variables related to cyclical movement.

Therefore, in this thesis, instead of using the fixed transition probabilities model suggested by Hamilton (1989), we use the time-varying transition probabilities (TVTP) structure, which is an extension of FTP. In the TVTP model, the transition probabilities are time-dependent and change continuously. The basis for the preference for this structure is that the Markov regime-switching model, in which the transition probabilities change over time, has three significant advantages over the first one.

Firstly, the TVTP structure allows the transition probabilities to increase just before an expansion or contraction regime. Fixed transition probabilities, on the other hand, do not change before, during and after the turning points (Filardo, 1994). Secondly, the TVTP model has a higher predictive power during periods with complex signals about regime persistence. The transition probabilities matrix is better able to explain how long cyclical movements will follow a regime and how long they will stay in that regime (Filardo, 1994). And thirdly, unlike the fixed transition probabilities models in which the expected durations of the contraction or expansion regimes are set unchanged, the expected durations of the regimes are constantly changing in time-varying transition probabilities models (Filardo, 1994). For this reason, the latter provides a more correct calculation of regime durations.

The Markov switching model, which was developed to predict financial stress periods in developing countries, is presented in eq. (4), where low or high financial stress periods in an economy are shown by $S_t = \{0,1\}$. Regimes are categorized under two different states: Financially low stress regimes are named “tranquil state” and financially high stress regimes are named “tense state”. Constants are calculated for each regime, and regimes are

determined endogenously. The estimated constants, which are the means of the financial stress series in each regime, provide information about the regimes in which the economy stays. For instance, the period during with the low estimated value of a constant is defined as a "tranquil state", and the period during which the estimated value is high defined as a "tense state".

$$FSI_t = \begin{cases} \mu^0 + \gamma^0 \mathbb{I} + \beta^0 FSI_{t-1} + \sigma^0 \varepsilon_t & S_t = 0 \\ \mu^1 + \gamma^1 \mathbb{I} + \beta^1 FSI_{t-1} + \sigma^1 \varepsilon_t & S_t = 1 \end{cases}, \varepsilon_t \sim \mathcal{N}(0,1) \tag{5}$$

Equation (5) depicts the basics of the Markov switching model, which we can refer to as "the base model" following Filardo (1994). Having the explanatory variables on the right side clearly makes sense in order to uncover the non-linear relationship between the FSI's dependent variable and the explanatory variables. However, instead of obtaining coefficient estimates of an explanatory variable set in different regimes of the economy, the aim of this study is to predict enter into and exit from a financially high stress period of the economy by using a set of candidate leading indicators. For this reason, the explanatory variable set of (X_t) is not placed in the base model shown in eq. (5), but rather it is inserted into the transition probability matrix shown in eq. (6).

Probabilities of transition from low to high financial stress periods (p_t) and from high to low financial stress periods (q_t) are calculated conditionally on a set of observables (X_t) as shown in eq. (6).

$$P(S_t|S_{t-1}, \boldsymbol{X}_{t-1}) = \begin{bmatrix} 1 - p_t & p_t = \frac{exp(\theta_{p,0} + \theta_{p,1} \boldsymbol{X}_{t-1})}{1 + exp(\theta_{p,0} + \theta_{p,1} \boldsymbol{X}_{t-1})} \\ q_t = \frac{exp(\theta_{q,0} + \theta_{q,1} \boldsymbol{X}_{t-1})}{1 + exp(\theta_{q,0} + \theta_{q,1} \boldsymbol{X}_{t-1})} & 1 - q_t \end{bmatrix} \tag{6}$$

If the variable set (X_t) is not included in the transition probability matrix shown in eq. (6), then the structure becomes Hamilton's (1989) traditional Markov regime-switching model,

and the variable set (X_t) will be unable to predict turning points related to the contraction/expansion of an economy. The parameters in eq. (5) and in eq. (6), on the other hand, are estimated together simultaneously in the structure of time-varying transition probabilities, and this is shown through the conditional joint density function, *f**, (Filardo, 1994). To provide a broader framework, the autoregressive n-order conditional density function is shown in eq. (7) similar to that of Filardo (1994).

$$
\begin{aligned}
f^* = (FSI_t | FSI_{t-1}, \dots, FSI_{t-n}, X_t) &= \textstyle\sum_{s_t=0}^{1} \dots \sum_{s_{t-n}=0}^{1} f(FSI_t, S_t = s_t, \\
& S_{t-1} = s_{t-1}, \dots, \\
& S_{t-n} = s_{t-n} | FSI_{t-1}, \dots, FSI_{t-n}, X_t) \\
& = \textstyle\sum_{s_t=0}^{1} \dots \sum_{s_{t-n}=0}^{1} \hat{f}\,(FSI_t | S_t = s_t, \dots, S_{t-n} \\
& = s_{t-n}, FSI_{t-1}, \dots, FSI_{t-n}) \\
& x\ P(S_t = s_t | S_{t-1} = s_{t-1}, X_t) \\
& x\ P(S_{t-1} = s_{t-1}, \dots, S_{t-n} = s_{t-n} | FSI_{t-1}, \dots, FSI_{t-n}, X_{t-1})
\end{aligned}
\tag{7}
$$

Following equation represents the log-likelihood function: $L(\theta) = \sum_{t=1}^{T} ln[f^*(FSI_t | FSI_{t-1}, \dots, FSI_{t-n}, X_t;\ \theta)]$. Information from the explanatory variable set of (X_t) and FSI affect the model both directly and indirectly. FSI and its lagged values directly affect the transition probabilities with the normal density function $\hat{f}$, whereas lagged values of the FSI alone indirectly affects transition probabilities through $P(S_{t-1} = s_{t-1}, \dots, S_{t-n} = s_{t-n} | FSI_{t-1}, \dots, FSI_{t-n}, X_{t-1})$. The explanatory variable set of (X_t) affects the transition probabilities by means of $P(S_t = s_t | S_{t-1} = s_{t-1}, X_t)$ directly and regime distribution through $P(S_{t-1} = S_{t-1}, \dots, S_{t-n} = S_{t-n} | FSI_{t-1}, \dots, FSI_{t-n}, X_{t-1})$ indirectly (Filardo, 1994). Information criterion method Akaike (AIC) will be used to choose the appropriate order of the lags of the variables in the Markov switching model with the TVTP. According to the estimation results, estimated means of the "tranquil state", μ^0, have negative signs, while estimated means of the "tense state", $\mu^0 + \mu^1$, have positive signs. In the following section, we would present the data sources in detail and introduce variables used in the empirical analysis.

3.3. DATA

The aim of this study is to predict financial stress in emerging countries, first by constructing financial stress indices for each selected country and then by using these indices as dependent variables in the framework of the Markov regime switching model with TVTP. To do so, the most relevant data for candidate countries must be attained. However, developing countries have some shortages in this regard; some of them do not have the appropriate market depth to produce the needed data, and/or some data series do not have a long enough time span. As a result, countries were selected with these factors in mind. Only Chile, Poland, South Africa, and Türkiye are compatible with the study's specifications. Quarterly data is used in the study and covered 2006: Q1– 2022: Q1 period for Chile, South Africa and Türkiye as well as 2010: Q1– 2022: Q1 for Poland[3]. This allows us to work with 65 observations for the first three countries, and 49 observations for Poland in each regression[4].

Table 6 gives the details of the candidate leading indicators that are used in this study. The candidate indicators are categorized under four different groups. In order to see the effects of macroeconomic developments, four candidate leading indicators are chosen. The industrial production index (*IND*) is chosen to reflect the real sector's production power. The year-over-year change of industrial production is used and the data has been collected from the statistics databases of the countries.

[3] We run our estimations also in monthly frequency between 2006:M01–2022:M03 (2010:M01–2022:M03 for Poland) in order to have a robustness check. We do not prefer to include results in the text since both quarterly and monthly regressions produce coherent outcomes. Rather, monthly results are shown in the annex.

[4] We use only one regressor in each estimation following prior studies Filardo (1994) and Duprey and Claus (2017). Depending on the lag structure of the regressor, number of observations may slightly decrease but it does not violate the degrees of freedom.

Table 6: Candidate Leading Indicators and Data Sources

Macro economy-related	**Code**	**Source**
Industrial production index, y-o-y change	***IND***	Statistics offices of the countries
OECD-composite leading indicator, y-o-y change	***OECD_CLI***	OECD
Foreign participation	***PART***	IIF
Property prices, in real terms, y-o-y change	***P_PROPERTY***	BIS
Global economy-related		
CBOE volatility index	***VIX***	FRED
Index of global economic activity	***GEA***	FRED
Index of energy prices, y-o-y change	***ENERGY***	FRED
Global Economic Conditions (GECON) Indicator, not standardized	***GECON***	Baumeister, C., D. Korobilis, and T.K. Lee (2022)
Debt-related		
Debt service ratio	***DSR***	BIS
Financial corporates debt, y-o-y change	***FC_D_GROW***	IIF
Non-financial corporates debt, y-o-y change	***NFC_D_GROW***	IIF
Household debt, y-o-y change	***HH_D_GROW***	IIF
Credit-related		
Business credits, in real terms, y-o-y change	***B_CREGROW***	Central banks of countries
Mortgage credits, in real terms, y-o-y change	***M_CREGROW***	Central banks of countries
Private sector credits, in real terms, y-o-y change	***CREGROW***	Central banks of countries
Household credit gap to GDP	***HH_CREGAP***	IIF
Non-financial corporates credit gap to GDP	***NFC_CREGAP***	IIF
Business credit interest rate minus mortgage interest rate, spread	***SPREAD***	Central banks of countries

Prior to econometric analysis, a negative correlation between industrial production growth and financial stress is expected, since industrial production growth could increase total output, which could help lower financial stress levels directly or indirectly. However, the relation could be just the opposite; high industrial production growth could fuel financial stress levels.

OECD-composite leading indicator (*OECD_CLI*) gives early signals regarding the direction of economic activity, not only in quantitative but also in qualitative terms. Positive developments in an economy may be accompanied by expansionary movements in economic

activity, and, as a result, it is expected that this indicator will follow an opposite direction with financial stress.

Foreign participation in domestic currency denominated bonds (*PART*), collected from the Institute of International Finance (IIF), is used as a proxy of trust in the macroeconomic fundamentals of each economy. This indicator may indicate increasing and/or decreasing foreign investor confidence on the economy. If foreign fund holders lost their investment appetite, capital inflows would decrease; therefore, eligible funds would begin to disappear, which in turn would trigger financial riskiness. Hence, this indicator is expected to move in the opposite direction from the financial stress indicators.

Finally, property price data (*P_PROPERTY*) is obtained from the Bank for International Settlements (BIS) and used as year-on-year changes in real terms. Real increases in property prices may indicate an overheating in the real-estate sector. This could put pressure on financial conditions and lead to financial stress. Therefore, a positive correlation is expected between property price increases and financial stress, hence real property price increases could provide a transition from a low to a high level of financial stress.

Under the global-economy-related indicator group, the Chicago Board Options Exchange (CBOE) Volatility Index (*VIX*) aims to provide a measure of how much the market thinks the S&P 500 Index will fluctuate in a given time period (CBOE, 2022). This index has a reputation as the “Fear Index” since it is widely believed that the index signals the level of fear or stress in the stock market. The higher the *VIX*, the greater the level of fear and uncertainty in the market, with levels above 30 indicating increased uncertainty (CBOE, 2022). Financial stress is expected to accompany the *VIX* index; therefore, an increase in the *VIX* index may cause the financial stress index to go upward.

The global real economic activity index (*GEA*) was obtained from the St. Louis Fed database and the Global Economic Conditions Indicator (*GECON*) was obtained from Baumeister et

al. (2022). These are similar indicators to measure fluctuations in the global economy. The *GEA* was structured first by Kilian (2009) and went through some minor modifications by Kilian (2019). The index is constructed using dollar-denominated global bulk dry cargo shipping rates and may be viewed as a proxy for the shipping volume in global industrial commodity markets (Federal Reserve Bank of Dallas, 2022). On the other hand, Baumeister et al. (2022) developed the *GECON* indicator in order to mimic the real-time setting of the economy. To do this, they put together a panel of 16 variables, including broad measures of real economic activity, commodity prices, financial indicators, uncertainty measures, weather-related variables, indicators of transportation demand, expectations measures, and energy-related indicators (Baumeister and Guérin, 2021: 1282). The *GECON* index is examined by a benchmark test, and based on the results, it is found to be the most useful one among others in forecasting economic growth (Baumeister and Guérin, 2021). Overall, we anticipate that an increase in these indices may diminish already-rising financial stress in an economy. If global economic conditions work in favor of economic growth, then these indices could signal a transition from a high financial stress period to a low financial stress period. On the other hand, the relation between economic activity and financial stress is ambiguous. In an economy, total output might be increasing while overall financial riskiness is doing so, i.e., domestic credit expansion might boost the economic growth; however, the total amount of loans might threaten the financial system depending on its fragilities. This, in the early stages, might increase financial stress.

There are four candidates in the debt-related indicators category. One of them is the private non-financial sector debt service ratio (*DSR*), which is defined as the ratio of interest payments plus amortizations to income. We obtained the DSR from the BIS data warehouse. We anticipate that an upward movement of the DSR will lead to an increase in the financial stress level. Therefore, the DSR might play a role in an economy's transition from a low to a high financial stress period.

Other indicators, which are collected from the IIF, are the indebtedness indicators of major stakeholders in the economy. Financial corporates debt growth (*FC_D_GROW*), non-

financial corporates debt growth (*NFC_D_GROW*) and household debt growth (*HH_D_GROW*) are expected to move in the same direction as the financial stress. An upward trend of these indicators may signal that the economy is overheating; thus, indebtedness indicators may capture any transition from a tranquil state to a tense state.

Finally, the credit-related indicators group contains year-over-year credit growth rates in real terms. These are credit to business sector (*B_CREGROW*), mortgage credits (*M_CREGROW*) and private sector credits (*CREGROW*). Data for these indicators are gathered from the data bases of the countries' central banks. Credit expansion could facilitate economic activity both in terms of consumption and investment. For this reason, we expect credit expansion to play a supporting role in dealing with sluggish economic growth. However, there are also numerous evidence indicating that credit expansion can create problems stemming from the weaknesses of the financial system. The main aspect at this point is whether the financial system and, in particular, the banking sector are operating under the control of a well-developed regulatory framework. As a result, we have no prior predictions about how to correlate the credit growth rate with financial stress. Credit growth can either mitigate financial stress and help the economy transition from a tense to a tranquil state, or it can drive financial stress up and cause the economy to move from a tranquil state to a tense state. Moreover, a relation between credits and financial stress can be observed when credits exceed or fall below their long-term averages. If credits are moving above their long-term averages, then it might cause an overheating problem in the financial system. Hence, this might cause the economy to shift from a tranquil to a tense state. To put this to test, we chose two potent candidate indicators: household credit gap to GDP (*HH_CREGAP*) and non-financial corporates credit gap to GDP (*NFC_CREGAP*) from the IIF database.

Finally, we use the credit interest rate spread (*SPREAD*) variable, which is calculated by the business credit interest rate minus the mortgage interest rate. This variable was first used by Sönmez and Kandemir Kocaaslan (2022) for Türkiye. Business credits are used by companies operating in the real economy to finance their production and investment processes. Besides, mortgage credits are used for real estate acquisition. The use of business

credits allows for activities with higher feed-forward whereas the use of mortgage credits finances activities without feed-forward, i.e., purchasing a final product. If, somehow, the cost of real estate financing stays lower than the cost of business financing, or if the spread between these two become narrower, then buying a new house might be more economically appealing than investing in new machinery or equipment and expanding production infrastructure. As a result, resources might move to less productive sectors. It is assumed that this situation may cause an inefficiency in resource allocation in the economy, and therefore *SPREAD* may predict regime shifts from low to high financial stress early.

It should be noted that, in unregulated market conditions, mortgage credit interest rates are generally higher than business credit interest rates. However, there may be situations in which the spread between interest rates decreases or turns in favor of using mortgage credits, either due to the intervention of governments or the existence of asymmetrical markets.

Following the inspiration given by the evidence from Türkiye, reported in Sönmez and Kandemir Kocaaslan (2022), this study aimed to investigate the results of the *SPREAD* variable in peer countries. Relevant data were obtained from the central banks of the countries.

Calculations and econometrical analyses have been conducted using the Eviews-10 statistical program and Microsoft Excel. The following chapter will present the results of the econometric analyses separately for each country, and a brief discussion will be carried out at the end.

4. EMPIRICAL RESULTS

In the process of model estimation, each candidate indicator was individually added to the transition probability matrix, introduced in equation (5), so as to understand which underlying factor plays a role in regime switches. As a result, models were run using just one indicator at once. Transition probability coefficients are listed in Tables 7 to 10. These coefficients provide information about the magnitude and direction of relevant regime transition probabilities.

4.1. CHILE

Table 7 presents the estimation results for Chile. Under the category of macroeconomy-related indicators, *OECD_CLI* was significantly found to lower the probability of entering a tense state in the coming quarter. In contrast, *P_PROPERTY* significantly increases the probability of entering a tense state in the following quarter. These findings are consistent with Duprey and Claus (2017). However, industrial production growth was found to be insignificant in predicting any regime switch. All of the indicators in the global-economy-related group, were found to have statistically significant coefficients. *VIX* gives signals up to three quarters prior to an exit from high a financial stress period in model A.

Table 7: Estimation Results of Chile

Methodology	Markov-Switching with time-varying transition probabilities
Country name	Chile
Period	2006Q1-2022Q1
Number of Observations	65
Dep. Var.	FSI-CL

		Probability of entering or exiting high financial stress in Markov Chain			
		Model A		Model B	
Regressor definition	Regressor code	Enter	Exit	Enter	Exit
Macro economy-related indicators					
industrial production index, y-o-y change	*IND*	**Regressor lag length: 3** 32.52 (41.31)	 4.56 (34.82)	**Regressor lag length: 3** 8.16 (34.02)	 -13.63 (20.68)
OECD-composite leading indicator	*OECD_CLI*	**Regressor lag length: 1** -102.35*** (28.18)	 57.46* (30.93)	**Regressor lag length: 1** -102.54*** (18.10)	 16.14 (12.73)
foreign participation, % of total local currency denominated government bonds	*PART*	**Regressor lag length: -** -	 -	**Regressor lag length: -** -	 -
property prices, in real terms, y-o-y change	*P_PROPERTY*	**Regressor lag length: 1** 44.29*** (15.84)	 -78.37** (37.73)	**Regressor lag length: 1** 32.89*** (3.54)	 -78.23* (42.22)
Global economy-related indicators					
CBOE volatility index	*VIX*	**Regressor lag length: 3** 8.51 (11.37)	 10.67** (4.33)	**Regressor lag length: 3** 10.18 (20.50)	 10.16 (8.00)
index of global economic activity	*GEA*	**Regressor lag length: 5** 1.68 (1.05)	 1.00 (1.07)	**Regressor lag length: 5** 16.28 (21.41)	 1.95*** (0.56)
index of energy prices, y-o-y change	*ENERGY*	**Regressor lag length: 4** 8.02*** (3.04)	 12.15*** (4.80)	**Regressor lag length: 4** 3.19 (3.10)	 5.63** (2.71)
Global Economic Conditions Indicator, not standardized	*GECON*	**Regressor lag length: 1** -6.05*** (1.58)	 2.62** (1.17)	**Regressor lag length: 1** -19.02** (8.26)	 1.67* (0.93)

Debt-related indicators					
debt service ratio	*DSR*	**Regressor lag length: -**		**Regressor lag length: -**	
		-	-	-	-
financial corporates debt, y-o-y change	*FC_D_GROW*	**Regressor lag length: 2**		**Regressor lag length: 2**	
		10.83	-10.28	16.52	-20.23
		(8.22)	(18.41)	(10.01)	(13.56)
non-financial corporates debt, y-o-y change	*NFC_D_GROW*	**Regressor lag length: 6**		**Regressor lag length: 6**	
		2.02	27.96***	5.96	27.72***
		(7.53)	(9.82)	(7.32)	(9.02)
household debt, y-o-y change	*HH_D_GROW*	**Regressor lag length: 6**		**Regressor lag length: 6**	
		7.03	17.61***	8.39	16.16***
		(4.94)	(6.87)	(5.43)	(5.38)
Credit-Related Indicators					
business credits, in real terms, y-o-y change	*B_CREGROW*	**Regressor lag length: 4**		**Regressor lag length: 4**	
		-23.79	62.85	-3.84	26.92***
		(20.56)	(49.66)	(17.45)	(10.05)
mortgage credits, in real terms, y-o-y change	*M_CREGROW*	**Regressor lag length: 3**		**Regressor lag length: 3**	
		-16.60	39.42***	17.31	39.49***
		(21.66)	(10.61)	(24.27)	(11.29)
private sector credits, in real terms, y-o-y change	*CREGROW*	**Regressor lag length: 6**		**Regressor lag length: 6**	
		16.78	11.82	-6.32	47.1***
		(21.21)	(645.1)	(17.95)	(15.92)
household credit gap to GDP	*HH_CREGAP*	**Regressor lag length: 7**		**Regressor lag length: 7**	
		-0.63	-0.77	-0.25	-2.93
		(0.48)	(0.59)	(0.87)	(7.19)
non-financial corporates credit gap to GDP	*NFC_CREGAP*	**Regressor lag length: 5**		**Regressor lag length: 5**	
		-0.01	-0.15***	-0.08*	-0.15
		(0.08)	(0.10)	(0.05)	(0.10)
business credit interest rate minus mortgage credit interest rate	*SPREAD*	**Regressor lag length: 4**		**Regressor lag length: 4**	
		-20.45	123.09**	-36.51	139.00***
		(51.55)	(48.39)	(49.24)	(27.75)

*Heteroskedasticity robust estimator was chosen. Dummy variable is used in model B to better capture the effects of global financial crisis in 2008-Q4. Model A does not contain any dummy variable either other term. Optimum lag length is selected by Akaike Information Criteria. Both model A and B use the same lag length. DSR and PART variables are not eligible for Chile. *p<0.1, **p<0.05, ***p<0.01. Standard errors are in parentheses.*

An upward movement in *VIX* or a decrease in global risk appetite could be associated with a decrease in fund inflows to emerging markets (Ghosh et al., 2014). Therefore, an increase in *VIX* may alleviate overheating pressures on financial markets, and in this way, it might lower

financial stress. *GECON* and *GEA* produced similar results in model B. They both gave significant signals prior to a regime switch from a tense to a tranquil state. Moreover, *GECON* decreased the probability of entering into a tense state. Nevertheless, global energy price changes gave ambiguous results. *ENERGY* increased both entering and exiting probabilities in model A; however, in model B, it gave signals up to four quarters before exiting a tense state. Two of the debt-related indicators, *NFC_D_GROW* and *HH_D_GROW* were found to be statistically significant, indicating an exit from a high financial stress period up to six quarters ahead. Under the credit-related indicators, *B_CREGROW* predicted an exit from a tense state up to four quarters in advance in model B. Similar results were observed in *M_CREGROW* and in *CREGROW*. They both indicated an exit three and six quarters in advance, respectively. In addition, *NFC_CREGAP* lowered the probability of an exit from a tense state. *SPREAD* has been found statistically significant in predicting the exit from a tense state four quarters in advance.

Overall, indicators related to both domestic (*OECD_CLI*) and global economic activity (*GEA* and *GECON*) could anticipate regime switches from tense to tranquil states. In Chile, restoring financial flows appeared to be effective in overcoming high financial stress episodes triggered by a shock. In line with this, real credit growth (including business and mortgage credits) could be useful for easing financial stress, although in the next turn, this could drive up indebtedness of both non-financial corporates (*NFC_D_GROW*) and households (*HH_D_GROW*).

Finally, *SPREAD* between business credit and mortgage interest rates, which further eases the conditions for individuals to acquire real estate, predicted exits from high financial stress periods. Hence, increasing the attractiveness of the housing market may contribute to cooling down high financial stress environment in Chile.

4.2. POLAND

Table 8 shows the estimation results for Poland. Under the macro-economy-related indicators category, findings were varied. While *IND* provided signals up to two quarters ahead of entering a tense state, *OECD_CLI* lowered the probabilities of entering a tense state. *P_PROPERTY* was not found to be statistically significant; however, *PART* lowered the probability of entering a tense state at the 10% significance level.

All global-economy-related indicators were found to have significant effects on the turning points. *VIX* and *ENERGY* strongly increased the probability of staying in a tense state for the next period. Indicators related to global economic activity, *GEA* and *GECON*, increased the probability of staying in a tense state, and they led to a regime shift from a tranquil to a tense state up to five quarters in advance.

Under the debt-related indicators group, *FC_D_GROW* and *NFC_D_GROW* lowered the probability of exiting high financial stress episodes. *DSR* and *HH_D_GROW* indicators were not found to be statistically significant.

Credit growth rates in all segments lowered the probability of entering a high financial stress period and increased the probabilities of exiting tense states. *CREGROW* signaled an exit from a tense state up to eight quarters in advance. *M_CREGROW* and *CREGROW* produced similar results. *HH_CREGAP* was not found to be statistically significant, yet, *NFC_CREGAP* lowered the probability of entering a tense state. *SPREAD* was significantly found to have an effect on exit from a tense state. It augmented probability of a regime switch from a tense to a tranquil state up to six quarters in advance.

Table 8: Estimation Results of Poland

Methodology	Markov-Switching with time-varying transition probabilities
Country name	Poland
Period	2010Q1-2022Q1
Number of Observations	49
Dep. Var.	FSI-PL

		Probability of entering or exiting high financial stress in Markov Chain			
		Model A		Model B	
Regressor definition	Regressor code	Enter	Exit	Enter	Exit
Macro economy-related indicators					
industrial production index, y-o-y change	*IND*	**Regressor lag length: 2**		**Regressor lag length: 2**	
		17.32***	-79.40*	23.95***	-73.66*
		(6.60)	(46.98)	(7.41)	(43.66)
OECD-composite leading indicator	*OECD_CLI*	**Regressor lag length: 6**		**Regressor lag length: 6**	
		-74.00**	-188.65	-78.35**	-219.34
		(30.38)	(181.70)	(34.14)	(131.11)
foreign participation, % of total local currency denominated government bonds	*PART*	**Regressor lag length: 8**		**Regressor lag length: 8**	
		-17.04*	8.57	-19.34	11.18
		(10.18)	(12.26)	(13.17)	(13.17)
property prices, in real terms, y-o-y change	*P_PROPERTY*	**Regressor lag length: 6**		**Regressor lag length: 6**	
		-10.74	-7.17	15.26	32.35
		(21.00)	(15.72)	(7.65)	(31.96)
Global economy-related indicators					
CBOE volatility index	*VIX*	**Regressor lag length: 1**		**Regressor lag length: 1**	
		21.26*	-10.40	-5.20	-238.62**
		(13.11)	(14.54)	(12.62)	(131.11)
index of global economic activity	*GEA*	**Regressor lag length: 4**		**Regressor lag length: 4**	
		2.9	-5.54	14.95**	-12.40**
		(2.61)	(4.28)	(6.97)	(6.03)
index of energy prices, y-o-y change	*ENERGY*	**Regressor lag length: 2**		**Regressor lag length: 2**	
		2.14	-12.36*	3.41*	-99.37***
		(1.56)	(7.17)	(1.85)	(9.68)
Global Economic Conditions Indicator, not standardized	*GECON*	**Regressor lag length: 5**		**Regressor lag length: 5**	
		2.91*	-5.89*	6.56***	-5.84**
		(1.63)	(3.57)	(1.57)	(2.71)

Debt-related indicators					
debt service ratio	*DSR*	**Regressor lag length: 8**		**Regressor lag length: 8**	
		-159.24	63.34	-88.33	82.40
		(207.00)	(362.97)	(337.10)	(164.19)
financial corporates debt, y-o-y change	*FC_D_GROW*	**Regressor lag length: 4**		**Regressor lag length: 4**	
		3.95	-41.27**	3.29	-46.33**
		(2.81)	(20.65)	(3.23)	(46.23)
non-financial corporates debt, y-o-y change	*NFC_D_GROW*	**Regressor lag length: 2**		**Regressor lag length: 2**	
		1.49	-26.53***	10.96	-75.28***
		(6.40)	(2.23)	(9.73)	(17.41)
household debt, y-o-y change	*HH_D_GROW*	**Regressor lag length: 4**		**Regressor lag length: 4**	
		1.72	-41.60	3.09	-39.75
		(4.38)	(47.90)	(5.02)	(59.53)
Credit-Related Indicators					
business credits, in real terms, y-o-y change	*B_CREGROW*	**Regressor lag length: 5**		**Regressor lag length: 5**	
		-49.20***	35.64	-53.91**	25.28***
		(16.57)	(23.96)	(22.22)	(2.64)
mortgage credits, in real terms, y-o-y change	*M_CREGROW*	**Regressor lag length: 8**		**Regressor lag length: 8**	
		-37.18*	19.79*	-35.42*	20.43*
		(20.59)	(11.93)	(20.80)	(11.95)
private sector credits, in real terms, y-o-y change	*CREGROW*	**Regressor lag length: 8**		**Regressor lag length: 8**	
		-181.00**	136.1***	-175.25**	139.1***
		(86.40)	(32.95)	(84.91)	(35.91)
household credit gap to GDP	*HH_CREGAP*	**Regressor lag length: 10**		**Regressor lag length: 10**	
		-26.82	13.48	-23.12	-25.16
		(26.15)	(27.68)	(12.75)	(24.22)
non-financial corporates credit gap to GDP	*NFC_CREGAP*	**Regressor lag length: 4**		**Regressor lag length: 4**	
		-42.52*	26.27	-43.10*	28.05
		(23.33)	(38.40)	(26.00)	(35.52)
business credit interest rate minus mortgage credit interest rate	*SPREAD*	**Regressor lag length: 6**		**Regressor lag length: 6**	
		-70.13	71.92***	-78.53*	58.96***
		(87.68)	(26.83)	(46.60)	(20.65)

*Heteroskedasticity robust estimator was chosen. Dummy variable is used in model B to better capture the effects of the pandemic outbreak in 2020-Q2. Model A does not contain any dummy variable either other term. Optimum lag length is selected by Akaike Information Criteria. Both model A and B use the same lag length. *p<0.1, **p<0.05, ***p<0.01. Standard errors are in parentheses.*

Evidence from Poland suggests that, when the financial stress level is already high, accelerating economic activity (*IND*, *GEA* and *GECON*) contributes to the probabilities of continuation of the high financial stress in the next or upcoming periods. The

restoration of cash flow through the credit channel (*B_CREGROW, M_CREGROW* and *CREGROW*) as well as boosting the attractiveness of the housing market (*SPREAD*) helped reduce financial stress. Additionally, credits to non-financial sector growth should stay above its long-term averages in order not to trigger financial stress. Similar to the evidence from Chile, economy policies may need to address cash-flow-insufficiency in Poland in order to overcome financial stress episodes.

4.3. SOUTH AFRICA

Table 9 presents the estimation results for South Africa. Under the category of macro-economy-related indicators, *IND* reduced the probability of exiting a tense state. *OECD_CLI* reduced the probability of entering high financial stress episodes, which is consistent with the results from Chile and Poland. Similar to the evidence from Chile, *P_PROPERTY* predicted entering a tense state up to 10 quarters in advance.

In the category of global-economy-related indicators, *VIX* signaled three quarters early before exiting a tense state. This contradicts the evidence from Poland, but it is consistent with the evidence from Chile. *GECON* signaled eight quarters before a regime switch from a tranquil to a tense state; *GEA*, on the other hand, lowered any probability of exiting from a high financial stress period. Furthermore, *ENERGY* predicted entering high financial stress up to seven quarters.

Among the debt-related-indicators, *DSR* was the only one that reduced the probability of entering a tense state. In contrast, *FC_D_GROW* and *HH_D_GROW* both took coefficients to increase the probability of entering a tense state. *NFC_D_GROW*, however, predicted an exit as early as 16 quarters. It also reduced the probability of entering a period of high financial stress.

Table 9: Estimation Results of South Africa

Methodology	Markov-Switching with time-varying transition probabilities
Country name	South Africa
Period	2006Q1-2022Q1
Number of Observations	65
Dep. Var.	FSI-SA

		Probability of entering or exiting high financial stress in Markov Chain			
		Model A		Model B	
Regressor definition	Regressor code	Enter	Exit	Enter	Exit
Macro economy-related indicators					
industrial production index, y-o-y change	*IND*	**Regressor lag length: 3** 1.34 (2.35)	 -27.00** (13.29)	**Regressor lag length: 3** 0.70 (2.50)	 -18.59** (8.01)
OECD-composite leading indicator	*OECD_CLI*	**Regressor lag length: 3** -9.40** (4.11)	 -31.28 (27.06)	**Regressor lag length: 3** -8.95** (5.06)	 -16.72 (19.54)
foreign participation, % of total local currency denominated government bonds	*PART*	**Regressor lag length: 3** 11.27 (8.40)	 -3.13 (5.48)	**Regressor lag length: 3** 31.94 (26.46)	 -23.09 (36.02)
property prices, in real terms, y-o-y change	*P_PROPERTY*	**Regressor lag length: 10** 15.08*** (5.32)	 -10.06 (10.27)	**Regressor lag length: 10** 13.36** (6.15)	 -11.44 (11.32)
Global economy-related indicators					
CBOE volatility index	*VIX*	**Regressor lag length: 3** -9.17* (5.03)	 10.14** (4.67)	**Regressor lag length: 3** -8.89 (6.23)	 5.79 (8.51)
index of global economic activity	*GEA*	**Regressor lag length: 4** 0.27 (1.21)	 -0.87 (1.02)	**Regressor lag length: 4** 0.10 (1.27)	 -1.17** (0.52)
index of energy prices, y-o-y change	*ENERGY*	**Regressor lag length: 7** 2.04* (1.15)	 -1.38 (5.43)	**Regressor lag length: 7** 3.14** (1.57)	 0.23 (3.13)
Global Economic Conditions Indicator, not standardized	*GECON*	**Regressor lag length: 8** 3.57*** (1.29)	 -6.76 (5.30)	**Regressor lag length: 8** 2.99* (1.75)	 6.97 (5.67)

Debt-related indicators					
debt service ratio	*DSR*	**Regressor lag length: 10**		**Regressor lag length: 10**	
		-113.13	117.1	-90.98*	126.06
		(69.58)	(180.8)	(54.66)	(141.13)
financial corporates debt, y-o-y change	*FC_D_GROW*	**Regressor lag length: 11**		**Regressor lag length: 11**	
		4.01**	-3.64	3.43	-5.94
		(1.78)	(6.12)	(4.90)	(6.64)
non-financial corporates debt, y-o-y change	*NFC_D_GROW*	**Regressor lag length: 16**		**Regressor lag length: 16**	
		-19.95**	18.54***	-18.92**	16.76**
		(8.90)	(6.83)	(8.82)	(7.13)
household debt, y-o-y change	*HH_D_GROW*	**Regressor lag length: 12**		**Regressor lag length: 12**	
		3.70**	-5.06	-0.36	-7.92
		(1.91)	(7.51)	(6.13)	(7.57)
Credit-Related Indicators					
business credits, in real terms, y-o-y change	*B_CREGROW*	**Regressor lag length: 6**		**Regressor lag length: 6**	
		18.19**	-4.12	14.06	-7.31
		(9.18)	(9.07)	(10.81)	(4.69)
mortgage credits, in real terms, y-o-y change	*M_CREGROW*	**Regressor lag length: 8**		**Regressor lag length: 8**	
		4.06	-7.54	-0.70	-8.58
		(5.27)	(5.90)	(6.87)	(6.44)
private sector credits, in real terms, y-o-y change	*CREGROW*	**Regressor lag length: 15**		**Regressor lag length: 15**	
		-12.00***	15.33	-9.23	53.27
		(3.99)	(47.48)	(5.90)	(48.62)
household credit gap to GDP	*HH_CREGAP*	**Regressor lag length: 17**		**Regressor lag length: 17**	
		-33.53**	-12.22	-89.91	-19.60
		(13.89)	(43.30)	(78.08)	(36.59)
non-financial corporates credit gap to GDP	*NFC_CREGAP*	**Regressor lag length: 18**		**Regressor lag length: 18**	
		-71.11	2.50	-70.74	5.63
		(13.89)	(43.24)	(54.28)	(34.36)
business credit interest rate minus mortgage credit interest rate	*SPREAD*	**Regressor lag length: 1**		**Regressor lag length: 1**	
		-50.81	61.28	12.26	80.00*
		(96.81)	(46.65)	(144.92)	(47.56)

*Heteroskedasticity robust estimator was chosen. Dummy variable is used in model B to better capture the effects of the global financial crisis in 2008-Q4. Model A does not contain any dummy variable either other term. Optimum lag length is selected by Akaike Information Criteria. Both model A and B use the same lag length. *p<0.1, **p<0.05, ***p<0.01. Standard errors are in parentheses.*

Among the credit-related-indicators, *B_CREGROW* increased the probability of entering a tense state, while *CREGROW* lowered it. Since *CREGROW* contained *B_CREGROW*, results were relevant with the results of Poland and indirectly relevant with the results of Chile. *HH_CREGAP* significantly lowered the probability of entering a tense state. *SPREAD* increased the probability of exiting a tense state a quarter in advance. This result is statistically significant at the 10% level. Other variables, *M_CREGROW* and *NFC_CREGAP*, were insignificant.

Evidence from South Africa suggests that cash flows should be maintained by providing adequate loans to the private sector in order to prevent financial stress conditions from deteriorating. In addition, the indebtedness of financial corporates and households must be closely monitored. Household indebtedness, as measured directly by *HH_D_GROW* and indirectly by *HH_CREGAP*, can give important clues about restraining financial stress level. Finally, relevant with the evidence from Chile and Poland, creating an attractive housing market may be an effective measure for overcoming high financial stress episodes.

4.4. TÜRKİYE

Table 10 presents the estimation results for Türkiye. Under the macro-economy-related indicators category, *IND* reduced the probability of exiting a tense state.

Except for Chile, this evidence is consistent with the results from Poland and South Africa. Unlike the results from other countries, *OECD_CLI* worked in favor of high financial stress and gave signals of entering a tense state three quarters in advance. *PART* significantly decreased the probability of exiting a high financial stress period.

Table 10: Estimation Results of Türkiye

Methodology	Markov-Switching with time-varying transition probabilities
Country name	Türkiye
Period	2006Q1-2022Q1
Number of Observations	65
Dep. Var.	FSI-TR

		Probability of entering or exiting high financial stress in Markov Chain			
		Model A		Model B	
Regressor definition	Regressor code	Enter	Exit	Enter	Exit
Macro economy-related indicators					
industrial production index, y-o-y change	*IND*	**Regressor lag length: 3**		**Regressor lag length: 3**	
		4.77	-15.96**	6.01	-16.49**
		(7.90)	(7.26)	(5.91)	(6.97)
OECD-composite leading indicator	*OECD_CLI*	**Regressor lag length: 3**		**Regressor lag length: 3**	
		12.67*	-25.43	13.33**	-25.18
		(7.33)	(25.21)	(6.49)	(21.65)
foreign participation, % of total local currency denominated government bonds	*PART*	**Regressor lag length: 3**		**Regressor lag length: 3**	
		8.32	-249.36***	9.58	-251.73***
		(12.96)	(69.51)	(14.22)	(71.33)
property prices, in real terms, y-o-y change	*P_PROPERTY*	**Regressor lag length: -**		**Regressor lag length: -**	
		-	-	-	-
Global economy-related indicators					
CBOE volatility index	*VIX*	**Regressor lag length: 4**		**Regressor lag length: 4**	
		-83.46	10.94*	-86.88	11.64*
		(58.78)	(6.16)	(57.49)	(6.57)
index of global economic activity	*GEA*	**Regressor lag length: 3**		**Regressor lag length: 3**	
		1.62	-1.56*	1.58	-1.50*
		(1.37)	(0.84)	(1.50)	(0.83)
index of energy prices, y-o-y change	*ENERGY*	**Regressor lag length: 2**		**Regressor lag length: 2**	
		1.77	-4.07	8.79***	1.93
		(1.94)	(2.42)	(3.77)	(1.46)
Global Economic Conditions Indicator, not standardized	*GECON*	**Regressor lag length: 2**		**Regressor lag length: 2**	
		-19.13***	6.92	-1.12	4.80*
		(5.34)	(4.79)	(8.13)	(2.57)

Debt-related indicators					
debt service ratio	*DSR*	**Regressor lag length: 3**		**Regressor lag length: 3**	
		21.17*	-9.29	21.70	-8.82
		(11.84)	(8.64)	(14.33)	(9.41)
financial corporates debt, y-o-y change	*FC_D_GROW*	**Regressor lag length: 9**		**Regressor lag length: 9**	
		-2.01	-9.22**	-3.17	-9.20***
		(3.44)	(3.62)	(2.67)	(3.54)
non-financial corporates debt, y-o-y change	*NFC_D_GROW*	**Regressor lag length: 9**		**Regressor lag length: 9**	
		1.46	-3.00	1.93	-2.50
		(3.75)	(5.45)	(3.89)	(4.79)
household debt, y-o-y change	*HH_D_GROW*	**Regressor lag length: 10**		**Regressor lag length: 10**	
		0.01	-3.57	-0.31	-2.60
		(3.54)	(4.27)	(3.02)	(4.29)
Credit-Related Indicators					
business credits, in real terms, y-o-y change	*B_CREGROW*	**Regressor lag length: 9**		**Regressor lag length: 9**	
		-3.97	-14.34*	-8.27	-17.06**
		(6.22)	(7.91)	(12.27)	(8.66)
mortgage credits, in real terms, y-o-y change	*M_CREGROW*	**Regressor lag length: 8**		**Regressor lag length: 8**	
		0.91	-4.66	-0.50	-5.15
		(0.92)	(4.40)	(4.79)	(4.91)
private sector credits, in real terms, y-o-y change	*CREGROW*	**Regressor lag length: 10**		**Regressor lag length: 10**	
		-3.91	-19.70**	-6.73	-20.93**
		(4.05)	(7.69)	(8.61)	(9.16)
household credit gap to GDP	*HH_CREGAP*	**Regressor lag length: 11**		**Regressor lag length: 11**	
		-19.85	-28.64	-28.62	-33.45
		(20.17)	(49.32)	(33.60)	(56.68)
non-financial corporates credit gap to GDP	*NFC_CREGAP*	**Regressor lag length: 1**		**Regressor lag length: 1**	
		-0.30	24.60**	3.29	21.53
		(11.60)	(11.52)	(18.69)	(26.37)
business credit interest rate minus mortgage credit interest rate	*SPREAD*	**Regressor lag length: 4**		**Regressor lag length: 4**	
		92.75*	-0.92	98.14**	-6.62
		(52.24)	(32.81)	(42.92)	(31.01)

Heteroskedasticity robust estimator was chosen. *Dummy variable is used in model B to better capture the effects of the global financial crisis in 2008-Q4. Model A does not contain any dummy variable either other term. Optimum lag length is selected by Akaike Information Criteria. Both model type A and B use the same lag length. P_PROPERTY variable is not eligible for Türkiye. *p<0.1, **p<0.05, ***p<0.01. Standard errors are in parentheses*.

Under the category of global-economy-related indicators, *VIX* predicted turning points up to three quarters prior to an exit at a 10% significance level. *GEA* and *GECON* gave different evidence, the former suggested maintaining a high financial stress regime, while the latter

predicted an exit from a high financial stress up to two quarters before as well as it lowered the probability of entering a tense state. *ENERGY,* on the other hand, gave signals of a transition from a tranquil to a tense state two quarters in advance.

DSR and *FC_D_GROW* were found to have an impact on transition probabilities under the debt-related indicators category. *DSR* predicted a regime switch from a tranquil to a tense state up to three quarters in advance. On the other hand, the results from *FC_D_GROW* could be interpreted as strengthening the probability of maintaining a tense state.

Credit-related-indicators seemed to promote maintaining a tense state in Türkiye. *B_CREGROW* and *CREGROW* lowered the probability of exiting a tense state, but they both increased the probability of being in a tense state in the next period. However, *NFC_CREGAP* worked in favor of exiting high financial stress episodes as well as it signaling a regime switch a quarter ahead. *SPREAD* indicated that, narrowing the gap between business and mortgage credit rates and/or lower mortgage interest rates compared to the business credit interest rates trigger regime switch from a tranquil to a tense state in Türkiye. *SPREAD* gave signals up to four quarters before such a regime change. This finding differs from the underlying results of other countries.

According to the findings, variables that measure economic activity (*IND* and *OECD_CLI*) indicated that accelerating economic activity through expansionary movements of bank credits to the private sector (*CREGROW*) could not help to overcome a high financial stress level in Türkiye. In contrast to other countries, credit expansion is likely to increase financial stress in Türkiye. An underlying factor of this could be the high course of the current account deficit to GDP ratio in Türkiye. Moreover, credit expansion could exacerbate the inflation outlook which is already problematic in the country. Besides, relatively low levels of foreign direct investment could drive forward the financing difficulties associated with such a high current account deficit.

In addition, in Türkiye, increasing energy prices must be taken into consideration since it can strongly serve as an early warning before the country enters a tense state. Finally, the evidence suggests that in cases when mortgage credits become more attractive than business credits, it might drive financial stress to climb in Türkiye.

Overall, increasing energy prices are seen as the common factor causing all four economies to enter a tense state. This might be originated from foreign exchange market conditions. Foreign exchange buffers are put out as the key factor in determining whether rising energy prices would lead to an increase in financial stress or not. In general, the effects of rising energy prices could be mitigated by boosting foreign exchange reserves and finding strategies to reduce current account deficit during "good days". On the other side, encouraging credit expansion in Chile, Poland, and South Africa during "dark days" could be helpful to reduce high financial stress. Additionally, in these countries, lowering the interest rates on mortgage credit could be the desired policy option for alleviating financial difficulties. Decelerating risk appetite in the advanced countries increases the probability of exiting high financial stress periods in Chile, South Africa, and Türkiye. When the economy is experiencing difficulties financially, capital inflows into these countries could put strain on the soundness of the financial system, and a decline in the flow of funds can cool the economy. To allow the international flow of funds without causing imbalances, these countries should improve the investment climate and enhance their institutions. Finally, credit expansions in Türkiye worsen the financial conditions and should not be encouraged further, especially in tranquil financial states. The most dangerous category seemed to be the real estate market. Evidence shows that, whenever the mortgage credit interest rates fall below the business credit interest rates or the gap between these two closes, then the financial stress rises dramatically. Policy makers in Türkiye should rather be incentivizing business credit, which provides the liquidity to keep production continuing.

CONCLUSION

The ultimate goal of economy policies is to increase national welfare by improving macroeconomic fundamentals and addressing the vulnerabilities of the economy. The latter also includes building resilience against factors (or shocks) that may have a negative impact on the total output. Predicting these factors could give policymakers room to maneuver. To forecast "unwanted shocks", a tool was needed that bring together various indicators and allow measurements by using high-frequency financial data proxies for real economy. Early warning indicators known as the "Financial Stress Index" (in some studies as "Financial Conditions Index") have been developed in an effort to convert financial data into a quantitative structure. Capturing cyclical movements of an economy via financial stress indices has been extensively studied for more than two decades.

Furthermore, economic activity involves fluctuations around peaks and troughs as well as asymmetric episodes of expansions and contractions, which cannot be captured by linear models. Non-linear models were developed for this purpose, and one of them, Hamilton (1989)'s Markov switching model, stands out because of its comparative advantages. This model, using an unobservable "Markov chain" structure, can divide time series data into two or more distinct regimes and allow the estimated parameters to switch between regimes based on constant transition probabilities. For instance, if the total output of an economy is to expand or contract in a specific time period, the probability of switching between contraction and expansion always takes the same value. The model was upgraded with new approaches that allowed the transition probabilities vary over time. The studies of Filardo (1994) and Diebold et al. (1994) made an important contribution to Hamilton (1989), where the transition probabilities were assumed to be constant, by providing an extension that allows for the transition probabilities to vary over time. In addition, they also introduced a structure that allows the transition probabilities to be conditionally linked to a set of leading variables related to cyclical movement.

Taking these studies as a starting point, this thesis attempted to predict financial turning points in emerging market economies using a group of potential leading indicators with time-varying transition probabilities (TVTP) structure.

Although there are many studies in the literature that focus on measuring financial stress using FSIs, only a few attempt both to develop an index as well as analyze the Markov switching model with TVTP. This could be due to the fact that FSIs were generally thought to be adequate for gauging financial stress on their own. This thesis attempted to use FSI as the dependent variable and predict its movements using potential leading indicators via the Markov switching TVTP model. A thorough review of the literature revealed that only Duprey and Claus (2017) conducted such an analysis specifically for European Union countries. Therefore, we were motivated to investigate whether some indicators that are thought to be useful for predicting financial stress in advanced countries could also provide insights for emerging countries to predict regime shifts or to examine how these indicators affect the transition between regimes in a group of developing countries. As far as we know, no such study has been conducted specifically for emerging countries.

Although conducting this type of analysis for emerging market economies may present some challenges, such as data quality and availability, four emerging countries were identified as fitting the objectives of this study: Chile, Poland, South Africa and Türkiye. This study is not only looking at these indicators, but it is also looking at how the *SPREAD* variable, which was introduced for the first time by Sönmez and Kandemir Kocaaslan (2022), gives results in these emerging countries. To the best of our knowledge, no previous study in the business cycle literature has examined the effect of the *SPREAD* variable, which is derived from the difference between business credit and mortgage interest rates, on the cyclical movements of financial stress.

The analysis showed that some variables produced different results than previously predicted and some produced compatible results. Overall, indicators listed under the macro-economy-

category yielded similar results across the countries studied. Prior to the analysis, a negative correlation between *IND* and financial stress was anticipated, as industrial production growth could help increase total output. However, *IND* increased the likelihood of all countries experiencing high financial stress in the coming quarter or quarters. To put it in another way, *IND* reduced the likelihood of all countries exiting high financial stress episodes. This finding suggests that during tense states, industrial production growth may be ineffective in overcoming already-increased financial stress. Therefore, supporting industrial production through policy tools such as credit expansions, tax deferrals and subsidies, may be ineffective in reducing financial stress. *OECD_CLI* lowered the probability of entering a tense state, as expected, in all countries with the exception of Türkiye. *PART* produced mixed results; in Poland and in Türkiye, it decreased the probability of entering and exiting a tense state, respectively. Increased foreign investments in domestic bonds may provide the needed funds in Poland, and ease financial tensions. In Türkiye, however, it may push asset prices up and give rise to an inflationary environment. *P_PROPERTY* produced signals in Chile and South Africa before entering a tense state, in line with the prior expectations and with the findings of Duprey and Claus (2017).

The results from the global-economy-related indicators are varied. *VIX* predicted exits from tense states in Chile, South Africa and Türkiye. Based on this, it might be suggested that decelerating the inflow of foreign funds in those countries might mitigate high financial stress. Only evidence from Poland suggested that *VIX* lowers the probability of exiting a high financial stress period. This could be an expected result, particularly for advanced countries, and not surprisingly for Poland, an EU member with a relatively stable economy in comparison to the other countries. *GEA* decreased the probabilities of exiting a tense state in Poland, South Africa and Türkiye. Only in Chile *GEA* predicted an exit from a tense state. Chile is a commodity exporter, with commodities exported from Chile accounting for about 60 percent of country's total exports in 2021. The *GEA* index excelled at measuring global economic activity by observing industrial commodity markets. Hence, *GEA* could be a precise indicator for predicting any turning point related to the economy of Chile. *GECON* gave early signals before entering a period of high financial stress in Poland and South Africa.

In these countries, *GECON* demonstrated similarities with *GEA* as both promote high financial stress episodes. However, *GECON* lowered the probabilities of entering high financial stress periods in Chile and Türkiye as well as provided signals before exiting tense states in these countries. This indicator suggests that Chile and Türkiye might be more successful than Poland and South Africa in taking advantage of changing global economic dynamics. Some arguments are presented below to support the foregoing. One of them is that main trade partners of Poland are European countries; as a result, Poland lacks the ability to reach new markets. Secondly, South Africa has made progress in export diversification through deliberate subsidies from the government; however, the export revenues from various markets are quite low. On the contrary, Chile and Türkiye appear to have a better ability to enter new markets, diversify their trade partners, and obtain solid export revenues as a share of total exports from newly entered markets. *ENERGY* predicted turning points from a tranquil to a tense state in South Africa and Türkiye due to the fact that these countries rely on energy imports more than Chile and Poland does.

According to the results from the debt-related category, *DSR* was found to have a lowering effect on the probabilities of entering a tense state in South Africa while it predicted entering a high financial stress period in Türkiye. *FC_D_GROW* lowered the probability of exiting a tense state in Poland and Türkiye as well as delivered signals before entering a tense state in South Africa. *NFC_D_GROW* predicted regime switches from a tense to a tranquil state in Chile and South Africa. *HH_D_GROW* predicted exit from tense state in Chile and from a tranquil state in South Africa.

Finally, from credit-related-indicators, *B_CREGROW* anticipated exits from financial stress episodes in Chile and Poland, however, in Türkiye it lowered the transition probability of exit. Likewise, *M_CREGROW* gave a signal before exiting a tense state in Chile and Poland. *CREGOW* in overall predicted turning points before regime switch from a tense to a tranquil state in Chile and Poland, it only lowered exiting probability from tense state in Türkiye. *SPREAD* provided signals before exiting any tense state in all countries except Türkiye. It predicted a regime switch from a tranquil to a tense state in Türkiye. This eventually implies

that housing markets in Türkiye are likely to exacerbate the financial conditions when mortgage credit interest rates move below business credit interest rates.

It will be beneficial for countries to improve their current account balances in order to reduce vulnerabilities to external shocks. Financial stress appears to be particularly amplified by the rise in energy prices. The governments should prioritize the development of renewable energy sources in response to this. Credit growth has been observed in countries apart from Türkiye to promote the exit from financial stress periods. From this point of view, it is clear that credit expansion can be used during periods of substantial financial stress without impairing the financial system's ability to function. Debt held by private sector and households should be taken into account, and changes in the balance sheets of the real sector should be regularly monitored. It has been noted that the outflow of foreign funds works in a way to reduce financial stress in countries apart from Poland. Although the situation first appears to be favorable, a country that is unable to benefit from foreign savings is denied the resources it needs for development. In order to maximize the benefit of these funds, the investment climate should be improved, and the institutions that guarantee business life should be strengthened.

This thesis made two new contributions to the body of existing literature by using a Markov switching model with TVTP to predict financial stress turning points in emerging countries for the first time. Furthermore, Sönmez and Kandemir Kocaaslan (2022)'s *SPREAD* between business and mortgage credit interest rates was employed for the first time as an explanatory variable to predict the turning points of financial stress episodes in emerging countries. Thereby, the study attempted to bridge the gap between the literature on traditional early warning systems and the literature on predicting regime switches in the context of non-linear models.

The most difficult issue in the business cycle literature has been to accurately measure the real movements of the economy by means of a tool. Studies to date have either only created

the index they think is the most accurate measure, or they have developed different analyzes using the index created by appropriate methods. It is thought that creating new indexes with methods that allow using dynamic and different frequency data together will improve the business cycles literature. Furthermore, there is not a financial stress index for the group of emerging countries that is updated frequently. The research that will be done on this topic is believed to be useful.

Expanding the country group and increasing the number of observations of this thesis could also be a possible extension. Small-scale fluctuations of the FSIs could be seen by substituting higher-frequency indicators for the variables reported on a quarterly basis. In addition to the method used in this work, factor analysis and principal component analysis are other methods that can be used to regenerate FSIs. However, and more importantly, developing new methods that enable financial measuring instruments to better capture business cycles is considered noteworthy.

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APPENDIX 1. ETHICS COMMISSION FORM

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GRADUATE SCHOOL OF SOCIAL SCIENCES
ETHICS COMMISSION FORM FOR THESIS

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Date: 17/01/2023

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My thesis work related to the title above:

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ADVISER COMMENTS AND APPROVAL

APPROVED

Doç. Dr. Özge KANDEMİR KOCAASLAN

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APPENDIX 2. THESIS ORIGINALITY REPORT

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
Ph.D. DISSERTATION ORIGINALITY REPORT

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
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Name Surname:	Eray SÖNMEZ
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Program:	Economics (English)- Ph.D. Program
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ADVISOR APPROVAL

APPROVED

Doç. Dr. Özge KANDEMİR KOCAASLAN

(Title, Name Surname, Signature)

APPENDIX 3. EMPIRICAL RESULTS ON MONTHLY DATA

Method	Markov-Switching-TVTP
Dependent Variable	FSI
Frequency	Monthly

Countries				Chile		Poland		South Africa		Türkiye	
Period:				2006M01-2022M03		2010M03-2022M03		2006M01-2022M03		2006M01-2022M03	
Number of Observations:				195		145		195		195	
				High Financial Stress Period		High Financial Stress Period		High Financial Stress Period		High Financial Stress Period	
Regressor definition	Regressor code	Crisis dummy	Prob. to…	Enter	Exit	Enter	Exit	Enter	Exit	Enter	Exit
				Regressor lag length: 10		**Regressor lag length: 7**		**Regressor lag length: 8**		**Regressor lag length: 7**	
Industrial production index, y-o-y change	*IND*	no		1.02 (7.61)	32.99*** (10.11)	14.68*** (5.31)	-8.24 (11.69)	-1.30 (3.21)	-23.01** (11.28)	4.93 (31.45)	-18.55*** (7.06)
		yes		62.86 (56.91)	18.72* (11.14)	-	-	-2.84 (12.72)	-21.36* (11.41)	27.08* (15.17)	-4.18 (9.79)
				Regressor lag length: 3		**Regressor lag length: 18**		**Regressor lag length: 9**		**Regressor lag length: 8**	
OECD-composite leading indicator, y-o-y change	*OECD_CLI*	no		-66.56*** (26.87)	-6.04 (4.80)	-61.42** (26.56)	-41.39 (38.39)	- 7.30*** (2.43)	-31.16* (19.37)	15.33*** (4.39)	8.32 (13.13)
		yes		-69.45*** (24.63)	-5.80 (4.62)	-	-	-6.62** (3.26)	-29.57* (15.74)	15.59*** (4.26)	7.37 (14.90)

CBOE volatility index	*VIX*	no	**Regressor lag length: 10**		**Regressor lag length: 1**		**Regressor lag length: 11**		**Regressor lag length: 8**	
			5.86***	16.15***	21.19**	-2.47**	-14.30***	12.79***	-9.39	5.48*
			(2.08)	(6.11)	(9.83)	(4.61)	(5.37)	(3.39)	(15.43)	(2.91)
		yes	1.41	7.65*	-	-	-19.81	11.51***	-7.87	4.86
			(2.35)	(4.39)			(13.46)	(3.41)	(11.76)	(3.80)
Index of energy prices, y-o-y change	*ENERGY*	no	**Regressor lag length: 14**		**Regressor lag length: 7**		**Regressor lag length: 21**		**Regressor lag length: 8**	
			2.20	6.39*	2.30**	-2.22	1.95**	-0.51	3.77***	0.15
			(1.46)	(3.64)	(0.94)	(1.39)	(1.01)	(4.31)	(0.90)	(1.62)
		yes	1.26*	2.79	-	-	2.46**	-0.01	3.45***	0.10
			(0.70)	(1.75)			(1.15)	(2.70)	(1.37)	(1.61)
Index of global economic activity	*GEA*	no	**Regressor lag length: 14**		**Regressor lag length: 15**		**Regressor lag length: 9**		**Regressor lag length: 9**	
			1.49	0.80	2.36**	-0.67	0.78	-1.57**	1.07	-1.74**
			(0.83)	(0.64)	(1.21)	(1.57)	(1.25)	(0.64)	(0.83)	(0.85)
		yes	0.34	0.35	-	-	0.65	-1.50**	0.79	-1.41**
			(0.44)	(0.34)			(1.35)	(0.76)	(0.94)	(0.64)
Global economic conditions indicator	*GECON*	no	**Regressor lag length: 3**		**Regressor lag length: 26**		**Regressor lag length: 21**		**Regressor lag length: 5**	
			-4.43**	-0.03	2.33***	0.20	1.80**	-2.00	-2.85	3.51***
			(1.98)	(0.20)	(0.90)	(1.11)	(0.83)	(2.70)	(7.12)	(0.98)
		yes	-4.75**	0.04	-	-	1.76**	-2.09	0.16	3.56***
			(2.09)	(0.16)			(0.85)	(1.93)	(2.17)	(0.93)

			Regressor lag length: 12		**Regressor lag length: 17**		**Regressor lag length: 13**		**Regressor lag length: 25**	
Business credits, in real terms, y-o-y change	*B_CREGROWTH*	no	7.41	-13.23	-68.82***	42.71***	13.77**	-8.71	-2.65	-7.43**
			(13.83)	(17.34)	(26.18)	(15.63)	(5.96)	(11.92)	(2.12)	(3.35)
		yes	6.14	-2.33	-68.17***	42.76***	12.25**	-11.60*	-6.44***	-19.80**
			(7.85)	(7.92)	(26.82)	(15.20)	(6.50)	(6.30)	(2.40)	(9.26)
			Regressor lag length: 7		**Regressor lag length: 25**		**Regressor lag length: 7**		**Regressor lag length: 24**	
Mortgage credits, in real terms, y-o-y change	*M_CREGROWTH*	no	-6.54	13.61**	-30.28**	23.39**	1.51	-5.94	-1.86	-5.89**
			(11.24)	(7.36)	(14.42)	(11.54)	(5.19)	(6.28)	(2.37)	(2.95)
		yes	-7.93	13.19**	-30.34**	23.29**	0.10	-7.24	-1.99	-5.79**
			(10.58)	(6.73)	(14.50)	(11.82)	(5.67)	(5.15)	(2.25)	(2.91)
			Regressor lag length: 30		**Regressor lag length: 19**		**Regressor lag length: 51**		**Regressor lag length: 29**	
Private sector credits, in real terms, y-o-y change	*CREGROW*	no	10.31	9.78	-50.98***	30.39*	-5.73**	60.16	-10.85***	-26.07***
			(30.83)	(15.00)	(12.52)	(17.50)	(2.86)	(85.80)	(4.23)	(8.57)
		yes	-3.49	0.42	-50.92***	30.27*	-5.54**	42.36	-10.94***	-24.79***
			(20.13)	(10.72)	(12.50)	(17.61)	(2.98)	(82.68)	(3.65)	(5.46)
			Regressor lag length: 9		**Regressor lag length: 22**		**Regressor lag length: 4**		**Regressor lag length: 9**	
Business credit interest rate minus mortgage credit interest rate	*SPREAD*	no	3.51	64.98	165.41	1443.33*	-56.12	50.15	68.78***	6.41
			(20.85)	(63.55)	(650.62)	(750.07)	(118.79)	(51.48)	(16.44)	(10.10)
		yes	-0.71	56.67***	-	-	-5.92	69.15**	70.97***	6.88
			(15.11)	(19.87)			(110.01)	(33.88)	(18.47)	(9.69)

Heteroskedasticity robust estimator was chosen. Optimum lag length is selected by Akaike Information Criteria. *p<0.1, **p<0.05, ***p<0.01. Standard errors are in parentheses.