DECOMPOSITION OF RISK PREMIA
IN EQUITY MARKETS THROUGH TIME

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ABSTRACT

Decomposition of Risk Premia in Equity Markets Through Time

This thesis contains the documentation of the time varying risk premia for Turkish equity market denominated in local currency, using two sophisticated asset pricing methods. In the first part, we choose a dynamic panel method that uses cross sectional and time series information simultaneously to infer the path of risk premia (Gagliardini, Ossola and Scaillet, 2016). Using this method, we asses the explanatory power of several conditioning information, and document time varying factor premiums in Turkey. In the second part, we use instrumental variables method to avoid errors in variable problem while using individual stocks as test assets (Jegadeesh, Noh, Pukthuanthong, Roll and Wang, 2019). With this method, we test several equity premium models whether they are valid under time varying settings. Therefore, our contribution to the literature can be summarized in three key points. (1) Documenting time varying risk premia in an emerging market like Turkey for different factors. (2) Extending the conditioning information set beyond the ones existing in the literature to include variables that are specifically important for an emerging market like Turkey. Such factors include but not limited to exchange rate, commodity prices, dividend yield etc. (3) Laying the groundwork to extend the study to international markets to assess the differences across dynamics of time varying risk premia denominated in local currencies, which should yield more information than the limited existing studies done with dollar denominated returns.

ÖZET

Hisse Senedi Piyasalarında Risk Priminin Zamana Bağlı Analizi

Bu tez, iki adet gelişmiş varlık fiyatlama yöntemini kullanarak, yerel para birimi cinsinden Türk hisse senedi piyasası için zamana bağlı değişen risk primlerininin incelemesini içerir. İlk bölümde, risk primini belirlemek için yatay kesit ve zaman serisi bilgilerini aynı anda kullanan dinamik panel yöntemini seçiyoruz (Gagliardini, Ossola ve Scaillet, 2016). Bu yöntemle çeşitli koşullu bilgi değişkenlerinin açıklayıcı gücünü değerlendiriyor ve Türkiye'deki değişken faktör primlerini inceliyoruz. İkinci bölümde, test varlığı olarak bireysel hisse senetlerini kullanırken değişkenlerin hatalı belirlenmesinden kaçınmak için araç değişken yaklaşımı yöntemini kullanıyoruz (Jegadeesh, Noh, Pukthuanthong, Roll ve Wang, 2019). Bu yöntemle çeşitli hisse senedi primi modellerinin, öğelerin değişken olması durumunda geçerli olup olmadığını test ediyoruz. Literatüre katkımız üç temel noktada özetlenebilir. (1) Türkiye gibi gelişmekte olan bir piyasada, farklı faktörler için zamana bağlı değişen risk primlerinin belirlenmesi. (2) Türkiye gibi gelişmekte olan bir piyasada özellikle önemli olan değişkenleri içerecek şekilde, koşullu bilgi değişkenlerini literatürde mevcut olanların ötesine genişletmek. Bu değişkenler, döviz kuru, emtia fiyatları, temettü verimi vb. içerir ancak bunlarla sınırlı değildir. (3) Dolar cinsinden getirilerle yapılan sınırlı çalışmalardan daha fazla bilgi sağlama ihtimali olan yerel para birimleri cinsinden değişken risk primlerinin dinamikleri arasındaki farklılıkları değerlendirme çalışmasının, uluslararası piyasalara genişletilmesi için zemin oluşturmak.

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CHAPTER 1

INTRODUCTION

The determinants of the market price of risk have received considerable attention in finance literature. For a riskless asset, nominal return is certain, and the default risk of the asset is negligible. On the contrary, expected return of a risky asset depends on market and firm conditions as in the example of stock return. The focus of this study is an emerging equity market denominated in local currency with its peculiar risk premium.

The equity risk premium —the expected compensation on assets for taking extra risk— is a key input for cost of capital for firms and saving decisions for individuals, it is also a measure of risk appetite for the wider market and indicator of expectations for the future. Hence, understanding equity premium is essential in finance to value a project, interpret financial results and decide capital structure.

There is ongoing debate as to what factors are important in explaining risk premia, if betas and premia are time invariant or varying, what test assets should be used and what conditional variables have predictive power in conditional models.

A number of models have been developed to estimate risk premium and its dynamic change over time. However, as stated above, existing studies lack a consensus as to which state variables should be included and to what extent they are impacting the risk premium. Therefore, it is important to document the power of conditioning information in determining the risk premia through time to address which factors should be paid particular attention through business cycles and different economic regimes.

More recently, a sophisticated econometric model is offered by Gagliardini, Ossola and Scaillet (2016). They developed an econometric method, which uses cross sectional and time series information simultaneously, to infer the path of risk premia. In the first part, we document time varying risk premia in Turkey and extend the conditioning information set beyond the ones existing in the literature to include variables that are specifically important for an emerging market using dynamic panel method. Our work is an assessment for the differences across dynamics of time varying risk premia denominated in local currencies, which should yield more information than the limited existing studies done with dollar denominated returns.

Harvey (1995) claims that emerging markets are segmented and correlation between emerging and developed markets is low. As emerging markets may not fully integrate to the world market, local variables rather than global could be more significant in explaining time varying risk premia. Harvey's (1995) and Chaieb, Langlois and Scaillet's (2021) findings support those local variables are more important in explaining time varying risk premia.

We aim at shedding further light on the issue by examining state variables affecting risk premium in Turkey as an emerging market. To the best of our knowledge, no study has tested the equity risk premium in an emerging market with a dynamic asset pricing model using data denominated in local currency and a wide enough set of conditioning information to incorporate local dynamics. Although Turkey is included in both Harvey's (1995) and Chaieb et al.'s (2021) studies, both use dollar denominated state variables.

In the second part, we employ instrumental variables approach proposed by Jegadeesh, Noh, Pukthuanthong, Roll and Wang's (2019) to avoid errors in variable (EIV) problem while using individual stocks as test assets to explain cross sectional differences among stock returns. The standard approach in academic literature to estimate risk premia involves calculating it via cross sectional regressions. The first step is to estimate the exposure of the stock or portfolio in question to various risk factors via time-series regression. After calculating betas for each asset, risk premium for each risk factor can be estimated using cross sectional regression among stocks or portfolios. This method is generally known as two pass regression or Fama-MacBeth (1973) method. However, because estimated betas are independent variables in the second stage, the errors-in-variables (EIV) problem arises.

Fama and MacBeth (1973) claim that EIV bias is reduced using with portfolios as test assets rather than individual stocks as positive and negative sampling errors in portfolios cancel each other out. Sorting stocks on factor characteristics and forming portfolios become standard approach to examine factors and models.

On the other hand, testing portfolios create other problems. Firstly, there are several factors proposed in the literature and sorting stocks on all these factors reduces the number of stocks in portfolio, whereas EIV bias is eliminated as the number of stocks in portfolios grows indefinitely. In other words, we have to form portfolios by limited number of characteristics and test these limited factors. Secondly, cross sectional diversification among stocks can be masked putting them into portfolios, which creates information loss. Thirdly, Lewellen, Nagel and Shanken (2010) argue that because we test portfolios sorted based on factor structure, factor variation is inherent in these portfolios. Even factors weakly correlated with sorting characteristics could explain variation across portfolios, and even characteristics that do not explain variation in equity premium across stocks could be significant.

Jegadeesh et al. (2019) propose instrumental variables approach (IV) to overcome EIV bias and use individual stocks as test assets instead of portfolios. In the second part, we test several equity premium models whether they are valid under time varying settings using IV method. Both panel method and IV method enable to use individual stocks as test assets. The former uses ex post data to infer path of risk premia, while estimation of variables is measured by real time data in the latter. However, consistency of the estimators is proven in an arbitrage free environment in panel method. Jegadeesh et al. (2019) use simulation results for small sample size to show instrumental variables approach performs better than simple ordinary least squares. Another difference is that omitted variable bias arises in panel method if omitted variables are correlated with errors. On the other hand, if instrumental variable is chosen on the condition that it is not correlated with explanatory variable, omitted variable bias do not exist in IV method.

Therefore, our contribution to the literature can be summarized in three key points: (1) Documenting time varying risk premia in an emerging market like Turkey for the first time via two sophisticated asset pricing model, including market risk premium as well as size, value, momentum, operating profitability and investment factor premia. (2) Extending the conditioning information set beyond the ones existing in the literature to include variables that are specifically important for an emerging market like Turkey. Such factors include but not limited to exchange rate, commodity prices, dividend yield etc. (3) Laying the groundwork to extend the study to international markets to assess the differences across dynamics of time varying risk premia denominated in local currencies, which should yield more information than the limited existing studies done with dollar denominated returns.

CHAPTER 2

LITERATURE REVIEW

Classical models divide the expected return of a risky asset into two components: the riskless return and the premium for the additional risk taken on. The riskless return is assumed to be exogenously determined, and conventionally the yield of government debt is used as a proxy for it. The risk premium, however, is not observed. Since this number is not directly observable, the literature offers several methods to infer equity risk premium from observable variables. We summarize factor pricing models and studies covering Turkey in the following sections.

2.1 Time invariant asset pricing models

The easiest approach to estimate risk premium is to use historical mean of realized market returns in excess of current risk free rate. However, in this method, it is assumed that market risk premium is constant at least over the estimation period and it is backward looking. It also changes very slowly, so it may fail to appropriately reflect the changes in risk premium. This ex-post estimation is used in practice and various academic studies. Salomons and Grootveld (2003) provide a comprehensive look at this method. However, this method's predictive power is dubitable or limited at best.

Dividend discount models, as in Gordon (1962), use the concept that the market price should equal to the sum of expected future cash flows, discounted at a rate to take into consideration time value of money and the riskiness of cash flows. This discount rate can be decomposed into risk free rate plus risk premium rate.

Although very practical and easy to implement, the drawback of this model is that it depends on how one estimates the future cash flows.

More sophisticated asset pricing models are based on two arguments in general. The first argument is that when there is an arbitrage opportunity in the market, investors tend to exploit this arbitrage opportunity and market becomes arbitrage free. In other words, prices tend to adjust towards an arbitrage free market. Arbitrage is an opportunity to gain positive return with zero cost.

The second argument is based on market equilibrium. Investors want to maximize gains with respect to the risk. It assumes mean-variance efficiency. With this argument, market equilibrium becomes an optimization problem which maximize mean of returns with respect to asset variances. Investors increase or decrease the share of the assets based on this principle, and each investor holds optimal “market portfolio” after adjustments. The market portfolio is the minimum variance portfolio, which means no other portfolio has the same expected return and smaller variance.

Ross’ (1976) arbitrage pricing theory describes returns by a factor model based on arbitrage free argument. He proposes that persistent arbitrage opportunity is not allowed in an efficient market. However, it does not state which factors explain returns. Another difference with equilibrium models is that many investors adjust portfolio when mean-variance efficiency is violated in equilibrium models. On the other hand, there are a few investors who take the opportunity of arbitrage and make market no-arbitrage condition in arbitrage pricing theory.

The capital asset pricing model (CAPM) (Sharpe, 1964; Treynor, 1961; Lintner, 1965; Mossin, 1966) is an example for one factor equilibrium models. The CAPM is a model stating that asset return is a linear function of the beta, which is the sensitivity to market risk. That is to say, this model assumes there is one risk determining asset returns. CAPM model is below:

$$\mathrm{E}(\mathrm{r_i}) = \mathrm{r_f} + \beta_\mathrm{i} \times (\mathrm{E}(\mathrm{r_m}) - \mathrm{r_f})$$

where $\mathrm{E}(\mathrm{r_i})$ is the expected return of asset i, $\mathrm{r_f}$ risk free rate, $\mathrm{E}(\mathrm{r_m})$ is expected market return and β_i is senstivitiy to market risk, and $\beta_\mathrm{i} = \mathrm{cov}(\mathrm{r_i}, \mathrm{r_m})/\mathrm{var}(\mathrm{r_m})$. Market risk premium is excess market return (i.e., market return - riskless return), and a comprehensive equity index return is usually used as a proxy for the market return.

Although very elegant and practical, CAPM still leaves some questions unanswered. It doesn't explain state variables forming market risk (such as inflation, unemployment rate, interest rate etc.) and it may leave other risk factors omitted, hence the limited explanatory power over the expected returns.

Multi beta asset pricing models are extended version of one factor asset pricing model. Multi beta asset pricing models should first address what risk factors should be included in the model to explain the expected returns of risky securities. Fama-French (1992, 1993) three factor model and Carhart (1997) four factor model, an extended version of FF three factor model, are the most well-known and widely accepted models in the literature. CAPM argues stock returns depend on only the state of the market, whereas FF three factor and Carhart four factor models consider the impact of firm conditions besides market state.

The method that is mostly favored in academic literature to estimate returns with beta asset pricing models known as two pass regression or Fama-MacBeth (1973) method. In the first part, the exposure of the stock or portfolio in question to various risk factors are estimated via time-series regression

$$\mathrm{r_{it}} = \mathrm{r_{ft}} + \beta_\mathrm{ijt} \times \Pi_\mathrm{jt} + \varepsilon_\mathrm{it}$$

where r_{it} is the return of i'th asset in period t, r_{ft} is the contemporaneous riskless return, Π_{jt} is the risk premium for factor j, $\beta_{ij}t$ is the sensitivity of the i'th asset to the risk factor j and ε_{it} is the error term signifying the idiosyncratic risk of the asset independent from all the other risk factors.

For example, if inflation is considered a risk factor, the risk premium for inflation is the additional compensation the market participants require for taking on the inflation risk, and beta, β, is the sensitivity of the i'th asset to the inflation. If return of i'th asset is not affected by inflation, then β should be equal to 0 and investors would not require extra return for inflation risk. As beta is the sensitivity of i'th asset to the risk factor, the degree to which the asset's return covaries with the change in the risk factor gives the sensitivity. Hence, theoretically, betas could be estimated using the statistical identity as well

$$\beta_{i,\text{inflation}} = \frac{\text{cov}(\text{return}_i, \text{inflation})}{\text{var}(\text{return}_i)}$$

After calculating betas for each asset, risk premium for each risk factor can be estimated using cross sectional regression among stocks or portfolios.

Hence, determining the right factor to explain premium is crucial for the validity of factor models. There are hundreds of studies proposing factors, some examples are as follows: Fama and French (2015) add operating profitability and investment factors to their three factor models and find that five factor model better explain the cross sectional of asset returns than the previous one. Basu (1977) states that assets with low price-to-earnings (P/E) ratio outperform assets with high P/E ratio on a risk adjusted basis. Other possible factor variable in explaining risk premia is liquidity, of which the most important indicator is bid-ask spread, as in Amihud and Mendelson (1986) study. Regulations about information disclosure, i.e., transparency, could be another variable in explaining risk premia; Li (2010) test whether the mandatory adoption of International Financial Reporting Standards in the European Union in 2005 reduces the cost of equity capital and found evidence mandatory IFRS adoption significantly lowers firms' cost of equity. Bekaert and Harvey (2000) and Henry (2000) studies suggest that cost of equity decreases with market integration, i.e., liberalization process, in emerging markets.

Actually, Harvey, Liu and Zhu (2013) review 313 articles and find 316 different factors. In order to group these factors, they firstly divide factors as common and characteristics. Common category includes risk exposures to all stocks, while characteristics category contains risk exposure specific to the stock. They subdivide each category into financial factors (e.g., market volatility), macro factors (e.g., inflation) – for only common category, microstructure factors (e.g., transaction cost), behavioral factors (e.g., investor sentiment), accounting factors (e.g., cash flow) and other factors (e.g., momentum). Principal component analysis or factor analysis could be used to choose factors. However, even if right factors are chosen to explain equity premium among the large number of factors, time invariant models should not be valid if betas and premia are time varying.

In this section, we summarize beta pricing models. Nonlinear factor models, continuous time models and macroeconomic models like consumption-based and production-based, or general equilibrium models are beyond our scope, therefore, they are not mentioned here.

2.2 Time varying asset pricing models

In early factor models, it is assumed that betas and factor risk premiums does not vary through time. However, it is unrealistic to accept firm's sensitivity to factor risks static while firm's characteristics change over time. Besides, there are some empirical anomalies in the stock market not explained properly by any of these time invariant models.

Several studies have been conducted to test whether betas and premium vary. Cochrane (1996), De Santis and Gerard (1997), Lettau and Ludwigson (2001a), Lewellen and Nagel (2006), are some well known studies finding time variation.

Therefore, there has been an increasing interest in time varying beta and risk premium models in recent years. Common method to estimate and to test time varying risk premia is to apply Fama-MacBeth two pass regression with rolling windows. Other common time varying models are dynamic or conditional models. Conditional asset pricing models focus on predictability of asset returns. In order to construct conditional time varying beta and risk premium models, information variables at time t, which affect risk premium at time t+1 need to be known. These types of models predetermine information variables and analyze their impact on the risk premia and/or beta.

Conditional version of CAPM is below:

$$\mathrm{E}(\mathrm{R}_{\mathrm{it+1}}|\mathrm{Z}_{\mathrm{t}}) = \gamma_0(\mathrm{Z}_{\mathrm{t}}) + \mathrm{B}_{\mathrm{imt}}\gamma_{\mathrm{m}}(\mathrm{Z}_{\mathrm{t}})$$

where $\mathrm{E}(\mathrm{R}_{\mathrm{it+1}}|\mathrm{Z}_{\mathrm{t}})$ is the expected rate of return at time t+1 with conditioning information Z_{t}. $\gamma_0(\mathrm{Z}_{\mathrm{t}})$ is the expected return when beta is equal to zero, $\gamma_{\mathrm{m}}(\mathrm{Z}_{\mathrm{t}})$ is the risk premium. Harvey (1989) tests conditional CAPM on United States data and rejects it, then he extends this test to other developed countries and rejects it again. (Harvey, 1991). His information variables include the first lag of the excess return on market portfolio, the junk bond premium, dividend yield, term premium and a dummy variable for the month of January. However, Lettau and Ludwigson (2001a) choose consumption to wealth ratio as information variable and find that conditional CAPM is better in explaining cross sectional returns than unconditional one. Other information variables that could have explanatory power will be discussed later in this section.

Jagannathan and Wang (1996) show that unconditional CAPM is valid if factor betas are not correlated with market volatility or equity premium, otherwise time varying results deviate from time invariant results. They derive an unconditional model from conditional CAPM.

$$\mathrm{E}(\mathrm{R}_{\mathrm{it}}) = \gamma_0 + \gamma_1 \overline{\mathrm{B}}_{\mathrm{i}} + \mathrm{Cov}(\gamma_{1t-1}, \mathrm{B}_{\mathrm{it-1}})$$

where $\gamma_0 = \mathrm{E}(\gamma_{0t-1})$ $\gamma_1 = \mathrm{E}(\gamma_{1t-1})$ $\overline{\mathrm{B}}_{\mathrm{i}} = \mathrm{E}(\mathrm{B}_{\mathrm{it-1}})$

γ_0 is the expected return of zero beta portfolio, γ_1 is the market risk premium and $\overline{\mathrm{B}}_{\mathrm{i}}$ is the expected beta. If the covariance between conditional beta of the asset and the condtional market premium is zero, unconditional CAPM holds. Otherwise, unconditional CAPM could not explain the asset returns completely.

He then decomposes conditional beta into three parts: (1) expected beta or unconditional beta, $\overline{\mathrm{B}}_{\mathrm{i}}$, (2) beta-prem sensitivity, υ_{i}, (3) residual beta, $\eta_{\mathrm{it-1}}$.

$$\mathrm{B}_{\mathrm{it-1}} = \overline{\mathrm{B}}_{\mathrm{i}} + \upsilon_{\mathrm{i}}\left(\gamma_{1t-1} - \gamma_1\right) + \eta_{\mathrm{it-1}}$$

$$\upsilon_{\mathrm{it-1}} = \mathrm{cov}(\mathrm{B}_{\mathrm{it-1}}, \gamma_{1t-1})/\mathrm{var}(\gamma_{1t-1})$$

In this equation residual beta should not correlated with market risk premium and it should not be correlated with conditional volatility of market return.

$$\mathrm{E}\left(\eta_{\mathrm{it-1}}\gamma_{\mathrm{it-1}}\right) = 0$$

$$\mathrm{E}\left(\eta_{\mathrm{it-1}}\upsilon_{\mathrm{t-1}}\right) = 0$$

Because assuming constant beta is unrealistic, they propose a conditional CAPM model, in which market sensitivity to business cycles are measured by the yield spread between BAA- and AAA- rated bonds. The proxy for the return on the wealth portfolio is the return of the value weighted portfolio of all stocks traded in

US. In order to measure complete aggregate wealth, they add return on human capital to the model. Proxy for the human capital is the growth rate in per capita labor income. Asset return equation becomes

$$E(R_{it}) = c_0 + c_{vw}B_i^{vw} + c_{prem}B_i^{prem} + c_{labor}B_i^{labor}$$

where B_i^{vw} is beta for wealth, B_i^{prem} is beta for market risk premium and B_i^{labor} is beta for return on human capital. They find that conditional CAPM better explain asset returns than unconditional one and adding firm size to this model does not provide any additional explanatory power. Jagannathan and Wang (1996) do not include conditional information variables to their model.

One of early attempts to develop a multi beta conditional model with information variables was made by Ferson and Harvey (1993). This work is an extension of the same model applied to US data in Ferson and Harvey (1991) study. They analyze equity returns of 18 countries by using a model that both betas and risk premia can vary over time. Betas are functions of local information variables, whereas risk premia are functions of global information variables. Their conditional CAPM model is

$$E(r_{it}|\Omega_{t-1}) = \sum_{j=1}^{K} \beta_{ij}(Z_{t-1}^{i})\lambda_j(Z_{t-1})$$

where Ω_{t-1} is information set as $\Omega_{t-1} = \left(Z_{t-1}, Z_{t-1}^{i}, i = 1, \dots, n\right)$. Z_{t-1} represents global information variables and Z_{t-1}^{i} local information variables. They assume globally integrated capital markets; hence, risk premia should not be country specific and depend only on the global variables, Z_{t-1}. Betas should be functions of local market information variables. $E(r_{it}|\Omega_{t-1})$ is the expected conditional excess return. $\beta_{ij}(Z_{t-1}^{i})$ are the expected conditional betas, $\lambda_j(Z_{t-1})$ are the expected factor returns on mimicking portfolios for the risk factors.

Their global risk factors are world excess market return, log first difference in the trade weighted US dollar prices of currencies of 10 industrialized countries, the unexpected component of a monthly global inflation measure, the monthly change in a measure of long term inflationary expectations, the change in the spread between the 90-day Eurodollar deposit rate and the 90-day US treasury bill rate, a weighted average of short term interest rates in the G-7 countries, the change in the monthly average US dollar price per barrel of crude oil, a weighted average of industrial production growth rates in the G-7 countries.

Global information variables are the yield of a one-month US treasury bill, the dividend yield of the world stock market index, a spread between the yields to maturity of 10-year US treasury bonds and 90-day US treasury bills, the lagged value of the Eurodollar-US treasury spread, the lagged return on the world market index and a dummy variable for the month of January. Country specific information variables are the replacement of world or US related variables with country specific ones.

In the application of the method, they regress returns on global risk factors, then they regress returns on betas of global risk factors, global information variables and country specific information variables.

They find (1) local information is included through betas, (2) movements in betas contribute only a small fraction of variance in national equity returns, on the other hand, the global risk premia are the dominant source of predictability. The most important factor in explaining the variance in the country excess returns is world excess return, it alone explains 5 to 71 percent of the ex-post variance depending on country. Other four factors which capture much of the predictable variation in most of the country returns are (1) the log first difference in the trade weighted US dollar prices of the currencies of 10 industrialized countries, (2) the monthly change in a measure of long term inflationary expectations, (3) the change in the monthly average US dollar price per barrel of crude oil, (4) weighted average of short term interest rates in the G-7 countries minus G-7 inflation rate. In their study with only US data, they find that the stock market risk premium is the most explanatory factor in stock returns (Ferson and Harvey, 1991).

Ferson and Harvey (1999), in another study, test FF three factor model using a conditional asset pricing model that simplifies the above model, and find that a set of lagged, economy-wide variables have predictive power.

$$E_{t-1}(r_{i,t}) = \alpha_{i,t-1} + \beta_{i,t-1} E_{t-1}(r_{p,t})$$

$$\beta_{i,t-1} = b_{0i} + b_{1i} Z_{t-1}$$

$$\alpha_{i,t-1} = \alpha_{0i} + \alpha_{1i} Z_{t-1}$$

where $E_{t-1}(r_{i,t})$ is conditional expected return at time t-1, $E_{t-1}(r_{p,t})$ is the expected return of risk factors at time t-1 and Z_{t-1} are information variables. Above formula can be rewritten as

$$r_{i,t} = (\alpha_{0i} + \alpha_{1i} Z_{t-1}) + (b_{0i} + b_{1i} Z_{t-1}) r_{p,t} + \epsilon_{i,t}$$

Constant betas, b_{0i}, are obtained by regressing excess returns on factor returns, $r_{p,t}$, and time varying betas, b_{1i}, are obtained by regressing excess returns on factor returns multiplied by lagged conditioning variables, Z_{t-1}.They found that five conditioning variables are significant in explaining excess returns: (1) the difference between the one-month lagged returns of a three-month and a one-month treasury bill, (2) the dividend yield of the S&P 500 index, (3) the spread between Moody’s Baa and Aaa corporate bond yields, (4) the spread between a ten-year and a one-year treasury bond yield, (5) the lagged value of a one-month treasury bill yield.

As stated in section 2.1. there are a lot of studies proposing new factors. Although studies on information variables are not as many as the ones on factors, we can group them as in Harvey, Liu and Zhu (2013) using Fama's efficient market hypothesis argument. Fama (1970) defines three market conditions: (1) weak form efficiency: if prices fully reflect past information related to prices (volatility, volume, lagged price values etc.), then market is weakly efficient. (2) semi-strong form efficiency: if prices fully reflect publicly available information (financial ratios, stock splits, dividend announcements etc.), then market is semi-strongly efficient, (3) strong form efficiency: if prices fully reflect all information whether publicly available or inside information, then market is strongly efficient. In the strong form efficiency, prices fluctuate randomly and adjust according to new information quickly. This theory is known as random walk theory.

Then, information variables could be divided into four groups: (1) information variables related to past information of price data, (2) information variables related to condition of firms, (3) information variables related to macroeconomic state and (4) other information variables.

In order to test lagged values of prices have explanatory power in returns, serial correlation tests are conducted. Fama and French (1988a) find negative autocorrelation in returns and suggest lagged returns as predictor variables. Lo and Mackinlay (1988) reject random walk in prices and support Fama and French's (1988a) findings. Ferson (1989) shows that conditional betas associate with short term interest rates. Another predictor variable related short term interest rate is the change in short term interest rates as in Campbell (1987). Term spread between short term and medium term interest rate is also commonly used information variable (Ferson and Harvey, 1999).

Yield spread between high quality and low quality bond yields (Ferson and Harvey, 1999), the book-to-market ratio as in the study of Pontiff and Schall (1998), the dividend price ratio (Fama and French, 1988b), the dividend yield (Lewellen, 2004), the earnings-to-price ratio (Lewellen, 2004), consumption to wealth ratio (Lettau and Ludwigson, 2001b) are other information variables that are often used in studies.

However, there are some critiques stating that predictability power of information variables may be misleading. Lo and Mackinlay (1990) claim sorting stocks on some specific characteristic and using them as test assets is a type of data mining. Kim, Nelson and Startz (1991) show that explanatory power of information variables is instable by comparing the results before and after World War II. Paye and Timmermann (2006) also support this finding. They analyze dividend yield, short interest rate, term spread and default premium, and find explanatory power of these information variables change in time and among countries.

Ferson, Sarkissian and Simin (2003) argue regressions of many studies on information variables may be spurious. Two independent but non-stationary time series can have spurious relationship because of trend, and we find significant relationship when regress one on another. In addition to spurious regression bias, they argue these studies have data mining bias as well. Data mining bias arises when information variable is chosen by searching data for reaching significant results. Explanatory power of information variables diminishes out-of sample if there is data mining bias.

Above models explained in detail require portfolios as tests assets and do not provide solutions to overcome problems related to using portfolios. As stated in introduction section, EIV bias is reduced by using portfolios as test assets instead of stocks. However, sorting stocks based on characteristics causes information loss as cross sectional dimension reduces. Additionally, this procedure causes variation among test assets as they are grouped based on some sort of characteristics at the beginning. The limited number of sorting characteristics causes another problem if one tries to examine large number of factors in the same model.

Berk (2000), Lewellen, Nagel and Shanken (2010), Conrad, Cooper and Kaul (2003) show that testing portfolios based on some characteristics creates biased returns. Phalippou (2007) tests some well known models and finds these models explain cross sectional returns of portfolios sorted on size and book-to-market ratio, on the other hand, they fail when test assets are portfolios sorted on institutional ownership and book-to-market ratio. This study is evidence of the importance of sorting characteristics in validation of the models.

Although limited, some recent studies provide time varying models using individual stocks, or some methods to avoid biased estimators.

Gagliardini, Ossola and Scaillet (2016) develop an econometric method, which uses cross sectional and time series information simultaneously, to infer the path of risk premia. Both individual stocks and portfolios can be used as test assets in this new method. They define excess returns $\mathrm{R_t}(\gamma)$ as

$$\mathrm{R_t}(\gamma) \; = \mathrm{a_t}(\gamma) + \mathrm{b_t}(\gamma)\mathrm{f_t} + \epsilon(\gamma)$$

where $\mathrm{a_t}(\gamma)$ is intercept and $\mathrm{b_t}(\gamma)$ are factor sensitivities, $\mathrm{f_t}$ are factors. Then, they define factor sensitivities vector $\mathrm{b_t}(\gamma)$ is a function of both $\mathrm{Z_{t-1}}(\gamma)$, stock specific information variables, and $\mathrm{Z_{t-1}}$, information variables common to all stocks. Betas are calculated using $\beta \; = (\mathrm{X'X})^{-1}(\mathrm{X'Y})$ in which Y is stock returns and X is a combination of lagged variables and factors.

They define a cross sectional parameter v_t such that $a_t(\gamma) = b_t(\gamma)'v_t$,and show consistency and asymptotic normality of estimators by letting the time dimension and cross section dimension grow to infinity simultaneously. In order to calculate ν, slope coefficients are regressed on estimated betas. λ_t is factor risk premiums and equal to the sum of cross sectional parameter ν and conditional expectations of factor returns.

$$\lambda_t = v_t + E(f_t|F_{t-1})$$

Conditional expectations of factors are estimated with the equation below

$$E(f_t|F_{t-1}) = FZ_{t-1}$$

Factor returns are regressed on lagged variables common to all stocks to estimate F. Finally, they multiply $v + F$ by Z_{t-1} to obtain time varying risk premia. Bias corrected estimators are derived from Hahn and Kuersteiner (2002) and Hahn and Newey (2004). Their findings suggest that CAPM, Fama-French three factor model and Carhart four factor model are not correct specification of the time varying models as they violate asset pricing restrictions required within the method. Additionally, risk premia are large and volatile in crisis periods; and conditioning variables, dividend yield and term spread, are not significant.

Jegadeesh, Noh, Pukthuanthong, Roll and Wang's (2019) instrumental variables approach to avoid EIV bias while using individual stocks as test assets is another method.

If $y = BX + e$ where y is vector of dependent variable, X is vector of independent variables, B is coefficient vector and e is error vector. In classical ordinary least squares method (OLS), $B_{OLS} = (X^TX)^{-1} X^T y$.

In instrumental variables approach, we define instrumental variable Z such that

$X = Z\delta + \varepsilon$ where $cov(Z, e) = 0$ and $cov(X, Z) \neq 0$. And $B_{IV} = (Z'X)^{-1}Z'y$. (Wooldridge, 2010; Wooldridge, 2015)

Instrumental variables estimator for factor premiums is below:

$$\lambda_{IV,t} = (B_{IV}B'_{EV})^{-1} (B_{IV}r'_t)$$

where B_{IV} and B_{EV} are instrumental and explanatory variables, respectively. Factor sensitivities are estimated from daily data within odd months and even months separately using time series regression as in the first stage of Fama-MacBeth regression. When month t is even, odd month betas are instrumental variables and even month betas are explanatory variables, and vice versa when month t is odd. Jegadeesh et al. (2019) claim measurement errors of instrumental and explanatory variables are uncorrelated as betas are estimated from disjoint samples.

By using N-consistent property of Shanken (1992), they prove consistency of IV estimator in large samples, where the number of stocks (N) grows infinitely. For small samples, they use simulations to show IV estimator is a better predictor than OLS estimator.

Their findings with actual data suggest that CAPM, Fama-French three and five factor model – an extended version of Fama-French three factor model with adding investment and profitability factors-, Hou, Xue and Zhang's (2015) q factor model and liquidity adjusted CAPM model by Acharya and Pedersen (2005) do not have significant risk premiums when choosing individual stocks as test assets and controlling corresponding firm characteristics.

Kim and Skoulakis (2018) estimate betas by dividing excess return covariance matrix $\Sigma_{rf} = E[(r_t - \mu_t)(f_t - \mu_f)']$ by factor covariance matrix $\Sigma_f = E[(f_t - \mu_f)(f_t - \mu_f)']$ where f_t is factor return, r_t is excess return, μ_t is expectation of excess return and μ_f is expectation of factor return. They use a calibrated beta matrix so that orthogonality condition between errors and estimated betas are satisfied. They name this method as the regression calibration method. Their results reject CAPM, Fama-French three and five factor models, and show evidence for value factor pricing.

Giglio and Xiu (2021) provide a solution to omitted variable bias that arises if omitted factor is correlated with some factors in the model and to EIV. They propose three stage estimation (1) Determining orthogonal factors by using principal component method, these factors do not necessarily have to be our observed factors, (2) Estimating risk premia for these orthogonal factors with Fama-MacBeth method, (3) Estimating risk premia for factors that we choose by regressing our factors to orthogonal factors and multiplying coefficients with premia vector.

Another model inspired by principal component method is Kelly, Pruitt and Su's (2020) instrumented principal component analysis (IPCA) model. They define return data as $\mathrm{r_{i,t} = B_{t,t} f_t + \mu_t}$ and $\mathrm{B_{i,t} = c_{t,t} \Gamma_t} + \eta_t$ where Γ_t is conditioning variables. We get

$\mathrm{r_{i,t} = c_{t,t} \Gamma_t f_t + e_t}$ where $\mathrm{e_t} = \eta_t \mathrm{f_t} + \mu_t$. They try to minimze squared of $\mathrm{e_t}$ and find time varying $\mathrm{c_{t,t}}$. In their models, conditioning variables could be firm characteristics, option greeks etc.

Litzenberger and Ramaswamy (1979) do not propose a new model, instead they suggest using generalized least squares estimator for betas and dividing each beta by residual standard deviation to avoid EIV Shanken (1992) generalizes their single factor model to multifactor settings. However, Jegadeesh et. al (2019) criticize this method as it assumes residual returns uncorrelated, and they claim residual returns would be correlated among assets because not all factors are priced in asset pricing models. Kim

(1995) proposes maximum likelihood estimation of betas using lagged betas to correct EIV bias.

Boons (2016) proposes to use EIV-robust standard errors derived from Generalized Method of Moments (GMM) for analyzing cross sectional differences in expected returns with individual stocks. He finds Fama-French factors and characteristics does not fully explain risk premia.

Another method for bias corrected return premium estimation with individual stock returns is developed by Chordia, Goyal and Shanken (2017). Their EIV-corrected coefficients are given by:

$$\widehat{\Gamma}_t^{EIV} = (\widehat{X}_t'\widehat{X}_t - \sum_{i=1}^{N_t} M'\widehat{\Sigma}_{\widehat{B}}M)^{-1\prime}\widehat{X}_t R$$

where M is a $k*(1+k+k_2)$ matrix defined as: $M = [0_{k*1}\ I_{k*k}\ 0_{k*k2}]$ and $\widehat{\Sigma}_{\widehat{B}}$ is the k*k White (1980) heteroskedasticity-consistent covariance matrix for the OLS time series estimate of factor. k is factor number, k_2 is number of firm characteristics. Based on this correction, they find book to market and momentum factors are insignificant, and there is negative premium for size factor and positive premiums for the profitability, investment and market factors.

2.3 Equity premium analyses on Turkey

Results with time-invariant models covering Turkey are contradictory. These contradictory results could be due to risk free rate choice, test asset choice and the use of different time frames in beta estimation.

Gursoy and Rejepova (2007) test CAPM on Turkish equity market by using two different methods, which are Fama-MacBeth regression and Pettengil, Sundaram and Mathur's (1995) model. Fama-MacBeth results suggest there is no meaningful relationship between market factor and excess returns, whereas there is strong beta-premium relationship if negative and positive market premiums are evaluated separately as suggested in Pettengil's (1995) study.

Dalgin, Gupta and Sraiheen (2012) find no evidence for validity of CAPM in Turkey equity market. Džaja and Aljinović's (2013) study examines if CAPM is valid in Central and Southeastern European emerging markets including Turkey and concludes CAPM fails to explain cross sectional asset returns. On the other hand, Cheng, Jahan-Parvar and Rothman (2010) investigate Middle Eastern and North African countries including Turkey, and they find a static international CAPM model is valid for Turkey. In international CAPM, they regress country excess returns on world market excess return implying Turkey's integration with world equity markets.

Aksu and Onder (2003) test both CAPM and Fama-French three factor model and their findings suggest market, book-to-market and size factors are positive and significant; in addition to this, Fama-French three factor model perform better than CAPM in Turkey, however, alphas-intercept coefficients- are significant in both models implying models do not fully explain variation. Güzeldere and Sarioglu (2012) and Atakan and Gokbulut (2010) use panel data analysis to test Fama-French three factor model, and they find all factor premiums are significant and positive, alphas are also significant in their models as well. All these models use individual stocks as test assets unlike in other studies covering Turkey, however, they do not explain how to avoid EIV bias.

Gonenc and Karan's (2003) findings are inconsistent with these studies. Their results show growth firms outperform value firms, and large firms outperform small firms. Eraslan (2013) also claims Fama-French three factor model has a limited potential to explain variations on the returns of portfolios as he finds that there is no size effect in big-sized firms, and book-to-market factor is significant for only firms having high book-to-market ratio. Akdeniz, Altay-Salih and Aydogan (2000) analyze the effect of market, size, book-to-market, earnings-to-price ratio and find returns vary positively with book-to-market factor and inversely with size. Additionally, explanatory power of these factors ceases when the model is applied to a subperiod.

Cakici, Fabozzi and Tan (2013) examine value and momentum effects in emerging markets. They find positive value premium, and momentum effect is not significant in the case of Turkey. Chiu, Titman and Wei (2011) also find insignificant momentum effect. There is a significant contrarian effect, and market, size and value factors are significant as well according to Bildik and Gulay's (2007) study.

Kandir (2008) claim that exchange rate, interest rate, world market return affect all portfolio returns, while inflation is significant for only three of twelve portfolios. Birgili and Duzer (2010) examine financial ratios and firms market value and find that sixteen financial ratios including price-to-earnings ratio and book-to-market ratio have explanatory power in firms' value. Other factors that could explain variation of asset returns in Turkey including money supply (Rjoub, Türsoy and Günsel, 2009), gold prices (Gençtürk, 2009), industrial production index and oil price (Buyuksalvarci, 2010).

Studies on time varying equity risk premium on Turkey is limited. To the best of our knowledge, time varying premia is not documented, and which state variables are significant in explaining its behavior is not analyzed. However, there are still some studies including whether conditional models are valid for Turkish equity market.

In order to examine whether conditional CAPM is valid in Turkish equity market, Yalcin and Ersahin (2011) conduct a study using Lewellen and Nagel (2006) approach and find that conditional CAPM does not work better than unconditional one. Although betas are allowed to vary, average conditional alphas are still significant for size and book-to-market portfolios. They also find significant alphas in most of the portfolios sorted according to momentum and liquidity.

On the other hand, Karatepe, Karaaslan and Gokgoz (2002) argue that conditional CAPM gives better results in Turkish equity market except in financial crises. They estimate conditional CAPM returns using GMM and test the similarity of actual returns and conditional CAPM returns.

Harvey’s (1995) study on time varying returns in emerging market by using Ferson and Harvey’s (1991) approach includes Turkey. His findings show that the conditional asset pricing models fail to explain cross sectional differences among assets in emerging countries, and local information variables have higher predictability power than world information variables. Local information variables are the local US dollar return, the change in the foreign currency rate versus the US dollar, the local dividend yield and a local interest rate.

Chaieb et al. (2021) also include Turkey and apply dynamic panel method to international stock returns. World dividend yield and country dividend yield are common conditioning variables, and factor risks are country market, size, value, momentum, operating profitability and investment. They find that excess country market factor is required to explain variation among asset returns in both developed and emerging markets.

CHAPTER 3

DYNAMIC PANEL METHOD AND DATA

Dynamic panel method and our data are detailed in this chapter. We use the longest reliable data set available for Turkish stock market going back to beginning of 1989 and compiling adjusted stock prices, market capitalization and book value of equity data for all stocks available at the time.[1] We correct the final prices of delisted firms by hand, assigning a price of zero if the reason is liquidation, and the appropriate last trade price if the reason is merger, acquisition or voluntary delisting.

Our final data set consists of Turkish-lira denominated weekly and monthly returns on 552 individual stocks traded at Borsa Istanbul over the last 32 years. The market return is computed as value weighted average return of all available stocks. We use the risk free rate as 1-month US Treasury Bill[2] rate plus local inflation minus the US inflation.[3] We use this proxy as risk-free rate to alleviate the fact that the Turkish government bond yields are not necessarily risk-free and they in fact exceed stock market returns for extensive periods leading to negative equity premium. The approximation is a reasonable choice as it proxies an international investor's parity adjusted or hedged risk-free return in Turkey.

Factor returns for size (Small Minus Big - smb), value (High Minus Low - hml) and 1-year momentum (Winners Minus Losers - mom) are computed per the standard procedure in the literature. As fundamental data and return of previous year

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[1] We use Finnet, the leading data vendor to the Turkish financial industry.

[2] Monthly and weekly US risk free rate retrieved from Ken French's website https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[3] The monthly CPI data for Turkey [TURCPIALLMINMEI] and the US [CPALTT01USM657N] are compiled by OECD and retrieved from FRED, Federal Reserve Bank of St. Louis website https://fred.stlouisfed.org

are needed to calculate factor returns, we end up with the time period of 31 years between January 1990 and December 2020 for our main results in risk premia. Descriptive statistics for monthly factor returns are summarized in Table 1

Table 1. Descriptive Statistics for Conditioning Variables and Factor Returns

	Mean	St. Dev.	Min	Max	Kurtosis	Skewness
Panel A: Descriptive Statistics for Conditioning Variables						
Change in consumer price index (ΔCPI)	0.0239	0.0198	0.0033	0.0715	1.7917	0.5821
Change in industrial production index (ΔIPI)	0.0043	0.0065	-0.0255	0.0183	4.8092	-0.9493
Change in Brent oil price (ΔOil)	0.0070	0.0274	-0.0893	0.0896	3.2573	-0.0834
Change in USD/TRY exchange rate (ΔFX)	0.0235	0.0242	-0.0211	0.1152	3.6867	0.7833
Market dividend yield (Div)	0.0428	0.0283	0.0091	0.2470	12.0952	2.4189
The US term spread (T s)	1.1470	0.8738	-0.4100	2.8300	1.7478	0.1683
Panel B: Descriptive Statistics for Factor Returns						
Excess market return (m)	0.0108	0.1305	-0.4577	0.7730	8.1585	1.0237
Size (smb)	0.0056	0.0695	-0.2892	0.4323	8.2024	0.4328
Value (hml)	0.0039	0.0780	-0.5364	0.4312	14.1147	-0.2977
Momentum (mom)	-0.0042	0.0847	-0.3850	0.6315	14.9686	0.7913

Notes: The table contains descriptive statistics for conditioning variables and monthly factor returns between 1990 and 2020. smb: Small minus big size factor, hml: High minus low book-to-market value factor; mom:1-year momentum.

We compute equity premia with three asset pricing models that have become the de facto standard in the academic literature as well as practice, namely Capital Asset Pricing Model (CAPM), Fama-French three factor model and four factor model an extension by adding momentum to three factor model. The tests are conducted with individual stocks as well as 25 Fama-French portfolios formed on size and book-to-market ratio and 48 industry portfolios. We also analyze both time-invariant along with time-varying versions of these models and data types.

Stock specific conditioning variable is natural logarithm of book-to-market ratio; conditioning variables common to all stocks are change in consumer price index, change in industrial production index, change in spot Brent oil price, change in USD to TRY exchange rate, market dividend yield and term spread between the US ten-year and two-year treasury bond yields as an internationally significant indicator. The selection is a mix of factors already studied in the literature across various published papers. We had to omit some potential factors, such as local term premia and credit spread, due to unavailability of data for the period studied. We calculate changes in variables and then take 12-month moving averages to smooth the trend. In order to avoid look-ahead bias, one month lagged value of consumer price index and two month lagged value of industrial production index are used. Descriptive statistics for the variables are reported in Table 1 with pairwise correlations in Table 2.

Table 2. Correlation Between Conditioning Variables

	ΔCPI	ΔIPI	ΔOil	ΔFX	Div	T s
Change in consumer price index (ΔCPI)	1					
Change in industrial production index (ΔIPI)	-0.1646	1				
Change in Brent oil price (ΔOil)	-0.0644	0.2598	1			
Change in USD/TRY exchange rate (ΔFX)	0.8120	-0.3436	-0.2247	1		
Market dividend yield (Div)	0.4747	-0.0131	-0.1592	0.3834	1	
The US term spread (T s)	-0.2833	0.0130	-0.0979	-0.2125	0.1038	1

Notes: The table contains correlations among conditioning variables. All returns are monthly and between 1990 and 2020.

The risk factors in our model will include the excess market return of classical CAPM in its simple form before we move on to Fama-French three factor model and Carhart four factor model. The extended the model will be

$$R_{j,t} - R_{f,t} = \alpha_{j,t} + \beta_1 (R_{m,t} - R_{f,t}) + \beta_2 (SMB)_t + \beta_3 (HML)_t + \beta_4 (WML)_t + \varepsilon_{j,t}$$

$R_{i,t} - R_{f,t}$: The excess return on asset i over risk free rate for time period t

$\alpha_{i,t}$: The abnormal return on portfolio i over the theoretical expected return

$R_{m,t} - R_{i,t}$: Market risk premium; the excess return on the value-weighted market portfolio over risk free rate of return for time period t.

$(SMB)_t$: Size effect; the difference between the return on a diversified portfolio of small stocks and the return on a diversified portfolio of big stocks for time period t.

$(HML)_t$: Value effect; the difference between the returns on diversified portfolios of high and low B/M stocks for time period t.

$(WML)_t$: Momentum effect; the difference between the returns on diversified portfolios of winner and loser stocks for time period t.

$\varepsilon_{i,t}$: Zero-mean residual for portfolio i for the time period t.

Gagliardini et al.'s (2016) panel method rectifies the shortcomings of Fama-MacBeth two pass regression. The model defines excess returns $R_t(\gamma)$ as

$$R_t(\gamma) = a_t(\gamma) + b_t(\gamma)f_t + \epsilon(\gamma)$$

where $a_t(\gamma)$ is intercept and $b_t(\gamma)$ are factor sensitivities, f_t are four factors; excess market return and returns of HML, SMB and momentum portfolios. Further, the intercept of the above regression is also modelled as $a_t(\gamma) = b_t(\gamma)'v_t$ and as the regression rewritten as

$$E(R_t(\gamma)|F_{t-1}) = b_t(\gamma)'\lambda_t$$

where $\lambda_t = v_t + E(f_t|F_{t-1})$ is the vector of the conditional risk premia and F_{t-1} is the information at time t-1. In the time invariant model, risk premia become $\lambda = v + E(f_t)$. For time invariant model, in the first pass, the betas are calculated using $\beta = (X'X)^{-1}(X'Y)$ in which Y is vector of stock returns and X is vector of factor returns. In the second pass, $a_t(\gamma) = b_t(\gamma)'v_t$ is used to calculate ν and $\lambda = v + E(f_t)$, time invariant risk premia.

For time varying model, $Z_{t-1}(\gamma)$ is defined as a lagged instrument specific to stock γ, which is natural logarithm of book-to-market ratio and Z_{t-1} is lagged instruments common to all stocks, which are change in consumer price index, change in industrial production index, change in spot Brent oil price, change in USD to TRY exchange rate, market dividend yield and term spread between the US ten-year and two-year treasury bond yields. Factor sensitivities vector $b_t(\gamma)$ is a function of both $Z_{t-1}(\gamma)$ and Z_{t-1} such that

$$b_t(\gamma) = B(\gamma)Z_{t-1} + C(\gamma)Z_{t-1}(\gamma)$$

The model assumes $\lambda_t = \Lambda Z_{t-1}$ and $E(f_t|F_{t-1}) = FZ_{t-1}$, and rewrites $a_t(\gamma)$ using $a_t(\gamma) = b_t(\gamma)'v_t$ as

$$a_t(\gamma) = Z'_{t-1}B(\gamma)'(\Lambda - F)Z_{t-1} + Z_{t-1}(\gamma)'C(\gamma)'(\Lambda - F)Z_{t-1}$$

Hence the conditional factor model becomes

$$R_{i,t} = Z'_{t-1}B'_i(\Lambda - F)Z_{t-1} + Z'_{i,t-1}C'_i(\Lambda - F)Z_{t-1} + Z'_{t-1}B'_i f_t + Z'_{i,t-1}C'_i f_t + \epsilon_{i,t}$$

where $B_i = B(\gamma)$, $C_i = C(\gamma)$ and $Z_{i,t-1} = Z_{t-1}(\gamma)$. In the first pass, betas are calculated using $B = (X'X)^{-1}(X'Y)$ in which Y is vector of stock returns and X is a multidimensional matrix in which columns are months and rows are the combination of factors and conditioning variables.

In the second pass, the identity $a_t(\gamma) = b_t(\gamma)'v_t$ is used to calculate ν. Since $\lambda_t = v_t + E(f_t|F_{t-1})$, regressed factor returns on lagged variables common to all stocks yield F in the equation of $E(f_t|F_{t-1}) = FZ_{t-1}$,. Finally, multiplying $v + F$ by Z_{t-1} yields time varying risk premia.

OLS estimator is used while estimating betas in the first part. However, weighted least squares estimator is chosen while estimating cross sectional parameter v in order not to driven by more volatile small stocks as weights are increasing with market capitalization. In no arbitrage environment, they show the consistency and asymptotic normality of estimators when time dimension and cross section dimension – number of stocks – grow to infinity simultaneously.

The difference between two pass regression and panel method is that risk premia are estimated by using rolling windows in the former method. Instead, betas are used to estimate cross sectional vector v in the latter, and vector v and conditional expectations of factors form risk premia. Because of measurement error in betas, vector v has a bias term, $\widehat{B}_v/T$. We extract this bias term from vector v before estimating risk premia.

In an arbitrage free environment, alphas either can be explained by factor betas, H_0: $a_t(\gamma) = b_t(\gamma)'v_t$ or alphas should be equal to zero, or H_0: $a_t(\gamma) = 0$. Test of asset pricing restrictions measure whether at least one of these two null hypotheses holds. Rejecting both restrictions shows that either factor model is not the correct specification of asset returns or there is an arbitrage opportunity among assets.

CHAPTER 4

ESTIMATION RESULTS FOR DYNAMIC PANEL METHOD

We discuss the estimation results for dynamic panel method by using different macroeconomic variables as lagged information variables in different sections. Each section has time varying estimation figures and test statistics for asset pricing restrictions.

One of the main methodological contributions of Gagliardini et al. (2016) is being able to infer the path of risk premia from a large panel data set of individual stocks. Hence our base case is using individual stocks as observations in estimating risk premia for three asset pricing models. However, we also test each model on 25 Fama-French test portfolios as well as 48 industry portfolios. We use monthly observations in our base case but also study weekly frequency to reach a more granular estimate with longer time series observations. Our initial tests spanned a 31-year period going back to 1990.

Turkey has four major economic crises between 1990 and 2020: 1994 currency crisis, the effect of 1997 Asian financial crisis in 1998-1999, 2000-2001 banking crisis and the effect of 2007-2008 mortgage crisis in US and Europe. Although 2001 crisis causes the highest GDP loss by 5.8%, inflation was not as high as during 90's because of demand reduction. Average inflation is 77% during 90's, 23% between 2000 and 2009, and %10 afterwards. Since 90's were particularly volatile, we also include a trimmed time series beginning in 2000 for a more recent and stable time period.

We begin our empirical tests with time-invariant version of the model. Our main results include testing explanatory power of candidate conditioning variables and compiling time-varying path of risk-premia conditional on the variables with explanatory power. We finalize empirical part of each section by testing asset pricing restrictions induced by the no-arbitrage condition.

4.1 Estimation results for time invariant model

Time invariant estimation results calculated from monthly returns between 1990 and 2020 are on Table 3, and between 2000 and 2020 on Table 4; results from weekly returns are on Table 5 and 6. The key findings can be summarized as follows: (1) High inflation environment in 90's causes higher market premiums for all data types and factor models between 1990 and 2020 compared to the period starting from 2000. (2) Positive market premiums are significant at 5% level and other factor premiums are not different from zero for the same time period, although there are some exceptions as we explain later. However, significance of market premium decreases between 2000 and 2020 as well. (3) Weekly results confirm both findings.

Market factor premium on monthly returns between 1990 and 2020 are significant for stocks and industry portfolios, results are similar for vector v. It is 22.92% for stocks, 19.54% for industry portfolios and 15.42% for Fama-French portfolios in four factor model. Market factor premium on weekly returns for the same time period is significant for all data types and all factor models except Fama-French portfolios in Fama-French three factor model. Premium levels are similar to premiums calculated from monthly returns; 23.01% for stocks, 18.01% for industry portfolios and 15.54% for Fama-French portfolios in four factor model. Between 2000 and 2020, market premium on both monthly and weekly returns is significant for only stocks in four factor model and CAPM. These results confirm that individual stocks indeed provide more information and possibly better estimates than test portfolios.

Size factor premium is positive but insignificant for all data types, all factor models and different time periods except it is significant on weekly returns in Fama-French model between 2000 and 2020 for stocks. It is 5.39% for stocks, 1.79% for industry portfolios and 7.75% for Fama-French portfolios on monthly returns; and 4.58% for stocks, 1.35% for industry portfolios and 7.56% for Fama-French portfolios on weekly returns in four factor model between 1990 and 2020. Vector v is also insignificant except on weekly returns in Fama-French model between 2000 and 2020.

Book-to-market factor premium is negative and significant on weekly returns for stocks between 1990 and 2020; and in Fama-French model between 2000 and 2020. Its effect is negative for stocks, positive for Fama-French portfolios and variable for industry portfolios. In four factor model, book-to-market factor premium is -7.57% for stocks, -2.33% for industry portfolios and 8.37% for Fama-French portfolios on monthly returns; and -9.98% for stocks, -6.31% for industry portfolios and 3.65% for Fama-French portfolios on weekly returns between 1990 and 2020. Vector v on book-to-market factor is negative and significant for stocks.

Momentum factor premium is positive and significant for stocks, and vector v for stocks is also positive and significant. It is 12.2% for stocks, -3.39% for industry portfolios and 20.84% for Fama-French portfolios on monthly returns; and 30.55% for stocks, -0.65% for industry portfolios and 25.83% for Fama-French portfolios on weekly returns in four factor model between 1990 and 2020. The differences in certain estimates can be explained by how 25 Fama-French test portfolios are shrinking the variability in betas, while individual stocks exhibit much larger heterogeneity in factor loadings.

Table 3. Estimated Annualized Risk Premia and Vector v for the Time Invariant Models for Monthly Returns Between 1990 and 2020

	Panel A: Risk Premia λ				Panel B: Vector v		
	Stocks	FF Portfolios	Indu. Portfolios		Stocks	FF Portfolios	Indu. Portfolios
Four-Factor Model							
λ_{m}	22.92 (7.16, 38.69)	15.42 (-0.85, 31.69)	19.54 (3.44, 35.64)	v_{m}	9.92 (6.95, 12.88)	2.41 (-1.62, 6.45)	6.53 (3.26, 9.81)
λ_{smb}	5.39 (-2.97, 13.77)	7.75 (-1.48, 16.99)	1.79 (-10.22, 13.80)	v_{smb}	-1.26 (-5.55, 3.01)	1.08 (-2.81, 4.98)	-4.87 (-13.48, 3.73)
λ_{hml}	-7.57 (-18.08, 2.93)	8.37 (-3.93 20.67)	-2.33 (-19.29, 14.63)	v_{hml}	-12.27 (-17.29, -7.24)	3.67 (-2.71, 10.06)	-7.02 (-20.34, 6.28)
λ_{mom}	12.2 (1.06, 23.34)	20.84 (-6.67, 48.36)	-3.39 (-23.03, 16.24)	v_{mom}	17.18 (10.76, 23.60)	25.83 (0.66, 50.99)	1.58 (-14.58, 17.75)
Fama-French Model							
λ_{m}	21.45 (5.69, 37.21)	15.52 (-0.65, 31.70)	19.59 (3.49, 35.69)	v_{m}	8.44 (5.72, 11.17)	2.51 (-1.14, 6.18)	6.58 (3.30, 9.87)
λ_{smb}	4.45 (-3.92, 12.83)	7.05 (-2.22, 16.32)	1.18 (-10.77, 13.14)	v_{smb}	-2.2 (-6.54, 2.12)	0.38 (-3.59, 4.36)	-5.47 (-14.01, 3.05)
λ_{hml}	-5.3 (-15.81, 5.20)	8.54 (-3.47, 20.56)	-1.33 (-18.81, 16.14)	v_{hml}	-10 (-14.71, -5.28)	3.84 (-1.98, 9.67)	-6.03 (-20.00, 7.93)
CAPM							
λ_{m}	23.05 (7.29, 38.82)	21.23 (4.62, 37.84)	20.4 (4.01, 36.78)	v_{m}	10.05 (6.92, 13.18)	8.23 (2.99, 13.46)	7.39 (2.94, 11.84)

Notes: Panel A contains the estimated annualized risk premia for monthly returns and their confidence intervals at 95% probability level, for the market (λ_{m}), size (λ_{smb}), book-to-market (λ_{hml}) and momentum (λ_{mom}) factors. Panel B contains the annualized estimates of the components of vector v and their confidence intervals at 95% probability level for the market (v_{m}), size (v_{smb}), book-to-market (v_{hml}) and momentum (v_{mom}) factors.

Table 4. Estimated Annualized Risk Premia and Vector v for the Time Invariant Models for Monthly Returns Between 2000 and 2020

	Panel A: Risk Premia λ				Panel B: Vector v		
	Stocks	FF Portfolios	Indu. Portfolios		Stocks	FF Portfolios	Indu. Portfolios
			Four-Factor Model				
λ_{m}	14.42 (0.83, 28.00)	7.98 (-5.93, 21.89)	9.94 (-3.99, 23.89)	v_{m}	9.39 (6.97, 11.81)	2.95 (-0.04, 5.95)	4.91 (1.76, 8.07)
λ_{smb}	6.28 (-3.31, 15.89)	8.09 (-2.38, 18.56)	6.62 (-5.78, 19.03)	v_{smb}	-1.77 (-6.38, 2.84)	0.02 (-4.15, 4.21)	-1.43 (-9.29, 6.42)
λ_{hml}	-6 (-15.18, 3.18)	7.69 (-2.81 18.20)	0.27 (-14.88, 15.42)	v_{hml}	-9.87 (-14.77, -4.97)	3.82 (-1.29, 8.93)	-3.6 (-15.65, 8.45)
λ_{mom}	11.27 (1.41, 21.13)	-2.44 (-24.53, 19.65)	6.21 (-10.01, 22.44)	v_{mom}	14.95 (8.14, 21.76)	1.23 (-18.53, 21.00)	9.89 (-3.00, 22.78)
			Fama-French Model				
λ_{m}	11.78 (-1.80, 25.36)	7.9 (-6.01, 21.81)	9.66 (-4.23, 23.57)	v_{m}	6.75 (4.79, 8.71)	2.87 (-0.15, 5.89)	4.64 (1.67, 7.60)
λ_{smb}	6.46 (-3.13, 16.07)	8.26 (-2.37, 18.89)	5.73 (-7.04, 18.51)	v_{smb}	-1.59 (-5.67, 2.49)	0.19 (-4.37, 4.77)	-2.32 (-10.75, 6.10)
λ_{hml}	-1.59 (-10.77, 7.58)	7.6 (-2.92, 18.12)	1.71 (-13.85, 17.29)	v_{hml}	-5.46 (-10.18, -0.75)	3.72 (-1.41, 8.87)	-2.15 (-14.73, 10.42)
			CAPM				
λ_{m}	15.27 (1.69, 28.85)	13.85 (-0.50, 28.20)	12.51 (-1.70, 26.73)	v_{m}	10.24 (8.16, 12.32)	8.82 (4.18, 13.46)	7.48 (3.27, 11.69)

Notes: Panel A contains the estimated annualized risk premia for monthly returns and their confidence intervals at 95% probability level, for the market (λ_{m}), size (λ_{smb}), book-to-market (λ_{hml}) and momentum (λ_{mom}) factors. Panel B contains the annualized estimates of the components of vector v and their confidence intervals at 95% probability level for the market (v_{m}), size (v_{smb}), book-to-market (v_{hml}) and momentum (v_{mom}) factors.

Table 5. Estimated Annualized Risk Premia and Vector v for the Time Invariant Models for Weekly Returns Between 1990 and 2020

	Panel A: Risk Premia λ				Panel B: Vector v		
	Stocks	FF Portfolios	Indu. Portfolios		Stocks	FF Portfolios	Indu. Portfolios
Four-Factor Model							
λ_m	23.01 (7.91, 38.12)	15.54 (0.23, 30.85)	18.01 (2.62, 33.40)	v_m	9.97 (7.57, 12.37)	2.49 (0.01, 4.99)	4.97 (2.03, 7.91)
λ_{smb}	4.58 (-4.23, 13.40)	7.56 (-2.06, 17.20)	1.35 (-12.03, 14.75)	v_{smb}	0.26 (-2.33, 2.86)	3.24 (-0.63, 7.12)	-2.96 (-13.04, 7.11)
λ_{hml}	-9.98 (-19.58, -0.39)	3.65 (-7.81, 15.12)	-6.31 (-27.14, 14.51)	v_{hml}	-13.15 (-18.05, -8.25)	0.48 (-5.80, 6.78)	-9.47 (-27.96, 9.01)
λ_{mom}	30.55 (20.35, 40.75)	25.83 (-5.23, 56.90)	-0.65 (-28.06, 26.74)	v_{mom}	29.53 (22.64, 36.42)	24.82 (-4.52, 54.16)	-1.67 (-27.10, 23.76)
Fama-French Model							
λ_m	20.63 (5.52, 35.74)	14.69 (-0.61, 29.99)	18.19 (2.88, 33.50)	v_m	7.59 (5.44, 9.73)	1.64 (-0.79, 4.08)	5.14 (2.66, 7.63)
λ_{smb}	5.72 (-3.09, 14.54)	6.86 (-2.78, 16.50)	0.73 (-12.78, 14.24)	v_{smb}	1.40 (-1.37, 4.17)	2.53 (-1.35, 6.43)	-3.59 (-13.83, 6.64)
λ_{hml}	-13.36 (-22.96, -3.77)	4.70 (-6.63, 16.03)	-4.79 (-25.94, 16.35)	v_{hml}	-16.53 (-21.53, -11.52)	1.53 (-4.49, 7.56)	-7.96 (-26.81, 10.89)
CAPM							
λ_m	22.43 (7.33, 37.54)	19.88 (4.19, 35.58)	18.85 (3.29, 34.42)	v_m	9.39 (8.20, 10.58)	6.84 (2.58, 11.10)	5.81 (2.06, 9.57)

Notes: Panel A contains the estimated annualized risk premia for monthly returns and their confidence intervals at 95% probability level, for the market (λ_m), size (λ_{smb}), book-to-market (λ_{hml}) and momentum (λ_{mom}) factors. Panel B contains the annualized estimates of the components of vector v and their confidence intervals at 95% probability level for the market (v_m), size (v_{smb}), book-to-market (v_{hml}) and momentum (v_{mom}) factors.

Table 6. Estimated Annualized Risk Premia and Vector v for the Time Invariant Models for Weekly Returns Between 2000 and 2020

	Panel A: Risk Premia λ				Panel B: Vector v		
	Stocks	FF Portfolios	Indu. Portfolios		Stocks	FF Portfolios	Indu. Portfolios
				Four-Factor Model			
λ_{m}	16.29	7.72	10.30	vm	9.58	1.01	3.59
	(2.46, 30.12)	(-6.23, 21.69)	(-3.62, 24.22)		(7.17, 12.00)	(-0.91, 2.95)	(2.00, 5.17)
λ_{smb}	8.81	8.65	9.31	vsmb	1.25	1.09	1.75
	(-0.49, 18.12)	(-1.51, 18.83)	(-6.11, 24.74)		(-0.81, 3.31)	(-3.00, 5.19)	(-10.55, 14.05)
λ_{hml}	-7.95	6.64	-7.39	vhml	-11.03	3.56	-10.48
	(-17.22, 1.31)	(-4.14, 17.43)	(-29.74, 14.94)		(-16.10, -5.96)	(-1.95, 9.08)	(-30.81, 9.85)
λ_{mom}	36.29	6.12	13.94	vmom	35.50	5.32	13.14
	(26.65, 45.94)	(-20.09, 32.34)	(-7.83, 35.72)		(28.51, 42.49)	(-19.05, 29.71)	(-6.38, 32.67)
				Fama-French Model			
λ_{m}	12.34	7.22	9.89	vm	5.63	0.51	3.18
	(-1.48, 26.17)	(-6.74, 21.18)	(-4.01, 23.80)		(3.45, 7.81)	(-1.43, 2.46)	(1.70, 4.67)
λ_{smb}	11.05	9.02	10.58	vsmb	3.49	1.46	3.01
	(1.74, 20.36)	(-1.20, 19.25)	(-5.09, 26.26)		(1.49, 5.49)	(-2.77, 5.69)	(-9.59, 15.63)
λ_{hml}	-11.04	6.58	-10.53	vhml	-14.12	3.50	-13.61
	(-20.30, -1.77)	(-4.20, 17.36)	(-33.30, 12.24)		(-19.25, -8.99)	(-2.01, 9.01)	(-34.41, 7.18)
				CAPM			
λ_{m}	15.97	13.48	11.80	vm	9.26	6.77	5.09
	(2.14, 29.80)	(-0.87, 27.83)	(-2.43, 26.03)		(8.11, 10.41)	(2.92, 10.62)	(1.72, 8.46)

Notes: Panel A contains the estimated annualized risk premia for monthly returns and their confidence intervals at 95% probability level, for the market (λ_{m}), size (λ_{smb}), book-to-market (λ_{hml}) and momentum (λ_{mom}) factors. Panel B contains the annualized estimates of the components of vector v and their confidence intervals at 95% probability level for the market (v_{m}), size (v_{smb}), book-to-market (v_{hml}) and momentum (v_{mom}) factors.

4.2 Conditional information: Best explaining information variables

We choose natural logarithm of book-to-market ratio as conditioning variable specific to assets following Gagliardini et al. (2016). Market dividend yield, change in consumer price index, change in industrial production index, change in USD/TRY exchange rate, change in Brent oil price and term spread between 10 year and 2 year US treasury bond yields are candidates for conditioning variables common to all assets. This is not an exhaustive list by all means, as we were limited by data availability of some of the other candidate variables. As change in consumer price index and industrial price index are monthly, we do not use them in explaining time varying risk premia of weekly returns. Test results for time invariance of factors conditional expectations and cross sectional parameter v for stocks are on Table 7.

Time variation has two sources: the conditional expectation of factors and cross sectional parameter v – i.e., intercept or alpha part explained by factor betas. We test time variation using chi-square statistic.

$$\gamma_F = A \times \hat{F}'$$

where $\hat{F}$ is the vector of conditional expectation of factors and provided by regressing factors on information variables. A is a matrix that selects the instrument coefficients and leaves out constant terms.

$$X_{iF} = T \times \gamma_F \times (A \times \sigma_F \times A))^{-1} \times \gamma_F$$

X_{iF} is the test number based on formula $\Sigma(\frac{(x-u)}{\sigma})^2 \cong \chi 2(n)$ Because we test whether conditional expectations of factors are different from 0, u = 0. Then, we get p value based on X_{iF} and degrees of freedom, which is equal to the number of factors multiplied by information variables. Same procedure is taken for cross sectional parameter v.

Between 1990 and 2020 for monthly returns, we can not reject time invariance of factors conditional expectations, but we reject time invariance of the risk premia due to the dynamics induced by cross sectional parameter v except for term spread. Overall, best explaining instrument is change in industrial production index, of which p value for conditional expectation is 0.1118 and p value for parameter v is 0. For weekly returns, conditional expectation of change in usd-try exchange rate is 0.0269 and significant at 5% level. Time variation induced by vector v is significant for change in Brent oil price and the US term spread.

From 2000 to 2020 for monthly returns, conditional expectations on change in consumer price index and dividend yield are significant, and all instruments are significant based on time variation vector v. Best explaining instrument is change in consumer price index, of which p-value for conditional expectation is 0.0032 and for vector v is 0.0004. None of instruments are significant at 5% level for weekly returns, however, vector v in explaining time varying factor premiums is significant for all except term spread.

We examine annualized time varying risk premia of weekly and monthly returns for 1990-2020 and 2000-2020 periods. Results for monthly returns are on Tables 8 and 9, and results for weekly returns are on Tables 10 and 11. As best explaining conditioning variables are used while calculating risk premiums; dividend yield and change in consumer price index for monthly returns, and dividend yield and change in USD/TRY exchange rate for weekly returns are conditional variables.

Table 7. Test Results for Time Invariance of Factors Conditional Expectations and Cross Sectional Parameter v for Stocks

	1990-2020		2000-2020	
	Ho: Avec[F] = 0	Ho: Av = 0	Ho: Avec[F] = 0	Ho: Av = 0
Change in consumer price index (ΔCPI)	0.6807	0	0.0032	0.0004
Change in industrial production index (ΔIPI)	0.1118	0	0.5750	0
Change in Brent oil price (ΔOil)	0.7710	0	0.1515	0
Change in USD/TRY exchange rate (ΔFX)	0.1844	0	0.0902	0
Market dividend yield (Div)	0.2709	0	0.0398	0
The US term spread (T s)	0.9502	0.1881	0.3571	0.0296
	Weekly Returns			
Change in Brent oil price (ΔOil)	0.5585	0	0.2974	0
Change in USD/TRY exchange rate (ΔFX)	0.0269	0.2582	0.0705	0.0056
Market dividend yield (Div)	0.0659	0.0957	0.0792	0
The US term spread (T s)	0.9882	0.0071	0.4794	0.2054

Notes: The table contains p values for the null hypotheses Ho: Avec[F’] = 0, time invariance of the factors conditional expectations, and Ho: Av = 0, time invariance of the risk premia due to the dynamics induced by the cross sectional parameter.

4.2.1 Estimation results with time varying model

Figure 1 shows path of risk premia for stocks in four factor model between 1990 and 2020. All returns are monthly. Dashed red line is time-invariant factor premium and solid blue line is the average of time varying estimation result. The vertical shaded areas denote recessions in Turkey’s economy.[4] During 90’s, risk premiums on market, book-to-market and momentum are having large positive strays, while on size factor is more stable. Market, book-to-market and momentum premiums are more stable after 90’s as well. Average time varying premiums for book-to-market and momentum factors are above time-invariant estimation result, while average time varying market and size premiums is below time invariant result for that factor.

Average time varying premiums for stocks are 21.19% for market factor (λ_m), -4.34% for size (λ_{smb}), 14.16% for book-to-market (λ_{hml}) and 26.48% for momentum

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[4] OECD based Recession Indicators for Turkey from the Peak through the Period preceding the Trough [TURRECP], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/TURRECP.

(λ_{mom}). As stated in Table 1, time invariant results are 22.92%, 5.39%, -7.57% and 12.20% respectively. Averages of risk premium during 90's are 29.72% for market, -1.34% for size, 23.98% for book-to-market and 56.90% for momentum. Averages between 2000 and 2010 are 16.82% for market, -5.63% for size, 10.46% for book-to-market and 13.83% for momentum. Averages after 2010 are 17.37% for market, -5.92% for size, 8.56% for book-to-market and 10.21% for momentum. Average factor premiums for 2000-2010 and 2010-2020 are close to each other.

Our finding is consistent with Gagliardini's findings; risk premia for factors increase during 90's economic contractions and high inflation environment and decrease afterwards. As detailed in Chapter 2, time invariant model holds if factor betas do not covariate with equity premium and market volatility, otherwise time varying results deviate from time invariant results. Discrepancy between time invariant results and average of time varying results can be explained by this bias.

Path of risk premia for stocks in four factor model between 1990 and 2020 on weekly returns is shown on Figure 3. While market factor has large positive strays during 90's, size factor has negative strays for the same period. Book-to-market and momentum factors are more stable and other factors are more stable after 90's as well.

Averages of risk premiums on factors are 19.31% for market, 6.15% for size, -1.84% for book-to-market and 34.62% for momentum. Time varying estimation for market is below time invariant results. Time invariant results are 23.01% for market, 4.58% for size, -9.98% for book-to-market and 30.55% for momentum factors. Averages of risk premium during 90's are 45.93% for market, -14.95% for size, -12.88% for book-to-market and 33.81% for momentum. Averages between 2000 and 2010 are 6.27% for market, 17.13% for size, 3.73% for book-to-market and 35.17% for momentum. Averages after 2010 are 7.34% for market, 15.07% for size, 2.96%

for book-to-market and 34.84% for momentum. Average factor premiums for 2000-2010 and 2010-2020 are close to each other. Because we explain different time periods with best explaining instruments, the weekly time series slightly deviate from the monthly series.

On Table 8 and 9, estimated annualized components of vec[F] and v for the time varying four factor model for monthly returns on dividend yield and change in consumer price index between 1990-2020 and 2000-2020 are shown. Between 1990 and 2020, when dividend yield and change in consumer price index is on average, conditional expectation of all factors are positive except momentum. However, they are insignificant at 5% level for all factors. Constant effect of vec[F] on market factor is 11.12% and positive effect of vector v increases the level. In total, constant effect on market factor is 21.17% for stocks, 13.96% for Fama-French portfolios and 20.18% for industry portfolios. Constant coefficient on momentum is -3.74%, in total it turns positive with the effect of vector v. Total constant effect on size and book-to-market are variable for different portfolio types. Among dividend and change in consumer price effect, only dividend yield effect is positive and significant for 5% level on market factor, and the effect of vector v is negative.

We have similar results for the time period between 2000 and 2020. When dividend yield and change in consumer price index are on their averages, constant components of vec[F] are positive except momentum. On the other hand, they are insignificant at 5% significance level. Total effect of constant is positive on market, size and momentum factors, and variable for book-to-market. Effect of dividend yield on market and momentum are significant, positive for market factor and negative for momentum factor. Conditional factor effect of change in consumer price index is significant and negative on momentum.

Effect of vec[F] and vector v for weekly returns are on Table 10 and 11. Between 1990 and 2020, constant effect on factors are positive and insignificant. When vector v is included, total constant effect is positive for market and momentum factors, variable on different portfolios for size and book-to-market factors. Effect of dividend on market factor is positive and significant, 31.45%. Dividend effect on v is not significant. Effect of change in foreign exchange rate on factor returns is negative but insignificant.

Constant effect on factors is positive but insignificant between 2000 and 2020. Dividend yield component of vec[F] has a positive effect on market factor and it is significant, additionally, positive effect of vector v increases the level. Dividend effect on size, book-to-market and momentum are negative, they are not significant though. Additionally, its negative effect turns positive in total with the effect of vector v on momentum factor. Exchange rate component of vec[F] is negative for all factors except size, however they are insignificant as well. Total exchange rate effect on market factor is -18.12% for stocks, -16.16% for Fama-French portfolios and -15.15% for industry portfolios. In summary, dividend yield has a positive effect on market premium, and we find evidence that inflation has a negative effect on monthly premium of momentum factor between 2000 and 2020.

4.2.2 Results on testing the asset pricing restrictions

If excess return is defined as below:

$$R_t(\gamma) = a_t(\gamma) + b_t(\gamma) f_t + s(\gamma)$$

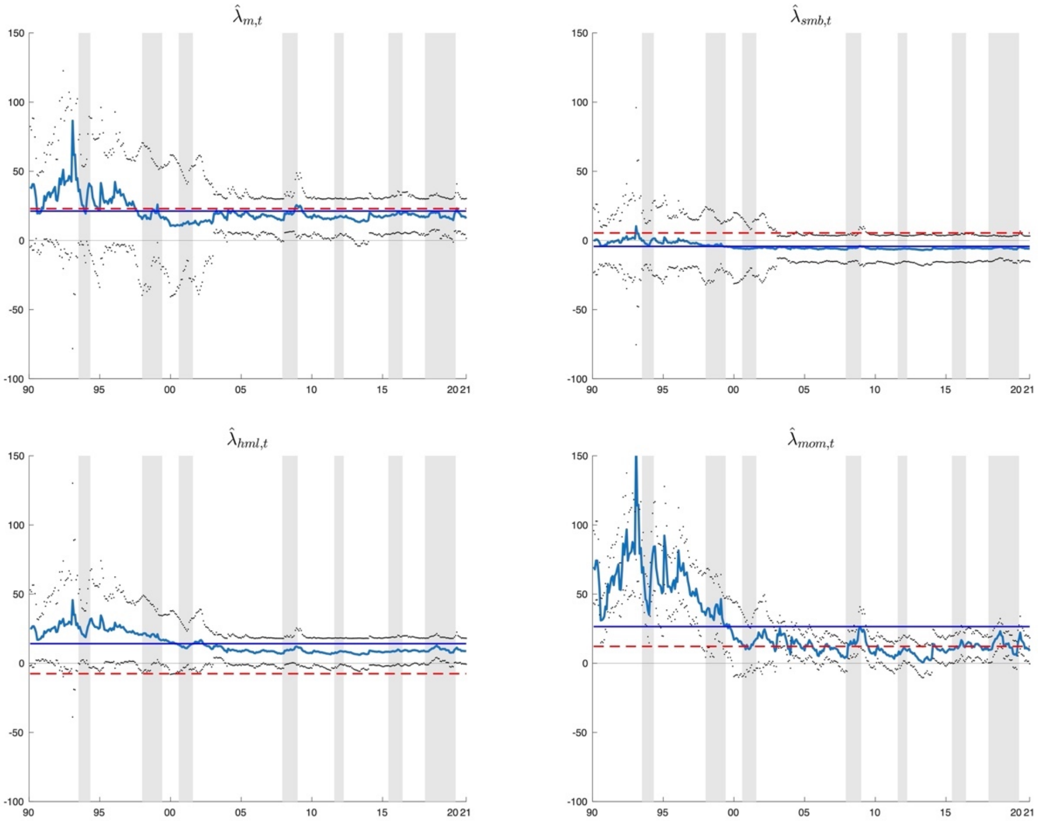
where vector v such that $a_t(\gamma) = b_t(\gamma)' v_t$; when we insert vector v into the equation, excess return becomes $E(R_t(\gamma)|F_{t-1}) = b_t(\gamma)' \lambda_t$ where risk premia, λ, equals to $\lambda_t = v_t + E(f_t|F_{t-1})$, i.e. total of vector v and conditional expectations of factors. We test whether $a_t(\gamma) = b_t(\gamma)'v_t$ or $a_t(\gamma) = 0$. Table 12 and 13 are test results for monthly returns for different time periods. Test results for weekly returns for different periods are shown on Table 14 and 15.

On monthly returns between 1990 and 2020, we reject the null hypothesis Ho: $a(\gamma) = 0$ for all factor models in time invariant estimation results at 5% significance level. However, we can not reject the null hypothesis Ho: $a(\gamma) = b(\gamma)'v$ in all factor models except in CAPM for Fama-French portfolios. In time varying estimation results, we reject both null hypotheses in all factor models. Between 2000 and 2020, we have similar results. In time invariant estimations, we can not reject the null hypothesis Ho: $a(\gamma) = b(\gamma)'v$ in all models except in CAPM for stocks. We can not reject the null hypothesis Ho: $a(\gamma) = 0$ in four factor model and Fama-French model for Fama-French portfolios. In time varying estimation results, we reject both Ho: $a(\gamma) = b(\gamma)'v$ and Ho: $a(\gamma) = 0$ in all factor models except for stocks and Ho: $a(\gamma) = b(\gamma)'v$ in CAPM for Fama-French portfolios.

On weekly returns between 1990 and 2020, we reject the null hypothesis Ho: $a(\gamma) = 0$ for all factor models in time invariant estimation results at 5% significance level, and we reject Ho: $a(\gamma) = b(\gamma)'v$ for stocks. In time varying estimation results, we reject both hypotheses except Ho: $a(\gamma) = b(\gamma)'v$ for stocks in Fama-French model. Between 2000 and 2020, we reject both null hypotheses in time invariant results except for Fama-French and industry portfolios in four factor model and Fama-French three factor model. We reject both null hypotheses based on time varying estimation results.

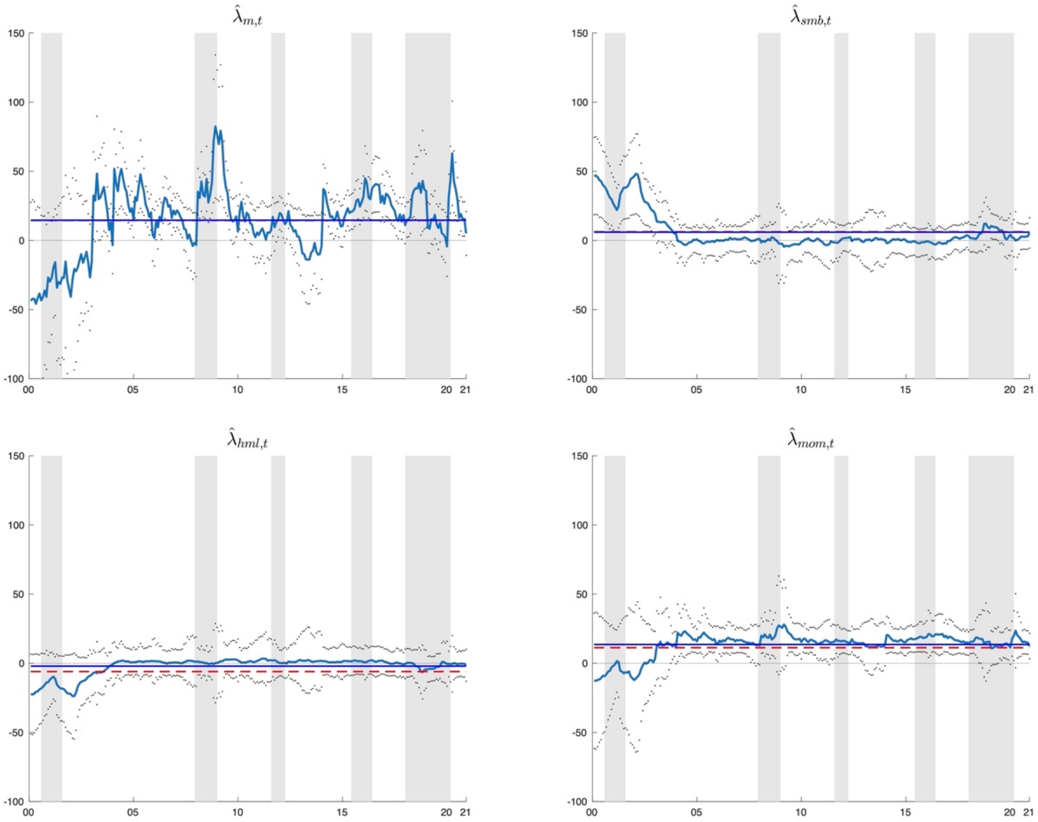
It can be said that capital asset pricing model, Fama-French three factor model and the four factor model are not correct specification of models for time varying estimation between 1990 and 2020. Hence, we can conclude that the factor models should be extended. However, we can not reject both null hypothesis in different models for stocks on monthly returns between 2000 and 2020 while conditional variables are dividend yield and change in consumer price index, meaning that these models do not produce alpha when using individual stocks as test assets during this period.

Figure 1. Path of estimated annualized risk premia on monthly returns for stocks in the four factor model between 1990 and 2020



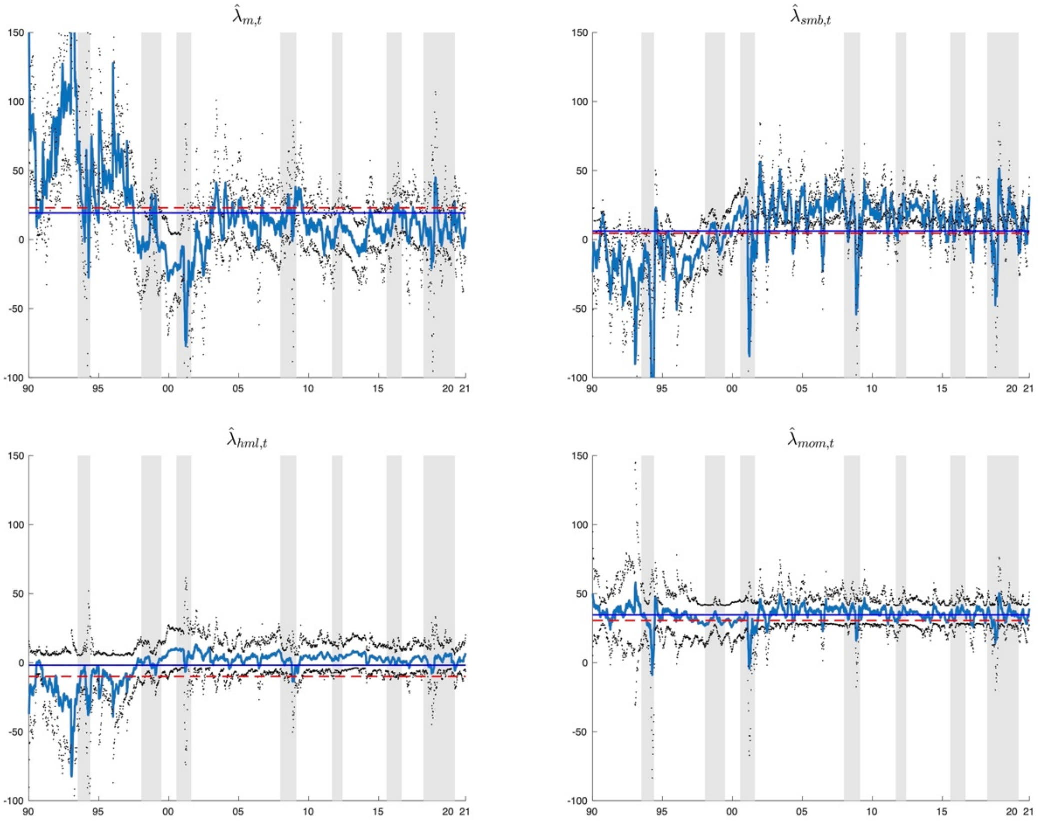
The figure plots the path of estimated annualized risk premia the market (λ_m), size (λ_{smb}), book-to-market (λ_{hml}) and momentum (λ_{mom}) and their pointwise confidence intervals at 95% probability level in the four-factor model. We use the returns of the stocks. We also report the time-invariant (dashed horizontal line) and the average conditional estimate (solid horizontal line). The vertical shaded areas denote recessions.

Figure 2. Path of estimated annualized risk premia on monthly returns for stocks in the four factor model between 2000 and 2020



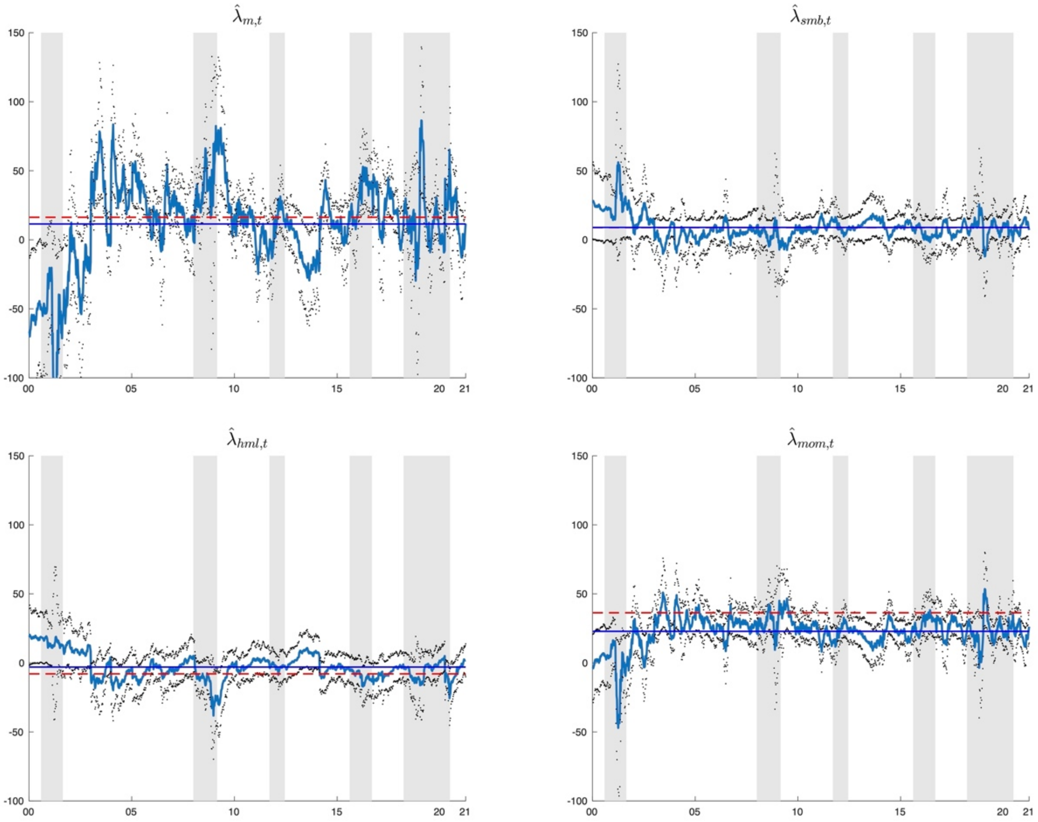
The figure plots the path of estimated annualized risk premia the market (λ_{m}), size (λ_{smb}), book-to-market (λ_{hml}) and momentum (λ_{mom}) and their pointwise confidence intervals at 95% probability level in the four-factor model. We use the returns of the stocks. We also report the time-invariant (dashed horizontal line) and the average conditional estimate (solid horizontal line). The vertical shaded areas denote recessions.

Figure 3. Path of estimated annualized risk premia on weekly returns for stocks in the four factor model between 1990 and 2020



The figure plots the path of estimated annualized risk premia the market (λ_m), size (λ_{smb}), book-to-market (λ_{hml}) and momentum (λ_{mom}) and their pointwise confidence intervals at 95% probability level in the four-factor model. We use the returns of the stocks. We also report the time-invariant (dashed horizontal line) and the average conditional estimate (solid horizontal line). The vertical shaded areas denote recessions.

Figure 4. Path of estimated annualized risk premia on weekly returns for stocks in the four factor model between 2000 and 2020



The figure plots the path of estimated annualized risk premia the market (λ_m), size (λ_{smb}), book-to-market (λ_{hml}) and momentum (λ_{mom}) and their pointwise confidence intervals at 95% probability level in the four-factor model. We use the returns of the stocks. We also report the time-invariant (dashed horizontal line) and the average conditional estimate (solid horizontal line). The vertical shaded areas denote recessions.

Table 8. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Dividend Yield and Change in Consumer Price Index for Monthly Returns Between 1990 and 2020

		vec[F]	v for Stocks	v for FF Portfolios	v for Industry Portfolios
m	const	11.12 (-4.11, 26.36)	10.05 (1.64, 18.46)	2.84 (-7.61, 13.29)	9.06 (-1.60, 19.72)
	Div_{t-1}	30.59 (6.47, 54.71)	-21.52 (-29.17, -13.88)	-10.73 (-18.65, -2.80)	-20.34 (-29.33, -11.34)
	$\Delta\mathrm{CPI}_{t-1}$	-14.84 (-34.98, 5.29)	14.82 (9.07, 20.57)	7.14 (0.65, 13.63)	13.86 (7.62, 20.11)
smb	const	6.22 (-2.16, 14.60)	-10.57 (-17.00, -4.14)	-1.66 (-10.45, 7.11)	-14.17 (-25.38, -2.96)
	Div_{t-1}	-8.46 (-20.86, 3.92)	10.39 (5.00, 15.77)	0.90 (-7.00, 8.82)	16.49 (9.60, 23.37)
	$\Delta\mathrm{CPI}_{t-1}$	5.87 (-5.37, 17.12)	-4.93 (-11.29, 1.43)	-0.36 (-8.07, 7.34)	-6.98 (-19.72, 5.75)
hml	const	5.06 (-4.39, 14.51)	9.08 (2.33, 15.84)	-7.44 (-20.29, 5.40)	3.45 (-13.34, 20.26)
	Div_{t-1}	-0.74 (-12.23, 10.74)	4.55 (-1.06, 10.18)	-2.47 (-15.00, 10.05)	-7.65 (-15.75, 0.45)
	$\Delta\mathrm{CPI}_{t-1}$	5.53 (-6.16, 17.23)	-0.59 (-8.11, 6.93)	-8.73 (-19.50, 2.04)	-1.45 (-18.31, 15.40)
mom	const	-3.74 (-13.74, 6.25)	30.18 (21.83, 38.53)	14.00 (-6.14, 34.15)	24.91 (10.19, 39.62)
	Div_{t-1}	5.84 (-6.63, 18.32)	11.85 (3.79, 19.90)	13.67 (-2.11, 29.46)	0.45 (-12.18, 13.10)
	$\Delta\mathrm{CPI}_{t-1}$	-9.18 (-21.10, 2.72)	20.07 (11.63, 28.52)	4.08 (-17.59, 25.76)	21.91 (7.96, 35.87)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 9. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Dividend Yield and Change in Consumer Price Index for Monthly Returns Between 2000 and 2020

		vec[F]	v for Stocks	v for FF Portfolios	v for Industry Portfolios
m	const	4.73 (-9.12, 18.60)	9.80 (4.46, 15.14)	3.70 (-9.14, 16.56)	6.63 (0.75, 12.52)
	Div_{t-1}	24.91 (7.07, 42.74)	-2.38 (-7.16, 2.39)	-15.49 (-24.52, -6.46)	-5.10 (-10.13, -0.07)
	ΔCPI_{t-1}	-6.42 (-27.14, 14.30)	3.94 (-4.35, 12.23)	-4.07 (-24.58, 16.43)	6.09 (-3.32, 15.50)
smb	const	6.94 (-1.67, 15.56)	-0.96 (-6.66, 4.72)	-1.61 (-12.76, 9.52)	-2.79 (-14.34, 8.75)
	Div_{t-1}	-1.49 (-11.93, 8.95)	0.08 (-4.79, 4.96)	7.36 (-1.40, 16.13)	-2.59 (-10.91, 5.72)
	ΔCPI_{t-1}	2.77 (-7.33, 12.88)	9.23 (2.18, 16.27)	13.22 (-5.91, 32.36)	-1.68 (-14.62, 11.25)
hml	const	3.25 (-5.46, 11.96)	-5.34 (-10.37, -0.31)	7.88 (-3.83, 19.60)	-2.66 (-15.25, 9.92)
	Div_{t-1}	1.48 (-9.32, 12.30)	-1.48 (-6.21, 3.24)	19.40 (10.11, 28.69)	6.08 (-5.12, 17.30)
	ΔCPI_{t-1}	-0.21 (-11.25, 10.83)	-6.28 (-12.59, 0.02)	0.18 (-13.20, 13.58)	-3.14 (-16.64, 10.35)
mom	const	-2.77 (-12.42, 6.86)	16.34 (10.94, 21.74)	23.30 (6.14, 40.46)	14.53 (3.03, 26.02)
	Div_{t-1}	-15.61 (-27.12, -4.09)	19.64 (13.38, 25.90)	20.44 (6.73, 34.15)	19.97 (7.15, 32.78)
	ΔCPI_{t-1}	-17.46 (-33.62, -1.31)	11.94 (4.34, 19.55)	8.00 (-16.19, 32.21)	2.82 (-15.73, 21.39))

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 10. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Dividend Yield and Change in USD-TRY Exchange Rate for Weekly Returns Between 1990 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	12.79 (-1.16, 26.76)	6.50 (2.55, 10.45)	2.77 (-0.60, 6.15)	5.89 (2.27, 9.51)
	Div_{t-1}	31.45 (12.82, 50.07)	3.82 (-1.77, 9.43)	3.47 (-1.80, 8.75)	-0.21 (-5.67, 5.23)
	ΔFX_{t-1}	-16.04 (-42.52, 10.43)	4.52 (0.37, 8.67)	-0.84 (-3.83, 2.14)	1.65 (-2.15, 5.46)
smb	const	4.24 (-4.06, 12.56)	1.92 (-3.44, 7.29)	4.26 (-0.66, 9.18)	-9.06 (-19.59, 1.47)
	Div_{t-1}	-4.93 (-16.37, 6.50)	-6.08 (-12.96, 0.79)	5.38 (-2.85, 13.62)	4.32 (-6.16, 14.81)
	ΔFX_{t-1}	-10.26 (-23.84, 3.30)	-7.46 (-12.50, -2.41)	-0.95 (-5.79, 3.87)	-0.25 (-8.68, 8.17)
hml	const	2.82 (-6.13, 11.77)	-4.66 (-11.52, 2.19)	-5.49 (-13.88, 2.88)	1.42 (-15.60, 18.45)
	Div_{t-1}	-0.70 (-13.83, 12.43)	-9.42 (-19.04, 0.19)	-1.92 (-15.60, 11.75)	-5.41 (-20.42, 9.59)
	ΔFX_{t-1}	-5.88 (-17.04, 5.28)	3.52 (-1.43, 8.48)	1.30 (-5.91, 8.53)	2.17 (-7.37, 11.73)
mom	const	0.94 (-7.82, 9.71)	33.68 (23.98, 43.38)	14.07 (-9.77, 37.92)	7.48 (-12.41, 27.39)
	Div_{t-1}	6.55 (-4.39, 17.49)	-3.37 (-11.21, 4.47)	-12.89 (-32.76, 6.97)	-10.88 (-28.46, 6.69)
	ΔFX_{t-1}	-5.56 (-15.80, 4.68)	-0.82 (-7.62, 5.97)	-3.91 (-17.95, 10.13)	4.46 (-9.83, 18.75)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 11. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Dividend Yield and Change in USD-TRY Exchange Rate for Weekly Returns Between 2000 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	6.04 (-7.12, 19.21)	5.42 (2.70, 8.14)	3.12 (0.79, 5.46)	2.91 (0.85, 4.98)
	Div $_{t-1}$	24.24 (5.50, 42.99)	1.71 (-1.16, 4.58)	1.31 (-0.86, 3.49)	0.86 (-1.79, 3.53)
	ΔFX $_{t-1}$	-14.93 (-35.81, 5.94)	-3.19 (-6.19, -0.19)	-1.23 (-3.40, 0.93)	-0.22 (-3.01, 2.56)
smb	const	7.43 (-1.15, 16.01)	1.52 (-2.30, 5.36)	2.38 (-2.30, 7.06)	5.71 (-2.27, 13.71)
	Div $_{t-1}$	-1.83 (-11.42, 7.75)	-3.54 (-7.39, 0.30)	-1.63 (-5.43, 2.15)	-3.41 (-10.37, 3.54)
	ΔFX $_{t-}$	3.88 (-6.20, 13.98)	2.07 (-1.54, 5.68)	-0.11 (-4.43, 4.20)	1.06 (-5.65, 7.78)
hml	const	2.76 (-6.14, 11.67)	-5.79 (-10.26, -1.32)	-1.50 (-8.36, 5.35)	-10.77 (-22.81, 1.27)
	Div $_{t-1}$	-4.29 (-11.50, 2.90)	-5.15 (-9.49, -0.80)	0.29 (-4.96, 5.55)	2.08 (-8.49, 12.66)
	ΔFX $_{t-}$	-7.23 (-15.21, 0.75)	7.81 (3.57, 12.04)	6.88 (0.69, 13.07)	10.65 (0.53, 20.77)
mom	const	0.96 (-7.60, 9.53)	21.88 (15.94, 27.83)	21.58 (4.52, 38.64)	14.88 (0.60, 29.16)
	Div $_{t-1}$	-2.44 (-11.26, 6.37)	9.62 (4.11, 15.13)	11.58 (-2.37, 25.54)	11.29 (-0.99, 23.58)
	ΔFX $_{t-}$	-1.64 (-10.66, 7.37)	-7.36 (-11.85, -2.86)	-16.84 (-28.67, -5.00)	-8.23 (-19.24, 2.77)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 12. Test Results for Asset Pricing Restrictions for Monthly Returns Between 1990 and 2020 – Conditioning Variables: Dividend Yield and Change in Consumer Price Index

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
Panel A: Time Invariant Models						
	Test of the null hypothesis Ho: a (γ) = b(γ)’v			Test of the null hypothesis Ho: a (γ) = 0		
Four Factor Model						
Test statistic	-0.4692	21.8431	43.8059	6.0856	47.6373	86.6695
p-value	0.6805	0.4086	0.5225	0	0.0041	0.0007
Fama-French Model						
Test statistic	-0.1165	31.1401	42.7156	5.9274	45.1069	82.93
p-value	0.5464	0.0933	0.6106	0	0.0081	0.0018
CAPM						
Test statistic	1.0357	36.7999	40.3202	10.6198	41.236	74.9427
p-value	0.1502	0.0458	0.7767	0	0.0217	0.01
Panel B: Time Varying Models						
	Test of the null hypothesis Ho: a (γ) = b(γ)’v			Test of the null hypothesis Ho: a (γ) = 0		
Four Factor Model						
Test statistic	2.3702	10.0778	12.1062	3.1964	10.9941	13.8530
p-value	0.0089	0	0	0.0007	0	0
Fama-French Model						
Test statistic	2.0705	9.6045	12.1582	2.1286	10.4952	13.1228
p-value	0.0192	0.0002	0.0005	0.0166	0	0
CAPM						
Test statistic	2.2076	12.7523	12.8159	2.1581	13.3215	13.4140
p-value	0.0136	0.0121	0.0031	0.0155	0	0

Notes: In Panel A, we test the null hypotheses Ho: a (γ) = b(γ)’v and Ho: a (γ) = 0 for time invariant models. In Panel B, we test the null hypotheses Ho: a (γ) = b(γ)’v and Ho: a (γ) = 0 for time varying models.

Table 13. Test Results for Asset Pricing Restrictions for Monthly Returns Between 2000 and 2020 – Conditioning Variables: Dividend Yield and Change in Consumer Price Index

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
Panel A: Time Invariant Models						
	Test of the null hypothesis Ho: $a(\gamma) = b(\gamma)'v$			Test of the null hypothesis Ho: $a(\gamma) = 0$		
Four Factor Model						
Test statistic	-0.1581	26.0227	56.778	5.6315	36.8519	81.0341
p-value	0.5628	0.2056	0.1120	0	0.0596	0.0027
Fama-French Model						
Test statistic	0.5848	26.1815	56.4874	5.4673	36.9185	77.2697
p-value	0.2793	0.2440	0.1383	0	0.0588	0.0061
CAPM						
Test statistic	3.2568	36.2291	56.8387	13.216	40.7261	76.4645
p-value	0.0006	0.0521	0.1790	0	0.0245	0.0073
Panel B: Time Varying Models						
	Test of the null hypothesis Ho: $a(\gamma) = b(\gamma)'v$			Test of the null hypothesis Ho: $a(\gamma) = 0$		
Four Factor Model						
Test statistic	1.0417	9.7742	8.5192	1.6258	13.3266	9.7965
p-value	0.1488	0	0	0.0520	0	0
Fama-French Model						
Test statistic	1.0061	12.7269	10.9380	1.2614	14.6825	11.5820
p-value	0.1572	0	0.0006	0.1036	0	0
CAPM						
Test statistic	0.5801	9.3389	10.4070	0.7216	10.2774	10.8232
p-value	0.2809	0.1029	0.0342	0.2353	0	0

Notes: In Panel A, we test the null hypotheses Ho: $a(\gamma) = b(\gamma)'v$ and Ho: $a(\gamma) = 0$ for time invariant models. In Panel B, we test the null hypotheses Ho: $a(\gamma) = b(\gamma)'v$ and Ho: $a(\gamma) = 0$ for time varying models.

Table 14. Test Results for Asset Pricing Restrictions for Weekly Returns Between 1990 and 2020 – Conditioning Variables: Dividend Yield and Change in USD-TRY Exchange Rate

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
Panel A: Time Invariant Models						
	Test of the null hypothesis Ho: a (γ) = b(γ)’v			Test of the null hypothesis Ho: a (γ) = 0		
Four Factor Model						
Test statistic	7.7329	23.8351	41.8318	12.8241	43.7916	78.0768
p-value	0	0.3011	0.6069	0	0.0114	0.0052
Fama-French Model						
Test statistic	8.0287	27.2780	43.7009	12.6047	43.9201	74.5721
p-value	0	0.2009	0.5690	0	0.0111	0.0107
CAPM						
Test statistic	11.7663	35.3050	47.9347	26.9654	40.3242	79.0283
p-value	0	0.0640	0.4755	0	0.0270	0.0042
Panel B: Time Varying Models						
	Test of the null hypothesis Ho: a (γ) = b(γ)’v			Test of the null hypothesis Ho: a (γ) = 0		
Four Factor Model						
Test statistic	1.7976	9.4203	10.5710	2.2163	10.3217	10.8958
p-value	0.0361	0	0	0.0133	0	0
Fama-French Model						
Test statistic	1.5677	9.5131	10.5314	1.7417	10.2967	10.8320
p-value	0.0585	0.0001	0.0001	0.0408	0	0
CAPM						
Test statistic	3.6606	14.7981	11.9521	4.6886	17.7865	13.0872
p-value	0.0001	0.0003	0.0006	0	0	0

Notes: In Panel A, we test the null hypotheses Ho: a (γ) = b(γ)’v and Ho: a (γ) = 0 for time invariant models. In Panel B, we test the null hypotheses Ho: a (γ) = b(γ)’v and Ho: a (γ) = 0 for time varying models.

Table 15. Test Results for Asset Pricing Restrictions for Weekly Returns Between 2000 and 2020 - Conditioning Variables: Dividend Yield and Change in USD-TRY Exchange Rate

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
Panel A: Time Invariant Models						
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
Four Factor Model						
Test statistic	8.9923	29.4435	51.6169	13.5875	45.2825	92.7196
p-value	0	0.1038	0.2310	0	0.0078	0.0002
Fama-French Model						
Test statistic	10.4060	29.8131	60.3928	13.5142	45.0105	91.8189
p-value	0	0.1231	0.0756	0	0.0083	0.0002
CAPM						
Test statistic	16.6682	40.4964	68.3051	33.3346	45.4403	98.9331
p-value	0	0.0189	0.0286	0	0.0074	0
Panel B: Time Varying Models						
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
Four Factor Model						
Test statistic	3.5377	13.1580	11.1741	3.9131	14.8837	11.8658
p-value	0.0002	0	0	0	0	0
Fama-French Model						
Test statistic	3.3006	13.6671	11.0488	3.4798	14.3899	11.6023
p-value	0.0005	0	0	0.0003	0	0
CAPM						
Test statistic	3.4342	14.6063	11.1699	3.8042	15.6672	11.4635
p-value	0.0003	0.0015	0.0010	0.0001	0	0

Notes: In Panel A, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time invariant models. In Panel B, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time varying models.

4.3 Conditional information: Change in consumer price index

Ferson and Harvey (1993) finds that the monthly change in a measure of long term inflationary expectations capture predictable variation in cross sectional variation among asset returns; therefore, we choose change in consumer price index (CPI) as one of the conditioning variables. Time invariance test results show that when we exclude 90's, change in CPI has predictive power on conditional factor expectations. However, we can not reject time variation of risk premia between 1990 and 2020 as well when we choose change in CPI as conditional information variable, because other component of time varying premia, cross sectional parameter v, is different than zero.

Results of time invariance test indicate that we do not reject time invariance of cross sectional vector v between 1990 and 2020 when Fama-French portfolios as test assets, implying Fama-French portfolios mask time variation. P-value is 0.7501.

4.3.1 Estimation results with time varying model

On Table 16 and 17, estimated annualized components of vec[F] and v for the time varying four factor model for monthly returns on change in consumer price index between 1990-2020 and 2000-2020 are shown.

Between 1990 and 2020, conditional expectations of all factors are positive at the average of CPI level except momentum. However, they are insignificant at 5% level for all factors. Parts of cross sectional parameter v explained by market and momentum betas, on the other hand, are positive and significant. Vector v on momentum is also significant and positive for portfolios.

Although they are insignificant the effect of change in CPI are negative on market and momentum factors, -0.33% and -6.41, and positive on size and book-to-market factors, 6.21% and 5.05%. Its effect on the parts of cross sectional parameter v explained by market and momentum factors are significant, %13.28 and % 15.45 respectively. Its total effect becomes positive 12.95% for market factor and 9.04% for momentum factor when we choose stocks as test test assets.

This result is not surprising as we stated change in CPI do not have predictive power on conditional factor expectations between 1990 and 2020, on the other hand, constant part explained by factors is time varying.

Between 2000 and 2020, conditional expectations of factors are positive except momentum while change in CPI on average, but results are insignificant. Effect of change in CPI is negative for all factors except size factor. For market factor, predictive power of change in CPI is negative and significant, -21.01%, in other words, excess market premium decreases in inflationary environment. When we add its effect on v, total effect is -11.02% for stocks, -12.77% for industry portfolios and -11.97% for Fama-French portfolios.

4.3.2 Results on testing the asset pricing restrictions

Table 18 contains test results for asset pricing restrictions for different models and different time intervals when conditional conditioning variable is change in CPI. Between 1990 and 2020, we can not reject Ho: $a(\gamma) = b(\gamma)'v$ in four factor and Fama-French models for stocks. In other words, alpha can be explained by factor betas, however, change in CPI does not have predictive power on factor conditionals. Between 2000 and 2020, we do not reject Ho: $a(\gamma) = b(\gamma)'v$ in all factor models for stocks. In other words, alphas can be explained by conditional factor betas when coniditioning variable is change in consumer price index between 2000 and 2020.

Table 16. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in Consumer Price Index for Monthly Returns Between 1990 and 2020

		vec[F]	v for Stocks	v for FF Portfolios	v for Industry Portfolios
m	const	11.15 (-4.32, 26.63)	12.03 (5.34 18.71)	6.35 (-3.02, 15.74)	5.30 (-4.01, 14.63)
	ΔCPI_{t-1}	-0.33 (-16.68, 16.00)	13.28 (8.97, 17.58)	2.44 (-3.65, 8.54)	4.80 (-1.31, 10.93)
smb	const	6.21 (-2.20, 14.63)	-2.65 (-7.71, 2.40)	-4.20 (-12.35, 3.94)	-3.48 (-13.92, 6.94)
	ΔCPI_{t-1}	1.86 (-7.72, 11.45)	-7.00 (-11.47, -2.53)	-0.68 (-6.89, 5.53)	-1.28 (-11.57, 9.00)
hml	const	5.05 (-4.39, 14.51)	3.33 (-2.03, 8.71)	-5.38 (-17.75, 6.99)	-0.75 (-15.46, 13.95)
	ΔCPI_{t-1}	5.17 (-6.65, 17.01)	0.05 (-5.75, 5.86)	-3.76 (-14.53, 7.00)	-1.00 (-16.16, 14.14)
mom	const	-3.73 (-13.75, 6.27)	25.85 (18.85, 32.85)	23.39 (2.59, 44.19)	40.31 (25.29, 55.33)
	ΔCPI_{t-1}	-6.41 (-17.06, 4.23)	15.45 (8.63, 22.26)	9.13 (-14.09, 32.36)	31.35 (17.27, 45.43)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 17. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in Consumer Price Index for Monthly Returns Between 2000 and 2020

		vec[F]	v for Stocks	v for FF Portfolios	v for Industry Portfolios
m	const	4.80 (-9.28, 18.89)	6.20 (2.04, 10.36)	3.18 (-2.57, 8.94)	2.36 (-3.02, 7.76)
	ΔCPI_{t-1}	-21.01 (-41.22, -0.80))	9.99 (4.06, 15.91)	9.04 (-0.29, 18.38)	8.24 (1.29, 15.19)
smb	const	6.94 (-1.67, 15.55)	-2.90 (-7.14, 1.33)	0.24 (-6.06, 6.55)	-4.10 (-13.68, 5.47)
	ΔCPI_{t-1}	3.64 (-4.64, 11.94)	-6.33 (-10.58, -2.09)	-0.50 (-9.86, 8.84)	-4.53 (-13.88, 4.81)
hml	const	3.25 (-5.45, 11.96)	-1.25 (-4.75, 2.24)	-0.29 (-7.72, 7.13)	7.14 (-5.81, 20.11)
	ΔCPI_{t-1}	-1.0 (-9.68, 7.51)	-1.33 (-5.72, 3.06)	-18.46 (-28.53, -8.39)	-4.02 (-14.04, 5.99)
mom	const	-2.81 (-12.59, 6.95)	17.49 (12.84, 22.15)	14.04 (-0.26, 28.35)	21.29 (8.86, 33.72)
	ΔCPI_{t-1}	-8.32 (-22.82, 6.17)	3.44 (-2.40, 9.29)	0.13 (-17.10, 17.36)	-2.61 (-14.55, 9.32)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 18. Time Varying Test Results for Asset Pricing Restrictions for Monthly Returns in Different Time Intervals – Conditioning Variable: Change in Consumer Price Index

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
			Panel A: 1990 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	0.6976	4.9076	4.9816	2.2817	5.4016	7.0036
p-value	0.2427	0	0.0051	0.0113	0	0
			Fama-French Model			
Test statistic	0.9761	4.6875	5.9068	0.1645	4.7849	6.0113
p-value	1.7258	0.0076	0.0135	0.0422	0	0
			CAPM			
Test statistic	2.3518	5.0747	6.9714	2.6703	5.1207	6.9868
p-value	0.0093	0.1998	0.0133	0.0038	0	0
			Panel B: 2000 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	1.3118	5.7407	4.8792	1.9709	6.7182	5.6580
p-value	0.0948	0	0.0172	0.0244	0	0
			Fama-French Model			
Test statistic	1.4388	6.1983	5.8423	1.7029	6.8470	6.0701
p-value	0.0751	0.0011	0.0230	0.0443	0	0
			CAPM			
Test statistic	0.5246	5.1139	5.4961	0.7851	5.9679	5.7927
p-value	0.2999	0.1979	0.1147	0.2162	0	0.0040

Notes: In Panel A, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time invariant models. In Panel B, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time varying models.

4.4 Conditional information: Change in industrial production index

Ferson and Harvey (1993) choose a weighted average of industrial production growth rates in the G-7 countries as global risk factor, its explanatory power is not significant though. We also apply change in industrial production index (IPI) as one of the information variables. However, time invariance test results show that it has no predictive power on conditional expectation of factors on both time intervals. Its p-value is 0.1118 and 0.5750 respectively. It still has a significant effect on cross sectional parameter v, which is time varying as the null hypothesis H_0: $Av = 0$ is rejected for both time intervals.

4.4.1 Estimation results with time varying model

On Table 19 and 20, estimated annualized components of vec[F] and v for the time varying four factor model for monthly returns on industrial production index between 1990-2020 and 2000-2020 are shown.

Between 1990 and 2020, conditional expectations of factors are positive except momentum, while change in industrial production index at the average. Market factor is 11.08%, size factor is 6.18%, book-to-market factor is 5.01% and momentum factor is
-3.71%. Parts of time varying cross sectional parameter v explained by market and momentum factors are positive and significant for stocks though, they are 6.42% and 15.39% respectively. In total, market premium is 17.08%, and momentum premium 11.68% when change in IPI is on average.

Although they are insignificant, change in IPI has a negative effect on all factors except momentum; -13.27% for market factor, -5.63% for size factor, -10.24% for book-to-market factor and 7.97% for momentum factor. On the other hand, its interaction effect with market factor on cross sectional parameter v is significant for stocks. After adding adding vector v, its total effect on factors is negative except momentum.

Between 2000 and 2020, its effect on conditional factor expectations is negative except momentum factor similarly. Interaction effects with factors on cross sectional parameter v are significant for stocks except market factor, and they are negative for market and momentum factors, -1.70% and -6.38%, and positive for size and book-to-market factors, 5.14% and 4.67% respectively.

4.4.2 Results on testing the asset pricing restrictions

Table 21 contains test results for asset pricing restrictions when conditioning variable is change in IPI. We can not reject the null hypothesis Ho: $a(\gamma) = b(\gamma)'v$ for both time intervals in different models for stocks. Although conditional factor betas can explain constant term, our conditioning variable does not have predictive power on factor premiums.

Table 19. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in Industrial Production Index for Monthly Returns Between 1990 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	11.08 (-4.33, 26.51)	6.42 (3.69, 9.16)	1.39 (-3.01, 5.79)	4.73 (0.55, 8.90)
	ΔIPI_{t-1}	-13.27 (-28.56, 2.02)	-2.66 (-5.29, -0.03)	0.89 (-3.52, 5.30)	0.19 (-3.51, 3.89)
smb	const	6.18 (-2.21, 14.58)	-1.95 (-4.60, 0.68)	0.61 (-3.53, 4.76)	-5.80 (-12.94, 1.33)
	ΔIPI_{t-1}	-5.63 (-14.27, 3.00)	4.80 (2.41, 7.19)	-1.27 (-5.98, 3.43)	4.03 (-2.97, 11.03)
hml	const	5.01 (-4.39, 14.43)	-1.78 (-4.81, 1.24)	6.69 (0.31, 13.06)	-0.68 (-11.50, 10.12)
	ΔIPI_{t-1}	-10.24 (-21.27, 0.78)	4.36 (1.97, 6.75)	-0.49 (-7.62, 6.63)	2.01 (-7.46, 11.48)
mom	const	-3.71 (-13.71, 6.29)	15.39 (11.61, 19.16)	7.44 (-7.41, 22.29)	10.01 (-0.17, 20.20)
	ΔIPI_{t-1}	7.97 (-4.19, 20.15)	-3.88 (-7.31, -0.45)	0.05 (-12.11, 12.21)	-2.00 (-12.15, 8.14)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 20. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in Industrial Production Index for Monthly Returns Between 2000 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	4.75 (-9.53, 19.04)	5.61 (2.88, 8.33)	3.15 (-0.16, 6.47)	2.39 (-1.27, 6.06)
	ΔIPI_{t-1}	-5.79 (-21.49, 9.90)	-1.70 (-4.30, 0.89)	0.73 (-2.50, 3.96)	2.21 (-1.69, 6.11)
smb	const	6.91 (-1.70, 15.53)	-0.39 (-3.19, 2.39)	-1.20 (-5.76, 3.34)	-0.41 (-7.88, 7.06)
	ΔIPI_{t-1}	-4.10 (-12.35, 4.14)	5.14 (2.68, 7.60)	-1.06 (-5.95, 3.82)	2.79 (-2.70, 8.29)
hml	const	3.22 (-5.46, 11.90)	-2.98 (-6.28, 0.31)	4.30 (-1.21, 9.83)	-0.09 (-11.47, 11.28)
	ΔIPI_{t-1}	-4.35 (-13.76, 5.06)	4.67 (2.06, 7.28)	2.55 (-3.65, 8.76)	1.96 (-4.83, 8.76)
mom	const	-2.76 (-12.49, 6.96)	16.41 (12.66, 20.17)	9.01 (-4.30, 22.32)	23.88 (15.17, 32.60)
	ΔIPI_{t-1}	7.88 (-7.09, 22.85)	-6.38 (-9.88, -2.89)	0.82 (-10.80, 12.45)	-10.88 (-18.31 -3.46)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 21. Time Varying Test Results for Asset Pricing Restrictions for Monthly Returns in Different Time Intervals – Conditioning Variable: Change in Industrial Production Index

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
			Panel A: 1990 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	0.8322	4.0743	5.5916	1.8263	4.6188	5.9123
p-value	0.2026	0	0	0.0339	0	0
			Fama-French Model			
Test statistic	0.6596	4.1278	5.6117	1.2870	4.7114	5.8267
p-value	0.2548	0.0858	0.0009	0.0991	0	0
			CAPM			
Test statistic	0.8436	5.2751	5.9382	1.6437	5.8096	6.1289
p-value	0.1994	0.0786	0.0083	0.0501	0	0
			Panel B: 2000 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	1.2187	6.4978	5.9213	2.2229	7.2260	7.1580
p-value	0.1115	0	0.0002	0.0131	0	0
			Fama-French Model			
Test statistic	1.2548	5.7172	6.7713	1.7488	6.3586	6.8500
p-value	0.1048	0.0002	0.0004	0.0402	0	0
			CAPM			
Test statistic	1.4036	6.5429	7.6469	1.8994	7.5030	7.9597
p-value	0.0802	0.0241	0.0006	0.0288	0	0

Notes: In Panel A, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time invariant models. In Panel B, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time varying models.

4.5 Conditional information: Change in brent oil price

Ferson and Harvey (1993) find that the change in the monthly average US dollar price per barrel of crude oil have predictive power on asset returns. However, we do not find evidence that it could explain factor premiums, it has significant effect on time varying alphas though.

4.5.1 Estimation results with time varying model

On Table 22 and 23, estimated annualized components of vec[F] and v for the time varying four factor model for monthly returns on change in brent oil price between 1990-2020 and 2000-2020 are shown, results estimated with weekly returns are on Table 24 and 25.

For monthly returns between 1990 and 2020, change in brent oil price has positive effect on all factors except market factor, although they are insignificant at 5%. Constant parts of cross sectional parameter v explained by market and momentum factors is positive and significant for stocks, 5.45% and 7.35% respectively. Its interaction effects with book-to-market and momentum factors on v are negative and significant for stocks, -5.70% and -6.97%. Results are similar on monthly returns between 2000 and 2020. Interaction effects with book-to-market and momentum factors are significant, -6.01% and -9.04% respectively.

For weekly returns between 1990 and 2020, its effect on factors is negative except momentum factor and insignificant. Unlike results on monthly data, its interaction with momentum on v is insignificant, its interaction effect with bm factor on v is -6.89% and significant. We get similar results between 2000 and 2020, its effect on factors is negative except momentum factor and insignificant. Additionally, it is significant on part of v explained by book-to-market factor, -7.27%.

4.5.2 Results on testing the asset pricing restrictions

Test results for asset pricing restrictions are on Table 26 for monthly returns and on Table 27 for weekly returns. We can not reject the null hypothesis Ho: $\mathrm{a}(\gamma) = \mathrm{b}(\gamma)'\mathrm{v}$ for stocks on monthly returns in different time intervals. However, we reject both null hypotheses in different models for different test assets in different time intervals on weekly returns, implying that CAPM, FF three factor model and Carhart four factor model do not capture time variation of weekly asset returns.

Table 22. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in Brent Oil Price for Monthly Returns Between 1990 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	11.15 (-4.35, 26.65)	5.45 (2.75, 8.15)	3.14 (-1.50, 7.79)	6.04 (1.91, 10.18)
	ΔOil_{t-1}	-1.55 (-22.23, 19.11)	-1.78 (-4.02, 0.45)	-0.88 (-4.60, 2.84)	0.26 (-2.88, 3.41)
smb	const	6.22 (-2.20, 14.64)	-0.48 (-3.26, 2.29)	3.34 (-0.99, 7.67)	-4.59 (-11.42, 2.23)
	ΔOil_{t-1}	3.32 (-6.35, 13.00)	0.22 (-2.03, 2.49)	1.86 (-1.55, 5.28)	0.04 (-6.80, 6.89)
hml	const	5.06 (-4.41, 14.55)	-2.88 (-5.81, 0.03)	-1.28 (-8.43, 5.87)	1.62 (-9.08, 12.33)
	ΔOil_{t-1}	0.18 (-9.46, 9.83)	-5.70 (-8.23, -3.17)	-8.09 (-13.83, -2.35)	-2.94 (-12.0, 6.11)
mom	const	-3.73 (-13.76, 6.28)	7.35 (3.75, 10.95)	14.40 (0.43, 28.37)	5.45 (-4.45, 15.36)
	ΔOil_{t-1}	5.39 (-4.52, 15.31)	-6.97 (-9.90, -4.04)	-18.31 (-31.32, -5.31)	-8.38 (-16.15, -0.60)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 23. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in Brent Oil Price for Monthly Returns Between 2000 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	4.76 (-9.48, 19.01)	4.95 (2.39, 7.51)	4.58 (1.30, 7.86)	2.60 (-1.42, 6.64)
	ΔOil_{t-1}	-12.56 (-26.98, 1.84)	-2.19 (-4.53 0.14)	-0.18 (-3.28, 2.91)	-1.51 (-4.86, 1.83)
smb	const	6.94 (-1.69, 15.57)	0.45 (-2.50, 3.41)	-0.93 (-5.38, 3.52)	-2.82 (-10.40, 4.75)
	ΔOil_{t-1}	-0.55 (-10.25, 9.15)	-1.10 (-3.42, 1.22)	-0.42 (-4.04, 3.20)	0.25 (-5.16, 5.66)
hml	const	3.25 (-5.46, 11.97)	-2.91 (-6.12, 0.28)	-1.61 (-7.39, 4.16)	6.97 (-3.98, 17.93)
	ΔOil_{t-1}	0.23 (-10.17, 10.64)	-6.01 (-8.63, -3.38)	-0.53 (-5.58, 4.50)	-3.57 (-11.56, 4.41)
mom	const	-2.78 (-12.50, 6.92)	6.95 (3.20, 10.70)	13.70 (1.78, 25.62)	14.13 (5.50, 22.76)
	ΔOil_{t-1}	12.01 (-1.63, 22.39)	-9.04 (-12.33, -5.75)	-10.73 (-21.03, -0.44)	-7.04 (-14.62, 0.53)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 24. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in Brent Oil Price for Weekly Returns Between 1990 and 2020

		vec[F]	v for Stocks	v for FF Portfolios	v for Industry Portfolios
m	const	12.79 (-1.25, 26.85)	6.72 (4.33, 9.11)	3.29 (0.88, 5.71)	5.36 (2.47, 8.26)
	$\Delta \mathrm{Oil}_{t-1}$	-1.03 (-14.93, 12.86)	-1.05 (-3.58, 1.46)	0.37 (-3.44, 4.20)	-0.39 (-3.23, 2.45)
smb	const	4.23 (-4.09, 12.57)	-0.72 (-3.93, 2.48)	1.24 (-2.62, 5.12)	-8.58 (-17.67, 0.49)
	$\Delta \mathrm{Oil}_{t-1}$	-1.80 (-10.75, 7.14)	5.45 (2.31, 8.59)	2.72 (-2.60, 8.06)	4.59 (-2.67, 11.87)
hml	const	2.81 (-6.14, 11.77)	-4.83 (-9.02, -0.64)	-1.58 (-7.71, 4.54)	3.91 (-10.87, 18.69)
	$\Delta \mathrm{Oil}_{t-1}$	-2.56 (-12.50, 7.38)	-6.89 (-10.23, -3.55)	-6.38 (-12.91, 0.14)	0.92 (-11.01, 12.86)
mom	const	0.94 (-7.82, 9.72)	19.67 (13.84, 25.50)	14.95 (-5.13, 35.04)	-2.65 (-21.11, 15.79)
	$\Delta \mathrm{Oil}_{t-1}$	8.71 (-3.02, 20.44)	1.79 (-2.57, 6.17)	-6.31 (-20.52, 7.89)	-1.36 (-14.31, 11.58)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 25. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in Brent Oil Price for Weekly Returns Between 2000 and 2020

		vec[F]	v for Stocks	v for FF Portfolios	v for Industry Portfolios
m	const	6.04 (-7.24, 19.32)	6.38 (3.99, 8.77)	2.55 (0.48, 4.62)	2.71 (0.88, 4.53)
	$\Delta \mathrm{Oil}_{t-1}$	-1.85 (-17.80, 14.09)	-1.88 (-4.50, 0.74)	1.69 (-0.83, 4.22)	-0.64 (-3.02, 1.73)
smb	const	7.43 (-1.15, 16.01)	1.78 (-1.65, 5.23)	-1.19 (-4.99, 2.61)	-3.14 (-11.00, 4.70)
	$\Delta \mathrm{Oil}_{t-1}$	-3.98 (-14.35, 6.37)	5.60 (1.94, 9.26)	3.48 (-1.78, 8.76)	4.52 (-1.79, 10.84)
hml	const	2.75 (-6.17, 11.68)	-6.89 (-11.19, -2.58)	5.31 (-0.10, 10.73)	3.67 (-9.44, 16.79)
	$\Delta \mathrm{Oil}_{t-1}$	-0.29 (-12.02, 11.43)	-7.27 (-10.86, -3.68)	-4.94 (-11.27, 1.38)	-2.65 (-12.53, 7.22)
mom	const	0.96 (-7.58, 9.52)	23.11 (17.25, 28.97)	18.49 (-0.17, 37.15)	19.47 (3.24, 35.70)
	$\Delta \mathrm{Oil}_{t-1}$	8.92 (-5.78, 23.63)	1.28 (-3.28, 5.86)	13.44 (-4.86, 31.75)	-1.90 (-12.95, 9.13)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 26. Time Varying Test Results for Asset Pricing Restrictions for Monthly Returns in Different Time Intervals – Conditioning Variable: Change in Brent Oil Price

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
			Panel A: 1990 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)’v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	1.2477	3.9222	5.1322	2.0846	5.5093	5.6403
p-value	0.1061	0	0.0001	0.0186	0	0
			Fama-French Model			
Test statistic	0.9500	4.3610	5.318	1.6089	5.1317	5.6336
p-value	0.1711	0.0030	0.0020	0.0538	0	0
			CAPM			
Test statistic	0.2647	3.8728	4.9234	1.0511	4.8401	5.4165
p-value	0.3956	0.3817	0.0887	0.1466	0	0
			Panel B: 2000 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)’v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	0.6573	5.4596	4.7061	1.5496	6.5934	5.6782
p-value	0.2555	0	0.0025	0.0606	0	0
			Fama-French Model			
Test statistic	0.4737	5.7791	5.2190	1.0868	6.2437	5.5360
p-value	0.3179	0.0002	0.0150	0.1386	0	0
			CAPM			
Test statistic	0.0514	4.8771	5.2998	1.2771	6.5163	6.2710
p-value	0.4795	0.1607	0.0751	0.1008	0	0

Notes: In Panel A, we test the null hypotheses Ho: a (γ) = b(γ)’v and Ho: a (γ) = 0 for time invariant models. In Panel B, we test the null hypotheses Ho: a (γ) = b(γ)’v and Ho: a (γ) = 0 for time varying models.

Table 27. Time Varying Test Results for Asset Pricing Restrictions for Weekly Returns in Different Time Intervals – Conditioning Variable: Change in Brent Oil Price

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
			Panel A: 1990 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	2.3654	6.3813	5.2927	3.2909	7.0973	5.6512
p-value	0.0090	0	0	0.0005	0	0
			Fama-French Model			
Test statistic	2.4119	6.4028	5.2691	3.0258	6.9666	5.5877
p-value	0.0079	0	0	0.0012	0	0
			CAPM			
Test statistic	3.2072	8.3474	5.7490	4.0302	9.0504	6.1260
p-value	0.0007	0.0004	0.0066	0.0000	0	0
			Panel B: 2000 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	1.6653	4.6341	4.5796	2.4398	6.0779	5.0807
p-value	0.0479	0	0.0002	0.0073	0	0
			Fama-French Model			
Test statistic	1.7445	5.4367	4.7576	2.3248	6.4697	4.8813
p-value	0.0405	0.0001	0.0032	0.0100	0	0
			CAPM			
Test statistic	2.2087	7.9334	5.5664	2.8619	9.2029	5.9575
p-value	0.0136	0.0062	0.0352	0.0021	0	0

Notes: In Panel A, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time invariant models. In Panel B, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time varying models.

4.6 Conditional information: Change in USD-TRY exchange rate

USD-TRY exchange rate does not have predictive power on monthly asset returns for both time intervals, however, its effect is significant on conditional expectations of factors between 1990 and 2020 when estimations are based on weekly returns.

4.6.1 Estimation results with time varying model

On Table 28 and 29, estimated annualized components of vec[F] and v for the time varying four factor model for monthly returns on change in usd-try exchange rate between 1990-2020 and 2000-2020 are shown, results estimated with weekly returns are on Table 30 and 31.

For monthly returns between 1990 and 2020, it has insignificant positive effect on market, size and book-to-market factors. On the other hand, its effect is -11.92% on conditional expectation of momentum factor and significant. Its effect on the parts of v explained by market and book-to-market factors are also significant, -5.13% and 11.68% respectively. After removing volatile 90's, its effect on momentum ceases. However, its interaction effects with market, size and book-to-market factors on v are significant,

-3.65%, 2.72% and 5.71%.

For weekly returns between 1990 and 2020, it has effect on neither conditional factor expectations nor cross sectional vector v. However, its effect on parts of v explained by momentum factor is negative, which is -8.23%, and significant between 2000 and 2020 for stocks.

4.6.2 Results on testing the asset pricing restrictions

Test results for asset pricing restrictions are on Table 32 for monthly returns and on Table 33 for weekly returns. We can not reject the null hypothesis Ho: $a(\gamma) = b(\gamma)'v$ for stocks when estimations based on monthly data except in Fama-French Model between 2000 and 2020, however, we reject both null hypotheses for weekly estimations.

Although test results for time invariance of factors conditional expectations suggest that change in usd-try exchange rate has predictive power on weekly factor returns between 1990 and 2020, decomposition of its effect on Table 30 shows that it does not have any significant effect on conditional expectations of factors. Time invariance test explained in detail in section 4.2. In general, we generate a chi-square test statistic using conditional expectation of factors and their variance.

In order to compare change in usd-try exchange rate with the change in brent oil price, which does not have explanatory power on conditional factors in the same period, we present conditional expectations of factors on both conditioning variable cases. Monthly conditional expectations of factors are -1.35%, -2.25%, -1.17%, -0.71% in the case of change in usd-try exchange rate; and -0.2 %, -0.3, -0.4%, 1.68% in the case of change in brent oil price. High conditional expectations and low variance could cause significant explanatory power in total.

Table 28. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in USD-TRY Exchange Rate for Monthly Returns Between 1990 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	11.15 (-4.33, 26.64)	7.48 (4.51, 10.46)	7.29 (2.26, 12.33)	10.15 (5.47, 14.83)
	ΔFX_{t-1}	2.81 (-13.88, 19.52)	-5.13 (-8.17, -2.09)	-3.94 (-8.19, 0.30)	0.60 (-3.20, 4.41)
smb	const	6.21 (-2.20, 14.63)	-2.23 (-5.14, 0.67)	1.96 (-3.42, 7.34)	-4.31 (-12.51, 3.88)
	ΔFX_{t-1}	2.09 (-8.49, 12.68)	0.36 (-2.35, 5.38)	1.44 (-2.86, 5.76)	-1.34 (-7.97, 5.27)
hml	const	5.06 (-4.39, 14.52)	2.41 (-0.55, 3.08)	-3.64 (-11.76, 4.47)	-5.36 (-18.15, 7.41)
	ΔFX_{t-1}	6.30 (-8.36, 20.98)	11.68 (8.48, 14.87)	-2.32 (-8.13, 3.48)	-3.52 (-13.54, 6.49)
mom	const	-3.74 (-13.71, 6.22)	6.08 (1.96, 10.21)	21.99 (5.97, 38.01)	13.53 (2.46, 24.60)
	ΔFX_{t-1}	-11.92 (-23.24, -0.59)	-3.85 (-8.62, 0.90)	8.54 (-4.20, 21.28)	7.33 (-3.61, 18.28)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 29. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in USD-TRY Exchange Rate for Monthly Returns Between 2000 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	4.78 (-9.48, 19.05)	8.10 (5.39, 10.81)	5.50 (2.10, 8.89)	6.07 (2.57, 9.58)
	ΔFX_{t-1}	-11.07 (-33.46, 11.30)	-3.65 (-6.58, -0.72)	-3.58 (-7.49, 0.32)	0.51 (-3.15, 4.18)
smb	const	6.94 (-1.65, 15.54)	-2.39 (-5.42, 0.62)	2.13 (-2.14, 6.42)	-1.04 (-7.74, 5.66)
	ΔFX_{t-1}	4.89 (-4.38, 14.17)	2.72 (0.61, 4.83)	1.44 (-3.14, 6.03)	-3.29 (-8.11, 1.51)
hml	const	3.24 (-5.44, 11.94)	-3.88 (-6.83, -0.93)	-4.23 (-9.93, 1.46)	-2.40 (-11.75, 6.95)
	ΔFX_{t-1}	-3.41 (-12.00, 5.18)	5.71 (3.25, 8.17)	-4.74 (-10.16, 0.67))	7.97 (2.13, 13.81)
mom	const	-2.83 (-12.60, 6.93)	13.18 (9.58, 16.78)	20.03 (6.68, 33.38)	14.07 (5.44, 22.69)
	ΔFX_{t-1}	-9.85 (-26.43, 6.72)	-0.13 (-4.29, 4.01)	6.89 (-5.89, 19.68)	5.63 (-2.60, 13.87)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 30. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in USD-TRY Exchange Rate for Weekly Returns Between 1990 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	12.80 (-1.23, 26.85)	6.76 (4.06, 9.45)	1.28 (-1.55, 4.13)	3.77 (0.83, 6.71)
	ΔFX_{t-1}	-7.01 (-32.40, 18.38)	1.01 (-2.09, 4.13)	1.65 (-0.94, 4.26)	2.27 (-1.36, 5.91)
smb	const	4.24 (-4.06, 12.56)	2.70 (-0.68, 6.10)	4.10 (-0.29, 8.49)	-2.49 (-11.28, 6.29)
	ΔFX_{t-1}	-11.68 (-24.69, 1.32)	1.55 (-2.04, 5.15)	-1.23 (-5.84, 3.37)	-0.007 (-7.87, 7.85)
hml	const	2.82 (-6.13, 11.77)	-5.49 (-10.04, -0.93)	-3.34 (-10.70, 4.01)	-4.83 (-19.68, 10.02)
	ΔFX_{t-1}	-6.08 (-17.07, 4.90)	0.94 (-2.59, 4.49)	0.63 (-5.72, 7.00)	0.32 (-7.20, 7.85)
mom	const	0.94 (-7.83, 9.72)	30.07 (23.89, 36.24)	11.21 (-10.93, 33.36)	-3.04 (-21.39, 15.29)
	ΔFX_{t-1}	-3.68 (-13.50, 6.13)	-0.07 (-5.44, 5.29)	0.95 (-12.47, 14.38)	9.16 (-4.85, 23.18)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 31. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Change in USD-TRY Exchange Rate for Weekly Returns Between 2000 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	6.05 (-7.19, 19.30)	7.50 (5.01, 10.00)	2.98 (0.75, 5.22)	3.93 (2.00, 5.87)
	ΔFX_{t-1}	-15.90 (-36.38, 4.58)	-1.03 (-3.97, 1.90)	-1.53 (-3.97, 0.90)	0.13 (-2.61, 2.87)
smb	const	7.43 (-1.15, 16.01)	2.23 (-1.22, 5.69)	-0.49 (-4.76, 3.77)	1.72 (-6.37, 9.83)
	ΔFX_{t-1}	3.96 (-6.18, 14.10)	2.08 (-1.39, 5.55)	-0.89 (-5.46, 3.67)	0.51 (-6.64, 7.67)
hml	const	2.76 (-6.15, 11.68)	-5.94 (-10.42, -1.46)	2.38 (-3.89, 8.66)	-4.40 (-17.78, 8.96)
	ΔFX_{t-1}	-7.05 (-15.15, 1.03)	3.30 (-0.71, 7.32)	8.36 (1.39, 15.33)	9.54 (-2.28, 21.37)
mom	const	0.96 (-7.60, 9.53)	33.40 (27.29, 39.50)	29.14 (11.46, 46.82)	23.92 (9.24, 38.59)
	ΔFX_{t-1}	-1.54 (-10.56, 7.46)	-8.23 (-12.80, -3.66)	-16.51 (-30.71, -2.32)	-3.46 (-15.83, 8.89)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 32. Time Varying Test Results for Asset Pricing Restrictions for Monthly Returns in Different Time Intervals – Conditioning Variable: Change in USD-TRY Exchange Rate

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
			Panel A: 1990 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	1.6176	6.4544	7.0992	3.2989	8.2983	7.8850
p-value	0.0529	0	0.0005	0.0005	0	0
			Fama-French Model			
Test statistic	1.3768	6.2705	6.8233	2.7427	7.6992	7.4638
p-value	0.0843	0.0037	0.0037	0.0030	0	0
			CAPM			
Test statistic	0.9604	4.1680	6.7119	2.5219	6.0804	7.6917
p-value	0.1684	0.3782	0.0179	0.0058	0	0
			Panel B: 2000 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	1.5014	5.5522	6.8729	2.6142	8.1020	7.8653
p-value	0.0666	0	0.0001	0.0045	0	0
			Fama-French Model			
Test statistic	1.6919	6.1018	6.6207	2.2879	8.1156	7.4913
p-value	0.0453	0.0001	0.0017	0.0111	0	0
			CAPM			
Test statistic	1.3654	5.2926	6.3914	2.7547	8.1906	7.9040
p-value	0.0861	0.1220	0.0126	0.0029	0	0

Notes: In Panel A, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time invariant models. In Panel B, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time varying models.

Table 33. Time Varying Test Results for Asset Pricing Restrictions for Weekly Returns in Different Time Intervals – Conditioning Variable: Change in USD-TRY Exchange Rate

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
Panel A: 1990 - 2020						
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
Four Factor Model						
Test statistic	4.0474	4.9577	6.1691	4.9083	5.3095	6.3023
p-value	0	0	0	0	0	0
Fama-French Model						
Test statistic	3.6216	4.8860	5.7980	4.0460	5.2194	5.9673
p-value	0.0001	0.0002	0.0007	0	0	0
CAPM						
Test statistic	4.4315	5.5784	6.1833	6.0173	6.6921	6.6753
p-value	0	0.0469	0.0069	0	0	0
Panel B: 2000 - 2020						
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
Four Factor Model						
Test statistic	2.9580	6.8619	5.7817	3.9695	8.4853	6.5688
p-value	0.0015	0	0	0	0	0
Fama-French Model						
Test statistic	3.1310	7.5566	5.9037	3.4916	8.1204	6.3451
p-value	0.0009	0	0.0002	0.0002	0	0
CAPM						
Test statistic	3.7734	7.9172	6.2771	5.4175	9.4747	7.0080
p-value	0.0001	0.0044	0.0045	0	0	0

Notes: In Panel A, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time invariant models. In Panel B, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time varying models.

4.7 Conditional information: Market dividend yield

Gagliardini et al. (2016) choose dividend yield as conditioning variable and find it has no predictive power on conditional expectations, however, Ferson and Harvey (1999) claims that the dividend yield of the S&P 500 index is significant in explaining expected returns. Lewellen (2004) also argues dividend yield has explanatory power in cross sectional variation of asset returns. Our results indicate that conditional factor expectations using dividend yield as conditioning variable are different than zero between 2000 and 2020 for monthly returns, dividend yield is also significant at 10% level for weekly returns between 1990 and 2020.

4.7.1 Estimation results with time varying model

On Table 34 and 35, estimated annualized components of vec[F] and v for the time varying four factor model for monthly returns on market dividend yield between 1990-2020 and 2000-2020 are shown, results estimated with weekly returns are on Table 36 and 37.

Dividend yield has a positive and significant effect on conditional market expectation, which is 23.55%, between 1990 and 2020 for monthly returns. Overall effect on market factor when taking into account v is 21.28% for stocks, 18.32% for industry portfolios and 19.48% for FF portfolios. Its effect on parts of cross sectional vector v explained by size and momentum factors are significant, -5.85% and 25.14% respectively. Between 2000 and 2020, its significant effect on market factor continues to exist, %28.67. It has predictive power on parts of cross sectional vector v explained by market and momentum factors, -6.58% and 13.98%.

For weekly returns between 1990 and 2020, its significant effect on market factor is 26.84%, and 24.84% between 2000 and 2020. It has a negative significant effect on v explained by size by -7.63% between 1990 and 2020. Between 2000 and 2020, its effect on v explained by book-to-market factor is negative and significant, -4.53%, while on v explained by momentum factor is positive and significant, 7.26%.

In conclusion, we examine dividend yield and change in consumer price index on monthly returns, and dividend yield and change in usd-try exchange rate on weekly returns in section 4.2. Dividend yield has a positive and significant effect on market factor premium on both monthly and weekly returns in different time periods. In this section, we see that results do not change when dividend yield taken as a sole conditioning variable.

4.7.2 Results on testing the asset pricing restrictions

Test results for asset pricing restrictions are on Table 38 for monthly returns and on Table 39 for weekly returns. We reject both of the null hypotheses for monthly returns between 1990 and 2020, however, between 2000 and 2020, cross sectional vector v can be explained by conditional factor betas when choosing stocks as test assets. Test results based on weekly returns show that conditional factor betas can explain cross sectional vector v for all models in both time periods except CAPM in 1990-2020 when choosing individual stocks as test assets.

Table 34. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Dividend Yield for Monthly Returns Between 1990 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	11.11 (-4.19, 26.42)	8.77 (5.09, 12.44)	1.23 (-3.41, 5.89)	7.32 (2.61, 12.02)
	Div$_{t-1}$	23.55 (2.98, 44.13)	-2.27 (-8.58, 4.03)	-4.07 (-12.10, 3.95)	-5.23 (-13.00, 2.52)
smb	const	6.22 (-2.18, 14.63)	-8.07 (-11.89, -4.25)	0.95 (-3.87, 5.77)	-13.76 (-22.52, -5.00)
	Div$_{t-1}$	-5.67 (-16.75, 5.39)	-5.85 (-10.51, -1.20)	3.74 (-2.86, 10.35)	6.52 (0.62, 12.42)
hml	const	5.06 (-4.40, 14.53)	-5.75 (-10.28, -1.23)	1.95 (-5.33, 9.24)	4.44 (-8.84, 17.73)
	Div$_{t-1}$	1.87 (-9.81, 13.56)	-1.98 (-8.02, 4.06)	-8.23 (-18.54, 2.06)	-13.61 (-22.15, -5.06)
mom	const	-3.74 (-13.79, 6.28)	29.40 (23.59, 35.22)	22.35 (3.99, 40.72)	12.05 (-0.98, 25.09)
	Div$_{t-1}$	1.48 (-9.67, 12.65)	25.14 (17.51, 32.77)	9.16 (-5.48, 23.81)	4.83 (-8.67, 18.34)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 35. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Dividend Yield for Monthly Returns Between 2000 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	4.72 (-9.16, 18.62)	5.90 (3.38, 8.42)	3.29 (0.12, 6.46)	3.46 (0.26, 6.66)
	Div$_{t-1}$	28.67 (10.72, 46.63)	-6.50 (-9.34, -3.65)	-4.48 (-7.92, -1.04)	-4.10 (-7.78, -0.42)
smb	const	6.94 (-1.66, 15.56)	-1.11 (-3.93, 1.70)	1.54 (-2.81, 5.90)	-3.69 (-10.18, 2.79)
	Div$_{t-1}$	-3.11 (-11.75, 5.51)	1.80 (-1.18, 4.79)	-2.81 (-7.24, 1.61)	0.79 (-5.34, 6.92)
hml	const	3.24 (-5.46, 11.96)	-6.38 (-9.56, -3.20)	-1.62 (-7.30, 4.05)	2.30 (-8.08, 12.69)
	Div$_{t-1}$	1.61 (-6.79, 10.02)	-0.54 (-3.97, 2.89)	8.06 (2.64, 13.47)	-6.51 (-13.84, 0.80)
mom	const	-2.80 (-12.62, 7.00)	11.09 (7.67, 14.52)	8.56 (-3.24, 20.37)	10.91 (2.45, 19.37)
	Div$_{t-1}$	-5.36 (-16.44, 5.72)	13.98 (9.62, 18.35)	7.42 (-2.09, 16.94)	5.28 (-4.17, 14.75)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 36. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Dividend Yield for Weekly Returns Between 1990 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	12.78 (-1.20, 26.78)	7.87 (4.31, 11.44)	2.83 (-0.24, 5.90)	6.70 (3.59, 9.80)
	Div $_{t-1}$	26.84 (8.80, 44.88)	1.32 (-4.03, 6.69)	2.05 (-2.45, 6.56)	1.25 (-3.92, 6.43)
smb	const	4.24 (-4.08, 12.57)	-3.33 (-8.18, 1.52)	2.23 (-2.18, 6.65)	-15.31 (-24.95, -5.67)
	Div $_{t-1}$	-7.88 (-18.86, 3.09)	-7.63 (-14.40, -0.86)	3.73 (-3.96, 11.43)	1.84 (-8.42, 12.11)
hml	const	2.81 (-6.14, 11.77)	0.33 (-6.42, 7.08)	1.53 (-5.40, 8.47)	13.83 (-3.40, 31.07)
	Div $_{t-1}$	-2.39 (-15.17, 10.39)	-0.56 (-9.67, 8.54)	1.69 (-11.27, 14.65)	-7.72 (-22.23, 6.79)
mom	const	0.94 (-7.83, 9.71)	36.87 (27.49, 46.25)	10.15 (-11.89, 32.20)	-3.16 (-24.40, 18.07)
	Div $_{t-1}$	4.95 (-5.55, 15.46)	-2.02 (-9.72, 5.67)	-11.24 (-33.64, 11.14)	-8.59 (-27.05, 9.85)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 37. Estimated Annualized Components of vec[F] and v for the Time Varying Four Factor Model on Dividend Yield for Weekly Returns Between 2000 and 2020

		vec[F]	ν for Stocks	ν for FF Portfolios	ν for Industry Portfolios
m	const	6.02 (-7.18, 19.23)	5.85 (3.55, 8.14)	1.86 (-0.29, 4.02)	1.89 (0.05, 3.73)
	Div $_{t-1}$	24.84 (6.04, 43.64)	-0.50 (-3.04, 2.02)	-0.009 (-2.15, 2.13)	-0.28 (-2.97, 2.40)
smb	const	7.43 (-1.15, 16.02)	1.86 (-1.50, 5.24)	1.90 (-2.32, 6.14)	2.06 (-5.84, 9.96)
	Div $_{t-1}$	-1.98 (-11.64, 7.66)	-1.71 (-5.45, 2.02)	-1.39 (-5.13, 2.34)	-0.30 (-7.41, 6.80)
hml	const	2.75 (-6.16, 11.68)	-9.05 (-13.42, -4.68)	2.12 (-4.31, 8.56)	-4.48 (-16.74, 7.77)
	Div $_{t-1}$	-4.01 (-11.29, 3.27)	-4.53 (-9.02, -0.05)	1.49 (-3.61, 6.59)	-0.12 (-11.22, 10.98)
mom	const	0.96 (-7.60, 9.52)	21.09 (15.46, 26.73)	15.28 (-2.60, 33.17)	15.33 (0.56, 30.11)
	Div $_{t-1}$	-2.38 (-11.23, 6.47)	7.26 (1.73, 12.80)	1.87 (-13.96, 17.72)	10.52 (-1.93, 22.98)

Notes: The table contains estimated annualized components of vec[F] and of vector v and their confidence intervals at 95% level for the individual stocks and portfolios.

Table 38. Time Varying Test Results for Asset Pricing Restrictions for Monthly Returns in Different Time Intervals – Conditioning Variable: Dividend Yield

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
			Panel A: 1990 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	2.7777	6.1019	7.0855	4.1115	6.8201	7.7521
p-value	0.0027	0	0.0001	0	0	0
			Fama-French Model			
Test statistic	2.8334	5.7214	6.2276	3.2173	6.0819	7.0663
p-value	0.0023	0.0023	0.0055	0.0006	0	0
			CAPM			
Test statistic	2.8731	6.5420	6.4533	3.2784	7.4943	6.8725
p-value	0.0020	0.0428	0.0212	0.0005	0	0
			Panel B: 2000 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	0.4104	6.6801	5.3426	1.6340	7.7135	6.4974
p-value	0.3408	0	0.0004	0.0511	0	0
			Fama-French Model			
Test statistic	0.5935	6.2154	5.5464	1.2962	7.0721	6.1710
p-value	0.2764	0.0001	0.0042	0.0975	0	0
			CAPM			
Test statistic	0.5670	6.4943	6.1263	1.4221	8.4882	6.8865
p-value	0.2854	0.0264	0.0129	0.0775	0	0

Notes: In Panel A, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time invariant models. In Panel B, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time varying models.

Table 39. Time Varying Test Results for Asset Pricing Restrictions for Weekly Returns in Different Time Intervals – Conditioning Variable: Dividend Yield

	Stocks	FF Portfolios	Industry Portfolios	Stocks	FF Portfolios	Industry Portfolios
			Panel A: 1990 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	-0.0291	5.6388	5.0643	0.6679	6.4087	5.5702
p-value	0.5116	0	0.0003	0.2521	0	0
			Fama-French Model			
Test statistic	-0.0499	5.6695	5.1586	0.1411	6.5543	5.6667
p-value	0.5199	0.0008	0.0066	0.4439	0	0
			CAPM			
Test statistic	1.6781	5.1508	5.5837	2.2678	6.2376	6.0525
p-value	0.0467	0.1205	0.0318	0.0117	0	0
			Panel B: 2000 - 2020			
	Test of the null hypothesis Ho: a (γ) = b(γ)'v			Test of the null hypothesis Ho: a (γ) = 0		
			Four Factor Model			
Test statistic	1.3693	6.2714	5.8171	2.1874	6.9904	6.0778
p-value	0.0854	0	0	0.0144	0	0
			Fama-French Model			
Test statistic	1.2256	6.2524	5.7444	1.6274	6.7027	5.8094
p-value	0.1102	0	0	0.0518	0	0
			CAPM			
Test statistic	1.4114	6.4891	5.4736	2.2969	7.8761	5.8261
p-value	0.0791	0.0197	0.0142	0.0108	0	0

Notes: In Panel A, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time invariant models. In Panel B, we test the null hypotheses Ho: a (γ) = b(γ)'v and Ho: a (γ) = 0 for time varying models.

4.8 Conditional information: The US term spread

In order to examine the effect of an international indicator, we choose term spread between the US ten-year and two-year treasury bond yields as an conditioning variable to the model. However, it does not have any explanatory power on neither conditional factor expectations nor cross sectional parameter v for different time intervals. Therefore, we do not present detailed information here.

4.9 Conclusion

In this part, we document time varying risk premia in Turkey for market, size, book-to-market and momentum factors between 1990 and 2020. We use three data types; stocks, Fama-French portfolios and industry portfolios; and two types of returns; monthly and weekly. Our stock specific conditioning variable is natural logarithm of book-to-market ratio; and conditioning variables common to all stocks are market dividend yield, Brent oil price, term spread between 10 year and 2 year treasury bond, USD/TRY exchange rate, consumer price index and industrial production index.

We find that because of high volatility and inflationary environment during 90's, risk premia have large strays for that period, and factor premiums are more stable after 2000. In general, only market premium is significant at 5% level between 1990 and 2020, its significance decreases after 2000 though.

Conditional monthly expectations on change in consumer price index and dividend yield are significant between 2000 and 2020, and conditional weekly expectations on change in USD-TRY exchange rate is significant between 1990 and 2020. Different explanatory power of conditioning variables in different time frames supports Kim, Nelson and Startz's (1991) and Paye and Timmermann's (2006) claims on instability in power of information variables.

The US term spread does not have any predictive power on conditional factor expectations and cross sectional parameter v -except on weekly returns in 1990-2020-, which supports Chaieb et al. (2021) and Harvey's (1995) findings stating that local variables are more important than global factors in emerging markets.

We reject time invariance of the risk premia due to the dynamics induced by cross sectional parameter v implying that equity premia are time varying even if conditional expectations of factor returns are not different that zero.

Significance of time variation increases when using individual stocks as test assets. For example, time invariance of the risk premia due to the dynamics induced by the cross sectional parameter v is rejected with a p-value of close to zero when using individual stocks as test assets, while p-value is 0.7501 if Fama-French portfolios chosen as test assets. This result also in line with Gagliardini et al. (2016) claim that time varying estimation on Fama-French portfolios is close to a time invariant model.

We find evidence that inflation has negative effect on market and momentum factor premia, which is not surprising as higher inflation leads higher interest rate, which diminishes factor premiums.

Dividend yield has positive effect on market factor premium. Although studies on predictive power of dividend yield have contradictory results, we expect positive relationship between stock returns and dividend yield as dividend yield is an indicator of future cash flow according to dividend signaling theory.

Time invariance of conditional factor expectations is rejected when usd-try exchange rate is used as conditional information. However, decomposition of its effect shows that it has no explanatory power on a specific factor premium.

Asset pricing restriction results show that CAPM, Fama-French three factor model and Carhart four factor model are better capture time variation when choosing individual stocks as test assets rather than portfolio returns that mask variation through aggregation. Most of the time we reject null hypotheses stating that either alphas equal to zero or they can be explained by conditional betas when Fama-French or industry portfolios are chosen as test assets.

The decomposition of effects of conditional information variables show that market, size and value premiums are positive, while momentum premium is negative at the averages of conditional variables; they are insignificant though. Additionally, we have positive and significant part of cross sectional parameter v explained by market and momentum betas.

An important shortcoming panel method is that ex post data is used to estimate cross sectional v and factor expectation, in other words, risk premia estimate at time t is based on information not available at time t. Comparison of estimation results for panel method with results for instrumental variables method are in section 6.5.

CHAPTER 5

INSTRUMENTAL VARIABLES METHOD AND DATA

In this chapter, instrumental variables method and our data are described. We use the same data set as in part I for Turkish stock market going back to beginning of 1989. Our final data set consists of Turkish-lira denominated daily returns on 552 individual stocks traded at Borsa Istanbul over the last 32 years. The market return is computed as value weighted average return of all available stocks. We use the risk free rate as 1-month US Treasury Bill rate plus local inflation minus the US inflation.

We compute equity premia with four asset pricing models, namely Capital Asset Pricing Model (CAPM), Fama-French three factor model, four factor model an extension by adding momentum to three factor model and Fama-French five factor model. We also add book-to-market ratio, natural logarithm of market capitalization as size, operating profitability and investment/total assets characteristics to Fama-French models.

Factor returns for size (Small Minus Big - smb), value (High Minus Low - hml), 1-year momentum (Winners Minus Losers - mom), operating profitability (Robust Minus Weak - rmw) and investment (Conservative Minus Aggressive - cma), are computed per the standard procedure in the literature. As fundamental data and return of previous year are needed to calculate factor returns, we end up with the time period of 31 years between January 1990 and December 2020 for our main results in risk premia. Descriptive statistics for daily stock and factor returns are summarized in Table 40.

We use instrumental variables method proposed by Jegadeesh, Noh, Pukthuanthong, Roll and Wang (2019), which do not use ex post data while estimating time varying premium. Additionally, omitted variable bias do not arise in instrumental variable method if measurement errors in explanatory betas do not correlate with measurement errors in instrumental betas.

Table 40. Descriptive Statistics for Stock and Factor Returns

	Mean	St. Dev.	Min.	Max.	Kurtosis	Skewness
Panel A: Descriptive Statistics for Stock Returns						
Market Cap (in million TL)	973	4203	0.000950	299323		
Book to Market Ratio	0.78	6.92	-191	1590		
Excess Return	0.0006	0.0373	-1	5.897		
Panel B: Descriptive Statistics for Factor Returns						
Excess Market Return	0.00047	0.02324	-0.17676	0.19141	5.357213	0.05626
SMB	0.00016	0.01207	-0.07533	0.23547	20.89039	0.70786
HML	0.00012	0.01235	-0.34567	0,07177	82.65610	-2.89021
Momentum	- 0.00003	0.01226	-0.08665	0.22259	17.84873	0.59553
RMW	0.00012	0.01073	-0.06239	0.23757	34.44710	1.38696
CMA	0.00007	0.00987	-0.07838	0.06255	3.894020	-0.10284

Notes: The table contains descriptive statistics for daily stock and factor returns between 1990 and 2020. SMB: Small minus big size, HML: High minus low book to market ratio, RMW: Robust minus weak operating profitability, CMA: Conservatively minus aggressively investment.

In classical ordinary least squares method (OLS), $y = BX + e$ where y is vector of dependent variable, X is vector of independent variables, B is coefficient vector and e is error vector. When we multiply each side by X^T equation becomes $X^T y = X^T XB + X^T e$ We assume that independent variables are not correlated with errors, i.e., X vector is orthogonal to e vector, $X^T e = 0$. (Wooldridge, 2010; Wooldridge, 2015)

$$B_{OLS} = (X^T X)^{-1} X^T y$$

Instrumental variables approach is used when there is omitted variable bias. When there is an omitted variable correlated with other independent variables, covariance between error terms and independent variables is not equal to zero, which violates our OLS assumption. An instrumental variable is used instead of independent variable. This instrumental variable should correlate with independent variable; however, it should not be correlated with error term.

If $y = XB + e$, we define instrumental variable Z such that $X = Z\delta + \varepsilon$. $Cov(Z, e) = 0$ and $Cov(X, Z) \neq 0$. When we multiply each side of regression by Z' it becomes $Z'y = Z'XB + Z'e$. As our assumption is Z is orthogonal to e, $Z'e = 0$.

$$B_{IV} = (Z'X)^{-1}Z'y$$

In the application of IV estimator, one can use two-stage least squares (2SLS). In the first stage X is regressed on Z and $\widehat{X} = Z\delta$, then we use estimated $\widehat{X}$ as independent variable and regress y on $\widehat{X}$. B_{2SLS} is identical to B_{IV} when there is only one instrument for X (Wooldridge, 2010).

Betas in odd months and even months are estimated separately. Jegadeesh et al. (2019) claim measurement errors of instrumental and explanatory variables are uncorrelated as betas are estimated from disjoint samples.

Excess return is defined as below:

$$R_t = \widehat{B}\Gamma_t + \Phi_t$$

where R_t is the vector of realized excess returns in month t, $\widehat{B}$. is the Nx(K+1) matrix including factor sensitivities, Γ_t is the vector of factor premiums and Φ_t is the vector of error terms. K is number of factors and N is number of stocks. Instrumental variables estimator for factor premiums is in the following equation:

$$\Gamma_{IV,t} = (B_{IV}B'_{EV})^{-1}\,(B_{IV}r'_t)$$

where B_{IV} and B_{EV} are instrumental and explanatory variables, respectively. Factor sensitivities are estimated from daily data within odd months and even months separately. When month t is even, odd month betas are instrumental variables and even month betas are explanatory variables, and vice versa when month t is odd. While calculating betas, we add one day lead and lagged values of factor returns and remove returns of first and last trading days as in the method to avoid non-synchronous trading effect. (Dimson, 1979)

IV estimator is consistent as the number of stocks in the sample (N) grows infinitely, and this property is referred N-consistent like Shanken (1992). In order to examine IV estimator performance in small sample size, simulation is conducted. Simulated returns are created using parameters in actual data. When comparing results for OLS and IV methods on simulated returns, and IV estimates are close to true betas whereas OLS estimates suffer from EIV bias.

In order to test if risk premiums estimated by IV estimator is different than zero, we use t-statistic:

$$t_{\Gamma} = \frac{\widehat{\Gamma}}{\widehat{\sigma_{\Gamma}} / \sqrt{T}}$$

where T is the number of time period as in Fama-MacBeth standard errors.

We use 36 month rolling windows for beta estimation, in which from month t-36 to month t-1 data are used for beta estimation of month t. Results of 60 month rolling windows and OLS estimation with both these time periods are also presented.

CHAPTER 6

ESTIMATION RESULTS FOR INSTRUMENTAL VARIABLES METHOD

This chapter consists of five sections; estimation results on four models; CAPM, Fama-French three factor model, Carhart four factor model and Fama-French five factor model with Turkish equity data are presented in the first three sections, then instrument strength is discussed, and findings are summarized at the end of the chapter. We also add firm characteristics to Fama-French three factor model and five factor model. Estimation results with instrumental variables estimator and ordinary least squares estimator for 36- and 60-month rolling windows are demonstrated separately for comparison. Our initial tests extend a 31-year period going back to 1990. Additionally, as in Part I, a trimmed time series beginning in 2000 for a more stable time period is analyzed as well.

6.1 Estimation results for CAPM, Fama-French three factor model and Carhart four factor model

We begin our analysis with CAPM, Fama-French three factor and Carhart four factor models. Table 41 contains the cross sectional correlations among factor sensitivities that are estimated with 36 month rolling window. The highest correlation is between market and size factors, 0.36. Correlation between value and other factors are also positive except momentum. Momentum has the least absolute value correlation results with other factors and correlation coefficients are negative; -0.08 with market, -0.04 with size and -0.01 with value factors.

Table 42 and 43 contains IV and OLS estimation results for 1990-2020 and 2000-2020 periods respectively. Alpha – constant term – is significant at 5% level and positive in all factor models for both periods and both estimation methods, which implies that CAPM, Fama-French three factor model and Carhart four factor model fail to explain cross sectional time varying risk premia among individual stocks adequately.

Table 41. Correlations Among Factor Sensitivities for Carhart Four Factor Model

Carhart Four Factor Model				
	MKT	SMB	HML	MOM
MKT	1			
SMB	0.36	1		
HML	0.19	0.30	1	
MOM	-0.08	-0.04	-0.01	1

Notes: The table contains correlations among factor sensitivities between 1990 and 2020. Factor sensitivities are calculated using daily returns from the previous 36 month. MKT: Excess market return, SMB: Small minus big size, HML: High minus low book to market ratio, MOM: Momentum, RMW: Robust minus weak operating profitability, CMA: Conservatively minus aggressively investment.

We find negative but insignificant market premium in all factor models for both periods and both estimation methods. Size premium is positive except four factor model in Panel A and Fama-French three factor model in Panel B between 1990 and 2020, and insignificant. In other words, market and size factors are not priced in these periods similar to Jegadeesh et al. (2019) findings.

In Fama-French three factor model, book-to-market risk premium 0.01 and significant at 5% level between 1990-2020, OLS estimation method gives similar result. However, positive premium on that factor becomes insignificant when betas are estimated with 60 month rolling window. We find positive and significant book-to-market risk premium between 2000-2020 as well when betas are estimated previous 36-month data.

There is a significant contrarian effect between 1990 and 2020. Similar to value factor, significant negative premium on momentum disappears when betas are estimated with 60 month rolling window. After truncating 90's volatile period, contrarian effect ceases away.

Table 42. Risk Premium Estimates with Individual Stocks for CAPM, Fama-French Three Factor Model, Carhart Four Factor Model Between 1990 and 2020

	Panel A: Previous 36 Months					
	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.03*	0.03*	0.02*	0.03*	0.02*	0.02*
	(4.40)	(4.72)	(4.41)	(4.44)	(4.76)	(4.74)
MKT	-0.007	-0.01	-0.01	-0.008	-0,009	-0.01
	(-1.01)	(-1.46)	(-1.58)	(-1.71)	(-1.38)	(-1.48)
SMB		0.0001	-0,0008		0.001	0.001
		(0.02)	(-0.15)		(0.49)	(0.47)
HML		0.01*	0.01		0.009*	0.007
		(2.27)	(1.40)		(2.02)	(1.62)
MOM			-0.02*			-0.01*
			(-2.10)			(-3.37)

	Panel B: Previous 60 Months					
	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.02*	0.02*	0.03*	0.02*	0.02*	0.02*
	(3.52)	(4.30)	(4.16)	(3.69)	(4.25)	(4.23)
MKT	-0.007	-0.01	-0.02	-0.008	-0.01	-0.01
	(-0.87)	(-1.57)	(-0.22)	(-1.06)	(-1.44)	(-1.55)
SMB		-0.001	0.00007		-0.0003	0.00007
		(-0.20)	(0.01)		(-0.08)	(0.01)
HML		0.01	0.01		0.007	0.004
		(1.60)	(1.11)		(1.52)	(0.98)
MOM			-0.02			-0.01*
			(-1.01)			(-2.31)

Notes: The table contains equity premium estimates for CAPM, Fama-French three factor and Carhart models in per month. Betas are estimated from previous 36 months in Panel A and 60 months in Panel B. t-statistic are reported in parentheses. IV is instrumental variables model results, OLS is ordinary least squares results.

Table 43. Risk Premium Estimates with Individual Stocks for CAPM, Fama-French Three Factor Model, Carhart Four Factor Model Between 2000 and 2020

Panel A: Previous 36 Months

	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.02* (4.06)	0.02* (4.79)	0.02* (4.66)	0.02* (3.96)	0.02* (4.36)	0.02* (4.39)
MKT	-0.01 (-1.70)	-0.02 (-1.58)	-0.02 (-1.85)	-0.01 (-1.77)	-0,01 (-1.11)	-0.01 (-1.23)
SMB		0.004 (0.68)	0,003 (0.52)		0.004 (1.05)	0.004 (1.03)
HML		0.01* (2.04)	0.01 (1.69)		0.006 (1.59)	0.005 (1.36)
MOM			-0.02 (-1.54)			-0.01* (-2.33)

Panel B: Previous 60 Months

	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.02* (3.44)	0.02* (4.17)	0.02* (4.51)	0.02* (3.45)	0.02* (3.87)	0.02* (3.92)
MKT	-0.01 (-1.39)	-0.01 (-1.28)	-0.02 (-1.88)	-0.01 (-1.48)	-0.01 (-1.91)	-0.01 (-1.05)
SMB		0.002 (0.40)	0.002 (0.42)		0.004 (0.91)	0.004 (0.98)
HML		0.01 (1.76)	0.01 (1.61)		0.008 (1.67)	0.007 (1.37)
MOM			-0.02 (-1.32)			-0.01 (-1.77)

Notes: The table contains equity premium estimates for CAPM, Fama-French three factor and Carhart models in per month. Betas are estimated from previous 36 months in Panel A and 60 months in Panel B. t-statistic are reported in parentheses. IV is instrumental variables model results, OLS is ordinary least squares results.

6.2 Estimation results for Fama-French three factor model with firm characteristics

Jegadeesh et al. (2019) find significant size and value premiums while examining Fama-French three factor model. After adding corresponding characteristics as independent variables to the model, factor premia become insignificant showing that Fama-French three factor model is not priced in the cross sectional excess returns among individual stocks when controlling firm characteristics. They claim that firm characteristics could be used as proxies for true betas, however, further tests show this claim to be false.

Although we do not find any significant size premium, we find some evidence for positive and significant value premium explained in 6.1. section. In this part, we add corresponding characteristics to Fama-French three factor model. Size is the natural logarithm of the market capitalization for previous month. Book-to-market ratio is book value divided by market value. Table 44 and 45 contains IV and OLS estimation results for 1990-2020 and 2000-2020 periods respectively.

We have significant and positive constant term except results based on previous 36-month estimation for 1990-2020 and results based on previous 60-month estimation for 2000-2020. Market and size factors are not priced similar to the results of the models without firm characteristics. Although we find positive value factor premium, its significance disappears in both time period after adding firm characteristics. Unlike Jegadeesh et al. (2019) results, firm characteristics themselves do not have any explanatory power in cross sectional variation among returns of individual stocks.

Consequently, none of the factors in Fama-French three factor model are priced after adding firm characteristics to the model.

Table 44. Risk Premium Estimates with Individual Stocks for Fama-French Three Factor Model with Firm Characteristics Between 1990 and 2020

Panel A: Previous 36 Months

	(1)	(2)	(1)	(2)
	IV		OLS	
Constant	0.03* (2.22)	0.02 (1.28)	0.02* (3.97)	0.02* (4.30)
MKT	-0.01 (-0.88)	-0.006 (-0.37)	-0.006 (-0.87)	-0.007 (-1.10)
SMB		-0.002 (-0.38)		0.001 (0.26)
HML		0.01 (1.39)		0.008 (1.83)
SIZE	-0.002 (-1.04)	-0.002 (-0.98)	0.0009 (1.68)	0.0009 (1.64)
BM	-0.003 (-1.11)	-0.005 (-1.09)	0.0007 (1.16)	0.0004 (0.71)

Panel B: Previous 60 Months

	(1)	(2)	(1)	(2)
	IV		OLS	
Constant	0.04* (2.06)	0.03* (2.58)	0.02* (3.44)	0.02* (4.02)
MKT	-0.01 (-0.48)	-0.01 (-0.17)	-0.005 (-0.75)	-0.008 (-1.12)
SMB		0.01 (1.81)		-0.001 (-0.31)
HML		-0.02 (0.46)		0.006 (1.32)
SIZE	0.004 (1.34)	-0.006 (-1.23)	0.002 (1.15)	0.002 (0.24)
BM	0.04 (1.16)	0.01 (1.06)	0.001 (1.75)	0.001 (1.63)

Notes: The table contains equity premium estimates for Fama-French three factor model with firm characteristics in per month. Betas are estimated from previous 36 months in Panel A and 60 months in Panel B. t-statistic are reported in parentheses. IV is instrumental variables model results, OLS is ordinary least squares results.

Table 45. Risk Premium Estimates with Individual Stocks for Fama-French Three Factor Model with Firm Characteristics Between 2000 and 2020

Panel A: Previous 36 Months

	(1)	(2)	(1)	(2)
	IV		OLS	
Constant	0.03*	0.03*	0.02*	0.02*
	(2.20)	(2.60)	(3.56)	(3.97)
MKT	-0.02	-0.02	-0.01	-0.01
	(-1.40)	(-1.32)	(-1.57)	(-1.89)
SMB		0.0006		0.003
		(0.07)		(0.80)
HML		0.03		0.006
		(1.17)		(1.57)
SIZE	-0.002	-0.003	0.001	0.01
	(-1.09)	(-1.04)	(1.66)	(1.62)
BM	-0.002	-0.006	0.0003	0.0004
	(-1.34)	(-1.19)	(0.12)	(0.19)

Panel B: Previous 60 Months

	(1)	(2)	(1)	(2)
	IV		OLS	
Constant	0.03*	0.02*	0.02*	0.02*
	(1.97)	(1.67)	(2.96)	(3.45)
MKT	-0.02	0.05	-0.007	-0.01
	(-0.63)	(1.03)	(-1.01)	(-1.50)
SMB		0.03		0.002
		(1.06)		(0.61)
HML		-0.05		0.008
		(-1.31)		(1.64)
SIZE	0.006	-0.004	0.002	0.002
	(1.35)	(-0.82)	(1.15)	(0.24)
BM	0.05	0.01*	-0.0002	-0.0005
	(1.06)	(2.06)	(-0.04)	(-0.11)

Notes: The table contains equity premium estimates for Fama-French three factor model with firm characteristics in per month. Betas are estimated from previous 36 months in Panel A and 60 months in Panel B. t-statistic are reported in parentheses. IV is instrumental variables model results, OLS is ordinary least squares results.

6.3 Estimation results for Fama-French five factor model

Fama and French add operating profitability and investment factors to their classical three factor model and claim five factor model better performs than previous three factor model. RMW (Robust Minus Weak) is the average return on the robust operating profitability portfolios minus the average return on the weak operating profitability portfolios and CMA (Conservative Minus Aggressive) is the average return on the conservative investment portfolios minus the average return on the aggressive investment portfolios. We examine five factor model as well as considering operating profitability and investment factors separately.

The cross sectional correlations among these five factors are shown in Table 46. Profitability factor has negative correlations with other factors; however, their absolute magnitudes are low; -0.03 with market and -0.01 with size and value factors, -0.16 with investment. Similarly, investment factor has low absolute correlation coefficients with other factors and magnitudes are negative except with market factor. Correlation between investment and market factors is 0.07.

Table 46. Correlations Among Factor Sensitivities for Fama-French Five Factor Model

	Fama-French Five Factor Model				
	MKT	SMB	HML	RMW	CMA
MKT	1				
SMB	0.36	1			
HML	0.20	0.32	1		
RMW	-0.03	-0.01	-0.01	1	
CMA	0.07	-0.02	-0.02	-0.16	1

Notes: The table contains correlations among factor sensitivities between 1990 and 2020. Factor sensitivities are calculated using daily returns from the previous 36 month. MKT: Excess market return, SMB: Small minus big size, HML: High minus low book to market ratio, MOM: Momentum, RMW: Robust minus weak operating profitability, CMA: Conservatively minus aggressively investment.

Table 47 and 48 contains IV and OLS estimation results for 1990-2020 and 2000-2020 periods respectively. Similar to previous models, we have positive and significant constant term – known as alpha in the literature – in both periods. Market premium is negative, other factor premia are positive except size factor in Panel B between 1990 and 2020. However, all these factors are not significant at 5% level, meaning that Fama-French five factor model fails to explain cross sectional variation among returns of individual stocks.

When we consider profitability and investment factors separately in model (1) and (2), results are not changed. Although these factors have positive premiums, they are not significantly different than zero. Results based on OLS estimator suggest the same conclusion. Jegadeesh et al. (2019) find insignificant results for these factors as well, and constant terms in their results are also positive and significant. In other words, Fama-French five factor model does not perform better than previous models.

We also add investment and operating profitability as firm characteristics to the model, and present estimation results on Table 49 and 50 for different periods. Estimation results for Fama-French five factor model with firm characteristics are similar to the model without characteristics except significant and positive premium on value factor,0.009, between 2000 and 2020 when betas are estimated with 36-month previous data. However, value premium does not exist if 60-month previous data are used.

Table 47. Risk Premium Estimates with Individual Stocks for Fama-French Five Factor Model Between 1990 and 2020

Panel A: Previous 36 Months						
	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.01* (2.21)	0.02* (3.17)	0.02* (4.28)	0.02* (3.47)	0.02* (3.61)	0.03* (4.81)
MKT			-0.01 (-1.72)			-0.01 (-1.55)
SMB			0.00008 (0.01)			0.002 (0.58)
HML			0.01 (1.81)			0.009* (2.05)
RMW	0.01 (1.00)		0.01 (0.81)	0.006 (1.31)		0.004 (1.04)
CMA		0.005 (0.84)	0.0004 (0.05)		0.003 (0.98)	0.002 (0.66)

Panel B: Previous 60 Months						
	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.01* (2.75)	0.01* (2.62)	0.03* (4.51)	0.01* (2.97)	0.01* (3.08)	0.02* (4.19)
MKT			-0.01 (-1.74)			-0.01 (-1.43)
SMB			-0.001 (-0.21)			0.0001 (0.02)
HML			0.01 (1.31)			0.006 (1.28)
RMW	0.01 (0.71)		0.02 (1.79)	0.006 (1.16)		0.008 (1.42)
CMA		0.01 (1.67)	0.01 (1.36)		0.002 (0.68)	0.004 (1.00)

Notes: The table contains equity premium estimates for Fama-French three factor model with firm characteristics in per month. Betas are estimated from previous 36 months in Panel A and 60 months in Panel B. t-statistic are reported in parentheses. IV is instrumental variables model results, OLS is ordinary least squares results.

Table 48. Risk Premium Estimates with Individual Stocks for Fama-French Five Factor Model Between 2000 and 2020

Panel A: Previous 36 Months

	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.009 (1.41)	0,01* (2.63)	0.02* (4.75)	0.01* (2.54)	0.01* (2.74)	0.02* (4.53)
MKT			-0.02 (-1.67)			-0.01 (-1.25)
SMB			0,003 (0.44)			0.003 (0.97)
HML			0.02 (1.79)			0.007 (1.79)
RMW	0.002 (0.17)		0.007 (0.58)	0.001 (0.44)		0.002 (0.62)
CMA		0.002 (0.48)	0.0004 (0.05)		0.0008 (0.25)	0.001 (0.54)

Panel B: Previous 60 Months

	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.01* (2.59)	0.01* (2.38)	0.03* (4.56)	0.01* (2.66)	0.01* (2.64)	0.02* (3.95)
MKT			-0.02 (-2.52)			-0.01 (-1.95)
SMB			0.0002 (0.03)			0.003 (0.84)
HML			0.02 (1.85)			0.008 (1.73)
RMW	0.002 (0.15)		0.009 (0.60)	0.002 (0.41)		0.001 (0.23)
CMA		0.009 (1.42)	0.005 (0.71)		0.001 (0.49)	0.001 (0.57)

Notes: The table contains equity premium estimates for Fama-French three factor model with firm characteristics in per month. Betas are estimated from previous 36 months in Panel A and 60 months in Panel B. t-statistic are reported in parentheses. IV is instrumental variables model results, OLS is ordinary least squares results.

Table 49. Risk Premium Estimates with Individual Stocks for Fama French Five Factor Model with Firm Characteristics Between 1990 and 2020

Panel A: Previous 36 Months

	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.01*	0.02*	0.02*	0.02*	0.02*	0.02*
	(3.04)	(3.13)	(3.82)	(2.14)	(2.84)	(3.11)
MKT			-0.01			0.003
			(-1.38)			(0.36))
SMB			0.002			0.006
			(0.57)			(0.73)
HML			0.007			0.01
			(1.59)			(1.11)
RMW	0.004		0.003	0.005		0.003
	(0.89)		(0.71)	(1.02)		(0.83)
CMA		0.003	0.003		0.002	0.004
		(0.74)	(0.77)		(0.92)	(1.23)
SIZE			0.001			0.004
			(1.12)			(1.65)
BM			-0.00005			-0.0008
			(-0.12)			(-0.49)
OP	-0.01		0.001	-0.007		0.008
	(-1.11)		(0.02)	(-0.98)		(0.17)
INV		-0.0005	-0.002		0.002	0.003
		(-0.006)	(-0.74)		(0.12)	(0.36)

Panel B: Previous 60 Months

	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.01*	0.01*	0.02*	0.01*	0.01*	0.01*
	(2.53)	(2.62)	(3.84))	(2.16)	(3.01)	(2.47))
MKT			-0.01			-0.002
			(-1.38)			(-0.67)
SMB			0.0006			0.0004
			(0.13)			(1.44)
HML			0.005			0.009
			(1.09)			(1.00)
RMW	0.01		0.01	0.008		0.007
	(1.51)		(1.94)	(1.09)		(0.85))
CMA		0.003	0.004		0.005	0.002
		(0.70)	(0.95)		(1.02)	(1.12)
SIZE			0.001			0.004
			(0.64)			(1.74)
BM			-0.0003			-0.0009
			(-0.40)			(-0.64)
OP	-0.03		-0.003	-0.005		-0.003
	(-148)		(-0.30)	(-0.93)		(-0.41)
INV		0.008	-0.003		0.004	0.001
		(0.47)	(-0.03)		(1.81)	(1.12)

Notes: The table contains equity premium estimates for Fama-French three factor model with firm characteristics in per month. Betas are estimated from previous 36 months in Panel A and 60 months in Panel B. t-statistic are reported in parentheses. IV is instrumental variables model results, OLS is ordinary least squares results.

Table 50. Risk Premium Estimates with Individual Stocks for Fama-French Five Factor Model with Firm Characteristics Between 2000 and 2020

Panel A: Previous 36 Months

	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.01*	0.01*	0.02*	0.01*	0.01*	0.02*
	(2.50)	(2.70)	(3.85)	(2.12)	(2.35)	(2.75)
MKT			-0.01			-0.01
			(-1.85)			(-1.33)
SMB			0.002			0.002
			(0.61)			(0.20)
HML			0.009*			0.005
			(2.11)			(0.67)
RMW	0.004		0.003	0.002		0.008
	(0.86)		(0.73)	(0.19)		(0.14)
CMA		0.001	0.004		0.007	0.006
		(0.40)	(1.53)		(0.46)	(1.41)
SIZE			0.002			0.001
			(1.62)			(1.07)
BM			-0.0002			-0.0004
			(-0.59)			(-0.93)
OP	-0.006		0.009	-0.01		0.003
	(-0.60)		(0.22)	(-0.94)		(0.50)
INV		0.004	0.002		-0.003	0.001
		(0.53)	(0.10)		(-0.87)	(0.64)

Panel B: Previous 60 Months

	(1)	(2)	(3)	(1)	(2)	(3)
		IV			OLS	
Constant	0.01*	0.01*	0.02*	0.01*	0.01*	0.02*
	(2.52)	(2.40)	(3.25)	(3.17)	(2.83)	(2.74))
MKT			-0.01			-0.01
			(-1.51)			(-1.56)
SMB			0.002			0.004
			(0.54)			(0.37)
HML			0.006			0.008
			(1.14)			(1.49)
RMW	0.004		0.002	0.007		0.008
	(0.70)		(0.34))	(0.93)		(1.26)
CMA		0.003	0.004		0.002	0.004
		(0.80)	(1.06)		(0.83)	(0.57)
SIZE			0.004			0.007
			(1.94)			(0.22)
BM			-0.0008			-0.001
			(-0.90)			(-0.83)
OP	-0.006		-0.004	-0.002		0.002
	(-0.33)		(-0.30)	(-0.23)		(1.08)
INV		0.001	0.006		0.007	0.001
		(0.76)	(0.65)		(0.68)	(0.95)

Notes: The table contains equity premium estimates for Fama-French three factor model with firm characteristics in per month. Betas are estimated from previous 36 months in Panel A and 60 months in Panel B. t-statistic are reported in parentheses. IV is instrumental variables model results, OLS is ordinary least squares results.

6.4 Instrument strength

In instrumental variables approach, covariance between instrumental and independent variables should be large enough to get a precise estimate of slope coefficients. Nelson and Startz's (1990) equation is used to test the strength of instrumental variables.

Instrumental variables are weak if

$$\frac{1}{p_{xz}^2} \geq N$$

where p_{xz} is the correlation between independent variable (x) and the corresponding instrument (z), and N is the number of individual stocks. Minimum stock number per month is 66 in our sample, correlation figure should be higher than 0.12. Correlation between explanatory and instrumental variables among factors in different models are presented in Table 51. Correlation results are in the range 0.27 to 0.76, in other words, weak instrument problem is not a concern in our data.

Another metric to measure the strength of instrumental variables is below:

$$\text{Correlation } (B^{true}, B^{even}) = \text{Correlation } (B^{true}, B^{odd}) = \sqrt{\text{Correlation } (B^{odd}, B^{even})}$$

Correlation between true betas and estimated explanatory betas is equal to correlation between true betas and estimated instrumental variable betas (Jegadeesh et al., 2019). These two correlations are calculated with the square root of correlation coefficient between estimated explanatory betas and instrumental variable betas.

Table 51 contains correlation between estimated betas and unobservable true betas, which is calculated according to above equation. Correlation figures are in the range 0.52 to 0.87. The least correlation between estimated beta and true beta is on momentum factor in Carhart model. Other relatively low correlations are for operating profitability and investment; they are 0.56 and 0.60, respectively. All these correlation coefficients are significantly above the critical value proposed by Nelson and Startz (1990).

Table 51. Instrument Strength

Panel A: CAPM

Odd and even month correlation	Correlation between “true” and estimated factor sensitivities
MKT	MKT
0.76	0.87

Panel B: Fama-French Three Factor Model

Odd and even month correlation			Correlation between “true” and estimated factor sensitivities		
MKT	SMB	HML	MKT	SMB	HML
0.74	0.70	0.53	0.86	0.83	0.73

Panel C: Carhart Four Factor Model

Odd and even month correlation				Correlation between “true” and estimated factor sensitivities			
MKT	SMB	HML	MOM	MKT	SMB	HML	MOM
0.74	0.70	0.53	0.27	0.86	0.83	0.70	0.52

Panel D: Fama-French Five Factor Model

Odd and even month correlation					Correlation between “true” and estimated factor sensitivities				
MKT	SMB	HML	RMW	CMA	MKT	SMB	HML	RMW	CMA
0.74	0.70	0.53	0.31	0.37	0.86	0.83	0.72	0.56	0.60

Notes: The table contains correlation between odd and even month estimates of betas for CAPM, Carhart Four Factor Model, Fama-French three and five factor model. Betas are estimated from previous 36 months. The square root of the odd and even month beta correlation gives correlation between unobservable “true” betas and estimated betas.

6.5 Conclusion

As a standard approach, portfolios are used as test assets to reduce EIV bias while estimating equity premia. Using portfolios create other problems; portfolios enable testing of a limited number of factors as they are sorted based on corresponding characteristics, variation is masked within portfolios, variation among portfolios formed at the beginning as stocks are sorted. In the first part, we examine time varying risk premia in Turkey equity market with panel method that enables individual stocks as test assets beside portfolios in explaining variation in factor premium.

Instrumental variables method not only avoid EIV bias while using individual stocks but also use ex ante data to estimate time varying premium unlike panel method. In order to compare results based on panel method, we test time varying risk premia in Turkey for market, size, book-to-market, momentum, operating profitability and investment factors as well as firm characteristics between 1990 and 2020 with instrumental variables method in this part. We make the same analysis for a subperiod from 2000 to 2020 similar to Part I. Firm characteristics are book-to-market ratio, natural logarithm of market capitalization as size, operating profitability and investment/total assets.

We find significant time varying alphas and insignificant time varying factor premiums with exceptions explained later after testing CAPM, Fama-French three and five factor models, and Carhart four factor model. We support Jegadeesh et al. (2019) claim that these models are insufficient to explain time varying premia. This argument is in line with the findings in the first part. Because these models either fail to satisfy asset restriction conditions requiring zero alpha or alpha explained by conditional betas, or conditional factor estimates are not different than zero at the averages of conditional information variables when using panel method.

There are some evidence for positive value premium and negative momentum premium, explanatory power of value factor disappears after controlling size and book-to-market ratio as firm characteristics though. Significance of value premium disappears when betas are estimated with 60 month rolling window and significance of momentum premium disappears after removing highly volatile 90’s period as well. Although conditional factor premiums are not significant at the averages of conditional variables, momentum premium is negative and value premium is positive in the results of Part I.

Unlike Jegadeesh et al. (2019) results, firm characteristics themselves do not have explanatory power in variation among returns of individual stocks.

Correlation between explanatory and instrumental variables are in the range 0.27 to 0.76, and they are above Nelson and Startz (1990) critical value that is 0.12 for our data. Correlation between our estimated betas and unobservable true betas are in the range 0.52 to 0.87.

An important shortcoming of panel method is that they use ex post data to infer path of risk premia. However, estimators are consistent in an arbitrage free environment. In instrumental variables method, simulation results are used for small sample size to show instrumental variables approach performs better than simple ordinary least squares, in other words, the argument that this estimation method produce unbiased estimator do not have strong base. Another difference is that omitted variable bias do not exist in IV method if measurement errors in explanatory betas do not correlate with measurement errors in instrumental betas.

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