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Full Length Research Paper

Conditional betas and Market re-definition: Revisiting the capital asset pricing model with Mexican data

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Abstract

This paper examined the time-series cross-section relation between conditional betas and stock returns using monthly data for Mexico for the period January 1999 to August 2008. The portfolio-level analysis and regressions indicated a positive relation between conditional betas and the expected returns. The two proxies for a more complete market return measure, the labor income beta and the foreign stock-market return, proved significant, adding explanatory power to the models. The results suggested, however, that it is necessary to allow for time variations in betas as well in order to explain the variations of the monthly average returns. A size effect was also found, although it is not very important. In spite of the empirical support found for the conditional CAPM over the static CAPM, both specifications explain about half of the monthly average return variation, which calls for differences in the pricing of risk between developed and emerging countries.

Keywords: CAPM, Human capital, conditional beta, time-series cross-sectional data.

INTRODUCTION

Until the late 1980s, the volume of private portfolio investment flows into the emerging market economies was almost negligible. Since then, securities have become another major international funding source other than bank loans for these countries. Moreover, a remarkable development in recent years has been the sharp increase in equity investment in all regions. As a result, the size of equity markets is now larger than the size of domestic debt markets or total credit extended to the private sector in most emerging economies (BIS, 2009).

Mexico has become the second largest recipient of portfolio capital flows, in terms of value, in Latin America (IPREO Holdings LLC, 2010). During 2010, flows of foreign direct investment into Mexico reached USD 17.7 billion while portfolio investment amounted to USD 23.7 billion. With an annual growth of 211%, portfolio investment was 1.3 times the investment in production (manufacturing/industrial) activities and the ratio of portfolio investment to direct investment has been increasing since 2008 (Garcia, 2011).

It is generally agreed that investors demand a higher expected return for investment in riskier projects or securities. However, the way investors assess the risk of the cash flows on a project and how they determine what risk premium they will demand is still not fully understood. This paper aims to contribute towards improving our understanding of how investors value risky cash flows in Mexico, an increasingly growing destination for international portfolio investments.

The Capital Asset Pricing Model (CAPM), developed by Sharpe (1964), Lintner (1965) and Black (1972), is widely used by financial managers in order to assess the cost of capital (PricewaterhouseCoopers, 2000; Graham and Harvey, 2001; Brounen et al, 2004; Fernandez and del Campo, 2010; Fernandez et al, 2012). According to the CAPM, (a) the risk of a project is measured by the beta of the cash flow with respect to the return on the market portfolio of all assets in the economy, and (b) the relationship between required expected return and beta is linear.

The CAPM was originally developed within the framework of a hypothetical single-period model economy. The real world, however, is dynamic and hence, expected returns and betas are likely to vary over time (Figure 1 shows cross sectional variation of betas and market risk premium in Mexico). (Evidence that conditional betas and expected returns depend on the nature of the information available at any point in time and vary over time is found, for instance, in Bollerslev et

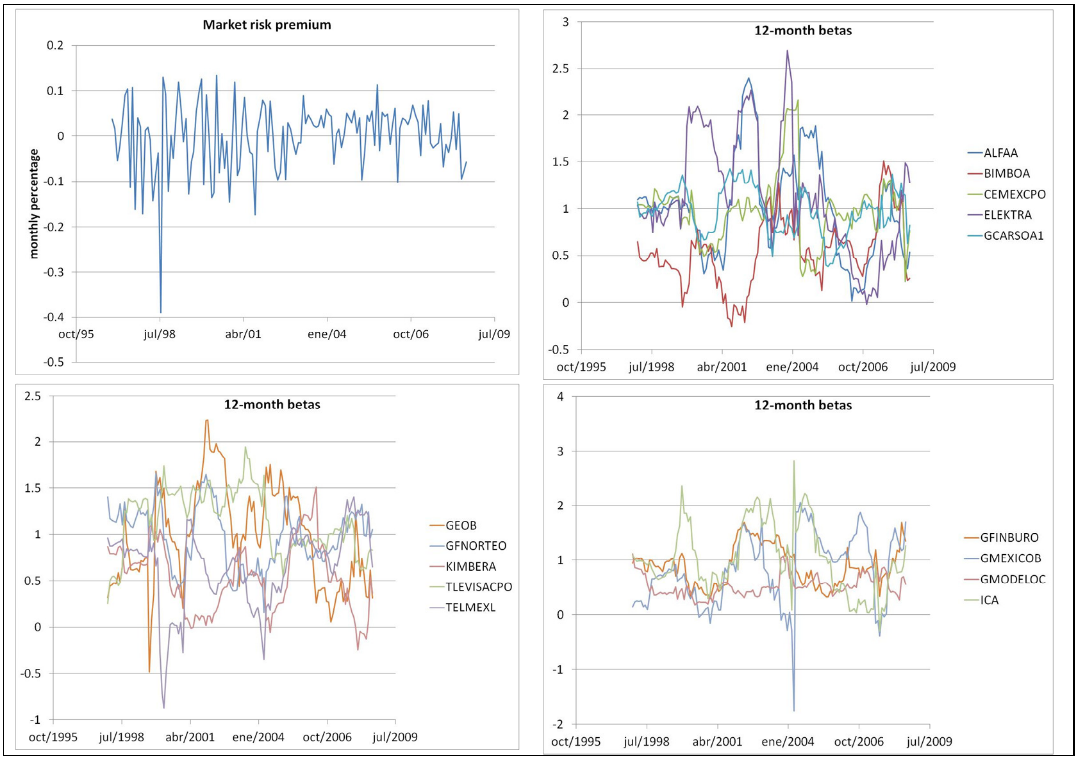

Figure 1. Cross sectional variation of betas (14 most-liquid stocks) and market risk premium (market return minus risk-free rate) in Mexico
Source: Own calculations using data from Banco de Mexico and Mexican Stock Exchange.

al (1988), Harvey (1989, 2001), Shanken (1990, 1992), Ferson and Harvey (1991, 1999), Fama and French (1997), Lettau and Ludvigson (2001), Campbell and Vuolteenaho (2004), Jostova and Philipov (2005), Petkova and Zhang (2005), Lewellen and Nagel (2006), and Ang and Chen (2007)." This may explain the poor empirical performance of the model and raises the need to use the conditional specification of the CAPM. (For a review of studies that empirically examine the performance of the CAPM see, for example, Fama and French (2004). Even when expected returns are linear in betas for every time periods, based on the information available at the time, the relation between the unconditional expected return and the unconditional beta could be flat. (This is because an asset that is on the conditional mean-variance frontier need not be on the unconditional frontier, as Dybvig and Ross (1985) and Hansen and Richard (1987) point out).

The stocks selected represent the most liquid assets traded in the Mexican Stock Exchange. Betas are calculated using information for the previous 12 months. The market risk premium is the difference between the monthly equity return and the monthly risk free rate.

This paper is an attempt to explain some of the anomalies of the static CAPM. Not only has this study no precedent in testing the conditional CAPM for the Mexican stock market, since the limited work done focuses on the Arbitrage Pricing Theory (Treviño, 2011), but more importantly, it analyses portfolio returns instead of individual stock returns as is the case for most of the previous work done for Mexico.

Using monthly data for the period January 1999-August 2008 for Mexico, we find empirical support for both the static CAPM and our conditional CAPM specification. When betas and returns are allowed to vary over time by assuming that the CAPM holds period by period, the market beta remains significant. When a proxy for the return on human capital is also included in measuring the return on aggregate wealth, the explanatory power of the model is improved, and time variation effects continue to be significant. The return on the foreign market adds to the models, thereby increasing the proportion of the monthly average return variations that can be explained by the CAPM. Size effects are found, but they are weak. Although the conditional model fits better than the static model, the proportion of the variation in monthly average returns that the two models explain is very similar, approximately 50 percent.

MATERIALS AND METHODS

The CAPM builds on the model of portfolio choice developed by Markowitz (1959). In Markowitz's model, an investor selects a portfolio at time *t-1* that produces a stochastic return at *t*. The model assumes investors are risk averse and, when choosing among portfolios, they care only about the mean and variance of their one-period investment return. As a result, investors choose "mean-variance-efficient" portfolios, in the sense that the portfolios 1) minimize the variance of portfolio return, given expected return, and 2) maximize expected return, given variance. Thus, the Markowitz approach is often called a "mean-variance" model.

According to the model, there is a linear constant relation between the expected return on an asset, $E[R_{i,t}]$, and its market beta (β_i),, which measures the sensitivity of the asset's return to variation in the market return. This version of the CAPM is called the static CAPM, since β_i is constant, or unconditional CAPM, and conditional information plays no role in determining excess returns.

Some of the anomalies that reject the CAPM are reviewed in Treviño (2010). As indicated by Jagannathan and Wang (1996), while a flat relation between the unconditional expected return and the unconditional market beta may be evidence against the static CAPM, it is not necessary evidence against the conditional CAPM. Following Merton (1980), it will be hypothesized that the CAPM will hold in a conditional sense. Therefore, for each asset *i* in each period *t*

$$E[R_{it}|I_{t-1}] = \gamma_{0t-1} + \gamma_{1t-1}\beta_{it-1} \qquad (1)$$

where β_{it-1} is the conditional beta of asset *i* defined as

$$\beta_{it-1} = Cov(R_{it}, R_{mt}|I_{t-1})/Var(R_{mt}|I_{t-1}) \qquad (2)$$

The subscript *t* indicates the relevant time period. R_{it} denotes the return on asset *i* in period *t*, and R_{mt} the return on the aggregate wealth portfolio of all assets in the economy in the period *t*. R_{mt} is referred to as the market return. I_{t-1} denotes the common information set of the investors at the end of period *t-1*. γ_{0t-1} is the conditional expected return on a "zero-beta" portfolio, and γ_{1t-1} is the conditional market risk premium.

Since the aim of this study is to explain the variations in the unconditional expected return on different assets, in line with Jagannathan and Wang (1996), we take the unconditional expectation of both sides of equation (1) to get

$$E[R_{it}] = \gamma_0 + \gamma_1 \overline{\beta_i} + Cov(\gamma_{1t-1}, \beta_{it-1}) \quad (3)$$

where

$$\gamma_0 = E[\gamma_{0t-1}] \quad \gamma_1 = E[\gamma_{1t-1}] \quad \overline{\beta_i} = E[\beta_{it-1}]$$

Here, γ_1 is the expected market risk premium, and $\overline{\beta_i}$ is the expected beta. (Note that expected betas are not the same as unconditional betas). If the covariance between the conditional beta of asset *i* and the conditional market risk premium is zero (or a linear function of the expected beta) for every arbitrarily chosen asset *i*, then equation (3) resembles the static CAPM, i.e., the expected return is a linear function of the expected beta. However, in general, the conditional risk premium on the market and conditional betas are correlated, and, therefore, $Cov(\gamma_{1t-1}, \beta_{it-1})$ is different from zero. (See, for example, Keim and Stambaugh (1986), Breen et al. (1989), Fama and French (1989), Chen (1991), and Ferson and Harvey (1991). This suggests that the unconditional expected return is not a linear function of the expected beta alone.

Jagannathan and Wang (1996) show that the unconditional expected return is a linear function of two unconditional betas as follows (The reader is kindly suggested to refer to Treviño (2010) and Jagannathan and Wang (1996) for a full derivation of the model).

$$E[R_{it}] = a_0 + a_1\beta_i + a_2\beta_i^{\lambda} \quad (4)$$

They refer to the first unconditional beta as the *market beta* and the second as the *premium beta*. They measure the average market risk and beta-instability risk, respectively. Thus, if β_i^{λ} is not a linear function of β_i, then there are some constants a_0, a_1, and a_2 such that equation (4) holds for every asset *i*.

In turn, the market beta can be decomposed into two components. The static version of the CAPM assumes that all assets are readily marketable so that each investor is free to adjust his or her portfolio to an optimum. In reality, however, every investor has nonmarketable assets, or assets that he or she will not consider marketing. In its seminal work, Mayers (1972, 1973) presented a model of capital asset pricing under conditions of uncertainty that explicitly included the effects of nonmarketable assets. Human capital is probably by far the most important of such claims. (See, for example, Becker (1964) for a thorough treatment of the concept of human capital.)

In line with this, the specification of the CAPM explicitly accommodating human capital would have two factors as a proxy for the return on the market portfolio: the return on a value-weighted stock index, R_t^{vw}, and the labor income growth, R_t^{labor}. (We will later explain why we use labor income growth as a proxy for human capital). Therefore, it is assumed that the market return is a linear function of R_t^{vw} and R_t^{labor}. Further, if we denote R_{t-1}^{prem} the proxy for the market risk premium, and β_i^{vw}, β_i^{labor}, and β_i^{prem} as the return sensitivity to these three factors, respectively, we get

$$E[R_{it}] = c_0 + c_{vw}\beta_i^{vw} + c_{prem}\beta_i^{prem} + c_{labor}\beta_i^{labor} \qquad (5)$$

according to which the unconditional expected return on any asset is a linear function of its three betas only.

There is a general agreement in the literature that stock prices vary over the business cycle. Figure 2

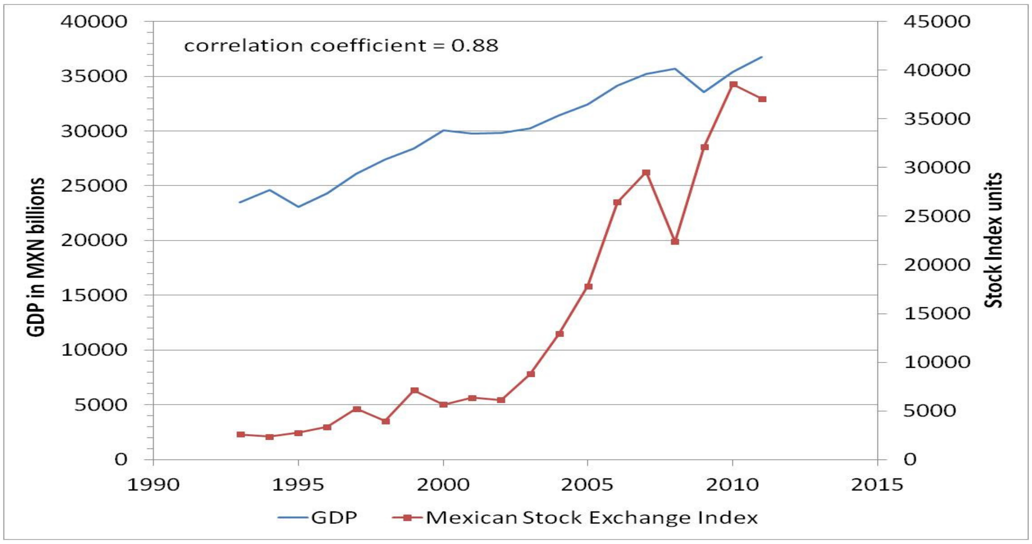

Figure 2. Correlation between Mexico's GDP and Stock Exchange Index, IPC
Source: National Institute of Statistics and Geography (INEGI) and Mexican Stock Exchange (Bolsa Mexicana de Valores)

depicts the Gross Domestic Product of Mexico and the Mexican Stock Exchange index (IPC) and shows a high correlation between the two series. Hence, one may suspect that the market risk premium will also vary over the business cycle. (See,for instance, Keim and Stambaugh (1986), Fama and French (1989), and Chen (1991).) It follows that making use of the same variables that help predict the business cycle might help forecasting the market risk premium as well. The literature on business-cycle forecasting suggests that, in general, interest-rate variables are likely to be most helpful in predicting future business conditions. (Stock and Watson (1989) find that the spread between six-month commercial paper and six-month Treasury bill rates and the spread between ten- and one-year Treasury bond rates both outperform nearly every other variable as a forecaster of the business cycle. Bernanke (1990) find, after an exhaustive analysis of different variables, that the best single business cycle forecaster is the spread between the commercial paper rate and Treasury bill rate first used by Stock and Watson (1989).) Based on Stock and Watson (1989), we choose the spread between the short-term rate of corporate debt and the 6-month Treasury bill rate, denoted by R_{t-1}^{prem}, as a proxy for the market risk premium. (Short-term corporate debt includes commercial paper and the so-called *certificados bursátiles*, which in the past few years have, in practice, substituted commercial paper as a source of corporate funding in Mexico.) It is, therefore, assumed that the market risk premium is a linear function of R_{t-1}^{prem}.

Campbell (1996) and Jagannathan and Wang (1996) argue that labor income growth may proxy for the return to human capital and find that it has a statistically significant risk price in cross-sectional tests of the CAPM. (Campbell (1996) derives a measure for the return on human capital, which is the current growth rate of labor income, plus a term that depends on expected future growth rates of labor income and expected future asset returns. If both the forecastable part of the growth rates of labor income and the forecastable part of the returns on assets are not important, the term added to the current growth rate of labor income will be very small. In this case, Campbell's measure and Fama and Schwert's (1977) measure for the return on human capital are approximately the same). It is then assumed that the return on human capital is an exact linear function of the growth rate in per capita labor income.

As discussed by Berk (1995), a natural specification test for the model is to examine whether any other variable has the ability to explain the returns not explained by the three-beta model, in particular size effects. Banz (1981) and Fama and French (1992) document a size effect: when stocks are sorted on market capitalization, average returns on small stocks are higher than predicted by the CAPM. We, therefore, examine whether any residual size effects to get

$$E[R_{it}] = c_0 + c_{vw}\beta_{it}^{vw} + c_{prem}\beta_{it}^{prem} + c_{labor}\beta_{it}^{labor} + c_{size}MV_{it} \quad (6)$$

where MV is the size of the portfolio measured as the logarithm of the weighted average of the market capitalization (in million pesos) of the individual stocks forming portfolio *i* in month *t*. (Market capitalization values are taken from *Economatica* and are used in constant terms as of August 31, 2008. *Economatica* system is a tool designed for investment analysis, whose clients include brokerage firms, investment banks, universities and individual investors. This database includes information on publicly traded companies in the following markets: United States, Brazil, Argentina, Chile, Mexico, Peru, Colombia, and Venezuela. Data are obtained directly from the stock exchanges of each country. www.economatica.com)

The subscript *t* in equation (6) denotes month. Instead of using the common procedure of calculating the average of the 116 monthly-return observations (January 1999 – August 2008) and use that as the only observation for portfolio *i* in the database, we chose a recursive analysis in which we calculate the average monthly returns for each of the 15 portfolios using the returns for the previous 24 months. We repeated this procedure month by month accounting for the rebalancing of the portfolios. By doing so, we are in fact *back-testing* the conditional (and static) CAPM. That is, we are testing if the model can explain the average of monthly past returns of the portfolios using present and past information.

The betas of equation (6) are recalculated for each observation using the information for the previous 24 months. (Using the common procedure of averaging monthly returns for each portfolio would reduce drastically the sample size hindering us from making inferences from the results). The values for β_{it}^{prem} used in the regressions are the part of this beta that is orthogonal to a constant and β_{it}^{vw}. (We estimated the static CAPM (see equation 8), and regressed its residuals to a constant, the market beta, β_{it}^{vw}, and the beta-prem, β_{it}^{prem}. The coefficients of beta-prem in the second regression are the orthogonal part mentioned). Similarly, the values used for β_{it}^{labor} are the part of this beta that is orthogonal to a constant, β_{it}^{vw}, and β_{it}^{prem}. (This allows to test for the isolated effect of β_{it}^{prem} and β_{it}^{labor} in our models).

The unconditional models in equations (5) and (6) are estimated using Least Squares Dummy Variable and within effect estimation methods for the time-series cross-sectional data described below. (We also estimated the models using the Generalized Method of Moments (GMM), but the results are unchanged. See Baum et al (2002) for a description and discussion about GMM). We use fixed effects regressions and robust standard errors. (Theoretically, fixed effects models are more appropriate for our data. Nonetheless, we applied a Hausman test (Hausman, 1978) to compare fixed with random effects coefficients in *Stata 11.1 (2009)*. The results (Prob>chi2=0.0000) indicated the appropriateness of the fixed effects model.) The models were estimated using *Stata 11.1* (2009). Since the model in equation (5) nests the static CAPM as a special case, it facilitates the comparison of the two models. For comparing the relative performance of the different empirical specifications, we use the R^2 in the time-series cross-sectional data regression as an intuitive measure, which shows the fraction of the variation of monthly returns that can be explained by the model. To test the statistical significance of the unrestricted models and their goodness of fit we perform likelihood ratio tests.

Monthly average returns were computed for the period January 1999-August 2008 for 15 diversified portfolios of Mexican common stocks. (The limitation of the sample period derives from the availability of information to compute the return on human capital. The indicator used was discontinued by the Mexican Statistics Agency (INEGI) in August 2008 and was not substituted for another series. As explained later, this variable is preferred to other indicators). First, mean monthly returns, standard deviation of returns, and pair-wise correlation coefficients were calculated for the individual stocks using 24 months of past-return. The individual stocks were then combined to form portfolios without allowing borrowing or lending at the risk-free interest rate. The portfolios were selected such that they lie on the mean-variance (efficient) frontier (t he portfolios include, of course, the minimum variance portfolio and the maximum return portfolio, which denote the lower and upper end of the efficient frontier) and the stocks used to construct the portfolios were those most actively traded in the Mexican Stock Exchange (Bolsa Mexicana de Valores, BMV) for the period of study, on a daily basis. (See Appendix A for a list of the stocks included in the study). The monthly return on each portfolio is the weighted average of the current monthly returns on the individual stocks forming the portfolio. The monthly average return is calculated using the returns on the previous 24 months. The average return on each of these portfolios is then computed for the following 12 calendar months. The selection procedure is repeated each calendar year, thereby allowing for the rebalancing of the portfolios. This gives a time series of monthly returns with 116 observations for each of the 15 portfolios. The return on the value-weighted stock index is measured as the monthly return on the Mexican Stock Exchange Index (Indice de Precios y Cotizaciones, IPC). Monthly returns are calculated as the change in the logarithm of the closing prices of consecutive months ($R_t = ln(P_t/P_{t-1})$). Closing prices are taken from *Economatica* database.

As mentioned before, we chose the spread between the short-term rate of corporate debt and the 6-month Treasury bill rate as a proxy for the market risk premium. The short-term corporate debt rate (*Tasa Promedio Ponderada de Corto Plazo de Valores Privados*) is taken from Mexico's Central Bank (Banco de Mexico) statistics and the 6-month Treasury bill rate is taken from *INFOSEL FINANCIERO* database. (Not until recently (as from 2003), Mexico's central bank (Banco de México) started to provide information about the secondary market of the Treasury Bills (risk-free rate). Previously, only the primary market rate (auction for market makers) was available. The drawback of using this information is that the rates are not updated (since the frequency of the auction is weekly) to reflect the current rate at the time of each observation we have in the dataset. For this reason and given that we need information from 1997 to 2008, we use the data from INFOSEL FINANCIERO, a domestic supplier of financial and economic information. www.infosel.com.mx).

To calculate the monthly market risk premium, we compute the change in the spread between short-term corporate rate and the 6-month T-bill (CETE182) rate for two consecutive months. Whereas a positive change denotes an increase in the spread between months *t* and *t-1*, a negative change denotes a decrease. The market risk premium is used with a one-period lag, that is, R_{t-1}^{prem}.

The return on human capital is proxied by the growth rate of labor income of people employed in the manufacturing sector (*Indice de Remuneraciones Medias Reales por Persona Ocupada. Industria Manufacturera No Maquila*) published by Banco de Mexico. (In contrast to the United States and Japan, for example, Mexico does not report income per capita disaggregated by source of income. Previous studies such as Jagannathan and Wang (1996) and Jagannathan et al (1998) used the rate of growth on labor income excluding dividends as a proxy for return on human capital. Due to the lack of similar information, we used the growth rate of labor income of people employed in the manufacturing sector (*Indice de Remuneraciones Medias Reales por Persona Ocupada. Industria Manufacturera No Maquila)* published by Banco de Mexico. We recognize that this proxy may lack representativeness for the market as whole. The manufacturing sector represents about 18 percent of Mexico's GDP, the second largest sector after the service sector (including commerce and education). Although there exist data on labor income for people employed in the service sector (specifically commerce), the series is very short (starting in 2001) and, therefore, not appropriate for our study. We also tested as a proxy for human capital the monthly rate of growth on minimum labor income in Mexico (*Indice Real de Salario Mínimo General,* published by Banco de Mexico), which is the minimum daily wage that should be paid in the country, on average, to satisfy the needs of a household, and is expressed in real terms. This proxy also resulted statistically significant in the regressions. However, the monthly growth in the minimum real salary reflects basically the monthly inflation rate in Mexico since the nominal salary is revised (increased) only once a year, in labor income series is constructed using the formula

= (Lt-2 + Lt-3) / (Lt-3 + Lt-4) (7)

where denotes the growth rate in labor income that becomes known at the end of month t and Lt-2 denotes the per capita labor income index for month t-2, which becomes known at the end of month t. This dating convention is consistent with the fact that the monthly labor-income data used in this study are typically published with a two-month delay. We use a two-month moving average in the per capita labor income index to minimize the influence of measurement errors. All rates of return used are expressed in real terms.

RESULTS AND DISCUSSION

Using the data described above, we first examine the traditional empirical CAPM specification, or static CAPM,

$$E[R_{it}] = c_0 + c_{vw}\beta_{it}^{vw}. \qquad (8)$$

The results are presented in column A of Table 1. The estimate for c_{vw} is statistically significant at the 1 percent level and has the expected positive sign denoting higher returns for riskier (higher market-beta) portfolios. The R^2 is 46.67 percent. (Nothing about the classical linear model assumptions require that R^2 be above any particular value (Wooldridge, 2009:199). It is simply an estimate of how much variation in the dependent variable can be explained by the independent variables in the population. A larger sample size produces a better estimate of the 'real world' correlation. Correlations are, after all, subject to random error, and a larger sample reduces that error and makes the estimate move closer to the true value. With small sample sizes the R^2 is very noisy. As sample size increases, random noise is reduced and a better indication of the true relationship between the two groups of variables is obtained. Other things being equal, a larger sample size does not necessarily result in a larger R-squared). We can conclude that c_{vw} is significantly different from zero. That is, we strongly reject the flat-relation between returns and market beta as evidence in favor to the static CAPM. The percent of the time-series cross-sectional variation in average returns that can be explained by this specification is substantially larger than that found by other studies. Jagannathan and Wang (1996) find that the proportion of cross-section monthly returns explained by the static CAPM in the United States is only 1.35 percent, and using Japanese data, Jagannathan, et al (1998) find such goodness-of-fit to be 2 percent. Lettau and Ludvigson (2001), find an R^2 of 1 percent and Santos and Veronesi (2006) as high as 8 percent.

January thus, we decided to keep the growth on labor income in the manufacturing sector as our proxy for human capital, given that its dynamics might reflect some other elements apart from the inflation rate). This index is published in real terms. The growth rate in the monthly

Table 1. Results of CAPM specifications

Independent variables	Models						
	A	B	C	D	E	F	G
c_0	-0.004	0.011	-0.005	0.015	0.001	0.024	0.025
	(0.002)	(0.178)	(0.001)	(0.148)	(0.367)	(0.030)	(0.004)
β^{vw}	0.034	0.030	0.034	0.030	0.027	0.022	0.022
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
β^{prem}			1.009	1.093	0.899	0.990	1.051
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
β^{labor}					2.117	2.220	2.042
					(0.000)	(0.000)	(0.000)
size (MV)		-0.001		-0.001		-0.002	-0.002
		(0.045)		(0.041)		(0.021)	(0.000)
β^{US}							0.041
							(0.000)
No. obs.	1740	1740	1740	1740	1740	1740	1740
Adj. R^2	46.67	46.84	47.36	47.64	48.38	48.76	49.68
LR tests				B nested in D		D nested in F	G nested in F
LR chi2(1)				27.51		38.47	32.73
Prob > chi2				0.000		0.000	0.000

Recursive analysis of 116 monthly average returns for the period January 1999-August 2008 for 15 diversified portfolios of Mexican common stocks. The models are estimated using Least Squares Dummy Variable and within effect estimation methods for the time-series cross-sectional data used with fixed effects and robust standard errors.

When size is added to the model (column B in Table 1), the R^2 goes slightly up to 46.84 percent and the estimate for size, -0.001, is statistically significant at the 5 percent level. We can conclude that size effects adds practically no explanatory power to the model. However, size has the expected negative sign suggesting that smaller portfolios (i.e., smaller stocks) yield higher returns. This is in line with the results of previous works such as Banz (1981) and Fama and French (1992).

We next allow betas to vary over time, that is, we assume that the conditional CAPM holds, but still use the stock market index as a proxy for the market return. The results are presented in columns C and D of Table 1. The estimated value of c_{prem} is significantly different from zero and has a positive sign implying that an increase in the market risk premium (the spread between corporate and government short-term debt) increases the expected return on the portfolio. The R^2 is 47.36 percent, which is just a little improvement compared with 46.67 percent of the static model. The estimate of c_{vw} remains significant and unchanged. When size is added, there is an apparent lack of size effect as with the static model since the R^2 increases only marginally.

Adjusted R-squareds are reported as percentages. The coefficients are estimates of stock return sensitivity to β^{vw} "market risk β^{prem} "risk premium, β^{labor} -human capital return, size (MV)-size effect, and β^{US}-US stock market return. *p*-values between parenthesis.

We now consider the main model developed in this paper whereby the return on the market portfolio of all assets is assumed to be a linear function of the stock index and the growth rate of labor income in the manufacturing sector. The estimation results are presented in columns E and F of Table 1.

The estimated value of c_{labor} is significantly different from zero at the 1 percent level. Both, c_{vw} and c_{prem} remain significant and show the expected positive sign. When size is added to the model one can see that size does not really explain what is left unexplained by this model after controlling for sampling errors. The R^2 of 48.38 percent this model shows an improvement, and although it explains almost half of the variation of the average returns, there remains a great deal of variation that the model leaves unexplained, at least for the sample employed.

When size is added to the specification, all beta coefficients present the expected sign. There is cause for concern even though our conditional CAPM specification does slightly better than the static CAPM in explaining the time-series cross-section of monthly average returns. It appears that there still are some important aspects of reality that the model is missing.

Our results contrast with those of Jagannathan and Wang (1996), Lettau and Ludvingson (2001) (for the US market), and Jagannathan et al (1998) (for the Japanese market), who find that their conditional specification of the CAPM performs substantially better than the static version of the CAPM explaining, respectively, up to 55.2 ,75 and 58 percent of the cross sectional stock returns. On the other hand, in line with our findings that the beta instability to business cycle (β^{prem}) has a positive and significant relation with monthly returns, Bali et al (2009) find that time-varying conditional betas can explain between 25 and 58 percent of the cross-section variation of expected returns at the firm and portfolio level.

Although the R^2 of our results may not seem high when compared with previous empirical studies, as pointed out by Leamer (1999), Gould (2003) and Cameron (2005), that should not be a criticism for the model. We may not be able to explain across portfolios the overall level of returns very accurately, but we might very accurately be able to measure the effect of the market beta, the conditional betas and the other explanatory variables.

Additionally, in contrast with Jagannathan, et al (1998), Lettau and Ludvigson (2001), Santos and Veronesi (2006), and Lustig and Van Nieuwerburgh (2005), who present cross-sectional studies, we estimate here time-series cross-sectional data models. Lewellen and Nagel (2006) argue that the dramatic increase in R^2 found in the conditional models of these previous studies is partly due to ignoring some key restrictions in the cross sectional slopes. Second, the papers all use returns on size–B/M (size – book to market ratio) portfolios that have two key features: the returns can be traced to three common factors (Fama and French, 1993) and betas on the factors explain most of the cross-sectional variation in expected returns. In this setting, it can be easy to find a high sample R^2.

From the above discussion we can conclude that R^2 is not the only measure to consider for testing the goodness of fit of our models. For this reason, we perform likelihood ratio (LR) tests to evaluate the difference between nested models. One model is considered nested in another if the first model can be generated by imposing restrictions on the parameters of the second. If the difference is statistically significant, then the less restrictive model (the one with more variables) is said to fit the data significantly better than the more restrictive model.

The results for the LR tests are shown in Table 1. The results show that adding conditional betas (β^{prem}) to the model as predictor variables together (not just individually) results in a statistically significant improvement in model fit. The same can be said for the labor income growth (β^{labor}) when comparing the models in columns D and F.

In contrast, Lewellen and Nagel (2006) conclude that the conditional CAPM performs nearly as poorly as the unconditional (static) CAPM. They find no evidence that the betas covary with the market risk premium in a way that might explain the portfolios unconditional pricing error.

As discussed earlier, one might hypothesize that “the market” might include securities traded in other (foreign) markets. In such case, the proxy for the market return can be complemented by including the return on some foreign securities. It is well known the close relation between the United States stock market and the Mexican stock market. (For the period of study and using daily closing prices, the correlation between the Dow Jones Industrial index and the Indice de Precios y Cotizaciones (Mexican stock-market index) is about 0.80) In order to examine the effect of the return on the New York Stock Exchange on the return of Mexican stocks we add to the specification in equation (6) the variable β_{it}^{US} , (This beta is calculated as follows:

$$\beta_{it}^{US} = \frac{Cov(R_{it}, R_{it}^{US})}{Var(R_{it}^{US})}$$

, where R_{it}^{US} is the return on the DJI) which is the sensitivity to the monthly return on the Dow Jones Industrial Average index (DJI) measured as the change in the natural logarithm of the closing prices of two consecutive months. This return is used in real terms and with a lag of one period in order to allow for delayed market reaction. (We also used the DJI-beta instead of the monthly return. This beta was calculated as the covariance between the portfolio monthly return and the DJI monthly return divided by the variance of the DJI monthly return. The information used for the calculation included the previous 24 months. The results are unchanged and we decided to keep the lagged-DJI return instead because the DJI-beta proved less significant than the lagged return). The results are presented in column G of Table 1.

The estimate for β^{US} is statistically significant at the 1 percent level and has the expected positive sign implying that higher returns in the US market would produce higher expected returns on Mexican stocks. (Interestingly, the correlation between monthly returns on the IPC and monthly returns on the DJI is only 0.10 for our sample period, as compared to 0.80 for daily changes). It can also be noted that the estimate for c_{US} is larger than the estimates for c_{vw} suggesting a more important impact of the US market than the domestic one on the returns of Mexican stocks. The average DJI-beta for the whole period and all portfolios is 0.92. This is in line with c_{US} estimate, which suggests that an increase in the return of the US stock market would produce a less than proportional increase in the return on Mexican stocks. Judging from the R^2, the model including the return on the DJI increases the explanatory power of the conditional specification of the CAPM. The conditional specification, incorporating size effects, has an R^2 over 50 percent. The likelihood ratio test shows that completing the market definition by including the return on international assets results in a statistically significant improvement in the model fit.

The real relationship between the Mexican and US stock markets suggested by the results is supported by the fact that this relation entails extensive commercial, cultural, and educational ties, with over 1.25 billion dollars worth of two-way trade and roughly one million legal border crossings each day. More than 18,000 companies with U.S. investment have operations in Mexico, and U.S. companies have invested $145 billion in Mexico since 2000. Mexico is the United States' second-largest export market (after Canada) and third-largest trading partner (after Canada and China). Mexico's exports rely heavily on supplying the U.S. market, but the country has also sought to diversify its export destinations. Nearly 80 percent of Mexico's exports in 2011 went to the United States. In 2011, Mexico was the second-largest supplier of oil to the United States. Top U.S. exports to Mexico include mechanical machinery, electronic equipment, motor vehicle parts, mineral fuels and oils, and plastics (Bureau of Western Hemisphere Affairs, 2012). This close relationship between the supply and demand of products and services of Mexican and US companies may justify the effect found beyond being just the reflection of time co-movements between the series.

We conclude that even though the conditional CAPM has proved to account for almost as much variation in stock returns of Mexican public companies as the unconditional CAPM, there is statistical evidence that adding conditional betas to the model as well as complementing the market return definition with labor income growth and foreign stock market return as predictor variables, together (not just individually), results in a statistically significant improvement in model fit. This implies that allowing for time variation of betas as well as augmenting the traditional market return definition is of crucial importance in order to explain stock returns. Our results are relevant for several reasons. First, there is a general consensus that the CAPM is unable to explain satisfactorily the cross-section of average returns on stocks. However, the vast majority of this research has been conducted on the stock returns of developed economies. Our findings may reflect the need, already suggested by some academics, to study emerging markets under a different perspective because their dynamics may obey to different underlying factors. Second, being Mexico the second largest recipient of portfolio capital flows in Latin America and an important one in the international arena it is striking that the amount of work done to understand the pricing of risk in the country, individually and not as part of a sample of countries, has barely been explored. Our results contribute to the research effort in finance directed toward improving our understanding of how investors value risky cash flows in an emerging market. Finally, here we have used a time-series cross-sectional sample in contrast to the cross-sectional analyses usually performed for testing the conditional CAPM. Not only we used a more appropriate methodology, but also we allowed for the rebalancing of the portfolios by giving a recursive treatment to the portfolios. For these reasons, our results are to be deemed robust.

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APPENDIX A. Stocks included in the study

Company name	Stock Exchange Ticker	Industry
Alfa, S.A.B. de C.V.	ALFAA	Various
Cemex, S.A.B. de C.V.	CEMEXCPO	Construction
Corporación GEO, S.A.B. de C.V.	GEOB	Construction
Empresas ICA, S.A.B. de C.V.	ICA	Construction
Grupo Bimbo, S.A.B. de C.V.	BIMBOA	Manufacturing
Grupo Carso, S.A.B. de C.V.	GCARSOA1	Various
Grupo Elektra, S.A.B. de C.V.	ELEKTRA	Commercialization
Grupo Financiero Banorte, S.A.B. de C.V.	GFNORTEO	Services
Grupo Financiero Inbursa, S.A.B. de C.V.	GFINBURO	Services
Grupo México, S.A.B. de C.V.	GMEXICOB	Mining
Grupo Modelo, S.A.B. de C.V.	GMODELOC	Manufacturing
Grupo Televisa, S.A. de C.V.	TLVISACPO	Telecommunications
Kimberly-Clark de México, S.A. de C.V.	KIMBERA	Manufacturing
Teléfonos de México, S.A.B. de C.V.	TELMEXL	Telecommunications

The list above describes the stocks most actively traded on a daily basis in the Mexican Stock Exchange for the period 1999-2008. Trading activity was denoted by: 1) the stock having a full time series of daily prices for the chosen period, and 2) stock prices showing variation (i.e., purchase-sale transactions) during the period of study.