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Devaluation Expectations and the Stock Market: The Case of Mexico in 1994/95

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Anthony J. Richards*

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Research Department

Devaluation Expectations and the Stock Market: The Case of Mexico in 1994/95

Prepared by Torbjörn Becker, R. Gaston Gelos, and Anthony J. Richards¹

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Abstract

Using company-level data, this paper examines the relative stock-market performance of firms with different foreign-exchange exposures around the time of the 1994/95 Mexican crisis. Contrary to what one might have expected given the alleged peso overvaluation, exporting firms outperformed the market beginning in late 1993. Although interest rates fail to show a clear confidence loss in the exchange rate regime, the relative performance of net exporters suggests that expectations of devaluation increased continuously. The methodology presented is relevant beyond the Mexican case: sectoral differences in stock market performance may constitute valuable leading indicators of exchange rate changes in emerging markets.

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Keywords: Stock market, Mexican peso devaluations, event study, exchange rate exposure, credibility of exchange rate regimes, leading crisis indicators

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I. INTRODUCTION

The Mexican currency crisis of 1994/95, called the “first financial crisis of the 21st century” has in retrospect proven to be the first of a series of currency crises of the nineties. While the episode has been extensively analyzed, to our knowledge, no study has examined in detail the behavior of stock prices around this event. This is surprising, given the forward-looking nature of stock markets. There is now an increasing body of literature that tries to identify leading indicators of currency crises. However, while a wide range of potential “signals” has been explored, there has not been a systematic examination of the performance of different sectors preceding devaluations.² Whereas overall stock market indices do not appear to be very useful leading indicators,³ a closer examination of relative price movements might provide valuable insights. This is due to the fact that one can expect different sectors to be affected in dissimilar ways by a devaluation. The likely impact of a devaluation on a firm’s discounted expected profits will depend, among other factors, on its currency exposure—that is its export orientation, its imports of intermediate goods, and the degree of unhedged currency mismatches between its assets and liabilities.

This paper explores the behavior of different stocks around the time of the 1994/95 currency crisis. For the non-financial sector, it makes use of detailed information on foreign currency exposures at the company level. While we do not have similar data for the financial sector, the overall relative performance of financial companies in the Mexican episode is also of interest. As pointed out by many observers, weaknesses in the financial sector were already apparent long before the devaluation and likely to be exacerbated by a devaluation, high interest rates, or a combination of both.

The paper aims to answer the following questions: To what degree did the stock market anticipate the devaluation? To which extent did the devaluation’s impact on stock prices depend on the exchange rate exposure of firms? Does the relative performance of financial sector shares support the notion that investors were well informed about weaknesses in the banking sector? Event-study methods are used to address these questions. The question of whether the stock market anticipated a devaluation is particularly interesting in the Mexican case since the crisis is generally viewed as having been an unanticipated event.

We find that in the week of the devaluation, companies with high net exports showed significant positive abnormal returns, while low net exporters underperformed relative to the market. In addition, companies in the financial sector also showed a significant negative abnormal return in the event week. Furthermore, the relative performance of high and low net

² One of the few papers that relates devaluation expectations to stock market behavior is Berglund and Löflund (1997) who study the Finnish market in 1989-94. However, they do not distinguish between sectors.

³ See Berg and Pattillo (1998).

exporting firms suggest that devaluation expectations may have started to build up approximately a year before the actual event, while relative performance after the abandonment of the peg display a strong correlation with the movements of the floating exchange rate.

The fact that rather than underperforming due to an presumably overvalued currency, the high net exporting stocks outperformed the rest of the market in the lead up to the devaluation, might come as a surprise to some. This fact is not easily be explained without referring to investors' assessments of likely future adjustments in the exchange rate. Thus this paper provides not only a new market based measure of exchange rate expectations, but also supports the notion that in this emerging market, stock-prices are to a large extent driven by forward-looking investors.

The remainder of the paper is structured as follows: In the next section we provide a very brief overview over the existing literature assessing the credibility of fixed exchange rate regimes, and we motivate our focus on the stock market. The section also introduces our proposed stock market measure of exchange rate expectations. Section III discusses Mexico's macroeconomic performance and the existing evidence on the extent to which devaluation expectations rose during 1993-94. It then presents details of our proposed methodology and the results that are obtained. Section IV. concludes.

II. MEASURES OF DEVALUATION EXPECTATIONS

Empirical approaches to measuring devaluation expectations can broadly be classified into three categories based on their use of market data, macroeconomic models, or surveys. The measure proposed in this paper falls in the market-data category. The innovative feature of our approach is that the market data used are stock market data. Before the stock-market measure is presented, we provide a summary of the traditional approaches.

A. Traditional Measures

Traditionally, economists have relied on interest and exchange rates in order to assess markets' devaluation expectations. The most common departing points in this context are the so-called covered and uncovered interest parities (CIP and UIP). According to UIP, the interest differential between two assets denominated in different currencies that carry the same default risk should represent the expected depreciation rate of one currency vis-à-vis the other. Let i_t and i_t^* denote interest rates on domestic and foreign-currency denominated assets, e_t the spot exchange rates expressed in terms of domestic currency per foreign currency, and E_t the expectations operator at time t . The relationship is given by:

$$(1 + i_t) = (1 + i_t^*) \frac{E_t(e_{t+1})}{e_t} \quad (1)$$

When substituting the expected exchange rate by the forward rate, one obtains CIP. These equations have been used to deduce the expected devaluation from interest differentials or from the forward exchange rate. However, the empirical evidence in favor of either UIP or CIP is mixed at best. The forward exchange rate has proved to be a bad predictor of future exchange rate movements, and it has been argued that this reflects the presence of large and time-varying currency premia.⁴ In practice, it is often difficult to find two securities denominated in domestic and foreign currency that carry the same default risks. For example, for the case of Mexico, Werner (1996) finds that the risk premia on the peso can partly be explained by relative supplies of dollar- and peso-denominated debt. These relative asset supplies, in turn, are endogenous, since the government reacts to changes in the cost of its debt. Additional problems that restrict the usefulness of UIP or CIP to infer devaluation expectations arise from less-than perfect capital mobility and the fact that in general, interest rates are also policy instruments, subject to various regulations, and therefore not always market-determined.

Nevertheless, most of the literature trying to assess the credibility of fixed-exchange rate regimes relies strongly on the validity of UIP. An example is Rose and Svensson (1995), who argue that in narrow target zones, the assumption of UIP may be more appropriate than under other circumstances. By contrast, without formally assuming UIP, Svensson (1991) proposes a test of target-zone credibility based on the argument that an exchange rate band implies a band for domestic currency rates of return. If the domestic interest rate is outside the rate-of-return band, then there either exist arbitrage opportunities or the exchange rate band is not fully credible.

Another approach focuses on the information contained in the prices of financial derivatives, see Söderlind and Svensson (1997) for a survey of this approach. Campa and Chang (1996) develop a test that relies on ERM cross-rate options. While, similarly to Svensson (1991), the approach has the advantage of being based on arbitrage and not on a particular model, unfortunately, however, the type of financial instruments analyzed are not available for many countries.

A different strand of the literature attempts to explain the timing of exchange rate crises based on the prediction of macroeconomic models of speculative attacks. Typically, such models rely on a money market equilibrium condition, which under a fixed exchange rate regime determines the path of central bank reserves. Based on parameter estimates from the key relationships in the models, estimates of shadow exchange rates and devaluation

⁴ Note that we have already excluded differences that are due to country—or political—risks. For a survey, see Lewis (1995).

probabilities can be constructed. Examples of this approach include Blanco and Garber (1986), and Goldberg (1994). However, these results are obviously strongly dependent on specific model assumptions and on a correct estimation of parameters, restricting their practical applicability somewhat. Recently, a related literature has attempted to assess probabilities of currency crises⁵ while imposing less structure and not explicitly constructing shadow exchange rates. A number of indicators such as the real exchange rate, money growth, debt levels, and reserves, are used as explanatory variables in probability models, such as those of Frankel and Rose (1996), Kaminsky, Lizondo, and Reinhart (1997), and Sachs, Tornell, and Velasco (1996a). As an in-depth evaluation of the methodology by Berg and Pattillo (1998) shows, this approach has only been moderately successful. Moreover, in practice the required macroeconomic data are generally not all available on a reliable, timely, and high-frequency basis.

The use of survey data can overcome some of the aforementioned difficulties. Asking market participants directly about their expectations seems to be a sensible alternative to the more indirect methods described above. However, there are potential drawbacks. Apart from the problem that market participants may not have the right incentives to correctly reveal their expectations, the link between average expectations and the marginal pricing in the foreign exchange market is not clear.⁶ More importantly, high-frequency and timely survey data are seldom available, especially in the case of emerging markets that we are primarily interested in.

These considerations suggest that a closer look at stock markets may be fruitful in order to assess market expectations of devaluations. At least in those countries in which stock markets are liquid and trading occurs at a high frequency, prices should quickly incorporate any changes in market expectations.

B. A New Stock Market Measure

The measure we propose is based on the assumption that returns on stocks (or portfolios) can be explained ex post by a multi-factor model of stock returns. Thus, we do not explicitly assume any ex ante model, such as any particular form of the CAPM. Formally,

$$r_{i,t} = \alpha_i + \beta_{i,1}r_{m,t} + \beta_{i,2}E_t + \beta_{i,3}X_t + \varepsilon_{i,t}, \quad (2)$$

⁵ Various definitions of currency crises are used in the literature. See Berg and Pattillo (1998).

⁶ For a survey of these issues, see Takagi (1991). For a study using survey data, see Goldfajn and Valdéz (1997).

where $r_{i,t}$ is the return on asset i , $r_{m,t}$ is the return on the market portfolio, E_t is the exchange rate factor and the main object of interest, X_t is another (set of) factor(s), the α and β 's are coefficients and ε_t is an error term.

It is important to note that the exchange rate factor does not include only the current exchange rate, but, due to the forward looking nature of stock prices, should represent the expectation about the entire future path of exchange rates.⁷ Therefore, returns on asset i should respond to both unforeseen actual changes in the exchange rate as well as changes in expectations about future exchange rates. In particular, returns should be sensitive to changes in devaluation expectations in a fixed exchange rate regime, even if we do not observe any actual movements in the exchange rate.

When estimating such an equation empirically in a flexible exchange rate regime, under certain restrictive assumptions, changes in the spot rate can be used for E_t . For example, if the exchange rate follows a random walk, a change in the spot rate implies a change in the rational expectation of tomorrow's exchange rate and therefore is a sufficient statistic for the change in the present discounted path of future exchange rates. In a fixed regime, the exchange rate factor is an unobservable and precisely the variable that we would like to estimate. In such a case, we do not know the true parameters or the error term, but in principle, we could obtain an estimate of the exchange rate factor in the following way:

$$\hat{E}_t = \frac{ar_{i,t}}{\hat{\beta}_{i,2}}, \quad (3)$$

where $\hat{\beta}_{i,2}$ is an estimate of the exchange rate beta (obtained, e.g., from a data sample where the exchange rate was floating), and $ar_{i,t}$ is the abnormal return on asset i . For now, the measure for abnormal returns can be thought of as the standard measure used in event studies (i.e., the actual minus the predicted return on asset i —see, e.g., MacKinlay, 1997) although in the empirical implementation some minor modifications will be made to the standard measure, to take account of the unobserved nature of the exchange rate factor. See Appendix I for derivations of the formulas and a discussion of these modifications.

To summarize the analysis in Appendix I, the conditions that are required in an empirical implementation of the measure are the following. First, and most obvious, we need to identify an asset that responds significantly to changes in the exchange rate. Second, the

⁷ See Appendix II for a more formal discussion of the exchange rate sensitivity of stock prices.

influence of other factors (X_t in Equation 2) on the asset's return should be minimal or controllable.

In the following empirical example of the Mexican devaluation of 1994 and the subsequent floating of the peso, we will argue that we can define an asset that fulfills these requirements reasonably well. However, the example also illustrates some of the difficulties involved in obtaining an estimate of the exchange rate beta that is needed for more precise statements about changes in exchange rate expectations. The methodology and results presented in this paper may also be of interest beyond the specific Mexican experience presented below, not least since the recent financial crises in Asia have sparked questions about early warning indicators, where the market's exchange rate expectations could be of particular interest.

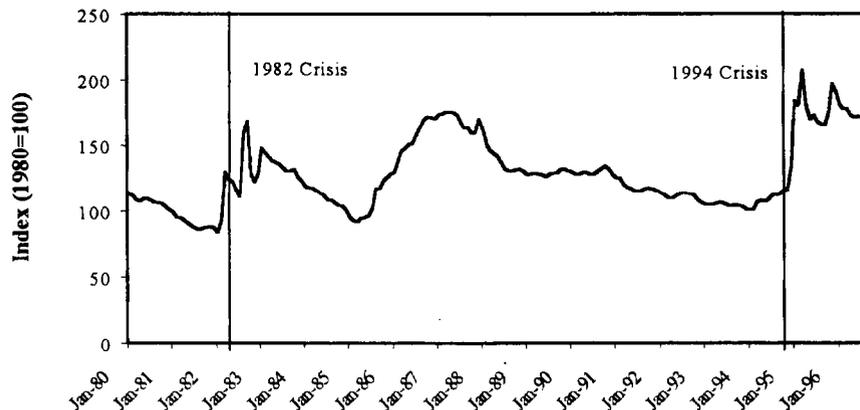
III. DERIVING EXCHANGE RATE EXPECTATIONS FOR MEXICO

This section contains a brief discussion of different views of the Mexican crises and the applicability of more traditional measures in gauging devaluation expectations before we present the empirical study of our proposed stock market measure.

A. The Macro Perspective

A variety of explanations have been offered for the collapse of the Mexican peso on December 20, 1994, and we will not discuss them in detail nor add a new one here. However, a few facts that are likely to have played a role in this context may be stated. First, partly fueled by growing capital inflows, the real exchange rate had been appreciating continuously under a crawling peg regime since 1987 and had reached levels similar to those seen before the 1982 and 1986 devaluations. This is illustrated in Figure 1.

Figure 1. The Real (Effective) Exchange Rate



Source: Banco de México.

Second, since the liberalization of the financial sector, banks had been engaged in what—at least ex-post—could be regarded as imprudent lending. The mild recession of 1993 had already partly exposed these weaknesses and the share of nonperforming loans was growing. Third, it has been argued that this in turn led the Mexican authorities to maintain low interest rates, adopting a monetary policy that most likely was too loose to be compatible with maintaining the fixed exchange rate regime. In particular, credit to the financial system expanded sharply after March 1994.⁸ Fourth, influenced by the upcoming presidential elections in August, fiscal policy was also expansionary, and the current account deficit continued to widen throughout 1994, reaching nearly 8 percent of GDP in that year.

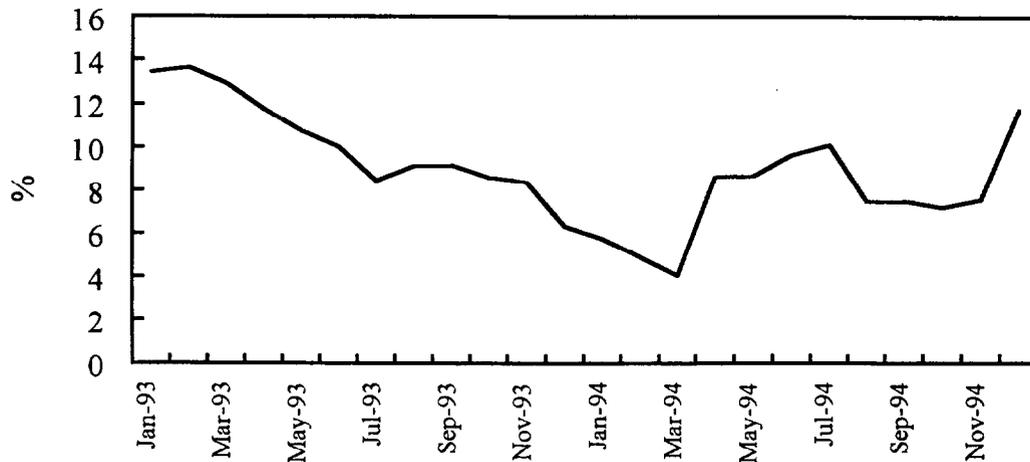
Interestingly, interest differentials with the U.S. (shown in Figure 2) were declining from the beginning of 1993 until March 1994, when the assassination of the presidential candidate Colosio resulted in increased political uncertainty. However, interest rates came down again in August 1994 and differentials remained low until shortly before the crisis.⁹ This behavior of interest rates has led many researchers to conclude that there had been no loss in confidence in the exchange rate regime.¹⁰ However, Werner (1996) has suggested that the currency risk premium is positively related to the share of peso-denominated debt in total debt. In particular, the authorities had been replacing peso-denominated government bonds (CETES) with short-term bonds repayable in U.S. dollars (Tesobonos). When Werner adjusts the observed interest differential for changes in the composition of external debt, the adjusted measure remains at high levels through 1994, suggesting low levels of confidence in the announced currency band.

⁸ See Masson and Agénor (1996).

⁹ The interest differential between dollar denominated debt (Tesobonos) and US CD's, a measure of default risk, also dropped to very low levels after an increase in March 1994. See Masson and Agénor (1996).

¹⁰ For a discussion, see Masson and Agénor (1996). See Domowitz, Glen, and Madhavan (1998) for a discussion of country and currency risk premia in Mexico prior to the devaluation.

Figure 2. Interest Rate Differentials, 1993-94.



Source: Banco de México.

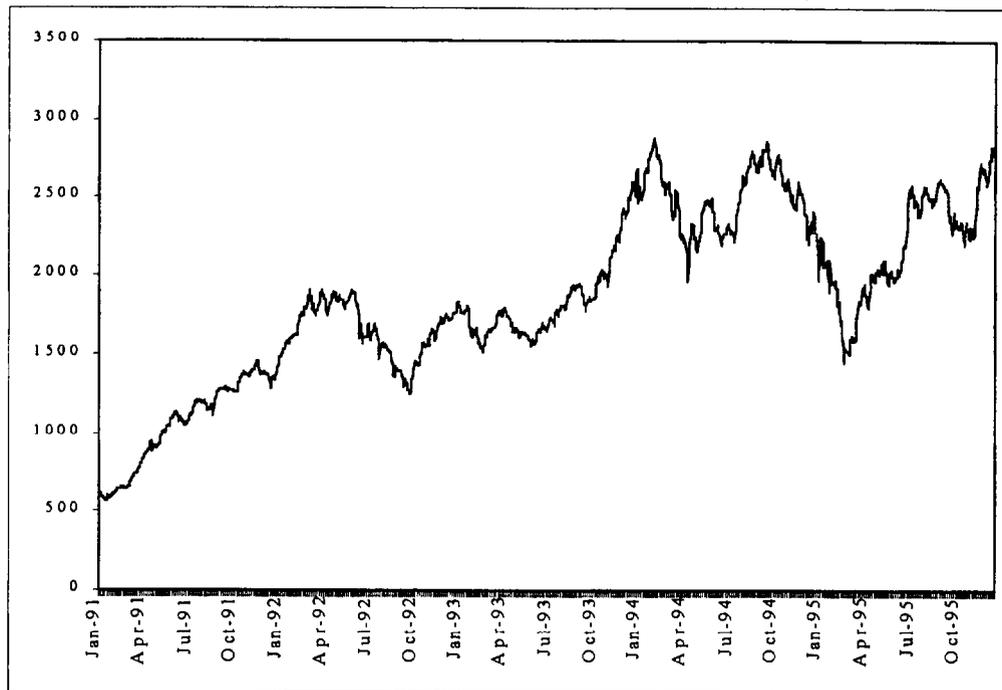
Note: Calculated as difference between yields on Tesobonos (U.S. \$-linked) and CETES (Peso-denominated). For 1/93-7/93 the figures are based on 1-month maturities, for the later period on 3-month bonds.

However, the debate as to whether the collapse of the exchange rate regime was a result of growing concerns about deteriorating fundamentals as opposed to a financial panic is not yet settled.¹¹ Essentially, two main views have been proposed. One explanation is related to the conventional theory of speculative attacks and argues that the devaluation was expected, while another interpretation is that the crisis was largely unexpected, and that the devaluation triggered a panic. A variant of the latter view, as proposed by Agénor and Masson (1999), is that the devaluation revealed the true preferences of the government regarding the costs of raising domestic interest rates versus maintaining exchange-rate stability.

In view of the somewhat inconclusive existing evidence, one main goal of our analysis is to ascertain the extent to which the stock market may have anticipated a devaluation. A cursory look at the overall stock market performance, shown in Figure 3, is, however, not very revealing. There is no apparent correlation between movements in the index and any of the indicators discussed above. After a continuous rise in 1993, the index started to drop sharply in February 1994, but soon recovered, nearly reaching its previous high in October of that year. The market then declined steadily until the end of March 1995.

¹¹ See for example Agénor and Masson (1999), Calvo and Mendoza (1996), Gil-Díaz and Carstens (1996), and Sachs, Tornell, and Velasco (1996b).

Figure 3. Stock Market Index (Mexbol)



Source: Bloomberg.

In the analysis that follows, we take a disaggregated look at the stock market, using company-level data. As stated in the introduction, the main idea is that companies differ in their exchange rate exposure. The impact on a firm's stock market valuation from exchange rate movements will depend on the value of its exports and imported inputs, its market power, the size of its foreign-currency denominated debt, its flexibility in reallocating factors of production, and on the reaction of domestic prices. A more detailed discussion of these issues is given in Appendix II. In the case of a devaluation, additional issues relate to the whether the devaluation happens in a "controlled" fashion or whether the currency collapses, inducing a widespread recession and possibly a cut-off from international capital markets.

B. The Exchange Rate Sensitivity of Stock Prices

In order to derive the exchange rate measure proposed in Section II, we first need to find assets with returns that are sensitive to news about the exchange rate. In other words, we need to identify assets with an exchange rate beta that is non-zero. To this end, we first use standard event study methods¹² to investigate the performance of individual stocks around the devaluation date. This enables us to test whether the company-level data provides a means to sensibly sort companies by exchange rate sensitivities, assuming that the

¹² For an overview of the event-study methodology, see MacKinlay (1997).

devaluation event and its timing were not *completely* anticipated.¹³ We then form portfolios based on these company-specific characteristics, and examine their returns in the period surrounding the devaluation.

Data

We work with two databases. Company-level data on exports and intermediate imports for non-financial firms were obtained from a database published by the Mexican business newspaper *Expansión*, covering the 500 largest companies in Mexico.¹⁴ The earliest data available are for the end of 1994, which we use in all analysis. While it might be preferable to have had access to earlier information, the devaluation only occurred in the last days of December of 1994, and therefore had little effect on export and import figures for that year. In order to obtain a variable measuring net exchange rate exposure, we subtract imports from exports and divide this amount by the total sales of the company. The database also contains information on the share of foreign currency-denominated debt in total, and we also explored this data, as discussed below.

Of the companies for which import and export data are available, there were 39, plus four financial firms, for which stock price data for 1993-95 are also available in the Emerging Markets Database (EMDB) produced by the International Finance Corporation (IFC). Data on weekly stock returns for these companies were calculated based on U.S. dollar prices, dividends, and capital adjustments as given in the EMDB.¹⁵

The Devaluation Event and Company Characteristics

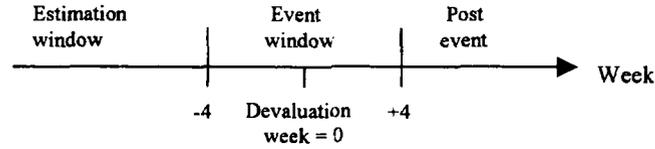
The methodology employed for studying the devaluation event is to estimate a market model for a pre-event or estimation window, and use these estimates to compute abnormal returns during the event window (see Figure 4).

¹³ To be more precise, a third important implicit hypothesis is that of stock-market efficiency.

¹⁴ "Las Empresas Más Importantes de México," Banco de Datos Expansión, Mexico. The Mexican Stock Exchange (BMV) collects similar information on exports, but no data on imports were available for 1994. Comparing export and sales data from the two sources, we found a very close match.

¹⁵ Four stocks (Grupo Aluminio, Bancomer BCP, Grupo Video Visa, and Spicer) initially covered by the IFC were dropped from the Mexican stock market during this period. Our understanding is that the circumstances of their exclusion from the EMDB do not raise any "survivorship" problems.

Figure 4. The Event Time Line



In order to compute abnormal returns for each stock i in period t , $ar_{i,t} = r_{i,t} - \hat{r}_{i,t}$, we first estimate individual market models for the pre-event estimation period according to:

$$r_{it} = \alpha_i + \beta_i r_{m,t} + \varepsilon_{it}, \quad (4)$$

where r_{it} is the return of an individual stock and $r_{m,t}$ is the market return as before. The normal or predicted returns \hat{r}_{it} in the event window are then calculated by using the parameter estimates of the intercept and slope coefficients obtained in the estimation window, while the standard errors from the estimation window are used to compute confidence intervals for the estimated abnormal returns. Carrying out an event study around the devaluation date presupposes that, while it might have been partially anticipated, the actual event provided relevant news for the stock market.

Once the abnormal returns for the devaluation week are obtained, we test if company characteristics have explanatory power for the differences in performance. We regress the abnormal returns of individual stocks on a set of explanatory variables Z , in particular those identified as relevant in Appendix II: exports, imports and foreign currency denominated debt.

$$ar_{i,event} = \gamma + \delta Z + \eta_i, \quad (5)$$

Here, γ and δ are the parameters to be estimated and η_i is the error term. These estimates constitute a first test of the hypothesis formulated in the previous section, i.e. that the impact of exchange rate changes on firms' stock valuation depends on certain key firm characteristics, including their exports and imports.

Equation (4) was estimated by OLS for the period starting January 1993 until four weeks prior to the devaluation.¹⁶ We investigated five company characteristics. Using exports (X), imports (M), and sales (S), we created the variables scaled net exports (X-M)/S,

¹⁶ We also estimated the market model with a GARCH specification, and the main results are robust to that specification change.

scaled exports X/S, and scaled imports M/S. We also employed a dummy for financial sector firms (BANK) and information on the ratio of foreign-currency-denominated debt to total debt (FEX). Table 1 shows the results from different regressions using these variables.

Table 1. Regression of Abnormal Returns on Company Characteristics

	(1)	(2)	(3)
Constant	-0.041 (0.039)	-0.017 (0.019)	-0.054** (0.024)
(X-M)/S	0.277*** (0.098)	0.298*** (0.097)	
Bank	-0.070 (0.064)	-0.094* (0.054)	-0.057 (0.057)
FEX	0.042 (0.062)		
X/S			0.308*** (0.093)
M/S			0.047 (0.203)
Adj. R ²	18%	19%	28%

Note: White heteroskedasticity consistent standard errors in parenthesis. *(**, ***) indicate significantly different from zero at 10% (5%, 1%) level. 43 observations in each regression.

Source: Authors' calculations based on data from IFC and *Expansión*.

The results indicate that net exports as a share of sales indeed significantly help to explain abnormal returns during the devaluation week. However, using net exports imposes the restriction that the coefficients on imports and exports are of equal magnitude but with opposite signs, while the results in column (3) indicate that they are not. As expected, X/S has a positive and highly significant impact on abnormal returns, while imports and foreign currency debt both have small and statistically insignificant positive coefficients. One explanation for the insignificant effect of imports is that imports do not vary much across firms and are strongly positively correlated with exports; with a limited sample this can yield poor estimates of the coefficient on imports.¹⁷ The results also indicate that the bank stocks underperformed in the week of the devaluation.

¹⁷ Another possible explanation which is hard to square with rational behavior, is that investors actually only take the revenue composition of the firm into account. In one of the few studies that uses company-level data on exports and imports to explain exchange rate sensitivities of stock prices, Martínez Solano (1998) finds that exports appear to matter much
(continued...)

Constructing Portfolios

Since we are ultimately searching for a measure of exchange rate expectations, we want to aggregate the results for individual stocks into a variable that summarizes the relative performance of different types of companies. One way of doing this is to form portfolios of stocks. Forming portfolios also has the advantage of reducing noise stemming from idiosyncratic shocks, thus reducing the likelihood that β_3 in Equation (2) is not equal to zero, which is one of the assumptions we make in deriving the exchange rate measure. Together with the theoretical considerations of Appendix II, the estimates from Equation (5) will guide us in forming portfolios of firms which differ systematically in their sensitivity to exchange rate movements.¹⁸ The devaluation event-study methodology presented above will then be used to assess the impact of the devaluation on the relative performance of these different portfolios. In all of the following empirical investigations, we will focus on the performance of portfolios rather than individual stocks.

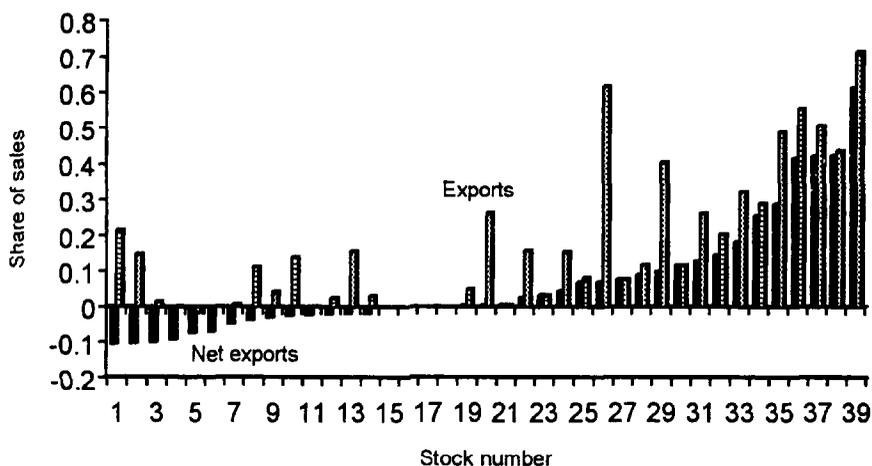
The regression results in Table 1 and theoretical considerations suggest that either exports or net exports should be used as sorting variables. Figure 5 displays the two series with the stocks sorted by net exports. In the remainder of the paper, we sort by net exports, since this is more in line with the theoretical arguments made in Appendix II, despite the fact that exports alone seem to perform slightly better from an empirical point of view in explaining abnormal returns.

The stocks are divided into three equally weighted portfolios: a bank portfolio consisting of the four banks in the sample (portfolio 1), a low net export portfolio consisting of two thirds of the non-bank stocks (2), and finally a high net export portfolio, consisting of the top third of non-bank stocks (3). In addition to these portfolios, a portfolio long in 3 and short in 2 is also included in the analysis; this portfolio is labeled the difference portfolio (4). This portfolio then measure the *relative* performance of the high and low net exporting companies.

more than imports for Spanish stocks. One possible explanation is that investors can observe a company's output more easily than its inputs, so stock prices respond more to output.

¹⁸ Taking a slightly different perspective, one could argue that the main difference in the portfolios is not their exchange-rate sensitivity, but differences in their insulation from domestic demand shocks. In the Mexican case, if investors were mainly preoccupied with the possibility of a recession as a result of the devaluation, export-oriented firms could have been perceived as more insulated from a likely drop in domestic demand. In other words, quantity as opposed to price effects as derived in Appendix I could have been viewed as most important. The analysis that follows is—except for the last part of the paper—not substantially affected by adopting this view; indeed, in most cases one could simply replace the words “exchange rate expectations” by “crisis expectations.”

Figure 5. Net Exports and Exports
(As Shares of Total Sales)



Source: Authors' calculations based on data from *Expansión*.

The reason that only a third—rather than half—of the stocks are included in the high net-export portfolio is that, below the 66-percentile, net exports of the companies represent less than ten percent of sales, so that these firms cannot be meaningfully labeled as exporters. It is worth mentioning that we experimented with some other cut-off points to evaluate the robustness of the results; the general conclusion is that the results are robust to such changes, especially in the upper end of the sorting. Furthermore, if exports is used as the sorting variable, only three stocks change portfolios, and the results regarding abnormal returns in the devaluation week are again robust to these changes.¹⁹

Abnormal Returns on Portfolios

In order to compute abnormal returns for the portfolios, we now estimate market models for the portfolios in the pre-event period (i.e., the index i in Equation (4) now refers to a portfolio rather than an individual stock). Figure 6 displays the abnormal returns during the event window, i.e., for the four weeks before and after the devaluation, with the almost horizontal lines representing plus or minus two standard errors. The figure clearly indicates that the high net-export portfolio outperformed the market in the event week in a statistically

¹⁹ In Appendix III, we examine other aspects of these portfolios in more detail, comparing both balance sheet, operational, and stock market characteristics for the different portfolios.

significant way.²⁰ The low-net-export portfolio experienced a significant negative effect and the difference portfolio a significant positive impact (which is not surprising given the other results). Furthermore, the bank stocks were strongly adversely affected by the developments in the devaluation week. This is then an indication that we indeed can find assets that respond to exchange rate news, which is the important first step in deriving a measure of devaluation expectations. Again, it should be noted that our hypothesis is that although there may have been expectations about a devaluation, the event was not perfectly predicted and thus when it occurred provided news about the future path of the exchange rate.

It should also be noted that there was only a slightly positive abnormal return for the difference portfolio in the week prior to the devaluation, suggesting that devaluation expectations did not change in a significant way shortly before the event. It is worth mentioning that the extent to which new information is incorporated quickly in emerging markets' stock market is in itself an area of research; the results presented here are supportive of the efficiency of the Mexican stock market.²¹

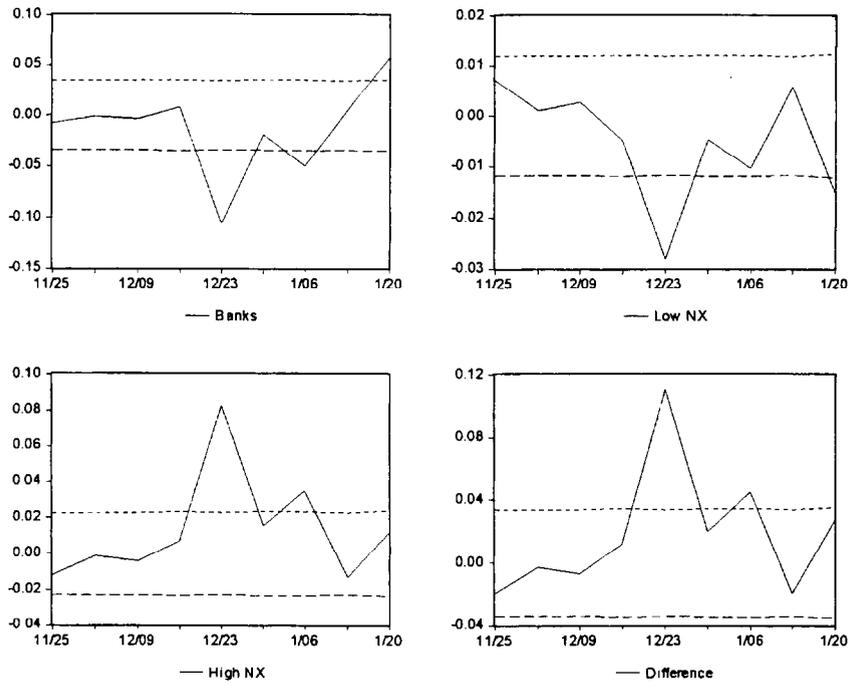
It is also of interest to consider how the magnitude of the abnormal returns recorded in the devaluation week are compared with other weeks prior to the event. Figure 7 indicates that the devaluation week was indeed a special event, and that there are no observations of the same magnitude either before or after the devaluation. (There are some other dates that produce significant observations, but from a statistical point of view this would be expected when studying a large number of pre-event observations. If abnormal returns are t-distributed, approximately five significant observations can be expected with 100 observations.)²²

²⁰ While a conventional p-value may not be entirely appropriate when information on exchange rate sensitivity in the event-week has been used to form the portfolios, the p-value on the difference portfolio is less than 0.0001.

²¹For other studies addressing the efficiency of the Mexican stock market, see Bailey and Chung (1995), Clark and Berko (1996), and Bhattacharya et al. (1999).

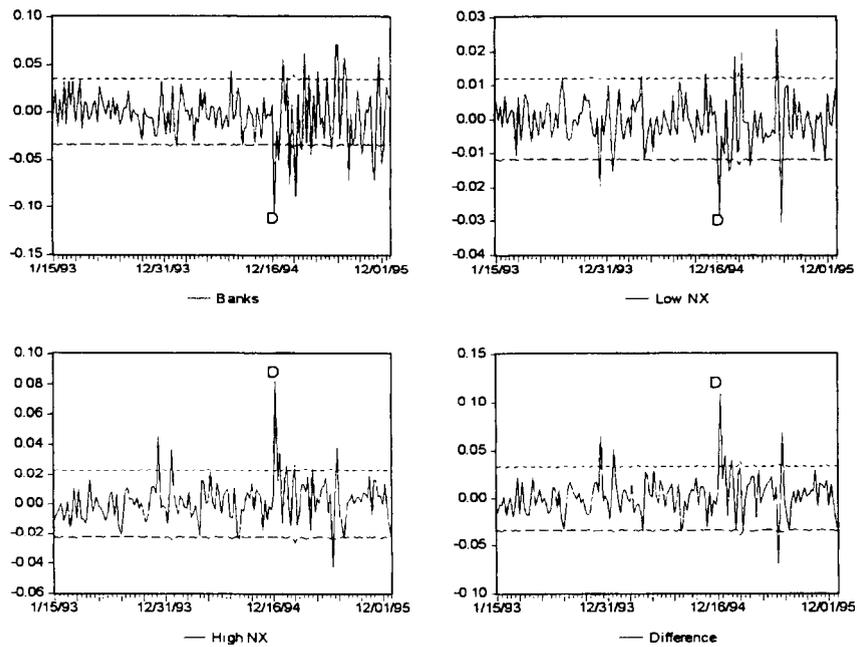
²² In Appendix IV, we also include some other potentially relevant events preceding the devaluation in order to gain further insights into the way stock prices are affected by news that should have dissimilar effects on different portfolios.

Figure 6. Abnormal Returns in the Event Window



Source: Authors' calculations based on data from IFC and *Expansión*

Figure 7. Abnormal returns for the entire sample period

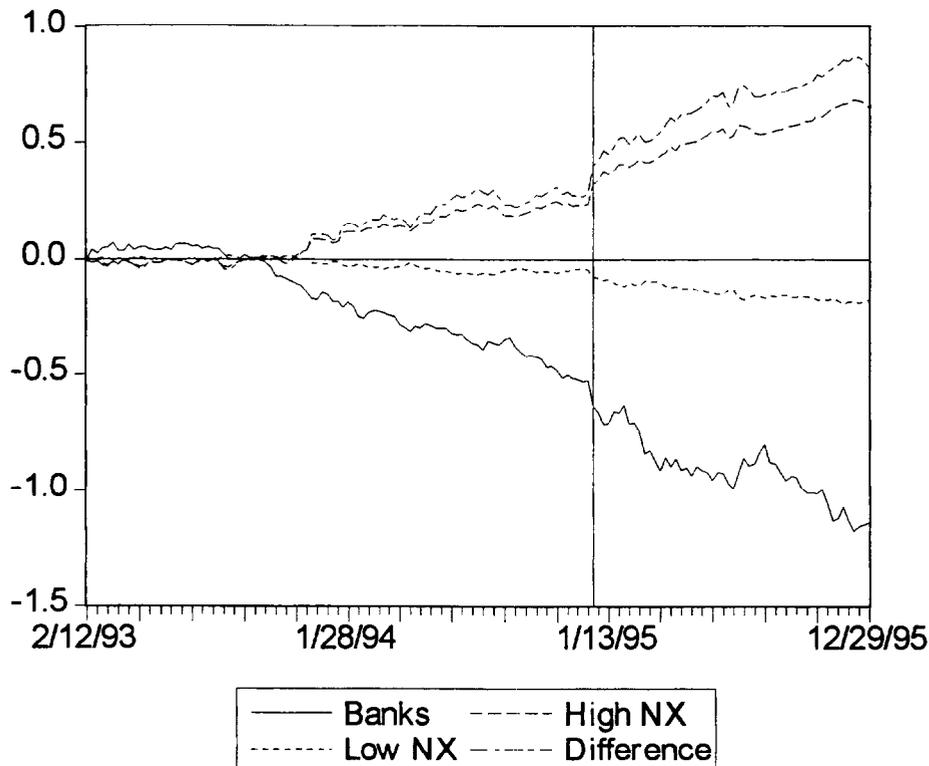


Source: Authors' calculations based on data from IFC and *Expansión*

C. The Stock Market Measure as a “Shadow” Exchange Rate

Until now, we have focused on the behavior of the different portfolios in and around the week of the **actual devaluation**. However, if the relative stock market performance of different sectors reflected changing **expectations about devaluation**, then we could potentially look for such effects over a long period prior to the devaluation. One possibility would be to sum up the abnormal returns shown in Figure 7 to obtain series for cumulative abnormal returns in the period leading up to the devaluation. However, since estimation-period abnormal returns are the residuals from an OLS regression they must by definition sum to zero in the estimation period, and can yield limited information about changing expectations in that period. Accordingly, we use a rolling regression technique, as discussed in Appendix I, to model the evolving relative performance of different sectors.

Figure 8. Cumulative Abnormal Returns on the Four Portfolios



Source: Authors' calculations based on data from IFC and *Expansión*.

We then estimate cumulative abnormal returns for each portfolio as the sum over time of the individual abnormal returns for each portfolio. Figure 8 displays these cumulative abnormal returns for the four portfolios over the entire sample period. Some rather striking patterns emerge from these estimates. In particular, after about November 1993, the high net export portfolio exhibits positive and generally increasing cumulative abnormal returns for the remainder of the sample period. The reverse is true for the low net export portfolio, and

even more so for the bank portfolio. Note that the strong performance of the net exporters is remarkable given the alleged overvaluation of the peso around that time, which was viewed to be primarily affecting the tradable sector.

These differences in relative performance are remarkable and interesting per se. However, the next step is to use these estimates to produce a stock market measure of exchange rate expectations. To do this, we focus our attention on the performance of the difference portfolio, since this provides a summary measure of the relative performance of high and low net exporting stocks and also has the potential benefit of removing other common factors that may be driving the returns of the two portfolios.

Estimating the Exchange Rate Elasticity

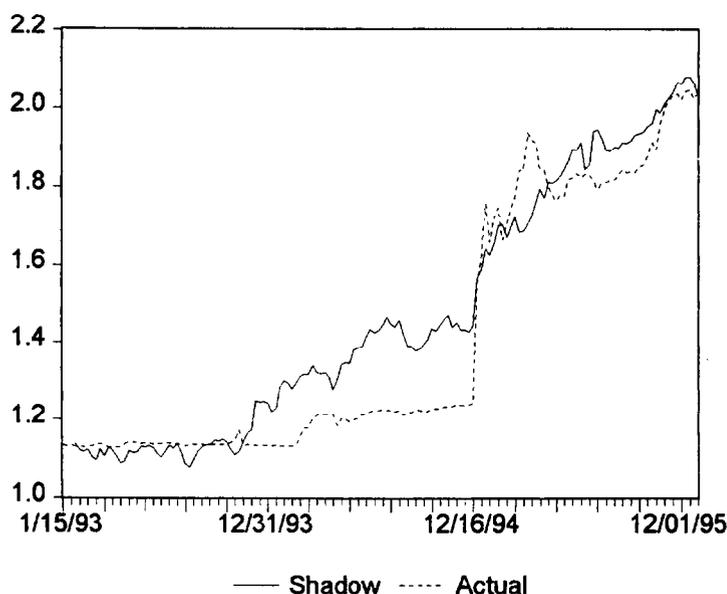
One crucial step in order to arrive at a stock market-based measure of exchange rate expectations is to produce an estimate of the exchange rate beta ($\hat{\beta}_{i,2}$ in Equation 3). The approach here is to estimate beta in a floating exchange rate regime, where the exchange rate factor is observable. The first somewhat heroic assumption that we adopt in this case is that the relationship between abnormal returns and the exchange rate factor is the same before and after the devaluation. The second assumption is that in the post-devaluation period, the actual change in the exchange rate (which is observable) is the only relevant variable for forecasting future exchange rates. As mentioned in before, this would be the case if the exchange rate followed a random walk after the devaluation.²³ If the cumulative abnormal returns are scaled by the exchange rate elasticity and level-adjusted, the resulting series can be interpreted as a shadow exchange rate.

A straightforward way of estimating the exchange rate beta in the post-devaluation is to run a regression with the cumulative market adjusted return of the difference portfolio displayed in Figure 8 as the dependent variable and the log of the exchange rate as the independent variable. Over the post devaluation period, this generates a beta estimate of 0.92 that is highly significant (the t-statistic is 9.62). To use this estimate to generate a shadow exchange rate, the cumulative abnormal return series is first scaled with the estimated elasticity and then level adjusted so that the derived series starts at the same level as the actual exchange rate. This latter adjustment is valid if the exchange rate was at its equilibrium level at the start of the sample (i.e., the devaluation expectations were close to

²³ Empirically, a unit root cannot be rejected for the post devaluation exchange rate. Furthermore, when an ARMA(1,1) model is estimated, it suggests that the lagged values of the exchange rate do not add much explanatory power to forecasts of the exchange rate, so the random walk assumption seems fairly consistent with the actual data.

zero at that date).²⁴ The shadow exchange rate measure generated in this way is shown as the dotted line in Figure 9 together with the log of the actual exchange rate. If the scaling and level adjustment is correct, one interpretation is that there was a build-up of exchange rate expectations starting at the end of 1993, and that the initial sharp depreciation was not anticipated to last. In other words, this measure would suggest that the stock market anticipated the devaluation and that there was an initial overshooting of the exchange rate in the first months after it was allowed to float.²⁵

Figure 9. The Actual and "Shadow" Exchange Rates from Level Estimation (in logarithms)



Source: Authors' calculations based on data from *Expansión* and IFC.

The shadow exchange rate described above and shown in Figure 9 is obviously dependent upon the estimated elasticity, and the issue of nonstationarity of the data suggests that the previous simple approach can be improved on by estimating a more conventional first-differences model. Accordingly, we estimate a version of Equation (2), explaining the

²⁴ Without these (or similar) assumptions regarding the scaling of abnormal returns, we would not be able to generate a quantitative estimate of the exchange rate, and only qualitative statements of increasing or decreasing devaluation expectations could be made.

²⁵ The correlation between the two series in the post-devaluation period in Figure 9 is not surprising since the exchange rate beta is estimated using these data. However, the pre-devaluation period data are not used to estimate the exchange rate beta, so the similarity of the initial actual depreciation and the cumulative prior stock market performance is quite noteworthy.

return on the difference portfolio in the post-devaluation period by the market return and the change in the actual nominal exchange rate. Since the data suggested the contemporaneous exchange rate change was not significant, we also included one lag of the exchange rate change. Table 2 presents the estimates for different starting dates for the sample periods both to study the stability of the estimates and because the response to exchange rate movements in the immediate post-float period may not be representative due to uncertainty about the new exchange rate- and policy regime and the overshooting of the exchange rate that is often experienced in countries that float their currencies.

Table 2. Estimation of the Exchange Rate Elasticity

Variable	Sample start			
	Jan. 1995	April 1995	June 1995	Aug. 1995
Constant	0.006** (0.003)	0.006** (0.003)	0.001 (0.003)	0.002 (0.004)
$r_{m,t}$	-0.286*** (0.088)	-0.279** (0.120)	-0.250* (0.126)	-0.332*** (0.101)
Δe_t	0.066 (0.117)	-0.240 (0.163)	-0.145 (0.212)	-0.010 (0.166)
Δe_{t-1}	0.138* (0.078)	0.374*** (0.087)	0.475*** (0.130)	0.401** (0.146)
Adj. R ²	24.9%	23.1%	25.5%	57.6%
Observations	52	39	31	22

Note: Newey-West standard errors in parenthesis. The *, **, *** indicate significance at 10, 5, and one percent levels, respectively. All samples end last week of 1995. The regression is $r_{4,t} = \alpha + \beta_{4,1}r_{m,t} + \beta_{4,2}\Delta e_t + \beta_{4,3}\Delta e_{t-1} + \varepsilon_{4,t}$.

Source: Author's calculations based on data from IFC and *Expansión*.

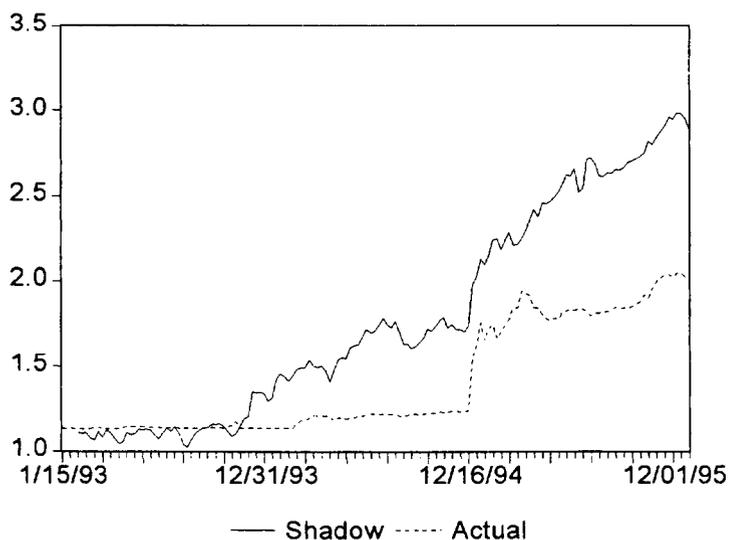
The estimations show that the contemporaneous change in the exchange rate has an effect on returns that is insignificantly different from zero, while the lagged exchange rate change has a positive and significant coefficient in all sub-samples.²⁶ The magnitude of this coefficient is not stable over the whole sample, however, with a substantial increase around three months after the devaluation. The coefficient then stabilizes around 0.4. The fact that it is the lagged exchange rate change rather than the contemporaneous one that affects the

²⁶ When a lag of the market index is added to the equation the coefficient is always insignificant. This suggests that the delayed response to exchange rate changes is not purely a result of non trading biases.

returns is not in line with a fast-responding efficient market; however, a similar behavior is documented in Glaum et al. (1998) for a mature market. There, the authors show that lagged exchange rate changes helped explain movements in the German stock market index during the 1980s. Although this apparent anomaly in timing may have implications for prediction exercises using the exchange rate measure, it has a very limited impact on the more general question that we are addressing of the possible build up in devaluation expectations in the year before the actual devaluation and float.

While there is clearly substantial uncertainty regarding any point estimate of the exchange rate elasticity, we use the estimate of 0.47 based only on the latter half of the sample. In addition to this, there still remains the question regarding the appropriate level, given that we are only estimating returns as a function of *changes* in the exchange rate. In the previous graph, the level of the shadow exchange rate was assumed to coincide with the level of the first actual exchange rate observation in the sample.²⁷ If this assumption is maintained, the paths for the cumulative returns adjusted with the estimated exchange rate elasticity are the ones displayed in Figure 10.

Figure 10. The Actual and “Shadow” Exchange Rates from Difference Estimation (in logarithms)



Source: Author's calculations based on data from IFC and *Expansión*.

²⁷ An alternative strategy is to assume that the exchange rate was at equilibrium at the end of the sample period, when the float had allowed it to adjust. We could then compute the over or under valuation of the currency in the pre-devaluation period based on this assumption about the equilibrium exchange rate. This graph can be produced by simply shifting the shadow exchange rate in Figure 10 so that it correspond to the last rather than first observation of the actual exchange rate.

The graphs indicates the importance of the elasticity for the derivation of more precise statements regarding the magnitude of the change in the expected exchange rate. However, as mentioned before, qualitative statements about the direction of the exchange rate expectations can be made without scaling. The disperse results that are generated by the different estimated elasticities indicate how sensitive the more precis statements are, and stresses the need to come up with more robust ways of estimating the elasticity.

Were Other Factors Driving Abnormal Returns?

In the above discussion, the factor driving the results is assumed to be the exchange rate or expectations of an exchange rate change. However, as pointed out in Appendix I, one assumption we make is that there are no other omitted factors in the market model that could explain the observed path of the abnormal returns. In thinking of different factors, it may be useful to distinguish between ones that are changing continuously and others that are more of an event type with only rare changes. The distinction between factors that are observable and those that are unobservable is also important, since observable factors can potentially be controlled for by including them in the estimated market model, while the introduction of another unobservable would basically make it impossible to distinguish that unobservable from the unobservable exchange rate factor. When it comes to the discrete nature of other factors, it is important to note that with forward looking and efficient stock markets, unanticipated events only generate infrequent abnormal returns and would not be able to explain a continuous build-up of abnormal returns.

For example, one event that coincides with the beginning of the divergence in relative performance is the passage of NAFTA, which also turns out to generate significant abnormal returns on the difference portfolio in two particular weeks (see Appendix II for a formal study of that and other events). However, if the stock market was forward-looking, and all of the NAFTA-relevant information was revealed by the time the US Congress and Senate passed the bill, this would give rise to a pattern for the net exporters that is quite different to the observed one: cumulative abnormal returns should have been rising during the period when NAFTA was becoming more likely to be implemented, and then remaining at that level thereafter. The explanation we are suggesting, on the other hand—that there was a continuous build-up in devaluation expectations from late 1993 until the actual event December 1994—is consistent with forward-looking stock prices. The exchange rate explanation is also in line with the behavior of the financial sector companies, which displayed a declining relative performance during the second half of the estimation period, as a result of concerns over the unhedged currency exposures of banks—which were borrowing cheaply in US dollars and lending in pesos—but also as weaknesses in this sector became more and more apparent throughout 1994.

Another explanation for the observed build up in abnormal returns could be a continuous improvement in demand factors affecting the export-oriented sector. In other words, the higher abnormal returns of the export sector might have been the result of persistently positive news regarding the demand for Mexican exports at a given exchange rate, rather than of a build-up in devaluation expectations. To investigate this hypothesis

empirically, we need a measure of news about Mexican export demand at a relatively high frequency, which rules out using official export statistics. A first attempt to study this alternative hypothesis can be found in Appendix III, where updates of Consensus forecasts for U.S. GDP were used as a proxy for news about Mexican export demand.²⁸ Although there were indeed a number of upward revisions of expected U.S. GDP during the period, they explain very little of the observed difference in relative performance. In addition, this type of story does not explain the observed performance of the financial sector discussed earlier. Thus a build-up in devaluation expectations appears to remain a more plausible explanation of the observed relative performance.

IV. CONCLUSIONS

In this paper we pursued a simple idea—that changes in devaluation expectations should have dissimilar effects on the stock valuation of companies that differ in their exchange rate exposure. In principle, this idea could also be exploited to assess the credibility of fixed-exchange rate regimes. In order to gauge the usefulness of this approach, we examined the Mexican case around the 1994-95 crisis.

Using event-study methods, we first related the abnormal returns of individual stocks around the Mexican devaluation to company characteristics, such as exports and intermediate imports. We then constructed portfolios based on these characteristics and examined the behavior of these different portfolios before and after the devaluation. The results indicate that the devaluation indeed affected net exporters, net importers, and financial companies in the expected ways. More interestingly, we find that starting in late 1993, net importers and financial companies began to continuously underperform the market, while net exporters showed continuously positive abnormal returns. This is particularly noteworthy given the fact that one might have expected the exporting sector to underperform the overall market due to a perceived overvaluation of the peso.

Using estimates for the exchange rate sensitivities of the different sectors, we attempt to construct a measure of the “shadow exchange rate” prior to the devaluation. This measure points to an ongoing build-up of devaluation expectations starting approximately a year prior to the devaluation. However, more precise inferences concerning the exact magnitude of changes in devaluation expectations depend on the estimated exchange rate elasticity about which there is a fair amount of uncertainty. Moreover, despite the fact that the results do not appear to be driven by the passage of NAFTA, revised expectations about U.S. demand, or other events, we are obviously not able to fully control for all conceivable alternative factors behind these results.

²⁸ In some sense, this can be viewed as another unobservable, since there are no real measures that we can use at a weekly data frequency. However, by using lower frequency data, we should hopefully be able to get an indication of the importance of this factor.

An important remaining question is: if the above interpretation of the results is correct, why should devaluation expectations be reflected in the stock market, but less so in the bond market? A possible explanation is related to informational asymmetries. If domestic investors have an informational advantage over foreign investors, and domestic investors tend to dominate the stock market, while foreigners represent the marginal investor for dollar-denominated Mexican bonds, this could potentially help to explain the puzzle. In the Mexican case, there is some evidence that domestic investors may have responded more quickly than nonresidents in the period surrounding the devaluation.²⁹

In summary, the results of this paper support the potential usefulness of this type of indicator for measuring the credibility of fixed exchange rate regimes. Market-based measures such as this—that are available at a reasonably high frequency—could potentially prove to be a valuable addition to the more traditional leading indicators of changes in exchange rate parities. In future work, we intend to examine the predictive content of relative sectoral stock-market performance using a panel of other emerging markets to assess the wider applicability of the approach presented in this paper.

²⁹ See International Monetary Fund (1995) and Frankel and Schmukler (1996) for evidence supporting this proposition, and Gil-Díaz and Carstens (1996) for suggestions to the contrary.

DERIVATION OF A STOCK MARKET MEASURE OF CHANGES IN EXCHANGE RATE EXPECTATIONS

In extracting the impact of unobserved exchange rate expectations on stock returns, we have in mind multi-factor model of the stock market³⁰, according to:

$$r_{i,t} = \alpha_i + \beta_{i,1}r_{m,t} + \beta_{i,2}E_t + \beta_{i,3}X_t + \varepsilon_{i,t} \quad (6)$$

where $r_{i,t}$ is the return on asset i , $r_{m,t}$ is the return on the market portfolio, E_t is the exchange rate factor and the main object of interest that we will return to shortly, X_t is another (set of) factor(s), the α and β 's are coefficients, and ε_t is an error term.

For expected returns we use,

$$\hat{r}_{i,t} = \hat{\beta}_{i,1}r_{m,t} \quad (7)$$

where a hat indicates an estimated value. We will return shortly to why this formulation is chosen and under what assumptions it will generate a well behaved measure.

With this definition of expected returns, the corresponding abnormal return is defined as

$$ar_{i,t} = r_{i,t} - \hat{r}_{i,t} = \alpha_i + (\beta_{i,1} - \hat{\beta}_{i,1})r_{m,t} + \beta_{i,2}E_t + \beta_{i,3}X_t + \varepsilon_{i,t} \quad (8)$$

Solving for the variable of interest, the exchange rate factor, we get

$$E_t = \frac{ar_{i,t} - \alpha_i + (\beta_{i,1} - \hat{\beta}_{i,1})r_{m,t} + \beta_{i,3}X_t + \varepsilon_{i,t}}{\beta_{i,2}} \quad (9)$$

The proposed estimate of the exchange rate factor is simply

³⁰ This model should be thought of as an ex-post model of stock returns, rather than as an *ex ante* CAPM-type model: it makes no assertions about the number of *ex ante* priced factors in a CAPM-type framework.

$$\hat{E}_t = \frac{ar_{i,t}}{\hat{\beta}_{i,2}} \quad (10)$$

To understand the properties of this measure, define the estimation error according to

$$u_t \equiv E_t - \hat{E}_t = \frac{ar_{i,t}}{\beta_{i,2}} - \frac{ar_{i,t}}{\hat{\beta}_{i,2}} - \frac{\alpha_i + (\beta_{i,1} - \hat{\beta}_{i,1})r_{m,t} + \beta_{i,3}X_t + \varepsilon_{i,t}}{\beta_{i,2}}$$

The estimator is unbiased, that is, $E(u_t) = 0$, if $E(\hat{\beta}_{i,1}) = \beta_{i,1}$, $\hat{\beta}_{i,2} = \beta_{i,2}$, $E(\alpha_i) = 0$, $E(\beta_{i,3}) = 0$, and $E(\varepsilon_{i,t}) = 0$.³¹ More loosely, if the intercept and other factors are negligible and we either know or can obtain good estimates of the betas, the estimate of the exchange rate factor should be well behaved from an unbiasedness perspective. However, we are confronted with two potential estimation problems. First, the estimate of $\hat{\beta}_{i,1}$ may suffer from omitted variable bias, and second, there is no obvious way of obtaining an estimate of the exchange rate elasticity $\hat{\beta}_{i,2}$. In the following, we will assume that the omitted variable bias in the market-beta estimate is relatively unimportant³², while the latter estimation problem is "solved" by using post-devaluation data, something that is discussed in Section III.

To understand why the assumption on the intercept is imposed, we need to discuss the estimation strategy. First of all, the measure is to be used as a way of generating a market prediction of a devaluation and as such, the model we estimate should only use information available at point t to make the prediction in period t . In the empirical implementation this means that the above model is estimated on a rolling basis, with coefficients potentially changing over time. Since the exchange rate factor is the unobservable that is of interest, it can obviously not be included in the regressions used to obtain the coefficient estimates. This has the effect that the rolling intercept will capture both the true intercept and the changing mean of the omitted exchange rate factor. To avoid this, we make the assumption that the

³¹ Note that the condition on the exchange rate coefficient, $\hat{\beta}_{i,2}$, is stated in actual value rather than expectations, since it appears in the denominator which complicates things if only the expectations version of the condition is used. If it is regarded as a constant we do not have to consider its co-variation with $ar_{i,t}$ to get the two first terms to cancel out in the estimation error equation.

³² This is indeed the case in the post devaluation period, where the estimate of the market beta does not change when the exchange rate is omitted.

true intercept is zero and attributes this part entirely to the exchange rate factor.³³ Ex ante, that should be a relatively uncontroversial assumption, consistent with e.g. CAPM. Ex post, the intercept could potentially be different from zero if there are other omitted factors that had non-zero means in the sample period, but our assumption here is that that is not the case.

This last observation is also linked to the assumption that $\beta_{i,3}$ is equal to zero, so that the only relevant factors are the market and exchange rate factors. Again, this is an assumption that can potentially be invalid, and will depend on the asset studied. In the paper, we use portfolios of stocks as the asset, and construct them such that they respond to exchange rate events. The assumption is then that the portfolios are aggregated enough to minimize the impact of other factors that could be relevant to individual portfolios. To investigate this in the empirical part, we also study some other event that may be relevant to the portfolios, but find little evidence that our results regarding expected exchange rate changes are driven by other factors.

³³ Another issue is that the cumulative abnormal returns will sum to zero over the estimation period if only the residual is used as a measure of abnormal returns. In other words, if the model was not estimated on a rolling bases and the intercept was not attributed to the exchange rate factor, the sum of changes in the exchange rate factor would be zero.

THE EXCHANGE RATE SENSITIVITY OF STOCK PRICES – THEORETICAL BACKGROUND

One can consider how the individual stock respond to exchange rate movements in a standard discounted cash-flow framework. We assume that “fundamentals” determine the price of a stock, excluding the possibility of asset bubbles. The value of a firm at time zero, V_0 , is thus assumed to equal the expected present value of current and future profits according to

$$V_0 = E_0 \sum_{t=0}^{\infty} \left(\pi_t \prod_{j=0}^t (1 + r_t)^{-1} \right), \quad (11)$$

where E_0 is the expectations operator at time zero, π_t is profits and r_t is the discount factor used by investors to discount flows at time t . In each period, profits can be expressed as the maximized sum of domestic and foreign sales minus domestic and foreign inputs according to³⁴

$$\pi_t = \max_{L, L^*} [p_t q_t + e_t p_t^* q_t^* - w_t L_t - e_t w_t^* L_t^*], \quad (12)$$

where q and q^* denote quantities of domestic and foreign sales, p and p^* are domestic and foreign output prices, L and L^* are domestic and foreign inputs, w and w^* are their respective costs, and e is the exchange rate measured in local currency units per foreign currency (later, pesos per dollar).

The maximization problem will not have a well-defined interior solution for all possible assumptions regarding technology and market structure. In particular, if perfect competition is assumed, i.e., the firm is a price taker, the quantities produced will be either zero or infinity if there are no fixed factors in the production function that generate decreasing returns. Also, if L and L^* are the only inputs, the choice of these would determine the total quantity produced but not the composition of domestic and foreign sales. Similarly, in the case of a firm selling in both the domestic and foreign markets, there need to be factors that restrict the sale in one market if the firm is a price taker in both markets. In summary, frictions prevent profits in each period from being equalized across sectors.

³⁴ Equation (12) follows Goldberg (1997). See also Hodder (1982) for a discussion of exchange rate exposure.

Differentiating profits with respect to the exchange rate, we get

$$\frac{d\pi_t}{de_t} = p_t^* q_t^* - w_t^* L_t^* + \frac{\partial p_t}{\partial e_t} q_t + e_t \frac{\partial p_t^*}{\partial e_t} q_t^* - \frac{\partial w_t}{\partial e_t} L_t - e_t \frac{\partial w_t^*}{\partial e_t} L_t^*, \quad (13)$$

where the first two terms are the direct effects on profits from a change in the exchange rate, i.e., the change in profit that will result if the firm produces the same quantities as before the change in the exchange rate with the same inputs and all input and output prices remain unchanged. The last terms are indirect effects that are all related to changes in prices, both of produced goods and inputs. Due to the envelope theorem, there are no quantity effects, since quantities are chosen to maximize profits. It is important to note that the lack of quantity effects is only valid for (infinitesimal) small changes in the exchange rate. In reality, in the case of the abandonment of a pegged exchange rate regime, the associated exchange rate change is usually large and would of course warrant the inclusion of quantity effects in the above expression.

In the empirical implementation, we will only control for the direct effects that account for the net exporting position of the firm (the two first terms), and ignore the other indirect price effects. The justification for this is twofold. First, we lack data for the other terms in the expression and second, there are reasons to believe that the other terms are relatively small. For example, if Mexican companies were price takers on international markets, the fourth and sixth term on the right-hand side would be zero. Whether the third and fifth term will be positive or negative depends on a variety of factors, related to market structure. For some firms, there may be room for price increases, since a devaluation will make imports more expensive in domestic currency. On the other hand, devaluations are often associated with a drop in domestic demand due to lower real wages and a credit squeeze.

An additional effect that is not modeled explicitly above is the effect from the existence of foreign-currency-denominated debt. Mexican firms often had large unhedged shares of US\$ debt, and the devaluation increased the cost of debt service immediately. If this effect were not offset by higher export revenues, companies could be hit severely through this channel. Moreover, in the presence of capital market imperfections, such a balance-sheet shock could result in a higher cost of capital.³⁵ The effect of foreign-currency-denominated debt is therefore also investigated in the empirical analysis in Section III.

While the focus so far has been on the contemporaneous effect of exchange rate movements on profits, the value of the firm depends on the discounted sum of all expected earnings. This raises three important issues. The first concerns the extent to which

³⁵ See Bernanke, Gertler, and Gilchrist (1996) for a discussion of such mechanisms and Gelos and Werner (1999) for Mexican evidence on financial constraints at the firm level.

discounting is affected by changes in the exchange rate. In reality, it is likely that domestic interest rates and discount factors will be sensitive to movements in the exchange rate, although we will ignore this in our empirical implementation. The more important second issue relates to the distinction between actual and expected exchange rate changes. The forward-looking nature of the firm's valuation indicates that it should depend on *expected* exchange rate movements as well as actual ones: this is the reason why stock market data can potentially serve as a measure of exchange rate expectations even under a fixed rate regime. Concerning the expected path of the nominal exchange rate *after* the devaluation event, we will make the simplifying assumption that the nominal exchange rate follows a random walk after it is allowed to float. Then, only actual movements in the exchange rate will affect the value of firms under a floating exchange rate regime. The third issue relates to the persistence of changes in profits. For any of the direct effects in Equation (13) to be present, changes in the nominal exchange rate must not translate immediately into corresponding domestic price movements. This assumption seems reasonable given the evidence that devaluations—in particular after substantial real exchange appreciations—tend to have long-lived real effects.³⁶

Based on the above-described model, our strategy in the empirical part of the paper is to examine whether some of the aforementioned variables—namely firm-level imports, exports, and foreign currency debt—help in explaining differences in relative stock-market performance before and after the devaluation.

³⁶ See Borensztein and de Gregorio (1999) and Edwards (1989).

PORTFOLIO COMPOSITION AND CHARACTERISTICS

Different classes of shares exist for many companies listed on the Mexican Stock Exchange, with these differences based inter alia on whether they can be held by residents or non-residents. To minimize problems of non-trading effects, we selected the class of share that appeared to be most liquid based on turnover data. The particular shares included in the three portfolios are listed alphabetically below, using the acronym used in the IFC's "Market Capitalizations and Weights" document:

Bank stocks: Banacci-A, Gfinver-BCP, GFP-B, GSerfin-BCP.

Low net-export stocks: Aeromexico-CPO, Alfa-A, Apasco-*, Bimbo-A, Ceramic-ULD, Cifra-B, CMA-A, Comerci-B, Contal-*CP, Desc-B, FEMSA-B, GGemex-CPO, Gigante-B, GISSA-A, Kimberley-A, Liverpool-1, Maseca-B, Moderna-A, Ponder-B, Posadas-A, Sidek-B, Situr-BCP, Televisa-CPO, Tolmex-B2, VISA-*, Vitro.

High net-export stocks: Celanese-B1, Cemex-BCP, Cydsa-A, GCarso-A1, Gmexico-B, ICA, Penoles-A*, San Luis-A, Synkro-B, TAMSA, Telmex-L, TMM-A, Codumex-A

Some information on the characteristics of the stocks that form the different portfolios is provided in Table A1, based on data for the period January-November 1994. The data indicate that high net-export stocks tended to be moderately smaller in terms of market capitalization than low net export stocks. An analysis of valuation ratios (e.g., price/earnings, price/book value) is difficult in light of the usual accounting issues in data for earnings and book value in emerging market stocks. Indeed, the data suggest that the median high net-export stock had a higher price-earnings ratio, but a lower price/book ratio than the median low net export stock, so it is difficult to evaluate whether there is any systematic difference in valuation ratios that might suggest differences in risk between these two groups of stocks. With regard to turnover, the median high net-export stock was traded less heavily than the median low net-export stock. For example, the median percentage of total outstanding shares traded every month was around 3.9 percent for low net-export stocks versus 2.5 percent for high net-export stocks. Further, the median low net-export stock tended to trade every day, while the median high net-export stock did not trade on about 5 days of each month. The low turnover effect is most pronounced for three particular stocks, which typically traded on only about five days each month. However, these stocks do not have any significant effects in the event week, so it seems highly unlikely that they would drive the results in the paper.

Table A1. Characteristics of the Portfolios

	Portfolio		
	Banks (P1)	Low Net- Export (P2)	High Net- Export (P3)
A: Balance sheet and operational data, 1994 (1995 in parenthesis)			
Exports (% of sales)	...	8.5 (14.5)	34.5 (43.2)
Imports (% of sales)	...	10.5 (14.8)	9.6 (11.9)
Net Exports (% of sales)	...	-2.0 (-0.3)	24.9 (31.3)
Foreign currency denominated debt (% of total debt)	...	55.4 (60.6)	71.6 (75.2)
B: Stock market data (median for all stocks within group, average for January-November 1994)			
Average market capitalization (millions of pesos)	2710	3467	3050
Average monthly turnover (millions of pesos)	164	243	29
Average rate of turnover (monthly turnover/market capitalization)	4.0	3.9	2.5
Average number of days within month that stock is not traded	1.8	0.3	4.8
Price/earnings ratio	7.9	28.0	47.0
Price/book ratio	1.61	2.45	1.64
Estimated beta (January 1993-November 1994)	1.07	1.07	0.81

Source: IFC and authors' calculations.

PRE-DEVALUATION EVENTS

Here, we explore the impact of specific pre-devaluation events which are likely to have influenced market perceptions about the likelihood of a devaluation and some other events that can be expected to have dissimilar impacts on the relative performance of different portfolios. The main purpose of this appendix is to provide corroborating evidence for the view that our difference portfolio really captures meaningful differences across companies in their exchange rate exposures.

The methodology used here is slightly different from the one used in the case of the devaluation event. Since we are now dealing with multiple events, we include them in the estimation period and capture the impact of each event, k , by a dummy variable in the market model estimation (see, e.g., Thompson (1993) for a more detailed account of this methodology). A significant coefficient on the dummy variable represents a significant impact of that event on the performance of the portfolio. The return on a portfolio i is thus estimated as:

$$r_{it} = \alpha_i + \beta_{i,1}r_{market,t} + \sum_{\forall k} \beta_{ik}D_k + \varepsilon_{it} \quad (14)$$

Before the actual devaluation, there were several events in 1994 that by some observers were thought of as having increased uncertainty regarding the maintenance of the peg. In Table A2, a list of such major events is presented. Note that the sixth and seventh events both took place in the same week, so that the coefficient on the dummy has to be interpreted as the combined effect of both. Moreover, we include three dates related to a major episode of late 1993, namely the passage in the U.S. of NAFTA, which may be viewed largely as an event unrelated to the sustainability of the peg that nevertheless presumably affected the relative performance of the portfolios. A priori, the effects of the NAFTA events are not clear, since NAFTA may have benefited net exporters and net importers. However, in general, exporting firms were regarded as the “winners” of the agreement.

Table A2. Pre-Devaluation Events

Date (93-94)	Event	Date (all 1994)	Event
1) Nov 9	Gore-Perot debate	9) May 17	FFR +0.5%
2) Nov 17	Congress passes NAFTA	10) Aug 16	FFR +0.5%
3) Nov	Senate passes NAFTA	11) Aug 26	Zedillo victory
4) Jan 1	Chiapas rebellion	12) Sept 28	Massieu ass'n.
5) Feb 4	FFR +0.25%	13) Oct 13	Camacho resigns
6) Mar 22	FFR +0.25%	14) Nov 15	FFR +0.75%
7) Mar 23	Colosio assassination	15) Nov 23	R. Massieu resigns
8) April 18	FFR +0.25%	16) Dec 1	Zedillo takes office

Note: Events three and four occurred in the same week. FFR events are changes in the US Federal Funds Rate. For details of the events, see Espinosa and Russell (1996) and Hanson (1998).

Changes in the U.S. federal funds rate (FFR) could conceivably have two possible impacts on high net exporters. First, an increase in the U.S. interest rate can be viewed as an attempt to contract U.S. demand, which would translate into reduced demand for Mexican exports and thus adversely affect high net exporters. The second effect is linked to the exchange rate, and would work in the opposite direction: an increase in foreign interest rates makes it more expensive to maintain a fixed exchange rate and thus increases the probability of a devaluation. This latter effect would therefore tend to generate relatively high returns on the high-net-export portfolio and the difference portfolio. Ex-ante, the political events cannot be unambiguously linked to devaluation probabilities with absolute certainty, either. However, ex-post, these events have often been cited as having increased uncertainty and investor nervousness regarding the maintenance of the exchange rate peg.³⁷ In fact, these events figure prominently in the reasoning of those who claim that the Mexican crisis was essentially the result of an unforeseen financial panic that was unrelated to fundamental weaknesses.³⁸

The regression results are displayed in Table A3, where we see that the passage of NAFTA in both the U.S. Congress and Senate had a significant positive impact on the high net exporters, while the Gore-Perot debate had no effect. The first five FFR events are all estimated to have had negative effects on the difference portfolio, with three of the events being statistically significant at the one-percent level. This suggests that in these cases, the stock market viewed the increases in U.S. interest rates mainly as contractions of foreign demand. Interestingly enough, the last, and largest, increase in the FFR, is accompanied by a significant positive effect on the difference portfolio, suggesting that this event contributed to a build-up of devaluation expectations. The “political/criminal” events had a negative impact on the relative performance of the high net export stocks in six of seven events, with the assassination of Massieu in September as the only exception. The largest negative impacts were related to the Chiapas rebellion and the Zedillo victory in the presidential elections. While the Chiapas rebellion was regarded as destabilizing, the Zedillo victory was viewed as reducing the probability of an exchange rate change. The fact that the effects of both events on the difference portfolio have the same sign is therefore surprising. If one believes that differences in returns for our portfolios are linked to the exchange rate—and the results around the devaluation strongly indicate so—then these results suggest that not all of these political/criminal events can be interpreted as having been as debilitating for the exchange rate regime as some other researchers have argued.

³⁷ See, for example Schwartz (1997) and Gil-Díaz and Carstens (1996).

³⁸ See Espinosa and Russell (1996), Gil-Díaz and Carstens (1996), and Schwartz (1997).

Table A3. Abnormal Returns for the Difference Portfolio at Pre-Devaluation Events

Variable	Coefficient	Variable	Coefficient
Constant	0.004* (0.002)	FFR4	-0.002 (0.008)
Market	-0.230** (0.101)	FFR5	-0.036*** (0.004)
NAFTA1	0.000 (0.007)	Zedillo victory	-0.033*** (0.004)
NAFTA2	0.014*** (0.005)	Massieu	0.007** (0.003)
NAFTA3	0.015*** (0.005)	Camacho	-0.010* (0.006)
Chiapas	-0.025*** (0.003)	FFR6	0.007** (0.003)
FFR1	-0.005 (0.005)	R.Massieu	-0.020*** (0.003)
FFR2/Colosio	-0.018*** (0.004)	Zedillo takes office	-0.004* (0.002)
FFR3	-0.036*** (0.002)		

Note: Newey-West standard errors in parenthesis. The *,**,*** indicate significance at the 10,5, and 1 percent levels.

Source: Authors' calculations based on data from IFC and *Expansión*

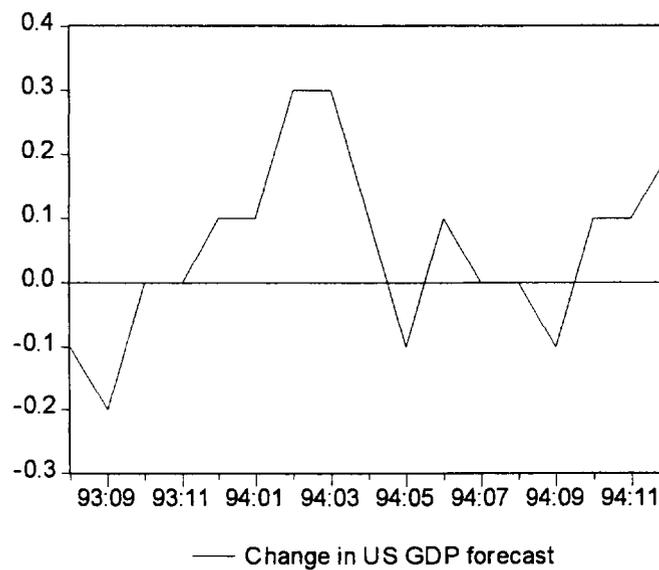
Summarizing, while the effects of the pre-devaluation events do not always have the sign that might be expected based on our own framework or the suggestions of other researchers, on balance the results indicate that our difference portfolio is capturing meaningful differences in the exchange rate exposure of firms.

DEMAND FACTORS FOR MEXICAN EXPORTS

In an attempt to control for news about Mexican export demand, monthly data from Consensus forecasts of U.S. GDP were used as a proxy for such news. In particular, we wanted to investigate if the timing of changes in expectations about US GDP coincided with the observed relative performance of high and low net-export stocks. Figure A1 displays the changes in expectations.

Figure A1. Changes in Consensus Forecasts for 1994 U.S. GDP Growth

(percentage points)



Source: Consensus Forecasts, various issues.

Since this is monthly data, the weekly abnormal returns for the different portfolios were aggregated to yield monthly abnormal returns. The simple correlation between U.S. GDP forecast revisions and abnormal returns is 0.19, and if the monthly abnormal return of the difference portfolio is regressed on the change in the U.S. GDP forecast, the coefficient is insignificant (0.067 with a t-statistic of 0.75) and the adjusted R^2 is negative. Since there may potentially be an issue of timing (although this does not seem likely with monthly data), the lagged forecast was also used, yielding similar results.

Obviously, the number of observations is not as large as one would like and the proxy for Mexican export demand is far from perfect. However, this represents an attempt at evaluating the role of demand factors for the exporting sector, and it turns out that it lends little support to the view that they were very important for explaining the observed relative performance of high and low net-exporters.

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