A New Empirical Study of the Mexican Treasury Securities Primary Auctions: Is there more underpricing?

Sara G. Castellanos*
Economic Studies Division
Banco de México
Avenida 5 de mayo # 18
Mexico City, D.F. 06059
Mexico
Ph: (52) 5237-2643
Fax: (52) 5237-2687
sgcastel@banxico.org.mx

First draft: January 15, 2001
This draft: September, 2001

Abstract

Examination of new data of the Mexican government securities primary auctions shows, not only that there exists underpricing with respect to the secondary market in CETES, the zero coupon Treasury bonds, of 28, 91, 182, and 365 days maturity, but also that such underpricing tends to increase over time, especially during the period of 1996-2000. This study also finds that changes to the auction format employed by the Mexican Treasury do not fully account for this pattern because in spite that since 1995 the discriminatory format is in place, some modifications have been adopted with the purpose of improving sales conditions in the primary auctions, like setting common maximum bidding limits for all participants or reopening securities issues with high observed interest rates. Usual factors assumed to affect auction prices by existing models, like competition level, bidder participation and market uncertainty seem to play a role. However, evidence is also found that some factors related to secondary market features suggested by the finance microstructure literature, like liquidity, inventory and adverse selection costs may be playing an even more important role. Overall, these findings provide confirmation of the relevance of resale markets and suggests that: 1) it may be fruitful to add some of these latter features in future theoretical models about government securities markets and 2) to improve secondary market conditions may be important to enhance efficiency in the primary market.

Keywords: primary auctions, secondary markets, treasury securities
JEL: D440

* The data set for this study could not have obtained without the collaboration of Mauricio Herrera, Ricardo Medina, and Guillermo Babatz. Conversations with Rafael del Villar, Alejandro Díaz de León, Jorge Galindo, Daniel Garcés and Lorenza Martínez have been valuable also. Several useful comments were made by the participants in the Economic Seminar of Banco de México's Economic Studies Division. Excellent research assistance was provided by Eduardo Camero. All remaining errors are the author's responsibility. The views expressed in this document do not necessarily represent those from Banco de México.

1. Introduction

Underpricing of the auction security relative to the secondary market, in effect, the resale in the secondary market of the security awarded in the primary auction to its winners at a higher price (or a lower interest rate), is a common finding which has arisen from the growing body of empirical evidence on government debt auctions. Nonetheless, because both theory and experience suggest that the persistence of such phenomenon may be due at least to some extent to the market's vulnerability to manipulation, it is constantly monitored and combated against by financial authorities throughout the world. Their concern is that market manipulability may undermine the price-discovery process and, ultimately, destroy public confidence in the efficiency and integrity of the market. As a result, cases of "market squeezes" –gaining control of an issue at the time of auction and subsequently restricting its supply on the cash and repo markets– arise concerns about rules and practices in the primary and secondary markets. Such concerns have translated into significant innovation in government market securities, which tend to benefit the taxpayer by increasing liquidity and thereby lowering government's financing costs.

Multiple academic articles and central bank reports suggest that this is what happens in the government securities markets of developed countries like the United States, Canada, United Kingdom, Germany, Switzerland, Italy or Spain, at least. The fact that Mexico's primary auction basic rules regarding the set of possible competitors, maximum bidding limits and auction format have not been changed substantially since 1995 suggests, however, that this may be true to a quite lesser extent in an emerging country perhaps due to weaker institutions or to legal or informational voids.

Thanks to the availability of a data set of government debt primary auction results, a new and more extensive examination of the price differentials of the Mexican Treasury zero coupon bonds denominated CETES[1] is carried out attempting to link the observed patterns with auction theory predictions. As is often the case in several areas of economics empirical research, quite less is known about government securities markets of emerging countries, in spite of the shared concerns of financial authorities and that the sales mechanisms employed are very similar at first glance. Hence another contribution of this study is to review some financial market regulatory changes that have affected the size, number and composition of firms and the complexity of Mexican financial sector, with special emphasis on auction format changes.

An important finding is that underpricing is not only a common but an increasing feature in the CETES of 28, 91, 182 and 365 days maturity. This pattern seems more pronounced after 1996 and despite that the Mexican Treasury later put in place a common maximum bidding limit for all auction participants and the reopening of securities for which high market interests rates are observed, two

[1] From the abbreviation in Spanish of "Treasury Certificates".

measures that hypothetically improve sales conditions of the primary auction. Price differentials are compared across titles and across the different sales rules employed. Evidence is found that besides price differentials are smaller in uniform format auctions than in discriminatory format auctions, they are also in the auctions where all participants face a maximum bidding limit based on their capital basis than in auctions where only brokerage houses, suggesting that leveling the competition ground among participants in the Mexican primary auctions indeed aid to reduce price differentials. However, in spite of evidence that auction reopening reduces treasury securities price differentials in Italy, Spain, and the United Kingdom (even though the primary auction format differs across these three countries), the evidence in favor of this practice shown in the present data set is mixed.

The price differentials' dependence on the usual factors proposed by auction theory like bidder participation, market volatility, issuance size, and auction format is also examined through regression analysis. For this exercise, the starting point is the well known paper of Umlauf (1993), which analyzes the bidding behavior in Mexico's 28-days CETES weekly auctions during the period of 1986-1991. Results from a 1996-2000 data set largely coincide with those reported by Umlauf, although the effects associated to bidder participation, market volatility, and issue size seem weaker both for CETES of longer maturity and for pooled least squares regressions than for the 28-days CETES. Following more recent work suggested by the finance microstructure literature, the possible effects associated to the secondary market characteristics such as liquidity, inventory costs and adverse selection components are examined as well. This study finds evidence supporting the relevance of these latter factors to explain underpricing in the primary auction, but again more strongly in estimations for 28 days CETES price differentials. Nonetheless, it can be concluded that in addition to adopting a uniform auction format or setting common maximum bids for all auction participants, some recent reforms to the secondary market rules may enhance market's efficiency.

This empirical evidence supports the relevance of resale markets. It suggests that future modeling of government securities auctions may benefit from including more secondary market characteristics. To a less extent, it also suggests that secondary market characteristics may themselves alter significantly the way in which some primary auction rules work in reality and thus, latter's rules should take into account the former's characteristics.

The rest of this paper is structured as follows. Section 2 reviews some previous results for treasury securities auction markets. Section 3 sketches some characteristics of the Mexican government debt market. Section 4 describes the data set examined and explains what variables are used in the empirical analysis. Section 5 presents the results. Lastly, section 6 summarizes our main conclusions and suggests some venues for further research.

2. Auction theory and empirical analysis for Treasury securities markets

A decade ago, most auction theory was couched in terms of a single good auctioned at a one-time event, with each bidder submitting a single bid at the relevant time in the auction process, and behaving according to certain restrictive assumptions.[2] Most of these theoretical models' predictions were extended to treasury securities auctions, in spite of recognizing that auctions for Treasury securities are repeated on a periodic basis and are for multiple goods, for which bidders may submit a whole schedule of bids, some of which may be viewed as underwriting bids; in increasing occasions there is an active well-defined when issued market in which participants can purchase the identical good (but at a known yield) at the time of an auction or before or after; and there is a well-defined group of bidders, which may or may not act according to the assumptions, that participate in virtually all auctions.

Chief among such predictions is the superiority, in terms of revenues for the seller, of the uniform format over the discriminatory format. It is not surprising that most of the recent models verify the validity of this and other theoretical predictions using assumptions that are more compatible with Treasury securities markets' features. Several early contributors, due to the difficulty on computing of equilibrium bidding strategies in multi-unit auctions, circumvented the analysis of strategic bidding behavior by assuming that bidders act as price takers, which may be plausible if the number of bidders is large as in many financial auctions. In this tradition, Nautz (1995) analyzes optimal bidding if the auctioneer sets a discrete price grid. Assuming risk neutral bidders, he showed that in a discriminatory auction optimal bidding requires bid shading almost everywhere whereas in a uniform auction truthful bidding is optimal. Nautz and Wolfstetter (1997) extends the analysis of price taking bidding to allow for risk aversion and a continuous random stop-out price. They show that in a discriminatory auction a risk averse bidder should bid less aggressively than a risk neutral bidder, at each price. However, even under risk aversion, optimal bidding requires bid shading everywhere. Therefore, trade is definitely inefficient. This is in sharp contrast with uniform auctions where truthful bidding is optimal even under risk.

Lengwiler (1999) argues that the assumption that the offered quantity is fixed is not appropriate for many applications because the seller may be able and willing to adjust the supply as a function of bidding, as is often the case in government securities auctions He addresses this shortcoming by analyzing a multi-unit auction game between a monopolistic seller who can produce arbitrary quantities at constant unit costs, and (non price-taking) oligopolistic bidders. He establishes the existence of a subgame-perfect equilibrium for price discriminating and for uniform price auctions and shows that bidders have an incentive to misreport their true demand in both auction formats, but they do that in different ways and for

[2] Bihkchandani and Huang (1993) and Bartolini and Cottarelli (1994) provide excellent early surveys of auction theory related to Treasury securities markets.

different reasons. Furthermore, both auction formats are inefficient, but there is no unambiguous ordering among them.

Back and Zender (1993), Wang and Zender (1998), and Ausubel and Cramton (1998) address the issue of ranking uniform and discriminatory auctions in terms of seller revenues, in the case of divisible goods, with smooth demand schedules. Extending an important result by Wilson (1979), their models show that uniform-price auctions may actually encourage implicit collusion among bidders and cost the Treasury money by awarding the auction at too low a price. Wang and Zender (1998) obtain an analytical solution and fully characterize the set of equilibria under risk neutrality and constant absolute risk aversion. They use the common value assumption: the good being sold has an unknown value; this is the usual assumption for Treasury securities auctions, given the existence of a secondary market. In their model, assuming that the noncompetitive demand is uniformly distributed, if bidders are risk-neutral the expected revenue in a uniform auction is smaller than in a discriminatory auction in almost all equilibria of a uniform-price auction. If bidders are risk-averse, the result is ambiguous. Ausubel and Cramton (1998) also establish that the ranking of uniform and discriminatory auctions is ambiguous: they are able to construct reasonable specifications of demand where the discriminatory auction dominates the uniform auction on expected revenue for the seller, and equally reasonable specifications of demand where the reverse ranking holds. Thus, they conclude that the choice between auction formats ought to be viewed as an empirical question that depends on the actual nature of demands. Other recent papers, Ausubel (1997) and Ausubel and Cramton (1999), also show that in the multi-unit setting the uniform format is not equivalent (in terms of the bidders' strategies) to the English or Vickrey auction and proposes a new ascending-bid auction applicable to treasury securities and further show their efficiency characteristics. Such work presumably will widen the research agenda on auction revenue comparisons in the future.

Although a comparison between theoretical predictions and actual design of treasury bill auctions may be interesting in its own respect, specially due to the contrasting results produced by different models, the academic and policy-oriented debate on the design of government securities auctions has intensified in recent years, motivated both by the desire for more cost-effective strategies to finance large stocks of government debt, and by the recognition that non-competitive behavior may be a pervasive and costly feature of auctions of government securities around the world.[3]

Table 1 is an extended and updated version from a table of Scalia (1997) which presents a set of findings about underpricing in several countries' Treasury securities, as reported by some recent studies. The variable of interest in these

[3] But even at some countries where the governments are issuing less debt there is an debate concerning auction design in the face of the possible deterioration of liquidity conditions due precisely to the reduction the number of titles traded in the market. The reports of Canada's central bank provide a good example of this case.

studies is some measure of the difference between the price (or interest rate) at which bidders acquire securities at the primary auction and the price (or interest rate) at which these are resold at the secondary market. This obeys to an emphasis on relative performance in terms of seller revenue of alternative securities' auction (discriminatory or uniform format, typically) or sale mechanisms, for which the secondary market price provides a natural comparison benchmark. In addition, the possibility that such difference represents profits for primary auction bidders obtained from the rest of the market participants and the Treasury in a setting with individual or collective manipulation, which has deserved the attention from the nonacademic audience, renders this price differential as the relevant one.[4] Notice that underpricing indeed is a common finding. However, since its significance and size varies among countries and among auction formats, no immediate lesson about auction design follows. The last two studies presented in the table, Umlauf (1993) and Laviada and Laviada (1997), focus on the Mexican Treasury securities auctions.

[4] Bikhchandani and Huang (1993) offers a more extensive discussion on the feasibility and possible effects of manipulability in the securities' auctions.

Table 1 Recent Empirical Studies about Treasury Securities Auctions

Author	Data and sample	Discount measures	Discount size (Prices)	Discount size (Returns)
Cammack (1991)	3 months US Tbills, discriminatory	Announced price at the day of the auction – Average allocation price	4 bp, sig	
Spindt & Stolz (1992)	3 months US Tbills, 1982-1988	Announced forward market price 30 minutes before the auction - Average allocation price	1.3 bp, sig	
Cherebuni et al. (1993)	Italian BTPs, 1990-1991, uniform	Log(Average secondary market at the day of the auction/Maximum allocation price)	14 bp sig	5.2 bp
Bikhchandani et al. (1994)	1 and 3 months US Tbills, 1990-1991, discriminatory	Announced forward market price – Average allocation price	1bp, not sig	
Simon (1994)	US T-Notes, 1990-1991, discriminatory	Average auction rate – Forward market at the time of the auction		0.37 bp, sig
Buttiglione & Drudi (1994)	Italian BTPs, CCTs and CROs, 1989-1992, uniform	Average secondary market price at the day of the auction – Maximum allocation price	7 bp, no tests	
Malvey, Archibald & Flynn (1996)	US T-Notes, 1992-1995, discriminator and uniform	Average allocation price – Forward market rate at the time of the auction		Uniform: -0.22bp, not sig Discriminatory: 0.4bp, not sig
Nyborg & Sundaresan (1996)	US Tbills, notes and bonds, 1992-1993, discriminatory and uniform	Average allocation rate – Forward market rate 30 minutes before the auction		
Breedon & Ganley (1996)	UK gilts, 1987-1995, discriminatory	Accepted bid-actual market price	4.66, sig (difference with average accepted price)	
Gordy (1996)	Portuguese bonds, 1988-1993, discriminatory	Reserve rate – Average wining rate		
Druddi & Massa (1997)	Italian BTPs and CCTs, uniform	Secondary market price just before the auction – Maximum allocation price	4 bp, not sig	
Scalia (1997)	Italian BTPs and CCTs, 1995-1996, uniform	Forward market price just before the auction – Average allocation price	4.2 bp, not sig	
Hamao & Jegadeesh (1997)	Japanese bonds, 1989-1995, discriminatory	Average auction rate – Secondary market rate the day after de auction		2.8 bp, not sig
Berg (1997)	Norway Bank certificates, 1993-1995, discriminatory	Average auction rate – Secondary market reference rate the day after the auction		5.7 bp, no tests
Heller & Lengwiler (1998)	Swiss treasury bonds, 1994-1997, uniform	Auction price – (Hypothetical) cut off price	2 bp	
Mazón & Núñez (1999)	Spanish bonds, 1993-1997, discriminatory	Weighted Average Price-stop out price	0.10, sig	
Umlauf (1993)	**1 month Mexican CETEs, 1986-1991, discriminatory and uniform**	**Average resale price/Average allocation price**	**1.7 bp, sig**	
Laviada & Laviada (1997)	**1 month Mexican CETEs, 1995-1997, uniform and discriminatory**	**Average resale price/Average allocation price**	**18.96 bp, sig (difference between unif. and disc. auctions)**	

Most of this recent empirical work also is accounted by central bank studies. For example, one of the most extensive and well known studies is the Joint Report on the United States government securities market. In September 1991, in the wake of Solomon Brothers' admissions of deliberate and repeated violations of Treasury auction rules beginning in 1990, the Treasury Department, the Federal Reserve

and the Securities Exchange Commission undertook a joint review of the government securities market. The report addresses a broad range of government securities market issues that arose directly or indirectly from the events of 1991, including the need to strengthen enforcement of Treasury's auction rules; the need to automate the auctions; potential changes in Treasury's auction technique and debt management policies; and the role of the primary dealers. According to the Joint Report, the three agencies considered that any degradation in the smooth functioning of the government securities market would result in higher costs to the taxpayer; at that time, an increase in financing costs of only one basis point –one hundredth of one percentage point – would cost taxpayers over $300 million each year. Thus, the agencies were sensitive to the need to avoid unnecessary responses that could drive investors and market makers out of the market in pursuing the goal of market integrity. Last year's adoption of the uniform auction format for the sale of Treasury bills comes as the result of a series of designed experiments with auction formats by the US Treasury.

In Canada, as a result of the declining amount of treasury bills, liquidity indicators for this market deteriorated between 1997 and 1999, excluding the turbulent period in the autumn of 1998. Bid-offer spreads widened, while the volume of transactions and the average coverage ratio at auctions declined. The major changes that affected the amount and issuance of government securities, together with the desire to maintain and enhance market liquidity and efficiency, led to a number of initiatives on the part of the Canadian authorities and market participants. Among the measures taken are changes to the auction rules for treasury bills, like redefining participant's status and maximum bids accepted, and their oversight by the Bank of Canada, as well as the guidelines adopted by the Investment Dealers Association of Canada. In addition, the Bank of Canada and the federal government have modified the bond program by creating a pilot bond buyback program and have adjusted the treasury bill program, in order to maintain the supply of benchmark issues. Again, the Bank of Canada reports concern that in a system operating under the threat of market squeezes, intermediaries would be reluctant to take short positions on the when-issued market and to engage in other market-making activities, or to participate in auctions and in the secondary market. Investors would also face a less-liquid and less-efficient market, and would be less active at auctions and in the secondary market. In addition, financing costs could rise for many issuers, including the federal government and others whose securities are priced against government benchmark issues.

What these two examples illustrate is that the policy-oriented debate goes a long way beyond aspects regarding auction technique choice. However, the choice between a uniform or a discriminatory auction format is one that has received much attention.

There are other technical aspect about auctions of concern. For example, studies about UK's Italy's, and Spain's securities' auctions test for the effects on underpricing from increasing the securities' liquidity through various means. For the UK's gilts (sold with a discriminatory format), Breedon and Ganley (1996) get

the standard result of the auction stock being underpriced relative both to the parent and the when-issued price in non-fungible auctions (i.e., auctions where the tranche trades on a slightly different basis from the parent for a period after the auction) and that when-issued trades deviate substantially from the parent even after the auction; but in fully-fungible auctions (i.e., auctions where the parent and the tranche are identical on auction day), introduced by the Bank of England in early 1994, no significant underpricing is found and the when-issued trades very close to the parent throughout.

Scalia (1997) analyzes the uniform price auctions of Italian Treasury bonds, where each issue is reopened regularly in order to improve information aggregation and increase the availability of each security. It shows that: i) as concerns the initial auctions, the discount based on when-issued prices before the auction is not statistically significant; ii) in the reopenings, employing a data set which includes all secondary market trades at firm level, both the market-average and the individual discounts are not significantly different from zero. These conclusions indicate that the uniform auction mechanism is revenue efficient for the Italian Treasury and provide support for the proposals aimed at introducing the practice of reopening in other countries. Mazón and Núñez (1999) analyzes the hybrid auction of Spanish Treasury bonds,[5] where auctions are also reopened, and finds similar results. While for initial auctions underpricing is statistically significant and with a mean value higher than the secondary market bid-ask spread, for reopening auctions the underpricing is statistically significant but with a mean value that is smaller than the secondary market bid-ask spread and much smaller than the mean value for initial auctions.

Many of the empirical studies also examine other determinants of auction underpricing, like uncertainty about the true value of the security (which may be due to the economic outlook, expectations for movement in absolute or relative interest rates, and any other factors affecting the portfolio decisions of dealers and investors) and the level of competition among bidders. However, they differ in the proxies used for such variables, in the inclusion of other explanatory variables and in the results they obtain. Since there is no generally accepted model for multiple-unit and multiple-bid auctions with a resale market, empirical models are somehow ad hoc, and the inclusion of variables as regressors for the auction underpricing relies on the grounds of having some weight in the determination of the auction price in some of the predictions of the existing theoretical models. Most predictions are still based on one unit auction theory. Data availability, of course, is another important issue that determines variable usage.

[5] The Spanish Treasury auction is regarded as hybrid because of rule it employs for determining the winning competitive bids (i.e., bids requesting an amount of securities at a price specified). Once that the accepted volume and the weighted average price of accepted bids are determined, competitive bids below the weighted average price are awarded at the bid price and bids above it pay the weighted average price. This rule contrasts both with the discriminatory format, which awards all competitive bids at their respective bid price, and with the uniform format, which awards all competitive bids at the maximum accepted price.

Among the first empirical studies of this kind is Umlauf (1993), which analyzes bidding behavior in Mexican Treasury securities auctions for the period 1986-1991. Umlauf presents results of ordinary least squares regressions of profit margins using proxies for information dispersion, bidding risk, competition, and event-specific dummies as explanatory variables. His results suggest that the presence of collusion among large bidders throughout a large portion of the sampling period and the presence of information asymmetries between small and large bidders. They also suggest that bidders account for the winner's curse and that participants bid more cautiously when uncertainty is high. Finally, they also suggest his best know conclusion: bidders' profits fell dramatically in 1990 when the Mexican Treasury substituted uniform for discriminatory pricing to combat collusion and to increase auction revenues. This conclusion is confirmed by Laviada and Laviada (1997) with a data set covering the 1995-1997 period.

This discussion is continued in more detail in section 4. Other key hypotheses about the effects of factors other than auction format, like market uncertainty, competition, etc., are presented there and are also related with the data and variables employed for this study.

3. Mexican Government Securities Market and Auction Techniques

If securities' primary auction prices are indeed affected by factors such as the economic outlook, expectations for movement in absolute or relative interest rates, and any other factors affecting the portfolio decisions of dealers and investors, or by competition level, then Umlauf (1993)'s results about Mexican securities primary auctions' may well deserve to be revisited. Starting in 1988 a very fast and deep process of financial deregulation began. Landmarks of the deregulation process up to the present time include, among others: the liberalization of interest rates, the abolishment of required reserves on banks' liabilities, the abolishment of selective credit controls, the creation of instruments to simplify the acquisition of stock in Mexican firms by foreigners, the liberalization of the investment regime of mutual funds, the arise of "stock market specialists", the privatization of commercial banks (which had been nationalized in 1982), the authorization to form financial groups among the different financial intermediaries of the system, the deregulation of commissions charged by securities dealers, the reforms to the pension system (including the formation of pension fund administration and investment societies), the permission for Canadian and US financial intermediaries to operate in Mexico through NAFTA (progressive, gradual, and up to specified market and firm level limits), the abandonment of universal savings insurance, the modernization of the payment system (including the adoption of "delivery against payment" practices in operations with government securities), and, most recently, the arise of "government securities market specialists".[6,7] In addition, there were some

[6] Appendix 1.
[7] Hardy (2000) provides a very similar recount about financial market development in Pakistan, as a result of IMF programs adopted at the time.

macroeconomic reforms that affected the financial system directly, like the drastic reduction of the fiscal deficit, the decision to finance this deficit through government debt instruments at market interest rates, the restructuring of the government's external debt, which made international capital markets accessible to Mexican institutions again, and the adoption of a flexible exchange rate.

A discussion of each of these reforms and a deep analysis of how they might be affecting the Mexican financial market is beyond the scope of this study, but some of them have an obvious effect. They broaden the set of securities available for investment (through the abolition of required reserves, the reduction of the fiscal deficit, and the introduction of new financial instruments to simplify stock acquisition), they mitigate market uncertainty (by making the payment system safer or establishing market specialists to enhance securities' liquidity), and they enlarge the set of possible participants in the market (like the privatization and globalization of the banking activity or the formation of pension funds investment societies),

A few data of the Mexican financial system is useful to show some of these reforms' effects. For instance, in the Mexican Stock Market there are not just more government securities but also more securities altogether available to investors. Umlauf (1993) focuses on auctions of one-month peso-denominated zero-coupon securities called CETES, because sufficient bid data for auctions for other instruments are unavailable for the period of 1986 to 1991. He records that outstanding issues of one-month CETES constitute an average of 25% of the face value of Mexican Treasury debt during that sampling period. Moreover, according to Table 2, CETES' outstanding issues of all maturities constitute almost 60% of the face value of all debt instruments on average during that sampling period, which in turn constitute 30% of all outstanding issues of securities in the Mexican Stock Market. The volume traded of all CETES issues constitute 84% of all debt instruments and 81% of all securities traded then. But the data suggests that CETES issues, as a percentage of both all debt instruments issues and of all outstanding securities issues are much less important by 1998, the last date that was available for this study: in terms of end of year market value they represent 18% of all debt instruments and 7% of all outstanding securities, while in terms of volume traded they represent 31% of all debt instruments and 32% of all outstanding securities.

The Mexican Treasury has also shifted its securities composition away from CETES. During 1986-1991 these titles represented 97% of the volume traded in government securities, while in 1998 they represent around half of it. This reductions also is observed in terms of end of year market value, from an average 67% in 1986-1991 to 30% in 1998. Nonetheless, they remain as the principal internal debt government securities and are the basis to price other government securities.

Table 2. The Mexican Stock Market

Volume Traded in Million Pesos at Market Value During the Year

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total	756,766	3,078,297	9,655,706	1,170,197.6	2,245,946	5,233,358	11,146,049	14,432,194	13,293,964	5,054,248	10,353,293	17,594,356	13,709,000
Variable Income Securities	37,009	230,248	175,453	35,778.8	54,601	119,603	156,466	200,225	298,646	227,322	331,720	438,315	333,100
Debt Instruments	719,757	2,848,049	9,480,253	1,134,418.8	2,191,345	5,113,755	10,989,583	14,231,969	12,995,318	4,692,141	10,021,573	17,156,041	13,375,900
CETES	410,943	2,401,877	8,364,606	997,885.5	2,100,032	4,707,417	10,172,952	1,423,428	11,559,334	1,352,771	1,346,477	5,690,387	4,306,400
TESOBONOS				36.6	3,345	1,005	8,588	6,215	124,118	118,626			
Bankers' acceptances	249,381	258,720	66,770	16,427.1	69	3	738	910	51	47	1,014	106,309	171,200
Negotiable Bank Promissory Notes			447,816	2,409.7	8,671	1	4,816	5,495	1,600	157	114	517,520	2,032,800
Commercial Paper	27,134	100,821	233,872	33,033.1	88,746	63,878	46,036	45,791	43,736	176,073	133,891	301,066	318,000
Certificates of Deposit						203			8	8	6	500	2,800
BONDES				64,268.1	81,875	116,563	241,774	12,135,666	581,832	1,498,714	2,002,973	3,842,527	1,889,700
AJUSTABONOS				172.1	12,986	269,581	476,806	556,673	633,040	1,351,891	3,388,803	1,205,071	213,600
UDIBONOS											418	2,725,578	1,600,400
BIBS	1,191	945	620	4.4	19	0.3							
Urban Renovation Bonds	68	134	33	0.6	9	2	9						
Debentures	5,351	12,182	20,173	3,578.3	6,769	14,994	24,565	34,631	30,698	27,541	15,251	7,514	8,500
Bankers' Bonds		9		1,359.1	11,200	6,277	2,724	11,074	10,584	5,581	12,478	15,920	165,100
Participation Certificates (CPOS)		54	787	217.9	288	1,059	3,595	5,583	4,433	13,045	1,292	2,635	26,400
Medium-term Promissory Notes						2,289	6,980	6,503	5,684	4,020	6,600	17,483	803,700
Other	2,432	4,390	7,677	11,242	5,299	3,382					3,112,200	2,724,000	1,837,300

Million Pesos at Market Value at the End of the Year

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total	17,860	56,041	137,887	213,328	336,643	584,491	647,547	874,316	941,001	984,744	1,203,383	1,701,900	1,522,600
Variable Income Securities	4,991	18,416	31,978	60,514	96,472	303,271	433,313	623,978	641,768	698,797	838,682	1,262,469	907,400
Debt Instruments	12,869	37,626	34,602	152,814	240,171	281,220	214,234	250,338	299,850	285,947	363,701	439,400	615,300
CETES	8,185	28,006	42,299	53,973	72,001	72,374	59,338	81,014	40,394	48,590	62,114	94,008	111,900
TESOBONOS				198	1,202	927	922	3,842	94,679	2,352			
Bankers' acceptances	2,676	4,875	35,718	28,749	7,827	6,310	12,617	22,103	26,173	33,983	39,718	22,300	30,900
Negotiable Bank Promissory Notes			41		59,173	70,720	20,551	26,795	29,516	45,693	71,762	79,200	125,200
Commercial Paper	68	160	695	4,629	6,809	4,587	2,643	3,563	4,058	4,301	2,602	13,558	21,600
Certificates of Deposit						2,287	64	727	1,120	874	1,015	2,752	6,400
BONDES		359	20,186	55,677	64,513	57,953	36,848	17,036	8,316	44,970	67,849	81,768	146,400
AJUSTABONOS				3,225	14,311	38,988	36,271	33,695	28,602	39,309	25,439	15,473	10,400
UDIBONOS											5,357	36,678	62,800
BIBS	109	92	83	49	33	0	1	1	1	1	1	1	1
Urban Renovation Bonds	7	15	18	18	20	23	23	23	8				
Debentures	198	463	1,128	2,560	4,786	10,388	17,443	20,497	20,773	26,132	23,213	21,894	18,900
Bankers' Bonds	17	10	81	2,112	6,640	10,775	6,883	15,913	20,560	25,627	37,224	28,056	29,700
Participation Certificates (CPOS)		2	42	175	482	3,591	11,369	10,014	10,590	8,816	14,619	25,600	24,000
Medium-term Promissory Notes						2,249	9,261	14,665	15,060	11,603	12,788	18,017	27,000
Other	1,591	3,646	5,619	583	1,530	48							

SOURCE: Mexican Stock Exchange and Banco de México

The number of firms is a very rough indicator of the level of competition (specially because different financial institutions may be part of one financial group), but a comparison between 1987 and 2000 anyway is useful to grasp the effects of some of the reforms in the market structure. In 1987, the major institutions of Mexico's financial system were 18 commercial banks,[8,9] 6 development banks, 25 brokerage houses, 79 investment funds, and 44 insurance companies.[10] At present the major institutions are 45 commercial banks,[11] 6 development banks, 26 brokerage

[8] Consolidation reduced the number of institutions to 13 by 1991, for sale to the private sector.

[9] Furthermore, the commercial banks at that time were not private because they had been nationalized in 1982. This fact is worth notice in the discussion of whether who earns the price differential.

[10] The system was complemented by 117 credit unions, 26 leasing, 14 bond guarantee, and 21 warehouses*. Source: 1988 Yearly Report, Banco de México.*

[11] This figure includes 15 foreign banks (Citibank, JP Morgan, Bank of Boston, Bank of America, Bank of Tokyo-Mitsubishi, Chase Manhattan, BNP, GE Capital, ABN Amro Bank, American Express, Bank One, Deutche Bank, Scotia Bank, RN Bank of New York, Dresdner Bank, ING Bank and Comerical Bank) and 11 commercial banks intervened by the Mexican Banking and Securities

houses, 286 investment funds, 68 insurance companies, and 13 pension funds investment societies. Leasing companies, money exchange houses, bond guarantees, and credit unions also operate regularly in the market. The financial system is complemented by six interdealer brokers, one securities depository firm, and six financial authorities. Three additional financial authorities were created as a result of some of the reforms, including a commission created to regulate and supervise pension fund investment societies, an institute to protect bank savings, and a commission to protect bank services' users. However, it is surprising that such changes do not seem to have had an important impact on the number of participants in the primary auctions. Umlauf reports that during 1986-1991, on average, over 40 bidders participated in the weekly government securities auctions that fell into one of the first five categories mentioned before, with an average of 25 bidders submitting competitive bids in each auction during the sampling period. In contrast, average bidder participation in the weekly government securities auctions during 1996-2000 is 19. At present, this bidders are banks and brokerage houses mostly. Hence, while there are more participants in the financial markets in general, they do not seem to be in the primary auctions. Thus, next it is interesting to see whether this pattern can be linked to the primary auction rules.

The sales mechanism of CETES has gone through some modifications since these titles were first issued in 1978. CETES were sold on tap at a fixed interest rate until 1982, when the issue was first auctioned using a discriminatory format. Bidders (who even today must be either domestic banking institutions, brokerage houses, investment funds or "persons specially authorized to bid" by the central bank) submitted multiple sealed bids that are discount quantity pairs and a single noncompetitive bid that specifies a quantity but not a discount (these bids are guaranteed to win the quantities specified up to a pre specified per-bid maximum). This procedure was substituted back with the tap during 1985-1986, because the Mexican Treasury considered it was paying an interest rate that was too high for its fixed issues. Therefore, when in July 1986 the discriminatory auction format was readopted (due to an observed decrease in the private sector's CETES holdings), it was established that, although the size of the issue to be auctioned would be set beforehand, the Treasury retained the right to cancel all or part of each weekly auction to take advantage of interest rate declines arising from macroeconomic shocks realized in the time window between bid submission and the announcement of results. In addition, no single competitive bidder could purchase more than 40% of the quantity offered to competitive bidders and brokerage houses also were limited to submit bids for debt with aggregate face values less than 100 times the values of their capital bases.[12] In July 1989 the maximum bid's level was raised to 60%. In July 1990, the uniform auction format was first introduced in an effort to combat collusion and raise auction revenues, according to

---

Commission (CNBV, by its initials in Spanish) that keep a balance account to for market operations with Banco de México (Bancrecer, Unión, Cremi, Oriente, Obrero, Interestatal, Sureste, Capital, Industrial, Promotor del Norte, and Anáhuac) during 2000, according to the roster of financial market institutions of the General Direction for Financial System Analysis of Banco de México.

[12] The latter of these rules perhaps resulted from financial authorities' concern about default risk among brokerage houses in the aftermath of the 1987 financial crash.

Umlauf (1993), and was substituted with the discriminatory format in January 1993. The uniform format was adopted once more on April 1994, but substituted with the discriminatory format, again in November 1995, as a means to raise market interest rates in the aftermath of the financial crisis.

Table 3 CETES' Sales Mechanisms 1978-2001

Date	Mechanism
January 1978-1982	Tap with a fixed rate
1982-1985	Discriminatory auction
1985-July 1986	Tap with a fixed rate.
July 1986-July 1990	Discriminatory auction - Treasury retains the right to cancel part or all of the weekly auction. - Brokerage houses cannot bid for debt of more than a 100 times their capital basis. - In July 1989 the miximum bid level is raised from 40% to 60%
July 1990-January 1993	Uniform auction Discriminatory auction
January 1993-April 1994	- Amounts allocated to non-competitive bids were reduced.
April 1994-November 1995	Uniform auction
November 1995-	Discriminatory auction - No institution can bid for debt of more than a 100 times its capital basis. - Banks were the only institutions allowed to submit bids in account for others until 2000. - The Treasury may increase the supply of securities at issue in an auction. - Some long term titles are tendered to pension fund investment societies. - Some titles are tendered to government securities market makers (September 2000)

This is the format that prevails until present, but not without some modifications, among which are: 1) bid limits based on institutions capital basis were extended to all bidders in 1995;[13] 2) all bidders must participate in the government securities auctions on their own account; 3) the Treasury can offer more of the securities at issue in an auction when it considers that the bided interest rates or prices are favorable up to a limit that keeps the interest rates or prices in line with those of the previous issue; and 4) the Treasury can offer more titles of a given issue when it observes liquidity problems.[14] Moreover, although non-competitive

[13] In the aftermath of the financial crisis that began on December 1994, it seems likely that this rule was extended to banks due to default risk fears again. But the side products of this modifications would be a more leveled competition ground.

[14] This modification is not in the auction rules, but according to some officials of Banco de México this measure has been put into practice for 182 days and 364 days CETES at least since 1998.

bids have become less important throughout this period, since recently some securities are sold directly to pension fund investment societies and, even more recently, to government securities market specialists.

4. Data Set and Variables

4.1 Data Set

Econometric analysis of price differentials between the primary and the secondary government securities markets involves detailed information requirements which, unfortunately, cannot be filled for Mexico since the first auction date to present. So although price differentials series can be constructed from 1988 or 1990 onwards, depending on the security, constraints to obtained the other data bind and dictate what samples can be examined. There are two data sets of primary auctions results available for this study. One data set consists of all CETES with maturity of 28, 91, 182, and 365 days auctioned since January 1993 to May 2000. For each auctioned issue it contains the maturity expressed in days, the announced and allocated quantity, the weighted allocation discount rate or price. Auction format is also indicated. The other data set covers all government securities primary auctions of the period between July 9, 1996 and May 16, 2000. Besides the information mentioned before, this data set contains the number of competitive bidders and bids, both asked and allocated in each auction. Maximum and minimum bids asked and allocated are also contained.

This study focuses on the CETES issues because results can be compared to those from other studies. But, more fundamentally, because only for these securities was possible to obtain resale prices data. No formal when issued market exists for government securities and most trading occurs over the counter. To measure the new securities' prices with those of secondary market trades of outstanding securities is tricky because most of that trade is not in direct but in repurchase agreements.[15] Moreover, in repurchase agreements it is a common practice, to ameliorate liquidity problems on some issues, to bundle different securities.

For CETES' secondary prices there are two main sources. First, secondary prices can be constructed from the daily funding rate with government paper. This is a representative interest rate of the mayor operations carried out by commercial banks and brokerage houses through repurchase operations with maturity of 1 day with government securities that have been liquidated in the INDEVAL delivery versus payment system. Since this is the source employed by Umlauf (1993) and Laviada and Laviada (1997), its use makes the present calculations perfectly comparable to those. Besides, it can be constructed for both auction data sets. However, if investors tend to use for repurchase agreements their most liquid

[15] Government securities market makers, who are to provide secondary market quotes and improve the securities' liquidity in the market started to operate on September 2000.

securities, the repurchase agreement rate will underestimate the liquidity premium of CETES with longer maturity and, in turn, will overestimate the underpricing of this titles in the primary auction with respect to the secondary market. In addition, the pricing formula we employ assumes that the liquidity premium is a linear function of maturity, when it may well be a concave, convex, or more complex function of it.

The other source for secondary market prices is a CETES price index published by one of the interdealer brokerage firms operating in the Mexican Stock Market, Enlaces Prebon. The IEP index (Enlaces Prebon Price Index, by its initials in Spanish) for CETES corresponds to the mean market interest rate at 12:15, determined through a survey to 12 participating institutions.[16] The three highest and three lowest reported rates are eliminated, so the CETES average rate is constructed from the remaining six reports. The index is constructed for CETES with 28, 91, 182, and 365 days maturity since June of 1996. It is worth noticing that this are perception indexes, not executable indexes, which means that there is no intention to buy or sell securities at the quoted rates. This may be seen as a disadvantage for this study purposes, although officials from Enlaces Prebon explain that for theirs perception quotes are better than buy and sell quotes, given that the latter tend to be biased by the traders' according to their market positions at the time of the survey.[17]

A third source to construct secondary market prices is available from June 2000 onwards because since then Banco de México constructs a yield curve for CETES with the expected return rate of the CETES in circulation, based on its direct open market operations, on direct operations among credit institutions, and the daily funding rate. This series is too short and lacks of the corresponding primary auction data, so it is not used for econometric analysis. However, auction securities price differentials with respect to each of the other two possible measures of the "true" price can be calculated and compared to assess their quality. Prices are calculated from discount rates with the formula:

$$\text{Zero Coupon Bond Price} = 100 - \text{discount rate} * \text{maturity}/360$$

While prices from the return rates are calculated as

$$\text{Zero Coupon Bond Price} = 100/(1 + \text{return rate} * \text{maturity}/360)$$

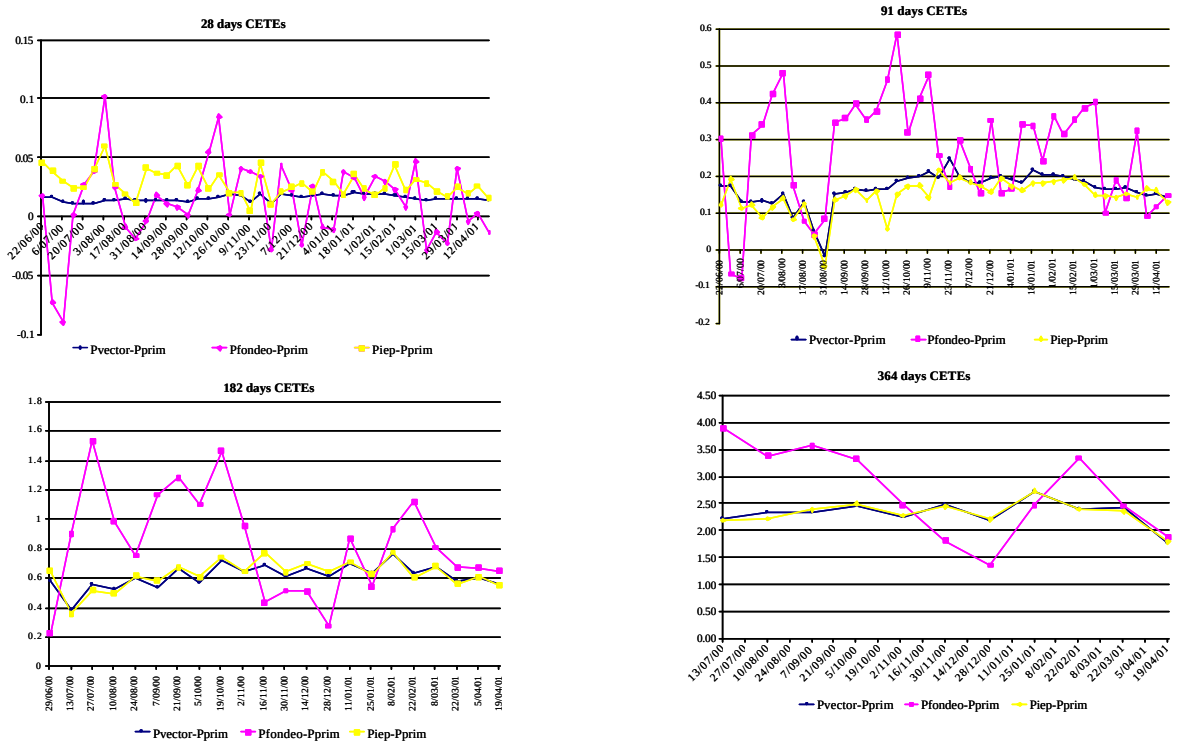
In Graph 1 it can be seen that between June 2000 and April 2001 it is observed that the differentials calculated with the IEP and with the Banco's yield curve seem more correlated with each other than with differential calculated with the funding

[16] Current sources for the CETES' IEP are Banamex, Bank of America, Banorte, BBV, Bital, Chase Manhattan, Citibank, ING, Invex, JP Morgan, Santander Mexicano and Serfin.

[17] It was also explained that initially the IEP indexes were executable. Participants were asked for a buy quote and it was well known that there was a 20 basis point spread between buy and sell prices.

rate. Interestingly, their correlation is stronger for the 182 and 365 days CETES than for the other two. This inclusion of a daily rate also makes the Banco's yield curve steeper for shorter maturities, which correspond to higher average price differentials with this measure than with the IEP. An additional reason for this pattern is that trades through Enlaces Prebon represent a higher proportion of all trades for the longer maturity securities. In terms of variability, it is observed that the price differential constructed from the daily funding rate are more volatile than the others.[18]

Graph 1 Difference between three alternative secondary market price measures and the primary auction price, May 2000-April 2001



Additional factors than can systematically bias calculations with the IEP and the funding rate away from the "true" secondary market price are difficult to find, although it is reckoned that difficultness to find would not make them unexistent.[19] But since for this study purposes there is no reason to prefer either of the two sources over the other, all calculations are carried out and reported with both when data is available. Besides, errors in the measuring of the dependent variables are

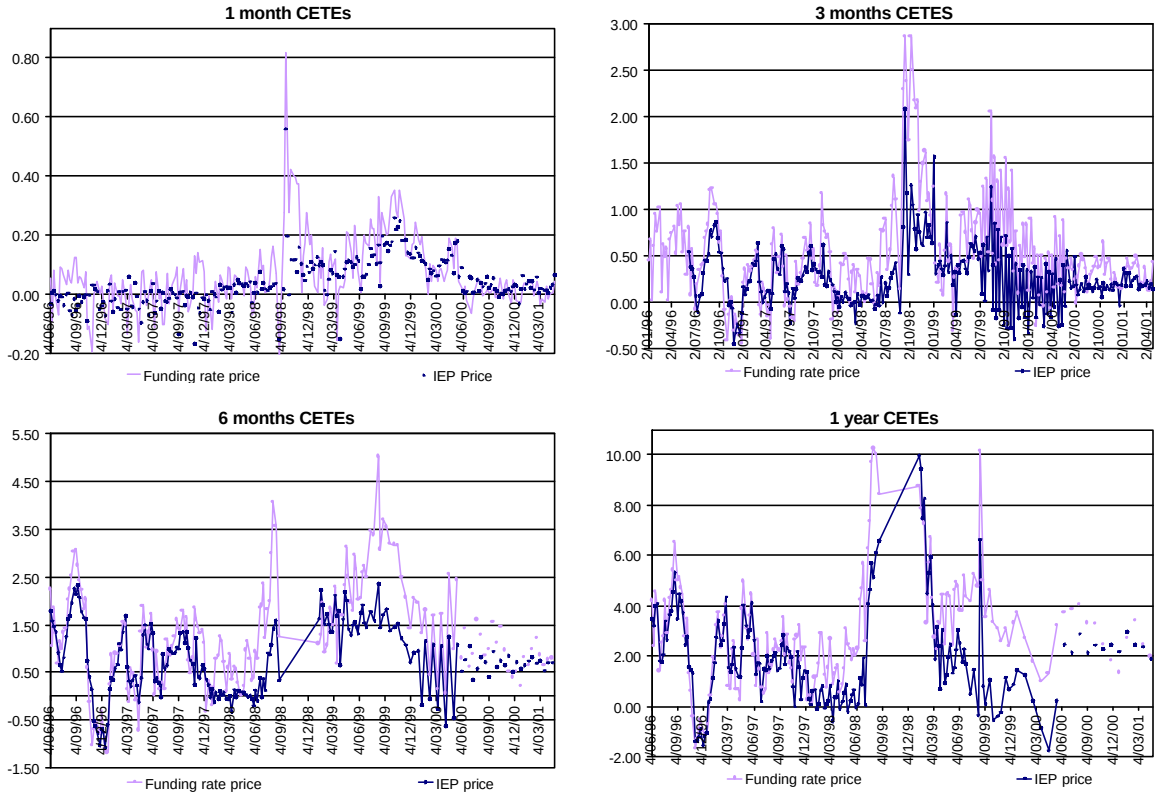
[18] Appendix 2.

[19] Proof of this was found by chance while the possible effects of monetary policy on the CETES price differentials between the primary and the secondary market. It was found that the reductions of the announced target for the banking institutions balances at the central bank, the so called "shorts" have an effect on the price differentials constructed with the funding rate but not on those constructed with the IEP. Actually, this result seems to match perfectly those that the author found about the effects of the that policy measure on the term structure of interest rates. For this study's purposes, however, such findings only support the need to build better data sets of secondary market prices.

incorporated in the disturbance term and their existence causes no problems for purposes of the econometric estimation and there is no reason to suspect that either measure of the true secondary price will not be independent of the regressors.[20]

Graph 2 shows the difference between the secondary market price and the primary auction weighted allocation price for the period of June 1996 to April 2001. Visual inspection reveals that price differentials constructed from the daily funding rate indeed increase with maturity, consistent with the hypothesis that this rate underestimates the liquidity premium of longer term government securities. However, such underestimation is observed not just across CETES with different maturity. For the four securities is observed also that differentials increase through time, especially after July of 1998, until June 2000 and then decrease somewhat. The latter pattern does not follow immediately from such hypothesis. Supporting this observation, price differentials constructed from the IEP CETES rate also show an increasing pattern for most of the period.

Graph 2 Difference between secondary market price and the primary auction price, 1996-2001



Yearly averages of the price differentials', including their significance is presented in Table 4. Both the prices' difference and ratio is presented because the latter can

[20] Kennedy (1993).

be compared to those of Umlauf (1993), which for 28 days CETES during the period August 1986-May 1991 reports an average ratio between the average resale price (constructed from the daily funding rate) and the average auction price of 1.000171 and statistically significant; that is, 1.71 basis points. The present calculations reveal that actually, this measure of underpricing is negative for CETES of all maturities during the whole 1989-1993 period,[21] but statistically significant only sometimes and mostly for the CETES of 182 and 365 days. Furthermore, it exhibits a tendency to become less negative, even positive, after 1993 in the four cases, albeit a mild decrease after 1999. It is positive and significant, nonetheless, only for the 28 days CETES during January-May 2001, when it reaches 9 basis points. This 'profit" is equivalent to 9 cents per title when measured as the price difference.

Table 4 Price Differences between the secondary market and the primary auction, 1989-2001

	IEP price		Funding rate price		IEP price		Funding rate price	
	$P^{SEC}-P^{PRIM}$	$P^{SEC}/P^{PRIM}-1$	$P^{SEC}-P^{PRIM}$	$P^{SEC}/P^{PRIM}-1$	$P^{SEC}-P^{PRIM}$	$P^{SEC}/P^{PRIM}-1$	$P^{SEC}-P^{PRIM}$	$P^{SEC}/P^{PRIM}-1$
	1 month CETEs				3 months CETEs			
1988	NA	NA	0.13052	0.00147	NA	NA	0.19196	0.00214
1989	NA	NA	-0.01596	-0.00016	NA	NA	0.07092	0.00081
1990	NA	NA	-0.14021	-0.00144	NA	NA	-0.31690	-0.00347
1991	NA	NA	-0.20015	-0.00203	NA	NA	-0.47801 ***	-0.00502 ***
1992	NA	NA	-0.11488	-0.00116	NA	NA	-0.29135	-0.00303
1993	NA	NA	-0.05788	-0.00059	NA	NA	-0.04628	-0.00048
1994	NA	NA	-0.03539	-0.00036	NA	NA	0.01764	0.00017
1995	NA	NA	0.02213	0.00023	NA	NA	0.04522	0.00051
1996	-0.01863 ***	-0.0002 ***	0.01182	0.00012	0.25463	0.00273	0.45960	0.00371
1997	-0.02213	-0.0002	0.00058	0.00001	0.25719	0.00271	0.33122	0.00349
1998	0.04899	0.0005	0.12014	0.00123	0.34875	0.00383	0.87390	0.00953
1999	0.11708 ***	0.0012 ***	0.15875	0.00161	0.36191	0.00386	0.73066	0.00775
2000	0.05699 *	0.0006 *	0.04800 ***	0.00049 ***	0.14880	0.00156	0.34527	0.00360
2001	0.02889 *	0.0003 *	0.00869 ***	0.00009 ***	0.21647	0.00226	0.30699	0.00321
	6 months CETEs				1 year CETEs			
1988								
1989	NA	NA	NA	NA	NA	NA	NA	NA
1990	NA	NA	-0.01985 *	-0.00014 **	NA	NA	-2.57884 *	-0.03220 *
1991	NA	NA	-0.88031 ***	-0.00968 **	NA	NA	-1.79147 **	-0.02130 **
1992	NA	NA	-0.48235 ***	-0.00521 ***	NA	NA	-0.97676 **	-0.01143 **
1993	NA	NA	-0.07131	-0.00074	NA	NA	-0.28183	-0.00308
1994	NA	NA	-0.00668	-0.00011	NA	NA	-0.31058	-0.00367
1995	NA	NA	-0.39653 ***	-0.00490 ***	NA	NA	-0.82864 ***	-0.01177 ***
1996	1.00562	0.01163	1.23204	0.01399	2.01881 ***	0.02679 ***	2.53507 ***	0.03027
1997	0.73004	0.00810	0.86861	0.00965	1.88112 ***	0.02310 ***	2.10782	0.02588
1998	-0.17552	-0.00143	0.75144	0.00890	1.46494 **	0.01951 **	3.51996	0.04549
1999	1.54906 ***	0.01757 ***	2.29940	0.02596	2.51571 ***	0.03415 ***	4.36709	0.05686
2000	0.58680	0.00642	1.12355	0.01226	1.39206 **	0.01679 **	2.60487	0.03108
2001	0.69847	0.00763	0.84177	0.00919	2.41605 **	0.02901 **	2.63552	0.03163

* 99% significance, ** 95% significance, *** 90% significance

IEP price data of 1996 corresponds to the June-December period

All price data of 2001 corresponds to the January April period

The pattern portrayed when the prices' ratio and difference is computed with the IEP index is quite similar. Secondary market prices tend to become higher, although measures differ across both quantitatively and on statistical significance: from 1996 on all CETES but those of 91 days maturity exhibit at least one positive

[21] Insignificant price differentials during 1990 and 1991 on 28 days CETES are consistent with Umlauf (1993) because it reports that the adoption of the uniform format at that time vanished the profits.

and significant price differential. Hence, absent any factor that can dramatically switch these patterns, the data suggests that price differentials have tended to increase through time.[22]

To what extent can these tendencies be matched with changes to the auction format? The present data sets allow the following comparisons: auctions with uniform format versus auctions with discriminatory format, auctions with capital based limits only for brokerage houses versus auctions with capital based limits for all participating institutions, and auctions without reopening versus auctions with reopening. Auctions can be classified in uniform, discriminatory, reopened and not reopened directly from the data sets. On one hand, there is an indicator of "uniform" or "discriminatory" auction. On the other hand, reopened auctions can be identified because the additional securities are tendered in a fully-fungible basis with the existing securities, so CETES with maturity dates of 362 days or less and of 179 days or less correspond to reopenings of 365 and 182 days CETES, respectively. The date for setting the same capital basis limit to all auction participants is clearly established on September 20, 1995.[23] Basic statistics of the price differences for these six categories are shown in Table 5. Their statistical significance is not high, but their size and sign do support some well known auction design hypotheses.

[22] The proportion of trades with CETES of all trades with government securities determining the daily funding rate may be a factor that affects the difference between this rate and the CETES rates. So the correlation between these two variables is checked, between monthly series from 1996 to 2001, and found to be low. Unfortunately, this exercise cannot be done including 1993 or 1988, when the largest changes in the CETES proportion of government securities happened.

[23] It was either unavailability of precise dates or of large enough samples that precludes examining the other format changes. The introduction of government securities market specialists is specially interesting because of the noticeable decrease on average price differentials after 1999, however, at present the sample of auctions in which these specialists operate is scant.

Table 5 Price Differences between the secondary market and the primary auction according to format issues, 1993-2001

	Uniform		Discriminatory		Only brokerage houses		All participants		Without reopening		With reopening	
	Funding rate	IEP	Funding rate	IEP	Funding rate	IEP	Funding rate	IEP	Funding rate	IEP	Funding rate	IEP
	All CETEs											
Promedio	-0.185	na	0.798	0.527	0.865	0.527	-0.061	na	-0.560	-0.344	-1.134	-1.988
Desv. Est	1.561	na	1.995	1.411	2.397	1.408	0.594	na	4.504	1.882	10.925	2.179
Máximo	6.579	na	10.530	10.359	10.530	10.359	4.351	na	7.620	3.160	6.280	1.880
Mínimo	-7.644	na	-13.794	-14.730	-13.794	-14.730	-4.880	na	-21.260	-35.290	-12.560	-8.570
	28 days CETEs											
Promedio	-0.014	na	0.043	0.031	0.057	0.031	-0.021	na	0.003	0.020	na	na
Desv. Est	0.050	na	0.032	0.040	0.036	0.040	0.034	na	0.056	0.203	na	na
Máximo	0.965	na	0.815	0.559	0.815	0.559	0.965	na	1.020	0.492	na	na
Mínimo	-0.828	na	-2.403	-2.595	-2.403	-2.595	-0.828	na	-2.462	-2.635	na	na
	91 days CETEs											
Promedio	0.009	na	0.439	0.290	0.511	0.290	0.001	na	-0.142	0.023	na	na
Desv. Est	0.492	na	0.288	0.126	0.283	0.126	0.342	na	0.743	0.320	na	na
Máximo	3.044	na	2.860	2.088	2.860	2.088	3.044	na	2.697	1.176	na	na
Mínimo	-2.269	na	-1.622	-0.445	-1.087	-0.445	-2.269	na	-4.896	-0.888	na	na
	182 days CETEs											
Promedio	-0.292	na	0.967	0.721	1.139	0.721	-0.184	na	-0.847	-0.477	1.332	0.313
Desv. Est	1.860	na	2.073	2.054	2.124	2.054	1.437	na	5.230	1.717	1.107	0.291
Máximo	4.351	na	5.016	2.354	5.016	2.354	4.351	na	4.352	1.246	3.148	1.154
Mínimo	-4.880	na	-13.794	-14.730	-13.794	-14.730	-4.880	na	-15.825	-17.085	-0.864	-1.429
	364 days CETEs											
Promedio	-0.598	na	2.416	1.492	2.083	1.492	-0.072	na	-3.313	-3.505	-1.808	-2.729
Desv. Est	4.850	na	4.112	3.743	5.843	3.743	1.158	na	21.812	5.326	11.473	3.926
Máximo	6.579	na	10.530	10.359	10.530	10.359	2.758	na	7.620	3.160	6.280	1.880
Mínimo	-7.644	na	-1.914	-1.913	-7.644	-1.913	-1.565	na	-21.260	-35.290	-12.560	-8.570

Price differentials tend to be lower in uniform auctions than in discriminatory auctions. This finding coincides with previous results for the Mexican government securities auctions presented in Umlauf (1993) and Laviada and Laviada (1997) because for all and for each type of CETES' price differentials of the discriminatory auctions are either positive or less negative than those of the uniform auctions, regardless of the secondary price employed in the calculations. Furthermore, notice (back in Table 4) that increases in the CETES' price differentials follow the adoption of the discriminatory format in 1993 and in 1996 while decreases in all CETES' price differentials follow the adoption of the uniform format in 1990 (except in 365 days CETES) and 1994 (except in 182 and 365 days CETES), although they did not fall continually in 1990-1993. Actually, their growth through that period may have contributed to the switch back to the discriminatory format in 1994. The financial authorities may have detected that collusion under the uniform format, as Back and Zender (1993), Wang and Zender (1998) and Ausubel and Cramton (1998) predict, was increasing as auction participants became more knowledgeable on the mechanism and preferred changing the game rules as a more cost effective solution than promoting a complex antitrust case with a fledgling Federal Competition Commission. [24]

[24] Umlauf (1993) reports collusion as being one of the main reasons for adopting the uniform format on 1990. It is worth noting that it is only since 1993, with the approval of an antitrust law and the

On the other hand, average price differentials in the auctions where all participants are subject to limits based on capital basis are lower than in the auctions where only brokerage houses are subject to such limits. This is true also for all CETES and for each CETES type individually. Therefore, subjecting all participants to a common standard seems to level the competition ground and, as a result, to reduce price differentials.

The statistics for not reopened and reopened auctions are mixed. But reopening an auction actually may generate opposite effects. On one hand, reopening auctions may reduce price differentials because the additional supply improves the securities' liquidity. But, on the other hand, the additional supply may as well increase price differentials if it produces further market uncertainty. At first glance, the lower average price differential associated to the latter for all CETES matches results available for Italy, Spain and the United Kingdom supporting the first effect. But this may just reflect that 182 and 365 days CETES auctions are those commonly reopened and are the ones exhibiting most negative differentials in the data set. This conjecture is confirmed by the fact that the average price differentials are higher for 182 and 365 days CETES when there is reopening than when there is not. Further examinations, presented in Appendix 2, reveal that for 182 days CETES price differentials are higher on the week before the reopened auction than on the reopened auction, supporting that the Treasury chooses to reopen securities with high price differentials and that this practice improves liquidity, but reveals the opposite for 365 days CETES. The evidence of the effects on the securities not being reopened is mixed as well because while the pattern for 28 days CETES resembles the one for 182 days CETES, the pattern for 91 days CETES resembles the one for 365 days CETES. Hence, tests are not conclusive in favor of either of the two hypotheses and cannot be matched with pattern changes from 1997 to 1998.

In sum, format changes do not fully account for the increasing price differentials in the CETES auctions. Although more tests regarding auction format are tested through the addition of dycothomic variables in the regression analysis of section 5, these results deem necessary to look at the other factors: market uncertainty, competition level, size of the issue, secondary market liquidity, etc. The variables employed to account for these and other factors are described next.

4.2 Variables

Auction price differentials

From the four price differential measures discussed before, the price difference between the secondary market price, constructed with either the funding rate or the

---

creation of an antitrust commission, that non-competitive practices are prohibited and punished in Mexico.

IEP CETES rate, and the primary auction price are those chosen to be used as dependent variable of all this study's regressions. These variables are labeled as DIFFR and as DIFIEP, respectively.

Past experience

The lagged endogenous variable would have a negative impact on the endogenous variable, if auction participants learn from the past and tend to reverse large profits or losses through their bidding strategy. This hypothesis is presented and tested in Scalia (1997). In addition, early estimations showed that an autorregresive term could be appropriate for econometric reasons.[25] As a result, an AR(1) process is included in the present estimations.

Market uncertainty

The variance of the daily funding rate with government securities over the five-day period leading to and including the day of auction execution (VARFR) is used to proxy resale risk and information dispersion, as in Umlauf (1993) and Laviada and Laviada (1997).[26] It is hypothesized that when the predictability of the funding rate is low, so is the predictability of demand for CETES. Thus, it is expected to observe a positive correlation between the variance of the funding rate and the CETES price differential if bidders are risk-averse and/or equilibrium expected profits increase when ex ante information disparities between bidders increase (provided this regressor indeed proxies for such information disparities). However, a negative coefficient associated to this coefficient may be considered consistent with the interpretation that variance of the funding rate is capturing propagation of information, not its dispersion.[27] The model of Admati and Pfleiderer (1988) predicts that under the assumption that traders may acquire information at some cost, the arrival of information in the market causes an increase in intraday volatility. Therefore, since the availability of information reduces the winner's curse, the latter would then be inversely related to price volatility, and consistent with the winner's curse effect on auction discount.

The Mexican Treasury's practice of suspending issues of longer term securities during episodes of financial turmoil suggests that including an indicator variable for such periods of high market volatility (DHIGHVOL) may be appropriate. Thus, such variable is constructed and added to the model expecting to find that it exhibits a positive coefficient.

[25] This possibility also is discussed in Umlauf (1993).

[26] This is done despite of this variable's recognized limitations as a proxy for resale price predictability due to the extent to which government securities prices created by rolling over daily repurchase contracts may differ from CETES prices.

[27] This argument is previously presented in Scalia (1997). Nevertheless, he reckons in his study that there are no clear arguments for the Admati-Pfleiderer model in the context of the Italian Treasury bond market .

Bidder participation and competition level

Participation is measured by the number of bidders submitting at least one competitive bid (BIDDERS). It may have a positive or a negative effect on the auction price differential. These predictions comes from single-unit single bid auction models with a finite number of players, where the effect of an increase in the number of players is ambiguous. On one hand, when the number of bidders increases the winner's curse is more severe, inducing lower bidding, and hence increasing auction price differentials. On the other, an increase in the number of bidders implies in increase in competition, reducing the probability of winning, and therefore inducing higher bidding and hence decreasing auction price differentials. Wilson (1988) and Bihkchandani and Huang (1993) argue that the increase in competition is the stronger of both effects. There is also a prediction of a zero coefficient associated to this variable, if the majority of the variation in this regressor is attributed to the entry and exit of smaller bidders who are presumed to be poorly informed. This implication comes from Englebrecht-Wiggans, Milgrom and Weber (1983). Empirical evidence for this variable is mixed, as well: at least Umlauf (1993) and Mazón and Núñez (1999) find a positive sign and Spindt and Stolz (1992), Berg 1997) and Scalia (1997) finds a negative sign.

The cover ratio (COVER), defined as the competitive volume of bids over competitive volume accepted is included also, to proxy for the competition level. In multiple-unit multiple-bid auctions an increase in participation does not necessarily imply an increase in competition, because the offered volume may vary as well. This possibility is supported in the Mexican data by the fact that the correlation between BIDDERS and COVER is low.[28] It is expected to have a negative effect on auction price differentials, as most of the above mentioned studies find.

The range of winning bids (RBIDASIG) is also included as a proxy for the degree of competition in this study because it is used by Umlauf (1993). He suggest two different effects. On the one hand, if the auction is competitive, the ex post dispersion of bids will proxy for disparities in ex ante estimates of bidders. On the other hand, a wider dispersion of prices may suggest partial or complete failure of cartel members to rig their bids collectively. The former effect suggests a positive coefficient (which in turn would be consistent with a positive coefficient associated to VARFR), while the latter suggests a negative one. He finds weak evidence of the latter effect his study of the Mexican auctions.

It is interesting to notice, however, that a positive coefficient could also be obtained if RBIDASIG proxies market uncertainty instead. This is the way it is included in Mazón and Núñez (1999), which conjectures that the dispersion in the bidders' submitted prices would decrease with an increase in the information set available to them. This is the sign that they find in the Spanish auctions.

[28] See Table A3.1 in Appendix 3 for further detail.

Quantity sold

The announced quantity to be sold (ISSUESIZE) may have a negative effect on auction price differentials. Umlauf (1993) argues that incentives to deviate from cartel equilibria are strongest during larger auctions when gains from price cutting are largest. A negative correlation between this regressor and auction profitability in the cartel sample regression would suggest that collusion breaks down in larger auctions. However, Umlauf (1993) finds the coefficient associated to this variable to be insignificant in the Mexican auctions,[29] while and Laviada and Laviada (1997) finds it to be positive. Laviada and Laviada (1997) argues that auction participation is highly concentrated in Mexico and, as a result, greater quantities sold may not be enough to increase competition.

The CETES kind proportion of all CETES being offered in the same auction date (PCETES) is included as well. Not only because the relative abundance of a title may affect its price differential, but because having different titles auctioned simultaneously may affect the bidders' strategies. It is hypothesized that both of this considerations reduce price differentials, so a negative sign is expected.

Secondary market liquidity, inventories and risk

The number of outstanding CETES in the secondary market of the same issue being auctioned (OUTINSEC) is included to proxy the security's liquidity in the secondary market. The fact that a bond with the same original maturity as the one being auctioned is outstanding in the secondary market may affect both the supply and the demand side of the auction, and therefore auction prices. This variable can have either a positive or a negative effect: larger outstanding quantities may imply lower pressure on the Treasury to issue a bigger quantity, and then a positive sign on auction price differentials could be expected. But on the other hand, if this variable gives some quantity information to bidders, then a negative effect on auction price differentials could be expected.[30]

If the number of outstanding CETES in the secondary market is a good proxy of the securities' trade, the literature on financial microstructure[31] provides another explanation for a negative coefficient on this variable. Bid ask spreads would be expected to vary inversely with the number of securities traded for at least two reasons. First, high volume securities generally require the specialist to maintain less inventory relative to the volume of transactions. The greater the volume the

[29] Breedon and Ganley (1996) also includes the size of the auction issue, but as a proxy of the issue's liquidity. It finds a positive but insignificant correlation among this variable and price differentials in United Kingdom's gilt auctions.

[30] Similar variables to capture this effect are included in Breedon and Ganley (1996) and Mazón and Núñez (1999). The first paper includes the size of the parent security and finds an insignificant positive correlation with parent-tranche differential. The second paper includes the amount of securities maturing at the auction date (the complement of the variable employed here) and finds an insignificant negative coefficient.

[31] This hypothesis goes back at least to Demsetz's classical article of 1968.

more closely buy and sell orders are likely to match up without the need for a large inventory buffer. Second, the specialist must spend some minimum amount of his time even on inactive issues. More active securities probably require more time to handle but the increase is likely to be less than proportional. Thus, a smaller time commitment and inventory buffer per transaction would be needed the higher the volume traded. Lower bid ask spreads in the secondary market presumably would translate into lower auction price differentials.[32]

Finance microstructure literature also suggests that low priced securities may tend to have higher percentage spreads for several reasons. Price discontinuities,[33] the tendency of limit orders to be set at even values (whole numbers before halves then quarters and then eighths), the fixed costs of executing a transaction and the desire of specialists to set their spreads high enough to permit room to maneuver would all tend to place a minimum value on the spread. This minimum is proportionately greater on a low priced than a high priced security. There may also be an element of risk involved in this relation between price and percentage spread. Branch and Freed (1977) mention that there is a widespread belief among investors and others that low priced securities are risky. The margin restriction on low priced securities reflects this view. Whether the view is correct or not, if investors and specialists view low priced securities as tending to be risky, they will act accordingly and the result is likely to be larger percentage spreads on low priced securities. To test for this kind of effects (which, unfortunately is not possible to disentangle) the reciprocal of the secondary market price (1/P, where either P=Funding rate price or P=IEP price, as appropriately) is included and a negative sign is expected.

The average bid size (AVGBID) is included as a proxy of a third kind of transaction costs suggested by finance microstructure literature.[34] This literature suggests a component of transaction costs associated to the fact that market makers may trade with unidentified investors who have superior information. When asymmetric information exists, informed traders profit by submitting orders that will be correlated with future price changes. Rational market makers in a competitive environment widen bid ask spreads beyond what it would otherwise be to recover from uninformed traders what they lose (on average) to the informed traders. This additional widening is called the adverse selection component because the market-makers face adverse selection in their order flows. Larger bids carry larger

[32] Amihud and Mendelson (1986) analyzes a model in which investors with different expected holding periods trade assets with different relative spreads. The resulting testable hypothesis is that market-observed expected return is an increasing and concave function of the spread. Their tests of this hypothesis, which is consistent with the prediction made above, with expected returns and bid-ask spreads data of NYSE stocks find empirical results consistent with the model.

[33] For example, in the US stock prices are quoted in no smaller units than eighths unless the price falls below a dollar.

[34] This literature includes, among others, Glosten and Milgrom (1985), Kyle (1985), Glosten and Harris (1988), George, Kaul and Nimalendran (1991) and Brennan and Subrahmanyam (1998).

adverse selection effects,[35] which in turn translate into higher auction price differentials. Hence, the hypothesized sign is positive.

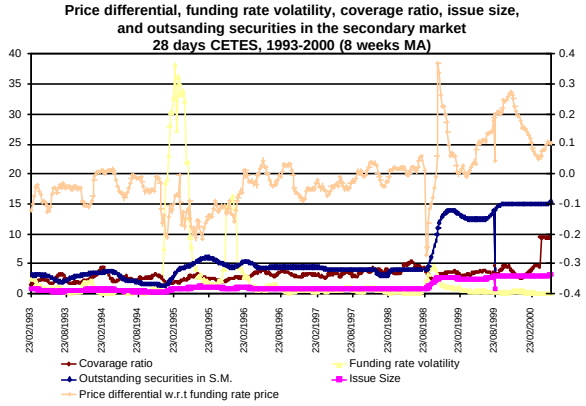
Both the matrix of crossed correlations among these variables and their basic statistics are presented for further consultation in Appendix 3. But there are some features of the data worth to be emphasized here. First, the strongest correlation with price differential are exhibited by the BIDDERS variable, although this correlation is high for 28 days CETES and diminishes for the longer term CETES (even becoming negative for 365 days CETES). This suggests some endogeneity among them that can be explained because higher expected returns generate more willingness to participate among potential bidders. Since this feature may be better accounted for with two stage least squares (TSLS) than with ordinary least squares (OLS), both sets of estimations will be carried out.[36] Unsurprisingly, ISSUESIZE and OUTINSEC exhibit a high cross correlation among them that also tends to diminish with CETES maturity, most likely as a result of the auction issuing calendar. But it was decided to include both anyway because, besides it is assumed that they account for different sources of effects, adding the latter does not affect substantially the former's sign, size or significance in regressions. Lastly, correlations do vary across CETES of different maturity for other variables, especially in the comparison of 28 and 91 days CETES against 182 or 365 days CETES, suggesting that regression results may vary across as well.

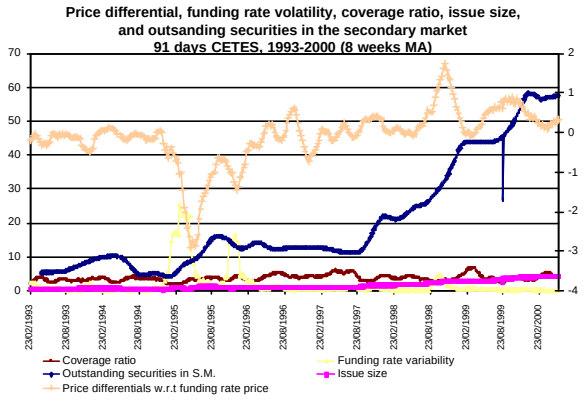
Graph 3 and Table 6 provide another glance at four of these factors regarded as the most important ones in empirical analysis of Treasury auctions. These factors, namely volatility of the bond market (as proxied with funding rate volatility), coverage, issue size and number of outstanding securities in the secondary market, are graphed along with each CETES price differential. Bond market volatility seems to have a mild decreasing tendency throughout the analysis period, excepting for the early months of the 1995 financial crisis which produce a high yearly average. Falling price differentials are also observed in that period and ultimately led to suspending the CETES of longer maturity until 1996. In the period 1996-2000, coverage fluctuates between 3 and 4 (except for a value of 6 in 28 days CETES during 2000) indicating a quite constant competition level throughout time and across securities. Lastly, both the issue size and the number of outstanding CETES in the secondary market exhibits an obvious upward tendency. Hence, at this level of analysis only the last two exhibit a pattern that can be reconciled with one of the hypothesis mentioned above in order to explain the observed increases in the CETES' price differentials.

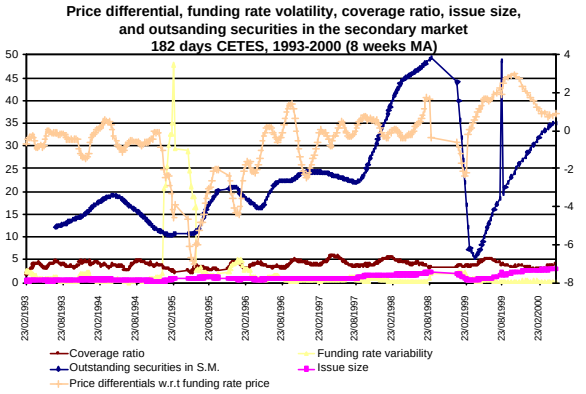
[35] The results of Brennan and Subrahmanyam (1998) point to a strong and negative cross-sectional relation between the average trade size and estimated fixed and variable costs of transacting per share, consistent with strategic trading.

[36] These are a common finding and a common way to proceed in this kind of empirical study, which most of the time lead to similar results, however.

Graph 3 Price differentials, funding rate volatility, issue size, coverage ratio, and outstanding securities in the secondary market, 1993-2000







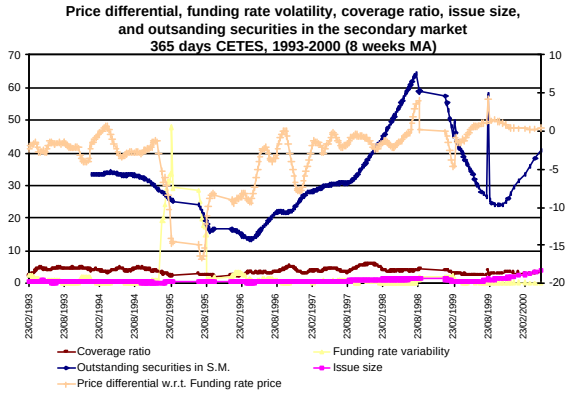


Table 6 Funding rate volatility, issue size,[1] coverage ratio, [2] and outstanding securities in the secondary market, 1989-2000[3]

28 days CETES

Year	Funding rate volatility	Issue size	Coverage ratio	Outstanding Securities in S.M.
1989	6.6555	NA	NA	NA
1990	5.7480	NA	NA	NA
1991	2.3452	NA	NA	NA
1992	1.0877	NA	NA	NA
1993	1.1170	631.0577	2.0726	2,889.2476
1994	0.4465	506.9231	2.7044	2,399.8196
1995	13.9066	1,012.5000	2.3339	4,837.8688
1996	0.7733	900.0000	3.1304	4,500.0000
1997	0.6779	811.5385	3.3175	3,969.2308
1998	0.9284	1,435.2941	3.8052	6,556.8627
1999	0.4890	2,755.7692	3.4293	13,721.1538
2000	0.1542	3,081.8182	6.0240	15,081.8182

91 days CETES

Year	Funding rate volatility	Issue size	Coverage ratio	Outstanding Securities in S.M.
1989	6.9493	NA	NA	NA
1990	3.6494	NA	NA	NA
1991	3.9736	NA	NA	NA
1992	1.0877	NA	NA	NA
1993	1.1170	524.2308	2.9227	6,921.0518
1994	0.7449	488.4314	3.2007	6,963.9280
1995	9.8671	929.8077	3.0660	11,488.5125
1996	1.1541	920.1923	3.8921	12,863.4615
1997	0.7034	1,103.7736	4.3169	14,252.8302
1998	1.0708	2,225.0000	3.3552	28,111.5385
1999	0.4132	3,378.8462	3.9215	48,009.6154
2000	0.1542	4,100.0000	4.1944	56,918.1818

182 days CETES

Year	Funding rate volatility	Issue size	Coverage ratio	Outstanding Securities in S.M.
1989	NA	NA	NA	NA
1990	1.8538	NA	NA	NA
1991	3.9736	NA	NA	NA
1992	1.0993	NA	NA	NA
1993	1.1170	544.0385	3.6174	14,326.4876
1994	0.4421	519.2000	3.7641	15,762.2400
1995	12.7070	947.2973	3.1381	15,344.5369
1996	1.1876	857.1429	3.7612	20,574.0163
1997	0.6779	1,107.6923	4.3117	25,598.0769
1998	0.6273	1,891.4286	4.1825	45,626.2857
1999	0.4260	1,346.0526	4.0364	15,732.8947
2000	0.1869	2,880.0000	3.7474	34,945.0000

365 days CETES

Year	Funding rate volatility	Issue size	Coverage ratio	Outstanding Securities in S.M.
1989	NA	NA	NA	NA
1990	3.4206	NA	NA	NA
1991	3.4314	NA	NA	NA
1992	1.1713	NA	NA	NA
1993	1.1170	631.4387	4.1808	NA
1994	0.4421	513.2000	4.0389	32,316.0835
1995	19.2441	668.8381	2.4505	20,233.3714
1996	1.1541	544.2308	3.5478	19,482.4615
1997	0.6779	826.9231	4.5041	32,603.8462
1998	0.4007	1,402.9412	4.0522	53,929.4118
1999	0.4260	1,003.9474	2.8677	34,071.0526
2000	0.1838	4,720.0000	3.8090	43,250.0000

1 and 2: In thousands of pesos
3 Yearly averages

5. **Results**

Results from the OLS estimations are presented in Table 7. It is interesting to focus on the 28 days CETES regressions that use the difference with respect to the price implied in the daily funding rate first because these are more comparable with Umlauf (1993) and Laviada and Laviada (1997). Umlauf's estimations are reproduced (to the extent that the present data allow) in Appendix 3 for further comparison.

The regression's constant, BIDDERS, and ISSUESIZE all have a positive and significant coefficient and RBIDASIG is not significant, as in those previous studies. In contrast with them, VARFR is found to be not significant, perhaps due to the daily funding rate for government securities tracking less closely CETES' specific volatility as their participation in the government debt market decreases.[37] Instead, DHIGHVOL is positive and significant, so the result that volatility increases underpricing as a result of bidders being risk averse or of large ex ante information disparities existing among them is captured in these estimations. PCETES is not significant, which suggests that there is no price effect associated to changing the

[37] However, this measure of volatility is highly correlated with other measures available, like stock price index volatility, which do not track CETES volatility more closely either.

proportion of 28 days CETES among total CETES being auctioned (notice that for the other CETES this variable is negative, although significant for 91 and 182 CETES only, suggesting that increasing those securities' proportion in total CETES being sold in an auction reduces underpricing[38]). COVER is negative and significant, suggesting that more competition reduces underpricing. 1/P and AVGBID are significant and their signs coincide with the finance microstructure hypotheses set for each of them. OUTINSEC is negative and significant, suggesting that a larger amount of similar titles in the secondary market contribute to reduce underpricing as well. This result coincides with the findings for treasury auctions in Spain and UK,[39] but is not fully supported by the other CETES regressions. Demand and supply effects of different sizes across CETES may also explain this feature and, in turn, may arise partly as a result of the bundling of securities with different maturity (in repurchase agreements) to ameliorate liquidity problems which would lessen the information effects in the less liquid longer term securities.

When the difference with respect to the IEP price is used as dependent variable instead of the funding rate price, there are some differences for the 28 days CETES regression: while COVER, 1/P, DHIGHVOL, and AVGBID no longer are significant, RBIDASIG becomes significant. Its positive sign is consistent with it being a better proxy for information dispersion than for collusion breaking. In both regressions the AR(1) term is positive and less than one, consistent with the bidding correction argument, although it is not significant in the regression that uses DIFIEP. Observe that overall regression fit, as measured with the adjusted R^2 is above 50% in both regressions. This statistic is quite high compared to similar studies, suggesting that the variables suggested by the finance microstructure literature add valuable information to this kind of empirical analysis.

Results of the 91, 182 and 365 days estimations support what has been explained so far to less extent because only the regression constant, BIDDERS, DHIGHVOL, ISSUESIZE, and 1/P keep coefficients consistent with those in the 28 days CETES estimations and significant in at least another security. However, the evidence against is not strong either because these regressions exhibit just two coefficients with signs opposite to those of the 28 days CETES, namely PCETES and OUTINSEC. Although for these two variables there are explanations associated to the Treasury's behavior for having some effects predominating over others differently across CETES, since such results may also be due to having smaller samples for longer term CETES[40] or to some differing security specific conditions an unbalanced panel is assembled with the four securities' data series to estimate a pooled least squares regression with fixed effects. BIDDERS, RBIDASIG,

[38] Since 1999 the Mexican Treasury changed its 182 and 364 days CETES sale schedule so that they are sold once every two weeks or once per month instead of on a weekly basis like the 28 and 91 days CETES.
[39] See Mazón and Núñez (1999) and Breedon and Ganley (1996), respectively, for more details.
[40] One of the reasons why Umlauf (1993) and Laviada and Laviada (1997) concentrated on 28 days CETES auctions is that there are more observations for this security than for the rest in the sample period each studies.

DHIGHVOL, PCETES, 1/P, and the fixed effects coefficients are significant. But this significance in the case of BIDDERS, RBIDASIG, and PCETES, which show signs differing from those in the individual regressions, is troubling in the first two of these variables (after all, the coefficient associated to PCETES in the panel regression coincides with the 28 days CETES regression and can be argued that underpricing in that title due to its proportion reduction in the total compensates the overpricing in the rest of the titles as their proportion increases, given that demand is stronger for shorter term titles).[41] OUTINSEC and AVGBID are both negative but not significant. The positive and increasing with maturity fixed coefficients in the regression that uses DIFFR suggests that the price differential with the primary auction is larger for the longer term securities, as visual inspection of Graph 2 also indicates. Mazón and Núñez (1999) obtain the same pattern and interpret it as another implication from market uncertainty. However, it is not obtained in the regression that uses DIFIEP.

On the other hand, TSLS estimation does seem to affect results also. Signs remain mostly unchanged, but their significance is lower than in the LS regressions. It is also the case with them that the results about competition level, bidder participation, volatility and secondary market liquidity show more strongly in the shorter term CETES. These findings are considered just as a confirmation of the well known weaknesses of the present empirical approach, already mentioned in section 2, so the regressions' results are presented in Appendix 3 for closer appreciation.

[41] However, these two sigh switches can be reconciled with there being different bidders for different CETES types that add up to more bidders overall because BIDDERS is expected to have a negative sign as the increased competition predominates over the winner's curse and, consistent with this, as collusion breaks RBIDASIG can also become negative (notice this variable is positive but not significant for the three longer term CETES regressions, suggesting it is not a good information dispersion proxy in them).

Table 7 OLS regression results, CETES 1996-2000 data set

Dependent variable: DIFFR

	28 DAYS CETES		91 DAYS CETES		182 DAYS CETES		365 DAYS CETES		ALL CETES[1]	
C	16.424	*	36.318	*	35.134	*	29.706	*		
COVER	-8.315	*	0.024		-0.011		-0.052		0.003	
BIDDERS	0.003	*	0.016	*	0.002		0.027	**	-0.005	***
RBIDASIG	0.006		0.307		0.733		0.063		-0.001	*
VARFR	-0.002		0.026		0.018		-0.007		0.013	
DHIGHVOL	0.244	*	1.158	*	0.182		0.441	***	0.387	*
ISSUESIZE	0.000	*	-0.001		0.001	*	-0.001		-0.100	
PCETES	0.097		-2.147	*	-13.026	*	-1.005		1.523	*
1/PASIG	-1.618	*	-3.341	*	-2.989	*	-1.936	*	-3.931	*
OUTINSEC	-0.040	*	0.018	***	-0.012		0.016		0.001	
AVGBID	0.196	**	0.235		0.123		-0.011	**	-0.093	
AR(1)	0.609	*	0.845	*	0.944	*	0.893	*	0.847	*
C-28									39.759	*
C-91									41.699	*
C-182									44.872	*
C-365									47.985	*
Adjusted R^2	0.644		0.666		0.536		0.766		0.862	
F Test	0.000		0.000		0.000		0.000		0.000	
Observations	196		189		133		104		570	

Dependent variable: DIFIEP

	28 DAYS CETES		91 DAYS CETES		182 DAYS CETES		365 DAYS CETES		ALL CETES[1]	
C	2.271		-3.411		-5.247		14.029	***		
COVER	-0.077		0.044	**	-0.015		-0.080		0.001	
BIDDERS	0.001	*	0.007	**	0.001		0.023		-0.008	**
RBIDASIG	0.027	*	0.328	*	-0.167		0.056		-0.001	*
VARFR	-0.003		0.006		-0.071		-0.037		-0.047	***
DHIGHVOL	0.027		0.579	*	-0.420		0.698		-0.163	
ISSUESIZE	0.001	*	-0.007	**	-0.008		-0.001		-0.001	
PCETES	0.024		-2.098	*	-2.552	**	-7.163		1.529	*
1/PFIEP	-0.227		0.381	**	0.667		-0.657		0.333	**
OUTINSEC	-0.020	**	0.011		-0.008		-0.007		-0.008	
AVGBID	-0.002		-0.106		1.195		-0.007		-0.026	
AR(1)	0.174		0.197	*	0.360	*	0.903	*	0.573	*
C-28									-3.562	
C-91									-3.296	
C-182									-2.537	
C-365									-4.369	
Adjusted R^2	0.533		0.372		0.257		0.753		0.706	
F Test	0.000		0.000		0.000		0.000		0.000	
Observations	196		189		131		104		570	

*, ** and ***: Significant at the 1, 5 and 10% level, respectively, using Newey-West adjusted standard errors.

1: Unbalanced panel estimated as pooled least squares regression with fixed effects and White heteroskedasticity-consistent standard errors and covariance.

Overall, these estimations provide evidence in favor of the hypothesis that the observed underpricing tendencies in the CETES may be connected to a set of factors less emphasized by auction theory. While they show evidence in favor of competition level, bidder participation and market uncertainty as reasons for price differences to increase between primary and secondary markets, these variables' observed time trends suggest these differences should be constant or decreasing through time. Thus, other factors may be playing an important role. Secondary

market's microstructure is a factor worth further research in the future because more powerful measures of liquidity, inventory, and adverse selection effects can be constructed as better secondary market data are collected. For example, two facts may suggest that adverse selection problems are increasing in the Mexican market. First, if it is assumed that foreign banking institutions and mutual funds or the pension fund investment societies are, besides in many occasions more sophisticated that the rest of the participants, "better informed" than the participants in the primary auctions, their increased number in the Mexican financial markets would tend to raise the adverse selection component of their trades. The recently adopted practice of tendering of some long term titles directly to pension funds outside the primary competition may be a result of this kind of consideration being in the financial authorities' minds. The second factor relates to the fact that at present and since not later than 1995 participants in the primary auction can only submit bids on their own account. If it is assumed that participants perceive bidding to get securities that they will resale immediately to customers as riskier when they have to bid on their own account than when they can bid on their customers' accounts (perhaps due to different default risks in the operations), this rule would also tend to increase spreads. Observe that average bid size exhibits an increasing tendency and is found to have a positive sign, in spite its significance is weak in several regressions. But what may be provoking that increase in addition to just an increase in the issue size given a fixed set of participants is not evident from the auction rules and, most predictions about bidding behavior regard either the number of bids or the whole bid demand (besides it can be questioned if this variable is a good proxy of secondary market adverse selection problems). Another obvious factor worth future research is to allow for more complex bidding strategies for the bidders because besides bid size bidders can choose entering or not to one or many auctions based on, for example, their secondary market positions. For example, many countries compute maximum bidding limits for auction participants discounting them by the amount of an issue they already have to mitigate market squeezes. This calls also to allow for more complex selling techniques because the counterpart of what is just said is a seller that decides increasing the size of the issues being offered in the primary auction and whether to offer them or not, again given existing amounts in the secondary market, for example. As was mentioned before, evidence for Mexico is that the government is shifting its securities' supply from shorter term CETES to longer term CETES and from these to even longer term BONDES and BONOS, which could not be included in the present study.

Due to the importance attributed to auction format we present a set of regressions exploring the three changes to the Mexican auction rules explained before. Estimations are carried out with the 1993-2000 data set which is less complete (BIDDERS, RBIDASIG, and AVGBID cannot be constructed and only DIFFR can be used as dependent variable), but permits to evaluate the effects on price differentials associated to the classical problem of choosing between a uniform and a discriminatory format and to setting common maximum bidding limits (recall such measures were implemented before June 1996). But to the extent that the omitted variables are significant in the previous analysis, the following results may be

biased and must be taken with the applicable cautions.[42] Three dycothomic variables are defined as follows: DISCRIMINATORY (=1 if the auction has discriminatory format and =0 if the auction has uniform format), DCAPITAL (=1 if only brokerage houses face maximum bidding limits and =0 if all participants face maximum bidding limits) and DREOPEN (=1 if the auction is reopened and =0 if is not). It is hypothesized that the coefficients associated to the first two variables are positive and that the last one is negative (however, DREOPEN is not included in the 28 and 91 days CETES regressions because these securities are not subject to reopening).

Table 8 OLS regression results, CETES 1993-2000 data set
Dependent variable: DIFFR

	28 DAYS CETES	91 DAYS CETES	182 DAYS CETES	365 DAYS CETES	ALL CETES[1]
C	4.073	44.712 *	56.020 *	40.064 *	
COVER	0.004	-0.014	0.023	0.006	0.009 **
ISSUESIZE	0.089	-0.675 *	0.082	-0.200	0.042
PCETES	-0.086	0.933 **	-0.403	0.811	-0.948 *
DISCRIMINATORY	-0.023	0.292	1.708 ***	0.533 ***	0.442 **
OUTINSEC	-0.009	0.052 **	-0.048	0.011	-0.004
VARFR	-0.000	0.016 *	-0.009 *	0.007	-0.001
DHIGHVOL	0.143 *	-0.183	0.410		0.417 *
INVSTPF	-0.397	-4.227 *	-4.918 *	-3.194	-4.627 *
DREOPEN			-0.879 *	0.583 *	0.146 **
DCAPITAL	-0.059 **	-0.019	-0.509	-0.675	-0.006
AR(1)	0.260	0.958 *	0.968 *	0.937 *	0.974 *
C-28					46.914 *
C-91					48.993 *
C-182					51.071 *
C365					55.010 *
Adjusted R^2	0.303	0.537	0.741	0.840	0.925
Observation	0.000	0.000	0.000	0.000	0.000
F Test	379	372	298	251	1247

*, ** and ***: Significant at the 1, 5 and 10% level, respectively, using Newey-West adjusted standard errors.
1: Unbalanced panel estimated as pooled least squares regression with fixed effects and White heteroskedasticity-consistent standard errors and covariance.

Table 8 presents the regression results. There is some additional but limited support to the estimations already presented. First, while DISCRIMINATORY has the hypothesized sign in the 91, 182, 365, and ALL CETES' equations, only is significant in the regressions corresponding to the two longer term CETES and to ALL CETES. Second, only the equation corresponding to the 28 days CETES has a significant coefficient for DCAPITAL, but it is not of the expected sign and contradict what is observed by comparing price differential means in the previous section. Third, the coefficient of DREOPEN has opposite signs in the 182 and 365 days CETES regressions and both are significant. However, in the pooled LS regression with ALL CETES the resulting coefficient is positively signed and significant. These two observations do match what is observed in the previous section, but just confirms that the analysis of this specific format change remains

[42] Comparison of Umlauf's specification with and without bidders in the Table A3.4 of the Appendix 3 provide some grasp about omitted variables' possible relevance.

inconclusive. Finally, notice that as before fixed effects coefficients are all significant, confirming that price differentials are larger as maturity increases.

6. Conclusions

The lack of adequate secondary market prices places extra strain for interpreting some of the present study's results. But absent any factors that can produce a systematic bias between the "true" secondary market prices and the measures employed here, they suggest that underpricing of CETES between the primary auction and the secondary market has been increasing in the recent years. However, deciding whether such findings require some kind of action by the authorities probably needs examining first whether similar patterns are observed in other government bonds and how these compare to other securities' bid-ask spreads in the secondary market. It may seem intuitive that the latter are a floor to the primary auction margins. If so, it may be somewhat unfair for auction participants that these margins are labeled "profit". But this is still an open question both at the theoretic and at the empirical level.

The standard techniques employed to study what factors may be producing such patterns, as measured with standard variables as well, provide only weak evidence in favor of increased market uncertainty or lower competition level, which besides are not fully consistent with these variables' recent evolution as an explanation of the increasing price discounts. Better measures of them can be constructed from data sets containing information at the bidder level, if they become available. However, empirical studies from other countries suggest that even with better proxies these variables' explanatory power may not increase much.

What is just said probably is true about collusion also. Umlauf (1993) finds evidence of collusion about the largest auction participants from a data set with information at the bidder level (although, to identify the collusive bidders he additionally relies on some reports by financial officials). This finding did not deserve much attention then because Mexico did not have neither an antitrust authority nor an antitrust law at the time. While this ceased to be true in 1993, it is puzzling that potential collusion in financial markets has received attention from antitrust authorities only at basic levels (e.g. authorization of mergers and acquisitions among financial intermediaries based on savings' market participation); furthermore, because of the concerns about market squeezes expressed by financial authorities of markets that are more liquid, deep, technically sophisticated, and have more participants than the Mexican markets. This study's findings definitely support a closer look at this factor and that will require information at the bidder level.

It is puzzling that average auction participation has remained almost constant since 1993, given that there are more firms operating in the Mexican financial markets that can qualify to participate in the present framework. Current primary auction rules still include stricter entry conditions for participants and higher maximum bidding limits than those observed in developed markets (e.g. current bidding limits

per participant in US and Canada are below 40%). Such measures make market participation thin and, therefore, it may be desirable to examine the need for them at present times, in the light of the safer delivery against payment practices adopted in the payment system and the availability of better monitoring technologies.

Studying the explanatory power of other factors, like liquidity, inventory and adverse selection costs in the secondary market, while interesting in its own sake may also shed additional light about this phenomenon. Despite that the proxies employed here are somewhat weak because they are not generated from secondary market data either, there is evidence in favor of the three of them. The importance of resale markets has been studied for some time in auction theory and perhaps these features can be added to those already considered by such models to produce specific predictions for treasury securities' markets. With adequate secondary market data, the importance of having different pools of participants across primary and secondary market or of news arrival before resale takes place, suggested by recent models of auctions with resale, may be examined as well.

Of the recent format changes to the Mexican primary auctions, evidence of power to reduce price differentials can be linked to uniform auctions, vis a vis discriminatory auctions, and to auctions with common maximum bidding limits to all participants, vis a vis auctions where the different participants face different maximum bidding limits. The former confirms previous findings. The latter may be due to the fact that participants in Mexico's primary auctions are mostly banking and brokerage institutions among which is not profitable to discriminate because of the many similarities that they share and, thus, the rule in question solely levels the competition ground. On the other hand, evidence about auctions reopening as a means to reduce price differentials is more limited. Although this may be connected with the lack of proper price information dispersion due to the lack of a when issued market, without which the additional supply of securities may exacerbate uncertainty rather than propitiate liquidity, results do not support this alternative hypothesis clearly either. Hence, estimating this securities demands through the non-parametric methods employed by Feldman and Reinhart (1995) may add useful information about it.

Government securities market specialists have been operating in the Mexican markets only since September 2000, so this data set is not suitable to examine what effects may they produce in price differentials. Their obligation to offer buy and sell quotes for government securities continuously may improve markets' liquidity and depth and may change the aforementioned factors in a way that underpricing decreases, under an appropriate set of rules. Their sole existence has already motivated the collection of institutions' securities positions data that in turn may be used both to calibrate both their operation rules and the maximum bidding limits in the primary auction, as is done in developed countries' to avoid market manipulability. It was not possible to examine the effect of reserving part of the securities for pension funds investment societies either. Such analysis may be important both because of these institutions' increasing role in financial market

operations and because the quantities allocated to non-competitive bids had been decreasing until this measure was into place.

Finally, efficiency in government securities primary auctions and secondary market is important for both the ability to absorb the amounts of Treasury securities made necessary by government's borrowing requirements at a low cost and the needs of the central bank in conducting open market operations effectively. It also provides benefits to the rest of the financial market by providing a benchmark for interest rates across the maturity spectrum. International evidence suggests that preserving these markets' efficiency requires continuous supervision and reforms. Nonetheless, even in countries with individually strong financial authorities, best results are obtained through coordinated efforts because of the different factors that come into play requiring multidisciplinary analyses and because of the need to avoid unnecessary responses that may drive investors and market makers out of the market in pursuing the goal of market integrity.

7. Bibliography

Amihud, Y. and H. Mendelson (1986),"Asset Pricing and the Bid-Ask Spread", Journal of Financial Economics 17, 1986, 223-249.

Ausubel, L. (1997), "An Efficient Ascending-Bid Auction", University of Maryland, Department of Economics Working Paper No. 97-06, June 25, 1997.

Ausubel, L. and P. Cramton (1998), "Auctioning Securities", University of Maryland, Mimeograph, March 1998.

Ausubel, L. and P. Cramton (1999), "Vickrey Auctions with Reserve Pricing", University of Maryland, Mimeograph, June 1999.

Babatz, G. (1997), "Ownership Structure, Capital Structure and Investment in Emerging Markets: The Case of Mexico", Ph. D. Dissertation, Harvard, December 1997.

Bartolini, L. and C. Cottarelli (1994), "Treasury Bill Auctions: Issues and Uses", International Monetary Fund WP/94/135, November 1994.

Bihkchandani, S. and C. Huang (1993), "The Economics of Treasury Securities Markets", Journal of Economic Perspectives, Volume 7, Number 3, Summer 1993, 117-134.

Branch, B. and W. Freed (1977), "Bid-Asked Spreads on the AMEX and the Big Board", Journal of Finance, Volume 32, Issue 1 (Mar 1977), 159-163.

Breedon, F. and J. Ganley (1996), "Bidding and Information: Evidence from Gilt-Edged Auctions", Bank of England, Working Paper Series No. 42, January 1996.

Brennan, M. J. and A. Subrahmanyam (1998), "The Determinants of Average Trade Size", Journal of Business, 1998, vol. 71, no. 1.

Copeland, T. E. and D. Galai (1983), "Information Effects on the Bid-Ask Spread", The Journal of Finance, vol. XXXVIII, No. 5, December 1983.

Debt Management Report 2000-01, Her Majesty's Treasury, United Kingdom, March 2000.

Feldman, R. and V. Reinhart (1995), "Auction Format Matters: Evidence on Bidding Behavior and Seller Revenue", IMF Working Paper 95/47.

Gordy, M. B. (1996), "Hedging Winner's Curse with Multiple Bids: Evidence from the Portuguese Treasury Bill Auction", Banco de Portugal, Estudos E Documentos de Trabalho Working Papers, WP 21-96, December 1996.

Haile, P. (1997), "Auctions with Private Uncertainty and Resale Opportunities", University of Wisconsin-Madison, Department of Economics, Mimeograph, December 1997.

Haile, P. (1999), "Auctions with Resale", University of Wisconsin-Madison, Department of Economics, Mimeograph, October 1999.

Hardy, D. C. (2000), "Bidding Behavior on Treasury Bill Auctions: Evidence from Pakistan", IMF Working Paper WP/00/111, June 2000.

Harvey, N. (1999), "Recent Initiatives in the Canadian Market for Government of Canada Securities", Bank of Canada Review, Summer 1999.

Heller, D. and Y. Lengwiler (1998), "The Auctions of Swiss Government Bonds: Should the Treasury Price Discriminate or Not?", Federal Reserve Board, Finance and Economics Discussions Series 1998-11.

Joint Report on the Government Securities Market, Department of the Treasury, Securities and Exchange Commission, and Board of Governors of the Federal Reserve System, United States of America, January 1992.

Kennedy, P. (1993), *A Guide to Econometrics*, MIT Press, third printing.

Lengwiler, Y. (1999), "The multiple unit auction with variable supply", Economic Theory 14, 373-392.

Mazón, C. and S. Núñez (1999), "On the optimality of treasury bond auctions: the Spanish case", Banco de España, Documento de Trabajo no. 9905, 1999.

Nandi, S. (1997), “Treasury Auctions: What do the Recent Models and Results Tell Us?”, Federal Reserve Bank of Atlanta Economic Review, Fourth Quarter, 1997.

Nautz, D. (1995), “Optimal bidding in multi-unit auctions with many bidders”, Economic Letters 48, 301-306.

Nautz, D. (1997), “How auctions reveal information –a case study on German repo rates”, Journal of Money, Credit and Banking.

Nautz, D. and E. Wolfstetter (1997), “Bid shading and risk aversion in multi-unit auctions with many bidders", Economic Letters 56, 195-200.

Scalia, A. (1997), “Bidder Profitability under Uniform Price Auctions and Systematic Reopenings: The Case of Italian Treasury Bonds”, Banco de Italia, No. 303, 1997.

Umlauf, S. R. (1993), “An empirical study of the Mexican Treasury bill auction”, Journal of Financial Economics 33, 1993, 313-340.

Uniform Price Auctions: Evaluation of the Treasury Experience, Department of the Treasury, U.S. Treasury, October 1995.

Uniform Price Auctions: Update of the Treasury Experience, Department of the Treasury, U.S. Treasury, October 1998.

Wang, J. D. and S. Vishwanathan (1996), “Auctions with When-Issued Trading: A Model of the U.S. Treasury Markets”, Duke University, Fuqua School of Business, Working Paper.

Zheng, C. (2000), “Optimal Auction with Resale”, Northwestern University, Mimeograph, October 2000.

Appendix 1

Table A1.1 Key reforms in the Mexican Financial System, 1987-2000

1987	Commercial banks are authorized to offer "Cuentas Maestras" (an instrument combining mutual funds and checking account services), which are the first checking accounts that pay interest in a high inflation environment.
1988	Previous limits on the amount of bankers' acceptances issued are removed and interest rate paid on these acceptances is liberalized. The liabilities resulting from bankers' acceptances and guarantees no longer face the reserve requirements and selective credit controls that are applicable to funds obtained through other instruments. Now the sole requirement on bankers' acceptances is a 30 per cent "liquidity ratio." Commercial banks are authorized to carry our repurchase agreements using bankers' acceptances. Bank promissory notes with interest payable at maturity begin trading in the stock market.
1989	On April 1st, financial liberalization is generalized, as the regime applicable to bankers' acceptances is extended to all other bank instruments. Banks are authorized to invest their domestic resources freely, subject to the sole restriction of maintaining a liquidity coefficient of 30 percent in the form of deposits at the central bank and/or in public debt instruments. Selective credit controls on domestic currency, and the channeling of funds to the federal government are abolished, changing the financing of the government from direct credit from banks to market financing by means of placing public debt on the market. In November, firms are allowed to issue "neutral" shares which do not carry voting rights and may be acquired by foreigners. Before this reform, foreign investment in most stocks was limited to 49% of the total, and in many firms most of the foreign-owned capital was held by an industrial partner. In December, Congress approved laws fostering the placement of a greater number of Mexican securities in international financial markets. A "Special Section" within the National Stock Registry was created for stocks of Mexican firms to be issued in foreign markets. "Stock market specialists" arise. These intermediaries are permitted to trade independently those securities in which they specialize. Specialized firms are authorized to offer rating services for securities. A rating requirement for commercial paper issues is established. Brokerage houses are authorized to form (non-banking) financial groups with warehouses, factory and leasing firms, foreign exchange houses, insurance companies, bond securities and investment societies. Banks social capital is open to a minority participation of foreign capital. Unnecessary restrictions to the generation, promotion and dispersion of risk control and to foster modernization and globalization of investment societies are eliminated.
1990	In June, the private sector is allowed once again to offer banking services, and privatization of the banking system begins. At the same time, universal banking laws are passed, so that banks, securities firms and insurance companies may form part of the same financial services group. Short sales in the stock market are authorized in September. In October, the investment regime for open trust funds is liberalized, scrapping requirements for government securities holdings as a proportion of total assets. The issue of commercial paper indexed to the dollar, as well as foreign investment in all government paper, is authorized in December. Private sector is again authorized to provide banking and credit services. Financial groups can be formed among all types of financial intermediaries in the system.
1991	Regulation of commissions charged by securities dealers for stock market operations is abolished in June. The 30 percent liquidity requirement on bank liabilities is removed. Foreign exchange controls, in force since 1982, are removed in November.
1992	General rules for the organization and operation of savings and loan companies are

	passed. 15% of their portfolio must be invested on government securities or banking instruments and the rest can be invested to acquire other assets denominated in national currency. The legal and conceptual framework to carry out the pension fund reform is set out. Individual worker accounts are set at the Social Security Institute to eventually be traspassed to investment societies. Pension funds must be invested in Federal Government securities and generate at least a 2 percent real interest rate, net of management fees.
1994	Mexico assumes the obligation to allow Canadian and US financial intermediaries to operate in the -National Territory (up to specified market and firm level limits) as part of NAFTA. Bond securities firms, warehouses, savings and loans companies, foreign exchange houses, stock specialists and investment societies and controllers are to be allowed in immediately. Banking institutions, brokerage houses, insurance companies, financial societies of limited objectives, financial factoring firms and leasing companies are to be allowed in gradually and progressively in a 6 years period, counted from January 1, 1994 to December 31, 1999. The authorization to establish a market to trade future contracts based on nominal interest rates ant the *INPC* is granted. A mayor reform of the payment system starts. It pursues 5 objectives: 1) Create a high value electronic payment system at the retail level. 2) Stimulate the use of electronic payment system at the retail level. 3) Establish overdrafting limits to the commercial banks' accounts at Banco de Mexico. 4) Adjust compensation rules applied to payment documents denominated in nominal currency. 5) Adopt "delivery against payment" practices in operations with government securities. 6) Modify the domestic system for paying documents denominated in dollars.
1996	Rules for the operation of pension fund administration and investment societies are published.
2000	Rules for the operations of "government securities market specialists are set . The first group of these specialists started to operate on September 2000.

Source: Babatz (1997) and Yearly Report of Banco de México, various numbers.

Appendix 2

Table A2.1 Correlation Matrix of Alternative Measures of the Auction Price Differential, May 2000-April 2001

	CETES 28			**CETES 91**		
PV-PP	1.00	0.21	0.07	1.00	0.35	0.87
PF-PP	0.21	1.00	0.23	0.35	1.00	0.14
PIEP-PP	0.07	0.23	1.00	0.87	0.14	1.00
	CETES 182			**CETES 364**		
PV-PP	1.00	-0.01	0.95	1.00	0.05	0.96
PF-PP	-0.01	1.00	-0.16	0.05	1.00	-0.16
PIEP-PP	0.95	-0.16	1.00	0.96	-0.16	1.00

PV-PP: Banxico's Vector Secondary Market Price-Primary Auction Price
PF-PP: Funding Rate Secondary Market Price-Primary Auction Price
PIEP-PP: IEP Secondary Market Price- Primary Auction Price

Table A2.2 Basic Statistics of Alternative Measures of the Auction Price Differential, May 2000-April 2001

	CETEs 28			**CETEs 91**		
	Pvector-Pprim	Pfondeo-Pprim	Piep-Pprim	Pvector-Pprim	Pfondeo-Pprim	Piep-Pprim
Promedio	0.011	0.007	0.023	0.208	0.311	0.190
Desv. Est.	0.021	0.030	0.020	0.076	0.135	0.083
Máximo	0.051	0.052	0.062	0.478	0.647	0.494
Mínimo	-0.036	-0.065	-0.032	0.003	-0.007	-0.038
	CETEs 182			**CETEs 364**		
	Pvector-Pprim	Pfondeo-Pprim	Piep-Pprim	Pvector-Pprim	Pfondeo-Pprim	Piep-Pprim
Promedio	0.699	0.897	0.643	2.439	2.787	2.381
Desv. Est.	0.144	0.365	0.432	0.311	0.863	0.314
Máximo	1.027	1.603	1.337	2.983	4.030	2.952
Mínimo	0.406	0.214	-0.238	2.010	1.335	1.895

Table A2.3 Price Differentials of Auctions With and Without Reopening

		With Reopening				Without Reopening	
		(Current Week)		(Previous Week)		(Current Week)	
		Funding price	IEP	Funding price	IEP	Funding price	IEP
All CETES	Average			0.288	0.140	0.349	0.318
	Std. Dev.			0.120	0.055	1.282	0.893
	Max			1.350	0.855	10.530	10.359
	Min			-0.302	-0.393	-13.794	-14.730
CETES 28	Average	0.093	0.087	0.098	0.089	0.032	0.031
	Std. Dev.	0.013	0.006	0.012	0.005	0.036	0.040
	Max	0.350	0.257	0.350	0.247	0.965	0.559
	Min	-0.212	-0.152	-0.155	-0.151	-2.403	-2.595
CETES 91	Average	0.657	0.427	0.480	0.192	0.356	0.290
	Std. Dev.	0.181	0.045	0.136	0.103	0.355	0.126
	Max	1.558	0.855	1.350	0.855	3.044	2.088
	Min	-0.302	-0.130	-0.302	-0.393	-2.269	-0.445
CETES 182	Average	1.798	0.565	2.047	1.467	0.512	0.565
	Std. Dev.	0.986	2.455	0.971	0.222	2.266	2.455
	Max	3.700	2.354	5.016	2.354	5.016	2.354
	Min	0.061	-14.730	0.522	0.128	-13.794	-14.730
CETES 365	Average	2.519	1.448	2.519	1.359	1.062	1.448
	Std. Dev.	4.268	4.422	4.429	3.772	5.690	4.422
	Max	9.801	10.359	10.530	10.359	10.530	10.359
	Min	-1.914	-1.585	-1.682	-1.798	-7.644	-1.585

Appendix 3

Table A3.1 Correlation Matrix, 1996-2000 Data Set

	DIFFR	DIFIEP	COVER	BIDDERS	RBIDASIG	VARFR	ISSUESIZE	1/PFR	1/PIEP	OUTINSEC	AVGBID	PCETES
28 DAYS CETES												
DIFFR	1.00	0.63	-0.03	0.41	0.09	0.24	0.50	0.05	0.22	0.43	0.06	0.46
DIFIEP	0.63	1.00	0.07	0.48	0.12	-0.08	0.68	-0.24	-0.21	0.65	0.17	0.45
COVER	-0.03	0.07	1.00	-0.03	-0.04	-0.08	0.09	-0.21	-0.21	0.10	0.93	-0.11
BIDDERS	0.41	0.48	-0.03	1.00	0.04	-0.03	0.55	-0.07	-0.03	0.55	0.06	0.38
RBIDASIG	0.09	0.12	-0.04	0.04	1.00	-0.01	0.09	-0.07	-0.07	0.09	-0.02	0.09
VARFR	0.24	-0.08	-0.08	-0.03	-0.01	1.00	0.02	0.42	0.47	-0.04	-0.05	0.17
ISSUESIZE	0.50	0.68	0.09	0.55	0.09	0.02	1.00	-0.04	-0.02	0.99	0.25	0.75
1/PFR	0.05	-0.24	-0.21	-0.07	-0.07	0.42	-0.04	1.00	0.98	-0.08	-0.18	0.36
1/PIEP	0.22	-0.21	-0.21	-0.03	-0.07	0.47	-0.02	0.98	1.00	-0.06	-0.19	0.38
OUTINSEC	0.43	0.65	0.10	0.55	0.09	-0.04	0.99	-0.08	-0.06	1.00	0.26	0.71
AVGBID	0.06	0.17	0.93	0.06	-0.02	-0.05	0.25	-0.18	-0.19	0.26	1.00	0.04
PCETES	0.46	0.45	-0.11	0.38	0.09	0.17	0.75	0.36	0.38	0.71	0.04	1.00
91 DAYS CETES												
DIFFR	1.00	0.27	-0.33	0.30	0.41	0.30	0.11	0.11	0.39	0.06	0.00	0.06
DIFIEP	0.27	1.00	0.12	0.04	0.07	-0.01	-0.10	0.14	0.01	-0.08	-0.01	-0.28
COVER	-0.33	0.12	1.00	-0.42	-0.21	-0.07	-0.15	0.07	-0.08	-0.08	0.14	-0.11
BIDDERS	0.30	0.04	-0.42	1.00	0.19	-0.07	0.07	-0.03	0.07	-0.02	-0.09	0.02
RBIDASIG	0.41	0.07	-0.21	0.19	1.00	0.20	0.01	0.32	0.43	-0.03	-0.02	0.12
VARFR	0.30	-0.01	-0.07	-0.07	0.20	1.00	-0.07	0.34	0.42	-0.04	-0.07	0.03
ISSUESIZE	0.11	-0.10	-0.15	0.07	0.01	-0.07	1.00	-0.24	-0.17	0.96	0.62	0.75
1/PFR	0.11	0.14	0.07	-0.03	0.32	0.34	-0.24	1.00	0.93	-0.18	-0.43	0.10
1/PIEP	0.39	0.01	-0.08	0.07	0.43	0.42	-0.17	0.93	1.00	-0.13	-0.40	0.17
OUTINSEC	0.06	-0.08	-0.08	-0.02	-0.03	-0.04	0.96	-0.18	-0.13	1.00	0.58	0.71
AVGBID	0.00	-0.01	0.14	-0.09	-0.02	-0.07	0.62	-0.43	-0.40	0.58	1.00	0.40
PCETES	0.06	-0.28	-0.11	0.02	0.12	0.03	0.75	0.10	0.17	0.71	0.40	1.00
182 DAYS CETES												
DIFFR	1.00	0.36	-0.02	0.12	0.00	-0.20	0.24	-0.51	-0.21	0.27	0.06	0.31
DIFIEP	0.36	1.00	-0.04	-0.10	-0.04	-0.35	-0.13	-0.11	-0.25	-0.25	-0.07	-0.26
COVER	-0.02	-0.04	1.00	-0.11	0.41	-0.07	-0.13	0.05	-0.03	-0.06	0.84	0.03
BIDDERS	0.12	-0.10	-0.11	1.00	0.08	-0.16	0.48	-0.36	-0.30	0.29	0.06	0.34
RBIDASIG	0.00	-0.04	0.41	0.08	1.00	0.09	-0.13	0.25	0.36	-0.05	0.32	-0.22
VARFR	-0.20	-0.35	-0.07	-0.16	0.09	1.00	-0.12	0.42	0.55	0.05	-0.07	-0.16
ISSUESIZE	0.24	-0.13	-0.13	0.48	-0.13	-0.12	1.00	-0.59	-0.34	0.58	0.27	0.42
1/PFR	-0.51	-0.11	0.05	-0.36	0.25	0.42	-0.59	1.00	0.80	-0.30	-0.24	-0.31
1/PIEP	-0.21	-0.25	-0.03	-0.30	0.36	0.55	-0.34	0.80	1.00	-0.03	-0.19	-0.36
OUTINSEC	0.27	-0.25	-0.06	0.29	-0.05	0.05	0.58	-0.30	-0.03	1.00	0.23	0.52
AVGBID	0.06	-0.07	0.84	0.06	0.32	-0.07	0.27	-0.24	-0.19	0.23	1.00	0.09
PCETES	0.31	-0.26	0.03	0.34	-0.22	-0.16	0.42	-0.31	-0.36	0.52	0.09	1.00
365 DAYS CETES												
DIFFR	1.00	0.49	0.20	-0.11	-0.02	-0.10	0.10	-0.37	-0.10	0.02	-0.39	0.50
DIFIEP	0.49	1.00	0.21	-0.26	-0.01	0.02	-0.20	0.10	-0.12	-0.08	-0.46	0.34
COVER	0.20	0.21	1.00	-0.13	-0.11	-0.10	-0.06	-0.13	-0.13	-0.04	-0.20	0.04
BIDDERS	-0.11	-0.26	-0.13	1.00	0.27	-0.01	0.12	-0.06	0.00	-0.01	0.06	-0.19
RBIDASIG	-0.02	-0.01	-0.11	0.27	1.00	0.09	-0.07	0.10	0.12	0.15	0.02	-0.17
VARFR	-0.10	0.02	-0.10	-0.01	0.09	1.00	-0.17	0.59	0.60	0.39	0.20	-0.25
ISSUESIZE	0.10	-0.20	-0.06	0.12	-0.07	-0.17	1.00	-0.48	-0.38	0.16	0.33	0.66
1/PFR	-0.37	0.10	-0.13	-0.06	0.10	0.59	-0.48	1.00	0.87	0.33	0.10	-0.53
1/PIEP	-0.10	-0.12	-0.13	0.00	0.12	0.60	-0.38	0.87	1.00	0.44	0.11	-0.48
OUTINSEC	0.02	-0.08	-0.04	-0.01	0.15	0.39	0.16	0.33	0.44	1.00	0.35	-0.13
AVGBID	-0.39	-0.46	-0.20	0.06	0.02	0.20	0.33	0.10	0.11	0.35	1.00	-0.20
PCETES	0.50	0.34	0.04	-0.19	-0.17	-0.25	0.66	-0.53	-0.48	-0.13	-0.20	1.00

Table A3.2 Basic Statistics, 1996-2000 Data Set

	DIFFR	DIFIEP	COVER	BIDDERS	RBIDASIG	VARFR	ISSUESIZE	1/PFR	1/PIEP	OUTINSEC	AVGBID	PCETES
28 DAYS CETES												
Mean	0.09	0.06	0.00	9.32	0.01	0.63	17.32	10.17	10.17	8.54	0.13	0.29
Maximum	0.98	0.56	0.04	49.00	1.43	7.50	36.00	10.33	10.28	16.80	1.75	0.67
Minimum	-0.18	-0.15	0.00	0.00	0.00	0.00	8.00	10.10	10.10	0.80	0.01	0.12
Std. Dev.	0.13	0.08	0.00	5.85	0.10	1.10	10.14	0.05	0.04	5.06	0.12	0.12
91 DAYS CETES												
Mean	0.72	0.38	0.00	10.09	0.00	0.63	22.87	10.58	10.54	31.16	0.10	0.37
Maximum	3.33	2.09	0.01	41.00	0.00	7.50	41.00	11.07	10.92	60.30	0.23	0.58
Minimum	-0.36	-1.01	0.00	0.00	0.00	0.00	8.00	10.12	10.13	1.60	0.05	0.27
Std. Dev.	0.56	0.38	0.00	5.23	0.00	1.10	11.89	0.15	0.14	17.69	0.04	0.11
182 DAYS CETEs												
Mean	2.09	1.34	0.00	9.11	0.00	0.71	14.21	11.19	11.04	24.71	0.09	0.25
Maximum	5.22	3.61	0.06	27.00	0.00	7.50	41.00	12.09	11.68	57.40	0.68	0.53
Minimum	-0.39	-0.96	0.00	0.00	0.00	0.00	2.20	10.39	10.41	0.50	0.04	0.05
Std. Dev.	1.05	0.68	0.01	4.35	0.00	1.21	7.29	0.24	0.23	12.27	0.07	0.08
365 DAYS CETES												
Mean	5.51	3.88	0.00	9.43	0.00	0.72	10.96	13.04	12.07	31.08	0.14	0.19
Maximum	13.20	10.83	0.03	56.00	0.00	7.50	50.00	15.55	13.37	51.40	1.61	0.33
Minimum	0.64	-1.68	0.00	0.00	0.00	0.00	1.00	10.93	10.65	1.20	0.03	0.03
Std. Dev.	2.54	2.33	0.00	5.56	0.00	1.22	8.21	0.71	0.44	11.25	0.19	0.06
ALL CETES												
Mean	1.88	1.26	0.00	9.55	0.00	0.67	16.75	11.13	10.88	22.61	0.11	0.28
Maximum	13.20	10.83	0.06	56.00	1.43	7.50	50.00	15.55	13.37	60.30	1.75	0.67
Minimum	-0.39	-1.68	0.00	0.00	0.00	0.00	1.00	10.10	10.10	0.50	0.01	0.03
Std. Dev.	2.42	1.85	0.00	5.30	0.05	1.15	10.63	1.12	0.74	15.89	0.12	0.11

Table A3.3 Basic Statistics, CETES 1993-2000 Data Set

	DIFFR	COVER	VARFR	ISSUESIZE	1/PFR	OUTINSEC	PCETES	DISCRIM	DCAPITAL	DREOPEN
					28 DAYS CETES					
Mean	0.04	3.17	2.55	1.27	10.19	6.18	0.29	0.79	0.36	0.00
Maximum	0.97	43.90	96.53	3.60	10.65	16.80	1.00	1.00	1.00	0.00
Minimum	-0.83	0.38	0.00	0.28	10.07	0.80	0.12	0.00	0.00	0.00
Std. Dev.	0.16	2.45	9.91	0.90	0.10	4.47	0.12	0.41	0.48	0.00
					91 DAYS CETES					
Mean	0.36	3.59	2.05	1.57	10.61	21.09	0.32	0.78	0.34	0.00
Maximum	3.04	9.60	81.14	4.10	12.17	60.30	1.00	1.00	1.00	0.00
Minimum	-2.27	0.00	0.00	0.25	10.12	3.76	0.13	0.00	0.00	0.00
Std. Dev.	0.63	1.50	7.10	1.19	0.33	16.62	0.10	0.41	0.47	0.00
					182 DAYS CETES					
Mean	0.74	3.88	2.17	1.09	11.16	22.32	0.29	0.78	0.35	0.13
Maximum	5.02	9.84	149.44	3.00	13.29	50.62	1.00	1.00	1.00	1.00
Minimum	-4.88	0.00	0.00	0.28	10.42	0.50	0.08	0.00	0.00	0.00
Std. Dev.	1.32	1.43	11.33	0.64	0.53	10.75	0.09	0.41	0.48	0.33
					364 DAYS CETES					
Mean	2.00	3.71	2.22	0.88	12.24	32.18	0.22	0.78	0.14	0.53
Maximum	10.24	8.53	149.44	5.00	16.57	70.30	1.00	1.00	1.00	1.00
Minimum	-7.81	0.00	0.00	0.10	10.85	1.50	0.04	0.00	0.00	0.00
Std. Dev.	2.65	1.34	12.28	0.70	0.87	12.48	0.08	0.41	0.35	0.50
					ALL CETES					
Mean	0.67	3.56	2.26	1.23	10.93	19.16	0.28	0.78	0.31	0.13
Maximum	10.24	43.90	149.44	5.00	16.57	70.30	1.00	1.00	1.00	1.00
Minimum	-7.81	0.00	0.00	0.10	10.07	0.50	0.04	0.00	0.00	0.00
Std. Dev.	1.54	1.81	10.08	0.94	0.88	15.05	0.11	0.41	0.46	0.34

Table A3.4 Umlauf (1993) estimations with CETES 1996-2000 data set

	28 DAYS CETES		91 DAYS CETES		182 DAYS CETES		365 DAYS CETES	
	DIFFR	DIFIEP	DIFFR	DIFIEP	DIFFR	DIFIEP	DIFFR	DIFIEP
Panel A: With AR(1)								
C	-0.056	-0.042 *	0.571 *	0.381 *	2.176 *	1.939 *	5.594 *	4.155 *
BIDDERS	0.002 *	0.001 *	0.0164 **	0.003	0.010	-0.001	0.033 **	0.024
RBIDASIG	0.025 **	0.023 *	0.386	0.452 *	0.443	-0.098	0.194	0.234
VARFR	-0.012	-0.000	0.056	0.046	0.009	-0.028	-0.069	-0.114
ISSUESIZE	0.007 **	0.004 *	-0.004	-0.005 **	-0.001	-0.039 *	-0.059 ***	-0.072
AR(1)	0.692 *	0.216 **	0.615 *	0.087	0.761 *	0.419 *	0.889 *	0.865 *
R^2	0.550	0.508	0.486	0.086	0.579	0.309	0.809	0.794
Obs	200	200	200	200	158	156	153	153
F test	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Panel B: Without AR(1)								
C	-0.053 **	-0.044 *	0.267	0.381 *	1.833 *	1.915 *	6.778 *	5.736 *
BIDDERS	0.004 *	0.001 *	0.020 **	0.002	-0.007	-0.009	-0.075 **	-0.112 *
RBIDASIG	0.049 *	0.040 *	1.351 *	0.491 *	2.129 *	0.584	0.698	0.724 ***
VARFR	0.032	0.001	0.148 **	0.049	-0.045	-0.069	0.135	0.256
ISSUESIZE	0.004 *	0.004 *	-0.001	-0.005 **	0.001	-0.038 *	-0.083 *	-0.115 *
R^2	0.331	0.489	0.311	0.085	0.079	0.196	0.114	0.309
Obs	200	200	200	200	158	157	153	153
F test	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000
Panel C: Without BIDDERS								
C	-0.035	-0.036 *	0.451 *	0.404 *	1.795 *	1.869 *	6.313 *	5.046 *
RBIDASIG	0.048 *	0.040 *	1.487 *	0.508 *	2.096 *	0.543	0.410	0.296
VARFR	0.031	0.001	0.139 **	0.048	-0.042	-0.064	0.126	0.242
ISSUESIZE	0.006 *	0.005 *	0.002	-0.004 **	-0.001	-0.040 *	-0.096 *	-0.134 *
R^2	0.303	0.477	0.278	0.088	0.084	0.199	0.095	0.249
Obs	200	200	200	200	158	157	153	153
F test	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table A3.5 TSLS regression results, CETES 1996-2000 data set

Dependent variable: DIFFR

	28 DAYS CETES	91 DAYS CETES	182 DAYS CETES	365 DAYS CETES
C	16.568 *	41.154 *	36.929 *	30.586 *
COVER	-11.673	0.119 *	0.046	-0.132 **
BIDDERS	-0.001	0.022 **	0.019	0.023 ***
RBIDASIG	0.004	0.357	0.663	0.032
VARFR	-0.002	0.036	0.025	-0.012
DHIGHVOL	0.233 *	1.493 *	0.256	0.455 **
ISSUESIZE	0.001 *	-0.002	0.190 *	-0.070
PCETES	0.069	-2.076 *	-15.059 *	-3.153
1/PFR	-1.629 *	-3.840 *	-3.127 *	-1.959 *
OUTINSEC	-0.039 *	0.018 **	-0.007	0.026
AVGBID	0.243	-1.805	-4.913	-0.012 **
AR(1)	0.616 *	0.818 *	0.943 *	0.876 *
Adjusted R^2	0.618	0.627	0.517	0.749
F Test	0.000	0.000	0.000	0.000
Observations	196	189	133	104

Dependent variable: DIFIEP

	28 DAYS CETES	91 DAYS CETES	182 DAYS CETES	365 DAYS CETES
C	-0.684	-6.381	-42.945	14.029 ***
COVER	51.738 ***	-0.060	-0.723	-0.080
BIDDERS	0.002	0.003	-0.018	0.023
RBIDASIG	0.052 *	0.159	1.725	0.056
VARFR	-0.002	-0.007	-0.318	-0.037
DHIGHVOL	-0.017	0.488	-1.214	0.698
ISSUESIZE	0.001 *	-0.001	-0.173	-0.020
PCETES	0.108	-2.066 *	10.106	-7.163
1/PIEP	0.054	0.702	3.936	-0.657
OUTINSEC	-0.024 **	0.015	-0.069	-0.007
AVGBID	-1.243 ***	1.892	59.380	-0.007
AR(1)	0.002	0.218 *	0.076	0.903 *
Adjusted R^2	0.036	0.304	-4.594	0.753
F Test	0.000	0.000	0.811	0.000
Observations	196	189	131	104

Instrument list: c, cover(-1), bidders, rbidasig, varfr, issuesize, 1/pfr, outinsec, avgbid