

## Systemic Risk and Financial Consolidation: Are They Related?

Gianni De Nicolo\*  
Myron L. Kwast\*

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### Abstract

The creation of a number of very large and sometimes increasingly complex financial institutions, resulting in part from the on-going consolidation of the financial system, has raised concerns that the degree of systemic risk in the financial system may have increased. We argue that firm interdependencies, as measured by correlations of stock returns, provide an indicator of systemic risk potential. We analyze the dynamics of the stock return correlations of a sample of U.S. large and complex banking organizations (LCBOs) over 1988-1999, and find a significant positive trend in stock return correlations. This finding is consistent with the view that the systemic risk potential in the financial sector appears to have increased over the last decade. In addition, we relate firms' return correlations to their consolidation activity by estimating measures of the consolidation elasticity of correlation. Consolidation at the sample LCBOs appears to have contributed to LCBOs interdependencies. However, consolidation elasticities of correlation exhibit substantial time variation, and likely declined in the latter part of the decade. Thus, factors other than consolidation have also been responsible for the **upward** trend in return correlations.

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## Systemic Risk and Financial Consolidation: Are They Related?

### Introduction

The on-going consolidation of the financial system is one of the most notable features of the contemporary financial landscape. The resulting creation of a number of very large and in some cases increasingly complex financial institutions has raised concerns that the degree of systemic risk in the financial system may have increased. For example, although consolidation may have increased the extent of diversification at individual institutions, and thus lowered individual firm's risk, consolidated firms may have become more similar, and thus raised the vulnerability of the aggregated financial system. In addition, greater concentration of certain activities, such as inter-bank loans and large dollar payment activities, may have augmented systemic risks.<sup>7</sup> However, as noted in the recent survey by **DeBandt and Hartmann (2000)**, research aimed at specifying empirical models of systemic risk is quite limited. In addition, no previous work has examined the relationship between systemic risk and financial consolidation. This paper attempts to contribute toward filling both gaps.

Guided by a broad definition of systemic risk, we argue that firm interdependencies provide an indicator of systemic risk potential, and measure interdependencies with correlations of stock returns. Our analysis proceeds in two steps. First, we analyze the dynamics of such correlations during the 1988-1999 period for a sample of U.S. large and complex banking organizations (**LCBOs**). With the exception of **Campbell et al. (2000)**, no prior study has focused on the dynamics of interdependencies at the firm level. Second, we relate firms' return correlations to their consolidation activity by estimating measures of the consolidation elasticity of correlation both cross-

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<sup>7</sup> See **Group of Ten (2001)**, chapter IV.

sectionally and through time. This is a novel contribution that builds on our previous efforts.<sup>2</sup>

We find that there was a significant positive trend in stock return correlations among the sample LCBOs during the 1990s. This finding is consistent with the view that the potential for economic shocks to become agents of systemic risk in the financial sector appears to have increased over the last decade. In addition, consolidation at the sample LCBOs appears to have contributed to LCBO interdependencies during the sample period. However, consolidation elasticities of correlation exhibit substantial time variation, and likely declined in the latter part of the decade. Thus, factors other than consolidation have also been responsible for the upward trend in return correlations.

The paper proceeds as follows. Section I defines systemic risk, focusing on the critical need for interdependencies between firms and the central role of the largest and most complex banking organizations. Section II presents our measure of total interdependency, and describes and interprets trends in this measure over the 1990s. Section III describes our measure of consolidation. Section IV presents estimates of the consolidation elasticity of correlation, and the final section concludes.

## I Defining Systemic Risk

Systemic financial risk is the risk that an event (shock) will trigger a loss of economic value or confidence in, and attendant increases in uncertainty about, a substantial portion of the financial system that is large enough to, in all probability, have significant adverse effects on the real economy.<sup>3</sup> Two critical assumptions underlie this definition. First, economic shocks may become systemic because of the existence of negative externalities associated with severe disruptions in the financial system. In

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<sup>3</sup> Group of Ten (2001), chapter IV

This is the definition used in Group of Ten (2001). Excellent discussions of systemic risk, including thoughtful reviews of the literature may be found in De Bandt and Hartmann (2000) and in Dow (2000)

particular, a negative shock at a single firm or small group of firms must be highly likely to have contagion effects on other financial institutions. This is the aspect of systemic risk that drives the analysis in this paper. However a second assumption, although not addressed further here, is also central to a broader consideration of systemic risk. Namely, in our view truly systemic financial events must be highly likely to induce undesirable real effects, such as substantial reductions in output and **employment**.<sup>4</sup>

We use the implications of the need for externalities between financial firms to obtain measures of the potential for systemic risk in the financial sector. Specifically, we argue that for externalities to exist, firms must be interdependent in some way. Interdependencies can either be direct or indirect. Direct interdependencies arise from inter-firm on- and off-balance sheet exposures, including linkages through payment and settlement systems. Indirect interdependencies arise from correlated exposures to nonfinancial sectors and financial markets. Either way, the size of a financial institution's total interdependencies (direct plus indirect) with other financial institutions, and the quantitative strength of these interdependencies across many firms will be key determinants of whether a shock to one (or a small number of) financial institutions has the potential to become systemic. Thus, estimation of systemic risk potential may be achieved using a measure of the interdependencies of financial institutions.

In the United States, systemic risk concerns have focused traditionally on the implications of bank deposit runs for the payments system, the money supply and financial intermediation. However, the advent of deposit insurance, an understanding of the need to maintain an adequate supply of money and money market liquidity, and the development of prudential supervision and regulation have essentially eliminated the

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<sup>4</sup> This definition is consistent with most definitions of **systemic risk** proposed in the literature. However, it is stricter than some because it explicitly requires that(i) the negative externalities of a systemic event

threat of deposit runs by retail customers (primarily households and small businesses) of insured depositories.’ Indeed, systemic deposit runs and flights to currency have not occurred in the United States since World War II. As a result, discussion of systemic risk has shifted more to consideration of issues raised at the wholesale level.<sup>6</sup> In practice, this means concentrating attention on the largest and most complex financial institutions. This refocusing has been reinforced by the forces of technological change, deregulation, globalization and the increasing use of financial markets that have been driving the rapid evolution of the U.S. and global financial systems. For all of these reasons, this paper is limited to attempting to clarify the relationship between systemic risk, the largest and most complex banking organizations, and consolidation activity at such institutions.

In order to conduct empirical work, the set of financial institutions that has the potential to impose systemic risk must be defined. One approach would be merely to use some arbitrarily defined group of the very largest institutions. However, recent developments in banking supervision allow us to adopt a more refined procedure. The sample of banking organizations used here includes firms that have been identified by Federal Reserve supervisors as large and complex banking organizations, or **LCBOs**.<sup>7</sup> In general, LCBOs (i) have significant on- and off-balance sheet activities, (ii) offer a broad

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extend both to agents in the financial **system** and to the real economy, and (ii) these **externalities** are highly likely to occur.

<sup>5</sup> Estimates from the Federal **Reserve Board’s** 1998 Survey of Consumer Finances indicate that only 2 percent of U.S. households that hold deposits have uninsured deposits in U.S. depository institutions. Uninsured deposits are estimated to represent about 14 percent of total household deposits. For more on the 1998 Survey of Consumer Finances see **Kennickell et. al. (2000)**.

<sup>6</sup> Wholesale financial services include the provision of intermediation, investment banking, securities trading, asset management and payments services to corporations and other institutions. Excellent discussions of the changing nature of systemic risk are found in Bank for International Settlements (September 1998) and Chapter IV of International Monetary Fund (1999).

<sup>7</sup> LCBOs are discussed in **DeFerrari and Palmer (2001)** and **Group of Ten (2001)**, pp. 132-135. The Federal Reserve does not publish a list of the names of LCBOs, and for that reason we do not identify the names of the banking **organizations** included in this study. Suffice to say that the largest **banking** organizations are included in our sample. In addition, a list of the 50 largest U.S. bank holding companies as of December 31, 1998 and which ones were considered LCBOs are reported in **Study Group on Subordinated Notes and Debentures (1999)**, p. 29.

range of products and services at the domestic and international levels, (iii) participate extensively in large-value payment and settlement systems, and (iv) are of substantial size.

It is important to understand that the set of LCBOs is not homogeneous, and even simple comparisons reveal clear variations in business mix. Indeed, market participants report that, for purposes of analysis, they typically divide large banking institutions into so-called “peer” groups.<sup>8</sup> For these reasons, we divide the sample LCBOs into five peer groups that have been identified by bank supervisors. These groups correspond roughly to a declining degree of complexity. “Active Trading” firms are distinguished in terms of their trading and derivatives activities, as well as in other dimensions such as global and custodial activities. The characteristics of “Second Tier” companies resemble some aspects of the Active Trading firms, but with somewhat less intensity. A group of “Trust and Custody” organizations have substantial fiduciary businesses and a range of complex trading or other activities that support those businesses. A “Cusp” set of banking organizations with predominantly traditional activities have commenced speciality businesses and expanded in ways that make them look somewhat like the Second Tier firms. Lastly, a group of relatively more “Traditional Intermediaries” continue primarily to fund themselves with deposits and to make loans.

For supervisory purposes, the set of LCBOs is fluid, and can change due to developments at either the individual firm or in the overall industry. DeFerrari and Palmer (2001) report that since the program’s formal establishment in 1999, the number of LCBOs has been in the range of 25 to 30 institutions.

## II. Trends in Total Interdependencies

This section first defines our measure of total interdependency, and describes our

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<sup>8</sup> See, for example, Study Group on Subordinated Notes and Debentures (1999)

LCBO sample in more detail. It then describes and interprets the evolution of our measure of interdependency over the sample period.

#### A. Definition of interdependency

Total interdependencies are measured by the correlations of percentage changes in LCBO stock prices (hereafter also called **returns**).<sup>9</sup> Stock prices seem ideally suited to this purpose, because they reflect market participants' collective evaluation of the future prospects of the firm, including the total impact of its interactions with other institutions. Thus, a fundamental assumption of our analysis is that an observed increase in correlations among LCBO stock returns may signal an increase in the potential for a shock to become systemic. Conversely, discovery of no change or a decrease in correlations would be consistent with the view that systemic risks had not increased or even declined.

For each year from 1988 through 1999, weekly percentage changes in stock prices are computed for each of the sample LCBOs. Following convention, cross-correlations of returns between pairs of firms are computed using a **52-week** rolling window.” As reported below, these correlations are used in a variety of ways, including for computing averages across all of the sample LCBOs, and within and across their peer groups.

Because the focus of this study is on U.S. firms, a sample of U.S.-chartered and –owned LCBOs is used.” Sample selection and data construction proceeded in two steps. First, the 18 U.S.-chartered and –owned LCBOs in existence on December 31, 1999 were identified. Second, inspection of the sample led to the addition of four more LCBOs that did not exist at the end of 1999, because they had been acquired by another firm,

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<sup>9</sup> Stock prices of LCBOs are end-of-Friday quotes taken from Bloomberg

<sup>10</sup> See **Engle (2000)** and **Campbell *et.al* (2000)**. Also following convention, as noted where appropriate below, the rolling window methodology is sometimes not used.

<sup>11</sup> Foreign banking organizations account for about one-third of the LCBOs. See **DeFerrari and Palmer (2001)**.

However, because the acquisition of these four firms occurred not earlier than year-end 1997, and because supervisors had informally classified each as an LCBO in 1998, we decided to, where possible, include all four firms in the sample. Thus, for the vast majority of the sample period we evaluate 22 LCBOs.

It is noteworthy that the importance of the sample LCBOs has risen substantially in recent years. For example (and as described in more detail in Section III), their share of the total assets of U.S. bank holding companies and independent banks grew steadily from 34 percent in 1988 to 69 percent in 1999. In addition, because the LCBO program was only formally established in 1999, it is not possible to “officially” identify LCBOs going back into our sample period. Thus, we examine the same 22 firms over the entire sample period.

## **B. Trends in interdependency**

Charts 1 and 2 present our first descriptions of how LCBO interdependencies evolved during the 1990s. Chart 1 plots the mean weekly rolling-window correlations between the (at most) 231 LCBO pairs from 1990 through 1999. Although there is considerable variability in the series, a substantial jump in the average correlations is evident beginning in 1996 and continuing through the rest of the decade.

The conjecture of an increase in return correlations is supported by the data summarized in Chart 2, which shows average R-squared statistics for two sets of “market model” regressions. The solid line gives the mean R-square for a two-index market model estimated for the LCBOs for each week in the sample. The two indexes include the S&P 500 market index, a measure of overall market returns, and an LCBO index computed by the authors of equally weighted LCBO returns. The dashed line summarizes results using only the S&P 500 index as an independent variable. Both models show a marked increase in mean R-square beginning in 1996, suggesting that the



ability of overall market conditions, including common conditions at LCBOs, to “explain” returns at individual LCBOs increased in the **latter** part of the 1990s. Put differently, the models suggest that returns at LCBOs became more vulnerable to overall market conditions in the last half of the decade.

These results also indicate that the evolution of **interdependencies** was **quite** different at our sample LCBOs than among the vast majority of other publicly traded firms. In their mammoth study of stock returns, Campbell *et. al.* (2000) “document the evolution of correlations among individual stocks by calculating all **pairwise** correlations among stocks traded on the NYSE, AMEX, and **Nasdaq**” from 1962 through 1997, using both daily and monthly **data**.<sup>12</sup> Calculations with daily data use a one-year rolling window, and calculations with monthly data use a five-year rolling window. Their results show “a clear tendency for correlations among individual stock returns to **decline** (emphasis added) over time,” and market model regressions comparable to the single index model used here display a declining trend in mean R-squares.”

Panels A and B of table 1 provide a more disaggregated analysis of the time trends in LCBO stock return correlations over the sample period. In both panels, statistics are presented for the full sample of LCBOs, each of the five peer groups described earlier, and the ten possible combinations of the peer groups.

Panel A presents the mean raw correlations between pairs of individual firms aggregated, as suggested by chart 1, over the **1989-1995** (column 2) and 1996-1999 (column 3) periods. Looking first at the full LCBO sample, the mean correlation between

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<sup>12</sup> Campbell *et.al.* (2000), p. 20. The number of stocks in their sample ranges from 1000 to 4500, and the number of **pairwise** correlations from 500,000 to just **over** 10 million. Campbell *et. al.* **are** primarily concerned with stock return volatility. Unfortunately, they do not report **pairwise** correlation results for the banking industry or for relatively large firms in any industry. Thus it is possible that (at least some) large firms in (at least some) other industries could exhibit increases in **return** correlations similar to **those** we find for LCBOs. Even if true, however, such a finding would not obviate **our** interpretation of the LCBO results for systemic risk potential in the financial sector.

<sup>13</sup> *Idem*

firm pairs increased by some 37 percent, from 0.41 to 0.56 between the two sample periods. However, when the pair-wise correlations are divided into peer groups, more complex patterns emerge. Particularly large increases in group means are observed at the relatively less complex firms (Trust and Custody, Cusp, and Traditional), while changes are small or nonexistent at the groups containing the more complex institutions (Active Trading and Second Tier). When means are computed across peer group combinations, substantial increases in mean correlations are observed from the earlier to the later period in all ten possible combinations. However, the hugest increases are concentrated at combinations of the less complex groups (2-3, 3-4, 3-5, and 4-5).

The relationships presented in panel A are only suggestive of a **potential** trend in correlations. As pointed out by **Boyer, Gibson and Loretan (1997)**, observed increases in correlations computed on data of different time periods do not necessarily indicate increases in interdependencies. For example, under the assumption of bivariate normal returns, correlations measured in periods of high stock return volatility can be higher than those measured in periods of low stock return volatility even though the underlying correlation is constant. To detect time variation in correlations, we followed **Longin and Solnik (1995)** by estimating for each pair of **LCBOs** in the sample the GARCH constant conditional correlation model introduced by **Bollerslev (1990)**, and tested the significance of a time trend included in the correlation equation. Specifically, for each of the 231 pairs of firms, denoted with indexes  $i$  and  $j$ , we estimated the following bi-variate GARCH model

$$R(i,t) = a(i) + e(i,t)$$

$$R(j,t) = a(j) + e(j,t)$$

$$h(i,t) = b(i) + c(i)e(i,t-1)e(i,t-1) + d(i)h(i,t-1) + h(i) t$$

$$h(j,t) = b(j) + c(j)e(j,t-1)e(j,t-1) + d(j)h(j,t-1) + \lambda(j) t \quad (4)$$

$$h(ij,t) = (\rho(i,j) + \Lambda(i,j) t) \sqrt{h(i,t)} \sqrt{h(j,t)} \quad (5)$$

Equations (1) and (2) are the return equations:  $R(i,t)$  ( $R(j,t)$ ) denotes firm  $i$  ( $j$ ) returns,  $a(i)$  ( $a(j)$ ) denotes the unconditional mean of firm  $i$  ( $j$ ) return, and  $e(i)$  ( $e(j)$ ) is the innovation, or the unexpected return, of firm  $i$  ( $j$ ). Innovations are assumed to be normal with mean 0 and 2x2 covariance matrix  $H(t)$ . The diagonal elements of  $H(t)$  are the variances of firm  $i$  and  $j$  returns, denoted by  $h(i,t)$  and  $h(j,t)$  respectively. The off-diagonal elements of  $H(t)$ , denoted by  $h(ij,t)$ , are the covariances of firm  $i$  and  $j$  returns. Equations (3) and (4) are the variance equations, where we added a trend term to capture potential time variation in conditional variances. Equation (5) is the correlation equation augmented with a time trend. Under the null hypothesis that the correlation between stock returns of firms  $i$  and  $j$  is constant, the coefficient associated with the time trend in the correlation equation, denoted with  $\Lambda(i,j)$ , should not be significantly different from zero.<sup>14</sup>

Panel B summarizes the results of this test by giving the total number of correlation time trend coefficients that are estimated to be statistically positive at the 5 percent level (column 2), the percent of all coefficients in a given group that are significantly positive (column 3), and the percent of coefficients in a given group that are statistically significant and negative (column 4). Looking at the row for all LCBOs, it is clear that positive coefficients are very common, with 47 percent estimated to be statistically positive, and only three percent (6 out of 231) negative. Dividing the coefficients by peer groups, the dominance of the positive time trend is evident for all but

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<sup>14</sup> As is standard, the model was estimated using the maximum of the conditional log-likelihood using the BHHH algorithm.

the Active Trading **firms**, where only 30 percent of the coefficients are estimated to be positive. Among the largest group, the Traditional Intermediaries, 93 percent of the time trend coefficients are significantly positive. Over 50 percent of the estimated time trends at inter-group combinations are significantly positive at half of the ten combinations of groups. As in panel A, the positive time trends are concentrated at the relatively less complex inter-group combinations, but not exclusively so. In addition, significantly negative time trends are quite rare, ranging from three to ten percent of coefficients at only three of the ten combinations of groups.

Overall, the results in this section strongly suggest that there was a significant positive trend in stock return correlations among the sample LCBOs during the 1990s. In addition, this trend was especially evident within and between the groups of relatively less complex financial institutions. Thus, given our maintained assumption regarding the interpretation of stock return correlations, the evidence is consistent with the view that the potential for economic shocks to become agents of **systemic** risk in the financial sector appears to have increased over the last decade.

### III. **Trends in Consolidation**

The first part of this section defines our measure of consolidation at the sample LCBOs. The second describes the evolution of this measure over the 1990s.

#### A. **Variable definition**

We measure consolidation as the change in an institution's, or pair of institution's, market share. Market share is defined, in turn, by the ratio of an institution's (or pair of institution's) total assets to total assets in the US. banking system. Total assets in the U.S. banking system are computed as the sum of total consolidated assets at bank holding

companies plus total assets at independent banks's This straightforward measure has considerable intuitive appeal, although it ignores off-balance sheet activities. However, because the primary goal is to create a variable that captures important consolidation events within the sample LCBOs, this deficiency does not appear to merit serious concern. Indeed, inspection of the data for the 22 sample LCBOs indicates that any completed major acquisition recorded by the federal banking agencies is matched by a jump at the same date in an acquirer's market share.

### **B. Trends in consolidation**

Charts 3 and 4 present two ways of describing consolidation activity at the sample LCBOs from 1988 **through** 1999. Chart 3 gives the (quarterly) evolution of market shares aggregated at the 22 LCBOs' level, and aggregated within each of the five peer groups. In each of the peer group figures, the aggregated LCBO market shares are also provided by a dashed line with their scale given on the right hand side of the figure. In each figure, group shares are calculated by weighting each individual institution's share by its total assets. Chart 4 provides the percentage changes in the market shares shown in Chart 3. As in Chart 3, aggregated LCBO figures are given by dashed lines and may be read on the right hand scale.

Chart 3 shows that the aggregate market share of the sample LCBOs increased steadily and substantially over the sample period, rising from 34 percent in 1988Q1 to 69 percent at the end of 1999, after peaking at 73 percent in 1998Q4 and 1999Q1. Active Trading, Cusp, and Traditional Intermediaries determined the overall trend.

Consolidation activities at Second Tier firms were muted until 1998, and Trust and Custody institutions experienced a burst of activity early in the period that moderated

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<sup>15</sup> Total **assets** data were acquired from holding company "Y9" and bank "call" reports submitted to the federal banking agencies.

thereafter. Consolidation activity at the aggregate LCBO and the peer group levels fell off in 1999 as merger and acquisition activity waned. On balance, however, these data indicate that a substantial amount of consolidation activity occurred among the sample LCBOs during the decade of the 1990s.

This overall view is supported by the data displayed in Chart 4. As measured by quarterly percentage changes in market share, substantial activity occurred throughout the period at the aggregate LCBO level and at the Active Trading, Second Tier, Cusp, and Traditional Intermediaries. Again, Trust and Custody firms had a spurt of activity early in the period, and then essentially maintained their market share for the rest of the 1990s

#### **IV. Relating Interdependencies and Consolidation**

We examine the relationship between LCBOs' stock return correlations (interdependencies) and consolidation by estimating measures of the elasticity of return correlations with respect to LCBO market shares. We refer to this measure as the consolidation elasticity of correlation. We begin by considering a pooled time series cross-section model estimated at annual frequency. However, due to the clear time variability of our results and the availability of higher frequency data, we also evaluate cross-section regressions estimated at weekly frequency.

Our observation unit in all models is a firm-pair. In the pooled time series **cross-section** model, for each year in our sample we compute the correlation of returns associated with a different pair of firms. Since our sample includes at most 22 firms in each year, we compute at most 231 correlations associated with a different pair of firms in each year. The stock return correlation among a pair of firms in year  $t$  is computed using weekly stock return data of the 52 weeks **preceeding** the last week of year  $t$ . The market share of a firm pair is the sum of the market share of each firm in the pair at the end of year  $t$ .

Our “basic” estimating equation is:

$$\text{Ln}(\rho(k,t)) = \alpha(t) + \beta \text{Ln}(X(k,t-1)) + \gamma \text{Ln}(\rho(k,t-1)) + \varepsilon(k,t) \quad (6)$$

The **correlation** of any firm-pair  $k$  in year  $t$  is denoted by  $\rho(k,t)$ . The variable  $X(k,t-1)$  is the sum of market shares of the two firms in firm-pair  $k$  in year  $(t-1)$ . Time fixed-effects are indicated by the vector  $\alpha(t)$ , which includes time dummies assuming the value of unity for year  $t$  and zero otherwise, with  $\alpha'$  denoting the transpose of the relevant coefficient vector. Time fixed-effects are introduced to control even at the annual level for the substantial time variation of correlations documented in section II. The lagged value of the correlation is included as an approximate control for other factors that may determine current correlation.

The coefficient  $\beta$  estimates the consolidation elasticity of correlation. Specifically, it estimates the percentage change in stock return correlation associated with a lagged percentage change in the market share of a firm-pair. The specification of a lag for the consolidation variable is consistent with our assumption that consolidation may be a causal factor in the increased correlation of returns documented in section II.

Table 2 presents estimates of equation (6) in which all firm-pairs are pooled (panel A) and in which we allow for different consolidation elasticities within groups and between groups (panel B). To save space, time fixed-effects coefficients are not reported. Looking first at panel A, the estimated consolidation elasticity is 0.11 and is significantly different from zero. Thus, a 10 percent increase in firm-pair market shares implies a 1.1 percent increase in correlation. Put differently, during the 1988-1999 period an increase in consolidation is estimated to have contributed to an increase in **LCBOs'** interdependencies, as measured by the correlations of their stock returns.

Turning to panel B, both consolidation elasticities are significantly **positive**, and the fact that the estimated consolidation elasticity for between-group correlation is 0.12,

whereas that estimated for within-group correlation is 0.11, suggests only a small difference in the effects of consolidation across the two groups. However, a test of the statistical significance of this difference reveals that the difference is significantly different from zero at the 5 percent level. Thus, between-group consolidation appears to have had a (slightly) larger positive impact on correlation (interdependency) than did consolidation within-groups. In other words, consolidation among relatively dissimilar **firms** has tended to have a slightly huger positive impact on correlation (interdependency) among firms' returns than has consolidation among firms with more similar degrees of complexity. These results are consistent with the view that consolidation has tended to make at least some firms look more alike.

As documented in section II, time variation in correlations has been pervasive during our sample period. In addition, and as documented in section III, consolidation activity at the sample **LCBOs** has been intense during the period, but has proceeded in waves of different intensity for different peer groups. Depending upon the peer group, consolidation has been intense at the beginning of the period, sustained during the period, and intense in the last year of the period. The time variations in both correlations and consolidation activity raise the question of whether the impact of consolidation on correlations is time varying.

To test for time variation in the consolidation elasticity, we estimate cross-section regressions of equation (6) using the highest frequency time series data available to us-- weekly data for correlations and quarterly **data** on market shares. Specifically, for each of the 520 weeks running from 1990.1 to 1999.52, we estimate equation (6) using correlations computed with a 52-week rolling window, and market shares of firm pairs observed in the previous quarter (i.e. lagged 13 weeks). As in the annual regression, lagged correlation is controlled for with correlations lagged 52 weeks.



Chart 5 summarizes results for the basic (constant elasticity across all groups) cross-sectional specification of equation (6). The top panel displays the time-series of the estimated consolidation elasticity, which clearly shows substantial variation over time. It **starts** off relatively high at the beginning of the sample period, decreases between the end of the 1980s through the beginning of 1994, increases sharply during 1994-1996, and then falls off quickly crossing 0 at the beginning of 1997, and becomes negative for most of the end of the sample period.

The middle panel of chart 5 reports the time series of p-values of the t-statistic of the consolidation elasticity. The dotted line indicates the 10 percent value (0.10). so that all values below the line are significant at least at the 10 percent level. These tests confirm the time variability of the estimated elasticity. Consolidation is estimated to have significantly positive effects at the very beginning and in the middle of the sample period, but quite mixed effects are found in 1991-1993 and towards the end of the sample period. These patterns are also reflected in the time series of the R-squares of the regressions, shown in the bottom panel of chart 5, which are largest in the middle of the 1990s. Chart 6 reports elasticity estimates and relevant p-values for within-group and between-group regressions in the same format as chart 5. Overall, the panels of the chart show that the time variation of within-group and between-group consolidation elasticities is very similar.

On balance, the results presented in this section suggest several general conclusions. First, over the 1990s it appears that increases in consolidation at the sample LCBOs contributed to increases in **LCBOs'** interdependencies, increases that are both statistically and economically significant. Moreover, consolidation among relatively dissimilar firms has tended to have a slightly larger positive impact on interdependency than has consolidation among **firms** with more similar degrees of complexity. However,

the estimated consolidation elasticities clearly vary over time, and likely declined in the latter part of the decade.

#### IV. Conclusion

This study has considered two basic questions. First, has the degree of Interdependency, and by implication the degree of systemic risk potential in the **banking** system, among a sample of large and complex banking organizations changed over the 1990s? Second, has the degree of interdependency been associated with consolidation activity at the LCBOs?

With regard to the first question, the evidence is highly consistent with the view **that** there was a significant upward trend in the degree of interdependency, as measured by stock return correlations, among the sample LCBOs during the 1990s. This trend seems particularly evident within and between the groups of relatively less complex banking organizations. This suggests that the potential for economic shocks to become agents of systemic risk in the financial sector has likely increased over the last decade.

The answer to the second question is more complex. Statistical tests suggest that consolidation activity at the sample LCBOs indeed had a positive effect on the degree of interdependency. Moreover, the effect may have been slightly stronger among relatively dissimilar **firms**. However, the strength of the positive effect varies considerably over time and appears to have waned in the latter part of the 1990s. In addition, the variables considered here, including consolidation and lagged correlation, generally “explain” well under half of the variation in stock return correlations. Thus, it seems clear that factors other than consolidation are also responsible to the upward trend in stock return interdependency. Identifying what these factors are seems a fruitful topic for future research.

Another interesting topic for future research is identification of the sources of

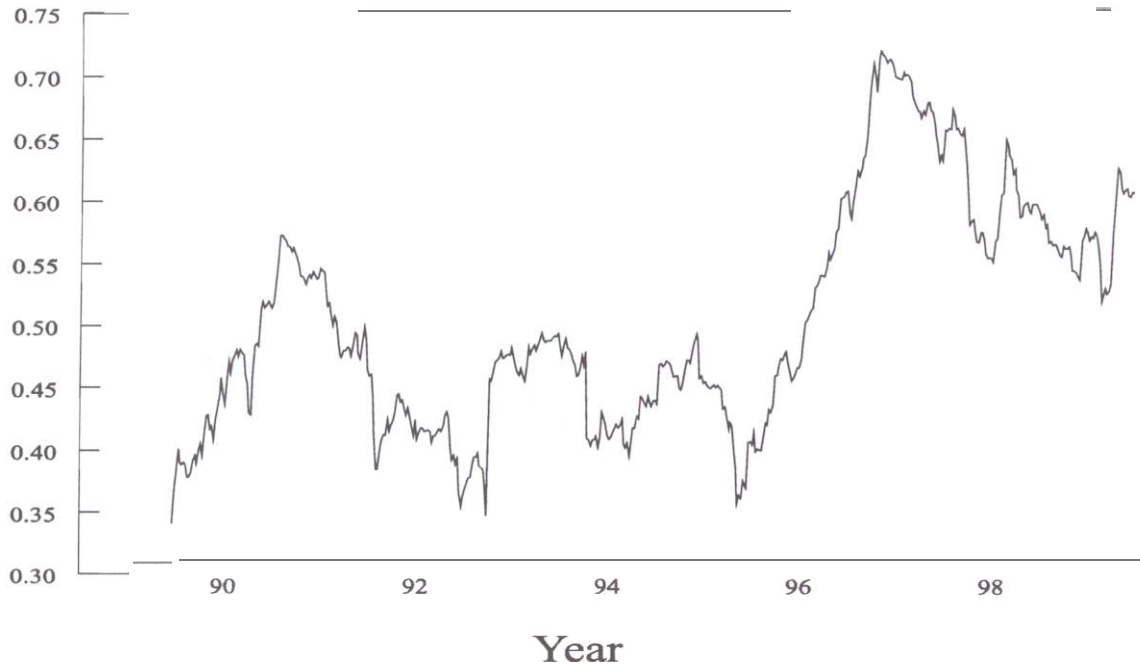
increased interdependency among **LCBOs** and the role, if any, of consolidation in creating these sources. Research conducted by the authors as part of the recently completed **G10** Report on Consolidation in the Financial Sector (2001) took some steps in this direction. As documented in that Report, it appears that LCBO direct interdependencies through short-term interbank lending and derivatives exposures increased substantially over the 1990s. In addition, direct interdependencies appear positively related to consolidation through short-term interbank lending and derivatives activities. Medium- to longer-term interbank loans did not appear either to have been associated with raised interdependency among LCBOs or to have been affected by consolidation. These results, although suggestive, deserve further investigation. In addition, we know of no studies of indirect interdependency, such as any tendency for loan portfolios to be correlated across firms.

The results of this study reinforce the view that policymakers should pay close attention to the implications of the changing financial landscape for systemic risk. Some consolidation of the banking industry and the creation of large and complex financial institutions capable of competing on a global basis may have many benefits, but it appears that these developments, and others not examined here, also may create somewhat different, although not necessarily new, risks.

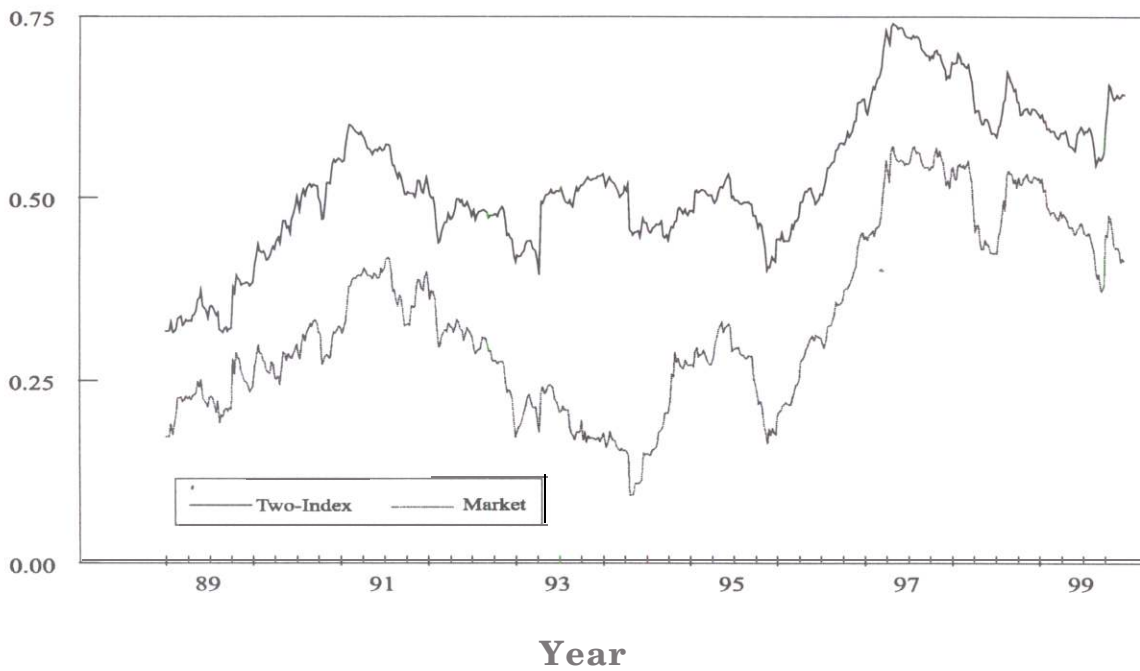
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## Charts and Tables

**Chart 1**  
**Mean of LCBO Stock Return Correlations**  
**52-week Rolling Window**



**Chart 2**  
**Two-Index and Market Model Average R2 Statistics**



**Table 1**  
**Time Trends in Stock Return Correlations**

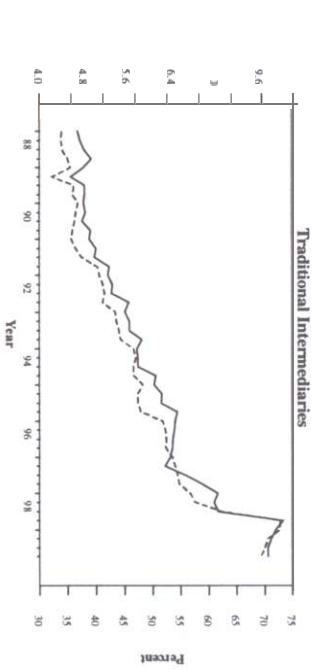
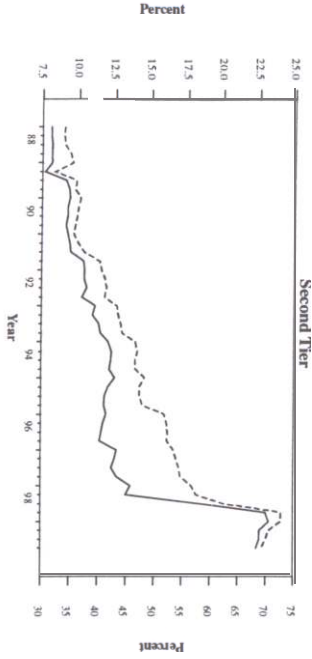
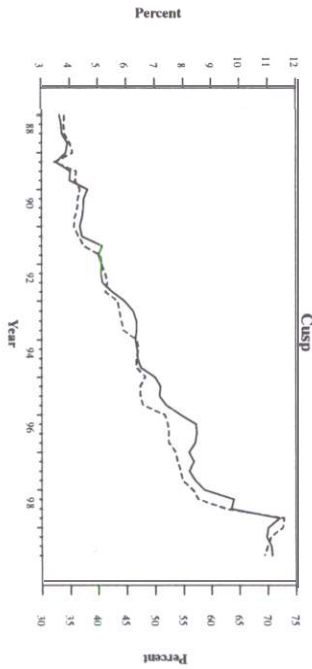
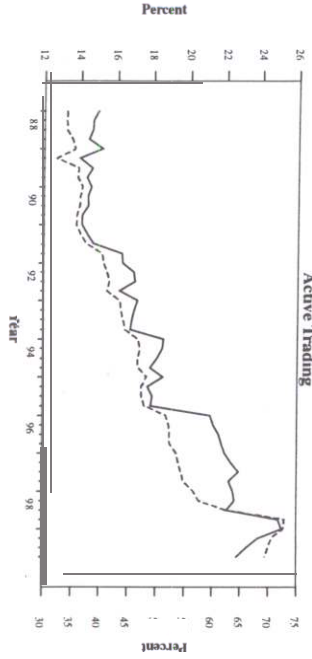
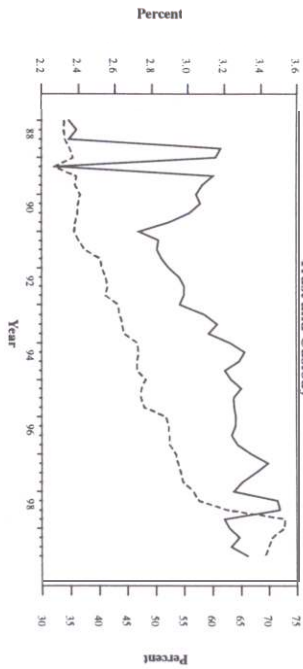
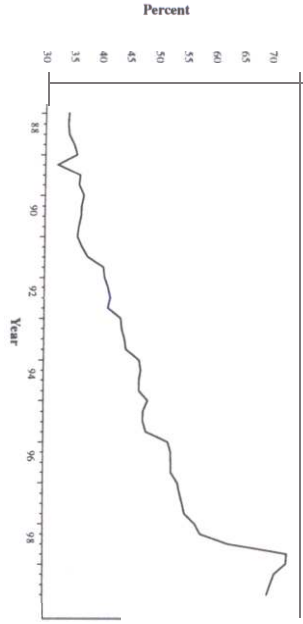
<b>A. Mean Correlations</b>	<b>(1)</b>	<b>(2)</b>	
<b>Group</b>	<b><u>Number of Correlations</u></b>	<b><u>1989-1995</u></b>	<b><u>1996-1999</u></b>
ALL LCBOs	231	0.41	0.56
Active Trading (1)	10	0.47	0.55
Second Tier (2)	3	0.49	0.48
Trust & Custody (3)	6	0.34	0.62
Cusp (4)	6	0.44	0.61
Traditional (5)	15	0.41	0.67
1-2	15	0.44	0.55
1-3	20	0.37	0.52
1-4	20	0.43	0.51
1-5	30	0.41	0.49
2-3	12	0.39	0.54
2-4	12	0.43	0.55
2-5	18	0.45	0.56
3-4	16	0.37	0.56
3-5	24	0.37	0.62
4-5	24	0.43	0.59

**B. Summary of Time Trend Coefficients**

<b>Group,</b>	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>	<b>(4)</b>
	<b><u>Number of Coefficients</u></b>	<b><u>Number of Coefficients &gt;0 at 5 Percent Confidence Level</u></b>	<b><u>Percent of Coefficients &gt;0 at 5 Percent Confidence Level</u></b>	<b><u>Percent of Coefficients &lt;0 at 5 Percent Confidence Level</u></b>
ALL LCBOs	231	109	47%	3%
Active Trading (1)	10	3	30	20
Second Tier (2)	3	2	67	0
Trust&Custody (3)	6	4	67	0
Cusp (4)	6	4	67	0
Traditional (5)	15	14	93	0
1-2	15	8	53	0
1-3	20	8	40	5
1-4	20	4	20	10
1-5	30	7	23	3
2-3	12	3	25	0
2-4	12	7	58	0
2-5	18	6	33	0
3-4	16	9	56	0
3-5	24	17	71	0
4-5	24	13	54	0

# Chart 3

## Evolution of LCBO Market Shares



# Chart 4

## Percentage Change in LCBO Market Shares

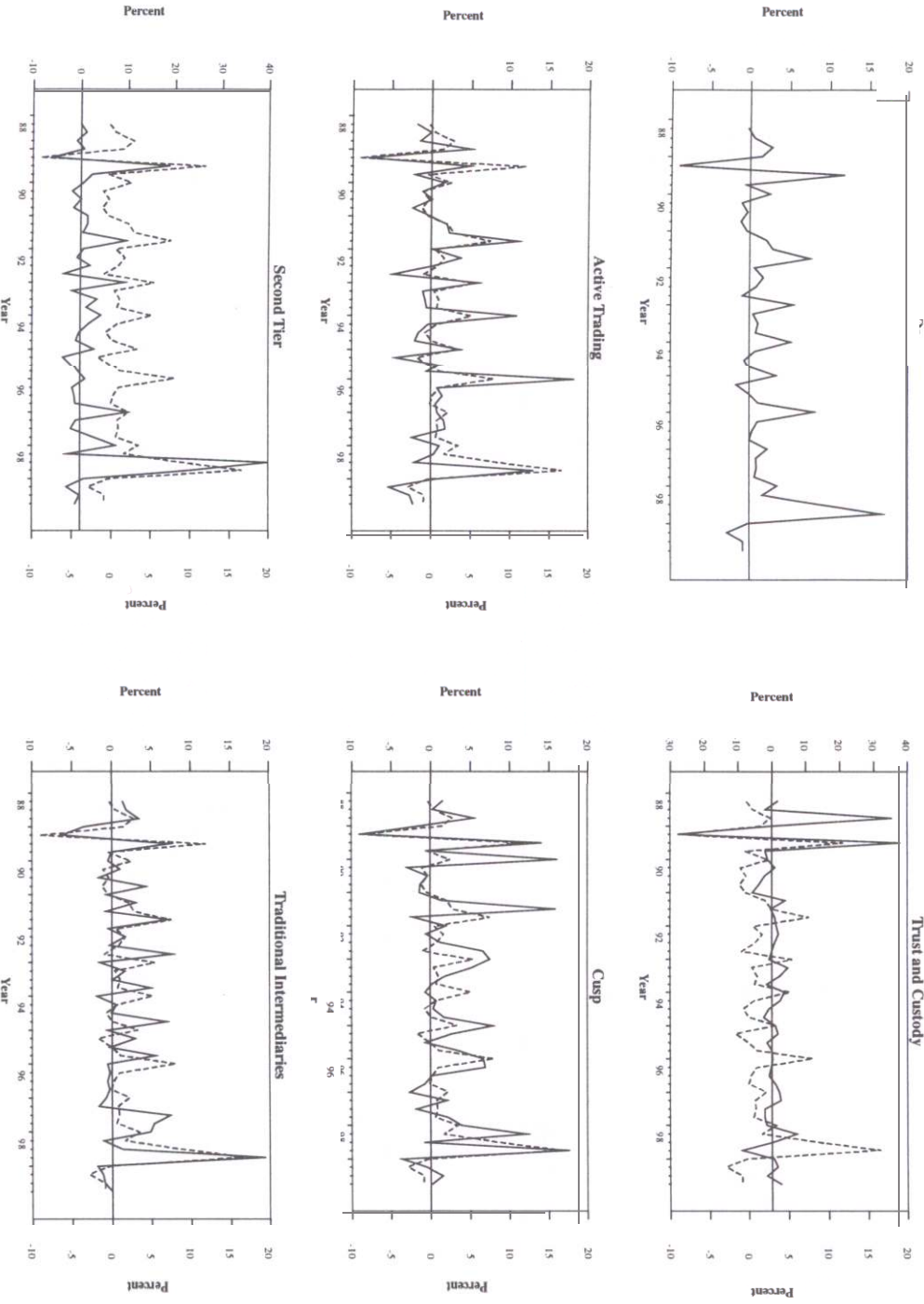




Table 2

**Estimated Consolidation Elasticities  
Pooled Time Series Cross-Section Regressions  
Fixed Time Effects**

**A. Equal within-group and between-group consolidation elasticity of correlation**

$$\text{Ln}(\rho(k,t)) = \alpha' \alpha(t) + 0.113 \text{ Ln}(X(k,t-1)) + 0.172 \text{ Ln}(\rho(k,t-1)) + \varepsilon(k,t)$$

t-stat	(6.63)	(5.19)
p-value	(0.00)	(0.00)

Adjusted R2 = 0.31

D.W.= 1.998

**B. Different within-group and between-group consolidation elasticity of correlation**

$$\text{Ln}(\rho(k,t)) = \alpha' \alpha(t) + 0.105 \overset{\textit{Within-group}}{\text{Ln}(XW(k,t-1))} + 0.118 \overset{\textit{Between-group}}{\text{Ln}(XB(k,t-1))} + 0.169 \text{ Ln}(\rho(k,t-1)) + \varepsilon(k,t)$$

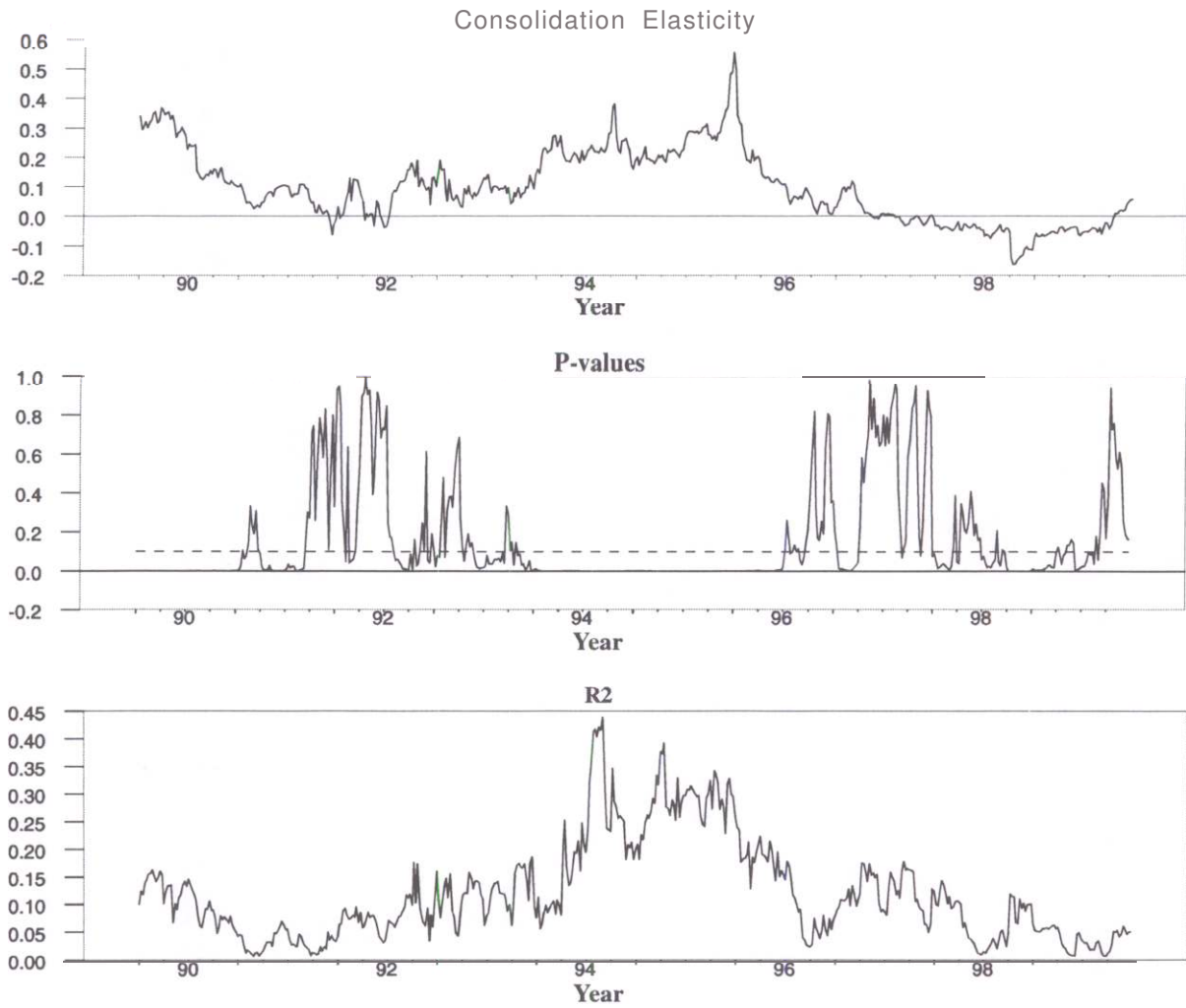
t-stat	(6.04)	(6.88)	(5.13)
p-value	(0.00)	(0.00)	(0.00)

Adjusted R2 = 0.31

D.W.=1.993

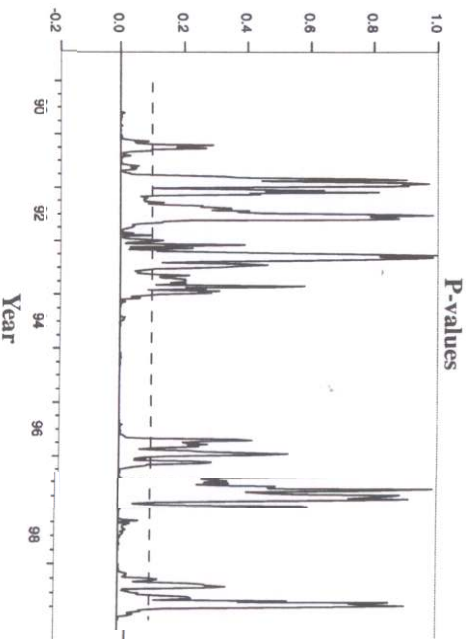
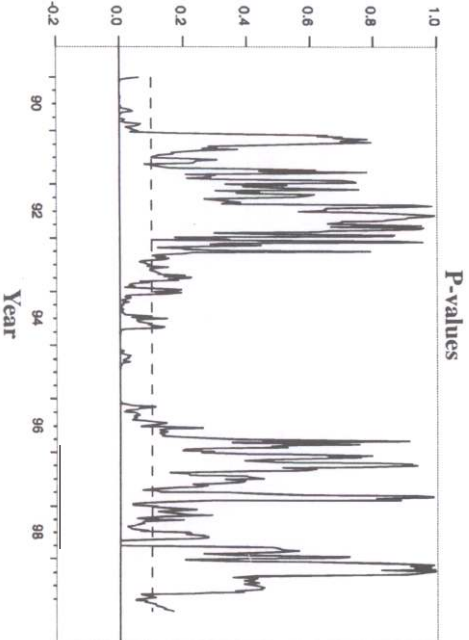
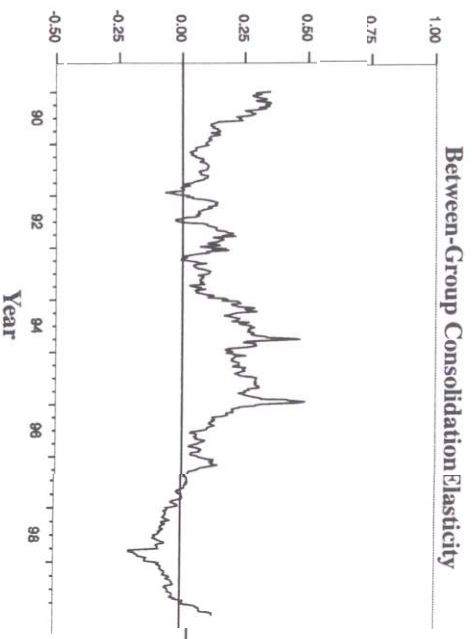
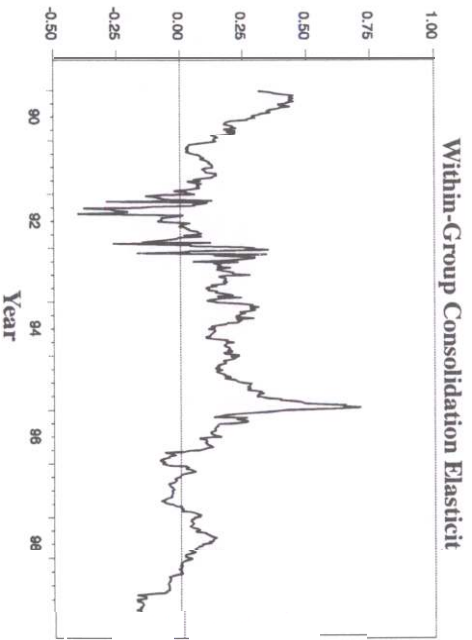
## Chart 5

### *Evolution of Consolidation Elasticity*



# Chart 6

## *Evolution of Within-Group and Between-Group Consolidation Elasticities*



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