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Banks and the World's Major Banking Centers, 2000

by
Sang Rim Choi
Daekeun Park
Adrian E. Tschoegl

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Sang Rim Choi
Department of Management
School of Business
Hanyang University
Seoul, Republic of Korea
Email: srchoi@hanyang.ac.kr

Daekeun Park
Department of Economics
Hanyang University
Seoul, Republic of Korea
Email: parkdk@hanyang.ac.kr

Adrian E. Tschoegl*
Senior Fellow, Dept. of Management
The Wharton School of the University of Pennsylvania
Philadelphia, PA 19104-6370
Email: tschoegl@alum.mit.edu

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Banks and the World's Major Banking Centers, 2000

Abstract

We update two earlier articles on the determinants of interpenetration of financial centers by banks. We add the year 2000 to analyses for 1970, 1980 and 1990, which enables us to document and analyze the substantial changes that have occurred between 1990 and 2000. First, the number of banks and the number of offices in other centers has fallen by over 20% since 1990. Second, despite this aggregate interconnectedness has held steady between 1990 and 2000, though there is an increasing asymmetry. Third, Tokyo has lost rank as a center while Hong Kong and Singapore have continued to gain importance. Fourth, Frankfurt, rather than gaining importance with the advent of the €uro has apparently lost importance. Lastly, some explicit or implicit agreements between banks from different countries not to compete in each other's markets have continued to wane though intra-European interpenetration remains relatively low.

Banks and the World's Major Banking Centers, 2000

Contents: I. Introduction. - II. Data. - III. The Degree of Interconnectedness. - IV. The Determinants of Interpenetration. - V. Results: Variables. - VI. Results: Centers as Sources and Destinations. - VII. Summary and Conclusion.

I. Introduction

This update of the articles by Choi *et al*., (1986) and Choi *et al*., (1996) on the determinants of interpenetration of financial centers by banks reveals that after some 30 years of growth in the number of foreign banks in major financial centers (Schenk 2002), the number is now dropping. This is clearly visible in Figure 1, which graphs the number of foreign banks in London, New York and Tokyo. Reasons include mergers among large banks that enable the banks to consolidate their operations in particular centers and the ongoing weakness of the Japanese economy that has resulted in bank consolidation, retreat from abroad, and poor prospects for profitability for foreign banks in Tokyo.

As Focarelli and Pozzolo (2001) and Buch and Delong (2001) show, much of the consolidation in banking is taking place within countries, rather than across countries. This reduces the number of banks with a headquarters in one of our centers via two mechanisms. First, often the merging banks are headquartered in the same city. For instance, Chase Manhattan Bank, Manufacturers Hanover and Chemical Bank were all headquartered in New York and were all part of the data in the previous papers. Two mergers in the 1990s resulted in the three becoming one bank. Second, sometimes a merger results in a shift of the headquarters out of one of our centers. In 2000, Royal

Bank of Scotland, with its headquarters in Edinburgh, acquired National Westminster Bank, which had its headquarters in London.

Adding an analysis of the data for the year 2000 to the analyses for 1970, 1980 and 1990 enables us to continue to track the evolution of the centers and the behavior of the banks that come from these centers. The replication of the earlier work by essentially the same researchers using the same methods and models provides a consistency that makes comparison of the results over time more meaningful. The exercise is worthwhile because scholarly interest in financial centers continues unabated.

Tschoegl's (2000) review of the literature covers much of what has appeared until the late 1990s. However, new articles continue to appear. Recently Gehrig (2000) has applied theoretical modeling to the area to formalize the intuition of the extant qualitative and inductive accounts. Deida and Fattouh (2000) develop a theoretical model of the emergence and growth of financial centers that they test on data for Hong Kong. The key element in their study is a center's ability to offer foreign investors a higher return on their savings than they can achieve in their home markets due to economies of scale in financial intermediation. Fattouh (2000) argues that banks locate in a center to gain access to the center's financial markets and to benefit from the various externalities that the center generates such as access to more liquid inter-bank markets, specialized intermediate inputs, and a highly skilled labor force. Grote, Lo and Harrschar-Ehrnborg (2002) examine the value chain for three different financial services (advisory, lending and trading), and argue that the new information and communication technologies may result in new spatial configurations of activities.

II. Data

We define interpenetration as the exchange of organizational presence. We begin by updating the matrices in Choi *et al.*, (1986) and Choi *et al*., (1996) for the year 2000. We use the same fourteen centers: London (LO), New York (NY), Paris (PA), Frankfurt/Hamburg (FH), Tokyo (TO), Singapore (SI), Hong Kong (HK), Los Angeles/San Francisco (LS), Zurich/Geneva (ZG), Amsterdam (AM), Brussels (BR), Panama (PN), Milan/Rome (MR) and Toronto/Montreal (TM). These centers then are the basis for a To/From (henceforth TOFROM) matrix (Table 1). The diagonal elements (Y_{ii}; i = 1...14) are the number of banks in the world's Top 300 (The Banker) with headquarters in the respective centers. Panama has no bank in the Top 300 so we used the largest bank. The off-diagonal elements (Y_{ij}; $i \neq j$) enumerate the number of banks from one center (center i) that have a presence (representative office, agency, branch, subsidiary or Edge Act subsidiary) in the other center (center j). We do not distinguish between representative offices, agencies, branches or subsidiaries but merely enumerate a presence, regardless of legal form, though we fully recognize that the different forms represent commitments to different product markets (Heinkel and Levi 1992).

Table 2 presents the ranks of each center for 1970, 1980, 1990 and 2000. The basis for the ranking is the sum of the columns in Table 1. The rank reflects how many banks of those in the sample have representation in the center in question. We also measure the "centrality" of each center, which we calculate by the proportion of centers that have at least one of their banks with representation in the center in question. Centrality takes on a value of 1 (i.e., 13/13) if all other centers have representation in the center in question, and 0 if none do (i.e., 0/13).

We may see that for 2000, NY is again first and London second. Obviously this contradicts the evidence in Figure 1; clearly London is better at drawing banks from outside our 14 centers and from below the Top 300 than is New York. Tokyo has dropped noticeably from third to fifth place, its poorest showing since 1970. With Japan having endured a waterlogged economy for over a decade, many banks have found too little business in Tokyo to warrant their remaining there. By contrast, Hong Kong and Singapore have continued the climb that was already visible in 1990. What our data cannot capture, however, is the rising importance of Shanghai as a center for China, or the increasing role of other national centers such as Seoul, Taipei and Kuala Lumpur. Most importantly, Shanghai may well return to the primacy over Hong Kong that it enjoyed between the World Wars, at least with respect to the presence of banks. (Shanghai still suffers from extensive restrictions on the banks' activities, exchange controls and political risk. Thus Hong Kong will continue to see considerable business being transacted.)

What continues to make New York the most central of our centers is the presence of a branch of the Banco Nacional de Panama. London's centrality remained unchanged at 0.92 relative to its value in 1990, and Los Angeles-San Francisco rose sharply to the same level. This may reflect the fact that California would rank as the world's fifth largest economy, if it were a separate nation. Most of the other centers lost centrality. This last is a consequence of banks retreating from unprofitable centers. What is perhaps most striking is the fall in Frankfurt's centrality; Frankfurt is the only one of the 14 centers to have a lower centrality in 2000 than it had in 1970. This has occurred despite the arrival of the €uro and the choice of Frankfurt as the home for the European Central

Bank. Interestingly, Panama has retained its centrality, suggesting that Miami is not yet a perfect substitute as a center for Central America and Northern South America.

III. Interconnectedness

Clearly, the amount of interconnectedness increased substantially between 1970 and 1980, only slightly between 1980 and 1990, and has fallen slightly between 1990 and 2000. The number of banks represented in the TOFROM matrix fell 24% from 100 in 1990 to 76 in 2000 and the sum of the off-diagonal cells fell 22% from 491 in 1990 to 381 in 2000 (Table 3). However, the average number of links per bank increased marginally from 4.9 in 1990 to 5.0 in 2000. As a result, the density of the matrix increased very slightly.

Although the proportion of one-way links has not changed since 1990, the proportion of two-way links has fallen to below the level pertaining in 1970. As a result the ratio of actual to potential links has eased slightly.

Lastly, the 2000 TOFROM matrix reflects extensive changes at the level of individual cells. The sum of the squared cell-by-cell differences between the 1980 and 1970 matrices the total is 1365. The sum of the squared differences between the 1990 and the 1980 matrices is 613. The sum of the squared differences between the 2000 and the 1990 matrices is 1280. The 1990-2000 period thus was more turbulent than the 1980-1990 period, though slightly less turbulent than the 1970-1980 period. However, in the 1970-80 period the turbulence derived from expansion whereas in the 1990-2000 period it derived from contraction. Most of this contraction came from the banks in two centers: Tokyo and NY.

The FROM Tokyo row of the matrix accounts for 46% of the sum of squared differences and the FROM NY row accounts for 28%. In both cases the differences include declines in the number of banks headquartered in the two cities as well as consolidation of presence abroad. The number of banks headquartered in Tokyo fell 30% from 20 in 1990 to 14 in 2000. For New York the corresponding numbers are eight and four, for a 50% reduction. The number of presences in other centers declined 56% and 57% for Tokyo and New York. The largest percentage decline in presences abroad, however, involves Los Angeles-San Francisco. In 1998, Nations Bank, headquartered in Charlotte, North Carolina, acquired Bank of America, which had its headquarters in San Francisco. This removed Bank of America and its extensive network of overseas offices from our matrix. At the same time, Wells Fargo Bank, also cut back its offices abroad, preferring instead to work through an alliance with HSBC.

What all this suggests is a hypothesis of an increasing asymmetry. Each of the surviving largest banks, which tend to come from the larger countries and to be headquartered in the larger centers, may have slightly extended its penetration or equivalently further filled out its network, though as a group they are less numerous than in the past. At the same time, the smaller banks, which tend to come from the smaller countries and the smaller centers may have rationalized their presence abroad.

In terms of declines in the number of presences of foreign banks, the largest declines were in Frankfurt-Hamburg (50%), Toronto-Montreal (50%), Paris (49%), Tokyo (42%), London (40%), Milan-Rome (38%) and Zurich-Geneva (38%). This list includes both what were or are top-tier centers, i.e., Tokyo and London, and centers that are redundant in the sense that a bank with a presence in any one of them or in a nearby center could serve its clients from there. Thus a bank can service Canada from New York, or any of the European centers from London, or any other center in the €uro zone.

IV. The Determinants of Interpenetration

The underlying structure of the models we use is that of the gravity model of international trade in goods. Deardorff (1998, 12) has argued that, "any plausible model of trade would yield something very like the gravity equation, whose empirical success is therefore not evidence of anything, but just a fact of life." More recently, Evenett and Keller (2002) have shown that the modeling accuracy of gravity models exceeds that attributable to Heckscher-Ohlin and Riccardian theories. Our models are also consistent with micro-economic approaches to foreign direct investment in banking. There the underlying model is a profit function with banks establishing themselves in foreign locations when it is profitable to do so. Lastly, our models incorporate considerations of rivalry between and collusion among firms as factors in the foreign direct investment decision.

Statistical techniques and the dependent variable

As in the two earlier studies we use both ordinary least squares (OLS) and non-linear weighted least squares (NLWLS). For the OLS regressions the dependent variable is the Box-Cox (1964) transform of Y_{ij} with $\lambda_1 = 0$ and $\lambda_2 = 0.5$. We use two techniques (OLS and NLWLS) with different assumptions and estimation methods to check that our results are not sensitive to our choice of method. For fuller descriptions of the models, variables and estimation techniques we use we refer the reader to the earlier articles.

Centers as destinations

We use two variables—$\underline{TO}$ and CGNP—to operationalize the attractiveness of the destination centers. $\underline{TO}_j = \underline{Y}_{.j} - \underline{Y}_{ij}$; the variable measures the number of banks from centers *other than i* that are in j. The logic behind $\underline{TO}$ is that the number of banks in a center is a signal both of the demand for bank services there and of the center's attractiveness as an interbank market. In the estimation of Model III, the elements of $\underline{TO}$ are the fitted values based on a first pass regression of Y_{ij} on the exogenous variables. We used this two-stage approach to reduce any simultaneity problems. We calculate $CGNP_i$, the GNP of center i, by multiplying the population of the city or city-pair by the national GNP per capita in US dollars. The variable also proxies for investment and trade flows between the areas the centers serve. Like lagged dependent variables in time series regressions, $\underline{TO}$ adds more to statistical fit than to economic explanation. It subsumes the effects of legal and regulatory regimes, the size of the economic area, agglomeration effects, and so forth. CGNP has more economic content but provides too narrow an explanation. Because both variables have their limitations we use them as alternatives.

Centers as sources

FROM represents the capacity of the banks headquartered in a source center to establish offices abroad. $FROM_i = Y_{ii}$; that is, we draw the elements of the variable from the main diagonal of our TOFROM matrix. Given our measures, a center cannot establish more offices in another center than the source center has banks.

Obstacles or costs and strategic considerations

The major potential obstacle in the models is the distance between centers. We measure this by $DIST_{ij}$, the airline distance between the centers. Airline distance is only roughly representative of the costs of operating far from headquarters. Still, in our case it correlates roughly with time-zone differences that complicate communications. Airline distance also correlates, arguably, with cultural distance. Furthermore, physical distance may have an indirect effect on interconnectedness in banking through its (negative) effect on trade volumes and hence on the demand for trade financing (Heinkel and Levi 1992).

JPN is a (0,1) dummy variable for those cases where Tokyo is the source center. Prior to 1982 the Ministry of Finance discouraged or at least slowed the international expansion of Japan's banks. After 1982, the Ministry of Finance progressively reduced its restrictions. Since the collapse of the bubble economy at the end of 1989, Japanese banks have been curtailing their international activities (Williams 1996; Peek and Rosengren 2000).

The first variable representing strategic behavior is $\underline{Y}_{ji}$, the reverse of the flow to $\underline{Y}_{ij}$. The variable proxies for mutual forbearance vs. actual or potential retaliation. In the estimations the elements of $\underline{Y}_{ji}$ are fitted values from a first pass regression of Y_{ij} on the exogenous variables. That is, the variable captures whether the number of banks in Center i from Center j is a function of the number of banks from j in i.

The second variable for strategic behavior is a nationality dummy for Swiss banks. Swiss banks have historically had few foreign branches and subsidiaries despite the extent of their international involvement. SWISS is a (0,1) dummy variable that takes on a value of 1 when Y_{ij} represents a flow from Zurich or Geneva to any one of the following five centers: Paris, Brussels, Amsterdam, Frankfurt/Hamburg, or Milan/Rome.

The third variable representing strategic behavior is a (0,1) dummy for intra-European pairs of centers. The variable reflects two opposing influences. First, in 1973 the EEC adopted the freedom of establishment provisions of the First Banking Coordination Directive and then in 1989 it adopted the single European banking license provisions of the Second Banking Coordination Directive. These would suggest that the coefficient for EURO should be negative in 1970, i.e., before liberalization, zero or positive in 1980 and 1990, with the coefficient being slightly larger in 1990 than 1980, and with more time having elapsed, strongly positive in 2000. However, historically, the European banks joined banking clubs that may have operated to reduce interpenetration by European banks of their partners' home markets (Ross 2002). EURO takes on a value of 1 when Y_{ij} represents a flow between any two of the following five centers: Paris, Brussels, Amsterdam, Frankfurt/Hamburg, or Milan/Rome.

The last of our variables for strategic behavior is FHZG. This is a (0,1) dummy variable that takes on a value of 1 whenever Y_{ij} represents a flow between Zurich/Geneva on the one hand and Frankfurt/Hamburg on the other. Although the Swiss banks did not join the European banking clubs, there is anecdotal evidence that they engaged in mutual forbearance pacts with the major German banks. We do not include the variable in the NLWLS regressions because including it frequently prevented convergence in the estimating algorithms in the earlier studies.

V. Results: Variables

Table 4 presents the OLS and NLWLS results for Model I (the simple gravity model) for all four years: 1970, 1980, 1990 and 2000. In both the OLS and NLWLS estimations the models are slightly weaker in 2000 than in 1990, reflecting the reduced number of banks and presences. The coefficients for TO and FROM are similar in size to each other within an estimation method. This is consistent with the symmetry assumption inherent in gravity models (Theil 1979). They are also similar in magnitude to their values in 1990. The one noticeable change is that for 2000 the coefficient of DIST is negative and large relative to its value in previous years. One probable factor is the reduced number of banks from Japan and the reduction in the number of their offices in New York and London. The coefficient may also reflect banks in general having reconsidered the value of distant offices that have little function.

Tables 5 (OLS) and 6 (NLWLS) present the results for Models II and III. Models II and III augment Model I with the explanatory variables we discussed in Section IV. The difference between the models is that Model II uses CGNP as the variable representing the attractiveness of a center and Model III uses TO.

In Models II and III for the OLS and the NLWLS estimations, the coefficients for CGNP in 2000 are similar with those for 1990. However, the magnitude of TO in 2000 is smaller. Still, the results suggest that whether we use TO or CGNP makes little difference to our overall goodness-of-fit. The coefficient of FROM appears slightly greater than in 1990, but not enough so as to mark a notable change. As in Model I, the coefficient of DIST is much larger in 2000 than in 1990, and negative.

Next we come to the variables that represent strategic factors. The first of these is JPN, the dummy for Japanese origin. This coefficient shows that before the relaxation in 1982 of what Engwall (1992) has called emigration restrictions, Japanese banks opened fewer offices abroad than what one would otherwise expect. By 1990, the year in which the "bubble economy" began to burst, the Japanese banks were over-represented. (The banks had rushed abroad in order to benefit from any opportunities arising from the need to recycle Japan's trade surplus and from their strong capital positions based on their shareholdings in companies whose shares had appreciated.) In 2000, after a decade of a waterlogged economy, the representation overseas of Japanese banks is in line with expectations. We can think of this as a "Goldilocks" outcome, with the most recent outcome being not "too cold" and not "too hot", but rather "just right."

The coefficients of $\underline{Y}_{ji}$ (the backflow variable), show a dramatic change in behavior between 1970 and 1980 on the one hand and 1990 and 2000 on the other. In 1970 and 1980 the coefficients are generally positive and statistically significant across both estimation methods. In 1990 and 2000, the coefficients are generally small, whether positive or negative. This suggests that the variable may be capturing history rather than strategic behavior. In 1970 and 1980 London and New York were both major destinations and major sources, with a number of other centers being much less important as either. By 1990, centers such as Singapore and Hong Kong had risen in importance as destinations rather than as sources. Furthermore, after 1990 Tokyo's importance as a source had grown more rapidly than its importance as a destination.

The coefficients for SWISS origin are negative across time and methods. The results are consistent with the Swiss reluctance to establish offices in continental Europe that we noted in the earlier articles. There is some sign that the magnitude of the effect has declined in 2000, but that may reflect little more than that the Swiss no longer stand out as dramatically now that other sources have cut back their overseas representation.

The coefficients for EURO, the variable for the links between the (non-Swiss) continental European banks remain negative. Because of the inconsistencies in the magnitudes of the estimated coefficients in the OLS and NLWLS estimations, one would be hard put to make a strong case that the effect is smaller in 2000 than in earlier years. This suggests that some implicit cooperation (i.e., non-aggression pacts) continues.

The coefficients of FHZG, the variable for mutual forbearance between Swiss and German banks, has turned mildly positive in 2000. As the earlier papers forecast, the détente, if any, has broken down.

VI. Results: Centers as Sources and Destinations

Table 7 compares the actual marginal totals for 2000 from Table 1 with the estimated marginal totals based on the cell frequencies from Model III. All marginal totals use only on the off-diagonal cells. The Source columns in Table 7 therefore show which centers have established more or fewer interconnections than we would expect from our models. The Destination column shows which centers have received more or fewer interconnections than we would expect from our model. The mean squared error for the difference between the actual and estimated marginal totals suggest that the model is better at accounting for sources than destinations.

As far as source centers is concerned, the model over-predicts the number of offices emanating from Hong Kong and underestimates the number emanating from

Amsterdam-Rotterdam. In 1991, HSBC relocated its headquarters from Hong Kong to London, removing from Hong Kong the headquarters its largest and most international bank. By contrast, the Netherlands is the home of ABN-AMRO Bank and ING Bank. ABN-AMRO has at its core Algemene Bank Nederland, which traces its ancestry back to 1827 and the Nederlands Handel-Maatschappij (Netherlands Trading Company), and is an extremely international bank. Though significantly newer in its international activities, ING has been expanding aggressively abroad.

That said, the only two large errors are underestimates of the number of banks coming to Singapore and Hong Kong. Both of these city-states act as financial centers for much larger catchment areas than their own size would suggest. Also, prior to the 1997-98 Asian crisis, Southeast and East Asia were fast growing areas.

VII. Summary and Conclusion

International financial centers and international banks evolve over time. Our update of Choi *et al*., (1986) and Choi *et al.,* (1996) has enabled us to support some of the earlier findings and to identify some changes both in the evolution of financial centers and in the behavior of the international banks.

First, aggregate interconnectedness has held steady or even decreased slightly between 1990 and 2000 although we had 24% fewer parent banks in our population in 2000 than in 1990. We hypothesize that what is happening is that the large banks, which tend to come from the large economies and the most important centers, are still filling out their networks slightly, while smaller banks from smaller economies and centers are rationalizing their networks, and especially their presence in remote centers.

Even if the number of foreign banks represented in each center has fallen, the depth and breadth of each foreign bank's presence may well have increased. Again, one source of the reduction in numbers of offices is mergers between the parent banks, mergers that should, *ceteris paribus*, have resulted in a combining of volumes of activities. The foreign banks could also be engaging in a wider range of activities. Unfortunately, information on the activities of foreign banks in various centers is even sparser than information on the presence of foreign banks.

Second, between 1990 and 2000, the tiering of centers that had developed earlier has become more ambiguous. London and New York remain in the top tier. However, Asia is now split between three centers—Hong Kong, Singapore and Tokyo—while the European centers have fallen into a third tier. One might conjecture that the move to the €uro may be one factor behind the European centers' loss of rank. Now, banks no longer need to have several offices in Europe to access separate money markets; instead one office within the €uro area suffices. Frankfurt, which many had expected to rise in importance as home of the European Central Bank, saw the largest decline in centrality. (The growth of several discount airlines based out of airports around London may also have served to reduce the value of offices elsewhere in Europe.) Zurich-Geneva's ability to retain its rank then may reflect not only its (albeit diminished) role as a safe haven but also its retention of an independent currency.

Third, the number of banks in a center remains a major indicator of the attractiveness of a center. The number of banks in a center reflects both the size of the market facing each bank independently of the presence or absence of other banks, and the benefits to the banks of being in a central marketplace.

Fourth, the Japanese banks are no longer under-represented abroad as they were in 1970 and 1980 due to Japanese government restrictions on their international expansion. Nor are they over-represented as they were in 1990. Now, in 2000, the need to reduce unprofitable activities has resulted in a pattern of presences in line with those of banks from elsewhere.

Fifth, any reluctance by the German and Swiss banks to penetrate each other's markets has disappeared. However, the EU Europeans in general remain under-represented in each other's markets. The Swiss still appear under-represented abroad.

Finally, the model is slightly better at estimating the number of offices a center sends out than at estimating the number of offices going to a center. That said, banks from New York, Amsterdam and Brussels have noticeably more offices abroad than the model would predict, and Hong Kong and Singapore have noticeably more offices than the model predicts.

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Figure 1

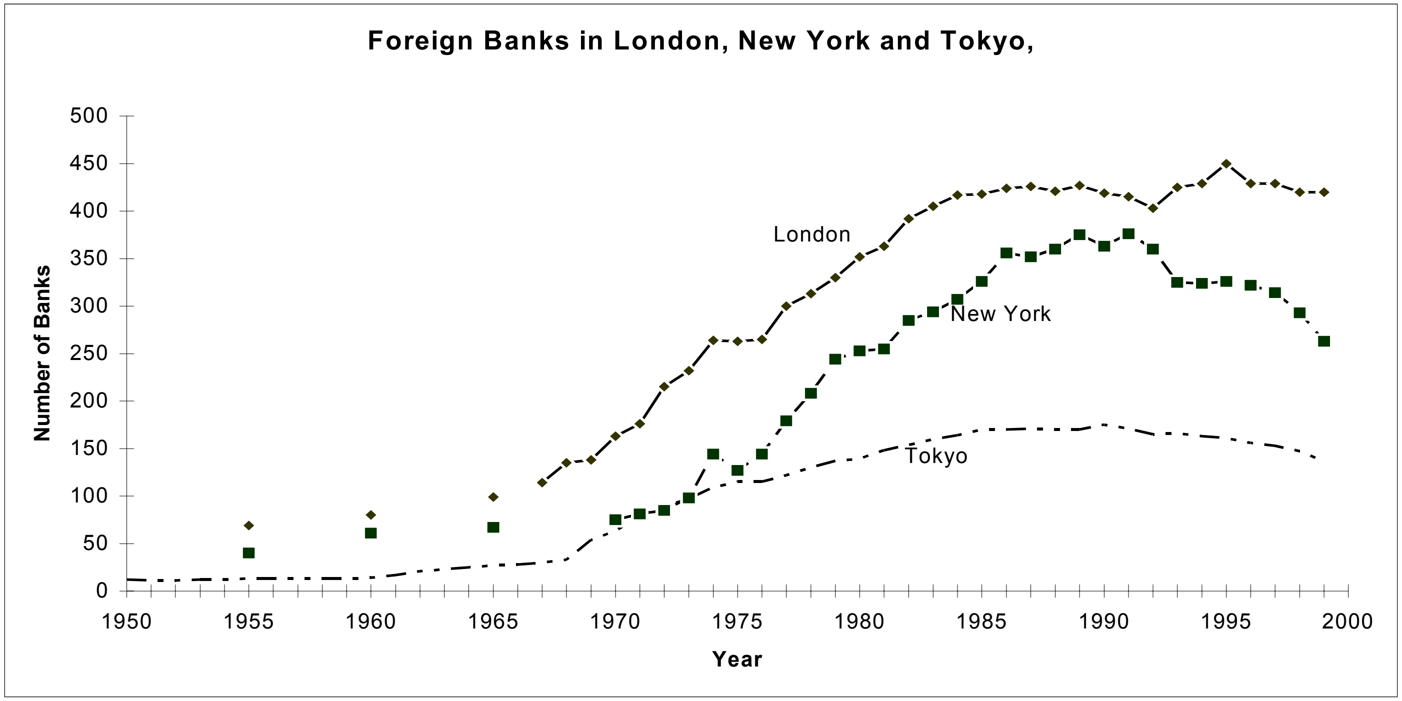
Foreign Banks in London, New York and Tokyo,
Number of Banks
500
450
400
350
300
250
200
150
100
50
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
Year
London
New York
Tokyo

Table 1 — Head-offices of major banks and their representation in other centers 2000

To: From:	LO	NY	TO	HK	SI	FH	PA	ZG	MR	LS	TM	BR	AM	PN	Σ
LO	**7**	4	4	4	3	3	2	3	2	1	2	2	3	2	42
NY	2	**4**	3	3	3	3	3	2	3	2	2	3	2	1	36
TO	9	12	**14**	9	10	2	1	5	1	3	3	3	2	1	75
HK	2	1	0	**4**	1	0	0	0	0	1	0	0	0	0	9
SI	3	1	4	5	**5**	0	0	0	0	3	0	1	0	0	22
FH	5	3	3	5	3	**9**	3	6	3	3	2	3	2	1	51
PA	4	5	4	4	5	5	**7**	4	4	3	3	4	3	2	57
ZG	2	2	2	3	3	2	3	**5**	2	2	2	0	1	1	30
MR	4	4	2	2	3	3	2	0	**5**	2	0	3	1	0	31
LS	1	1	0	0	0	0	0	0	0	**2**	0	0	0	0	4
TM	6	6	4	5	6	0	1	2	1	3	**6**	0	0	1	41
BR	2	4	1	2	3	1	3	2	3	1	0	**4**	4	0	30
AM	2	2	2	2	2	2	2	2	2	1	2	2	**3**	1	27
PN	0	1	0	0	0	0	0	0	0	0	0	0	0	**1**	2
Σ	49	50	43	48	47	30	27	31	26	27	22	25	21	11	457
Rank	2	1	5	3	4	7	8	6	10	8	12	11	13	14	

Source: *Bankers Almanac* (2000)

Table 2 — The ranking and centrality of the fourteen centers

Center	1970		1980		1990		2000	
	Rank	Cent.	Rank	Cent.	Rank	Cent.	Rank	Cent.
New York (NY)	2	0.85	1	1.00	2	1.00	1	1.00
London (LO)	1	0.77	3	0.92	1	0.92	2	0.92
Hong Kong (HK)	8	0.69	5	0.92	4	0.92	3	0.85
Singapore (SI)	11	0.69	6	0.92	5	0.92	4	0.85
Tokyo (TO)	3	0.69	2	0.92	3	0.92	5	0.77
Zurich/Geneva (ZG)	11	0.54	12	0.62	8	0.77	6	0.62
Frankfurt/Hamburg (FH)	4	0.69	4	0.69	6	0.69	7	0.62
Paris (PA)	3	0.69	7	0.77	7	0.77	8	0.69
Los Angeles/San Francisco (LS)	7	0.69	8	0.77	10	0.77	8	0.92
Milan/Rome (MR)	6	0.54	9	0.69	9	0.77	10	0.69
Brussels (BR)	10	0.54	11	0.69	12	0.62	11	0.62
Toronto/ Montreal (TM)	13	0.31	10	0.69	11	0.69	12	0.54
Amsterdam (AM)	9	0.54	13	0.62	13	0.69	13	0.62
Panama (PN)	14	0.23	14	0.62	14	0.62	14	0.62

Source: Choi *et al.,* (1986), Choi *et al.,* (1996) and Table 1.
Note: Cent. is Centrality; see text.

Table 3 — Measures of the degree of interconnectedness of the centers in 1970, 1980, 1990 and 2000

	Number of presences			Percentage of links		
	Main diagonal	Off-diagonal	Density[1] (%)	One-way	Two-way	Actual to potential
1970	102	187	1.1	78	59	60
1980	105	444	2.5	91	64	77
1990	100	491	2.9	93	65	79
2000	76	381	3.0	93	54	74

Note: The density is the ratio of the number of off-diagonal presences to the product of 168 (the number of off-diagonal cells) and the number of banks (i.e., the sum of the main diagonal). It can range in value from 0 (no bank has any off-diagonal presence) to 1 (every bank has a presence in every center).

Source: Choi *et al.,* (1986), Choi *et al.,* (1996), and Table 1.

Table 4 — OLS and NLWLS estimation of Model I

	OLS				NLWLS			
	1970	1980	1990	2000	1970	1980	1990	2000
Constant	**-2.60**	**-4.28**	**-3.60**	**-1.78**	**-4.10**	**-4.73**	**-4.87**	**-3.48**
	(-5.21)	(-8.68)	(-7.17)	(-3.68)	(-6.69)	(-9.49)	(-9.77)	(-5.88)
ln TO	**0.51**	**0.76**	**0.77**	**0.74**	**0.91**	**0.88**	**0.89**	**1.05**
	(6.28)	(7.86)	(7.69)	(6.65)	(9.63)	(14.7)	(8.62)	(6.93)
ln FROM	**0.57**	**0.76**	**0.85**	**0.88**	**0.91**	**0.99**	**1.14**	**1.15**
	(10.5)	(5.06)	(16.3)	(11.8)	(7.80)	(9.61)	(17.9)	(11.2)
ln DIST	0.05	**0.14**	0.02	**-0.17**	-0.01	0.05	**0.05**	**-0.16**
	1.15	(3.41)	(0.69)	(-4.80)	(-0.29)	(1.41)	(1.65)	(-4.23)
R^2	0.43	0.60	0.63	0.53				
F	45.4	67.1	99.2	66.7				
SER	0.71	0.64	0.61	0.61				
LR Statistic					68	258	404	186
Pseudo R^2					0.09	0.26	0.40	0.25

Note: The number of observations is 182; t-statistics are in parentheses; R^2 is the coefficient of determination; F is the F-statistic; SER is the standard error of the regression; **Bold** face indicates that the coefficient is significant at the 5% level on a one-tailed test. The LR statistic is -2ln(the ratio of the likelihood at convergence to the likelihood with all the slope coefficients set to zero) and is distributed as χ^2 with 3 degrees of freedom. The pseudo R^2 is 1 minus the ratio of the likelihood at convergence to the likelihood with all the slope coefficients set to zero.

Table 5 — OLS estimation of Models II and III								
	Model II				Model III			
	1970	1980	1990	2000	1970	1980	1990	2000
Constant	-0.11	**-1.30**	**-2.75**	**-2.33**	-1.42	**-3.20**	**-3.35**	-0.82
	(-0.19)	(-2.54)	(-3.69)	(-2.97)	(-1.10)	(-3.94)	(-4.73)	(-1.11)
ln TO					0.38	**0.62**	**0.97**	**0.49**
					(0.93)	(3.36)	(6.49)	(2.74)
ln CGNP	-0.12	**0.12**	**0.19**	**0.19**				
	(-1.02)	(2.28)	(5.11)	(4.87)				
ln FROM	**0.40**	**0.76**	**0.75**	**0.84**	**0.50**	**0.78**	**0.77**	**0.86**
	(5.43)	(12.8)	(12.1)	(9.23)	(5.84)	(13.3)	(13.0)	(8.94)
ln DIST	-0.01	0.06	**-0.10**	**-0.22**	-0.04	0.06	-0.07	**-0.16**
	(-0.15)	(0.96)	(-2.05)	(-4.21)	(-1.64)	(1.09)	(-1.51)	(-3.02)
JPN	-0.22	**-0.38**	**0.49**	-0.02	-0.15	-0.31	**0.61**	-0.13
	(-0.95)	(-1.74)	(2.35)	(-0.09)	(-0.65)	(-1.44)	(3.04)	(-0.55)
ln $\underline{Y}_{ji}$	**0.74**	**0.22**	-0.06	-0.08	-0.29	**0.18**	0.02	0.00
	(3.12)	(2.59)	(-0.75)	(-0.82)	(-1.07)	(2.34)	(0.36)	(0.04)
SWISS	-0.36	**-0.72**	**-0.80**	**-0.63**	-0.27	**-0.65**	**-0.66**	**-0.59**
	(-0.96)	(-2.18)	(-2.56)	(-1.98)	(-0.72)	(-2.00)	(-2.17)	(-1.80)
EURO	-0.21	**-0.51**	**-0.45**	**-0.18**	-0.35	**-0.46**	-0.25	-0.18
	(-0.92)	(-2.60)	(-2.46)	(-1.96)	(-1.46)	(-2.34)	(-1.42)	(-0.93)
FHZG	-0.24	**-1.11**	-0.39	0.35	-0.83	**-1.17**	-0.55	0.25
	(-0.39)	(-2.19)	(-0.81)	(0.72)	(-1.27)	(-2.35)	(-1.19)	(0.49)
R^2	0.44	0.60	0.62	0.50	0.44	0.61	0.65	0.46
F	16.7	32.3	35.6	22.0	16.7	34.2	40.2	18.4
SER	0.72	0.65	0.63	0.64	0.72	0.64	0.60	0.66

Note: The number of observations is 182; the t-statistics is in parentheses; R^2 is the coefficient of determination; F is the F-statistic; SER is the standard error of the regression; **Bold** face indicates that the coefficient is significant at the 5% level on a one-tailed test; underlining (__) of a variable's name indicates a fitted value from a first-pass regression.

Table 6 — NLWLS estimation of Models II and III

	Model II				Model III			
	1970	1980	1990	2000	1970	1980	1990	2000
Constant	**-1.79**	**-1.05**	**-3.46**	**-3.34**	**-1.62**	**-3.30**	**-4.80**	**-2.03**
	(-2.29)	(-2.25)	(-4.92)	(-3.83)	(-2.01)	(-4.12)	(-6.95)	(-2.43)
ln TO					0.55	**0.70**	**1.08**	**0.47**
					(1.05)	(3.83)	(7.39)	(2.24)
ln CGNP	-0.03	**0.14**	**0.18**	**0.18**				
	(-0.20)	(2.77)	(4.93)	(4.02)				
ln FROM	**0.70**	**0.83**	**0.93**	**1.14**	**0.79**	**0.86**	**0.98**	**1.17**
	(4.81)	(9.91)	(11.2)	(7.88)	(4.85)	(10.6)	(12.5)	(7.83)
ln DIST	0.04	-0.01	-0.06	**-0.16**	-0.02	0.00	0.00	**-0.09**
	(0.46)	(-0.24)	(-1.35)	(-2.93)	(-0.17)	(0.06)	(0.01)	(-1.71)
JPN	-0.35	**-0.28**	**0.29**	-0.16	-0.24	-0.15	**0.40**	**-0.28**
	(-1.36)	(-1.67)	(2.10)	(-0.78)	(-0.91)	(-0.96)	(3.12)	(-1.34)
ln Y_{ji}	**1.26**	**0.24**	-0.03	0.07	**0.91**	**0.15**	0.06	0.14
	(4.02)	(3.20)	(-0.36)	(0.64)	(2.47)	(1.94)	(1.15)	(1.25)
SWISS	-0.72	**-1.24**	**-1.18**	-0.17	-0.72	**-1.17**	**-0.98**	-0.16
	(-0.56)	(-2.05)	(-2.03)	(-0.94)	(-0.68)	(-1.99)	(-1.80)	(-0.87)
EURO	0.31	**-0.34**	**-0.43**	**-0.50**	0.16	-0.28	-0.13	-0.46
	(0.94)	(-1.81)	(-2.54)	(-1.36)	(0.46)	(-1.54)	(-0.78)	(-1.22)
LR Statistic	73	210	383	160	75	218	408	148
Pseudo R^2	0.10	0.21	0.38	0.22	0.10	0.22	0.40	0.20

Note: The number of observations is 182; asymptotic t-statistics are in parentheses; **Bold** face indicates that the coefficient is significant at the 5% level on a one-tailed test; underlining (__) of a variable's name indicates a fitted value from a first-pass regression. The LR statistic is -2ln(the ratio of the likelihood at convergence to the likelihood with all the slope coefficients set to zero) and is distributed as χ^2 with 7 degrees of freedom. The pseudo R^2 is 1 minus the ratio of the likelihood ratio at convergence to the likelihood ratio with all the slope coefficients set to zero.

Table 7 — Comparison of actual and estimated totals for the number of foreign banks in a center in 2000, based on the cell estimates from Model III (NLWLS)

Center	Source			Destination		
	Actual	Estimate	Error (%)	Actual	Estimate	Error (%)
New York (NY)	32	12	-63	46	26	-43
London (LO)	35	35	0	42	27	-36
Hong Kong (HK)	5	12	140	44	18	-59
Singapore (SI)	17	14	-18	42	17	-60
Tokyo (TO)	61	55	-10	29	22	-24
Zurich/Geneva (ZG)	25	16	-36	26	24	-8
Frankfurt/Hamburg (FH)	42	45	7	21	23	10
Paris (PA)	50	32	-36	20	23	15
Los Angeles/San Francisco (LS)	2	0	-100	25	19	-24
Milan/Rome (MR)	26	18	-31	21	22	5
Brussels (BR)	26	13	-50	23	20	-13
Toronto/ Montreal (TM)	35	24	-31	16	18	13
Amsterdam (AM)	24	9	-63	17	20	18
Panama (PN)	1	0	-100	10	6	-40
Mean Square Error		107			148	

Error: (Estimate – Actual)/Actual