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Abstract

This paper reports results from an analysis of the relationship between the structure of the city-to-city network of global airline passenger flows and the interstate world system. While many scholars suggest that the broader parameters of the world system structure the urban hierarchy embedded within or articulated to it, others argue that the urban hierarchy is decoupling from the world system. The analyses show that there has been some modest convergence in the distribution of power in the world city system. Moreover, they suggest that the mechanism for this convergence is the upward mobility of cities located in the semi-periphery and the east Asian region. The paper closes by considering the implication of these findings for a larger understanding of the relationship between globalisation, the structure of the world city system and its articulation with the world system.

Introduction

The role that globalisation plays in restructuring the world economy and polity is a hotly debated topic in the social sciences. While there are many debates about precisely what 'globalisation' means, many believe that the past three or four decades were a period of fundamental world-wide change (for an overview, see Dicken, 2007). During this same period, 'world cities' (Hall, 1966; Friedmann and Wolf, 1982) and 'global cities' (Sassen, 1991) increasingly attracted the attention of urban-focused social science research.

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Indeed, leading scholars argued that the new dispersion of manufacturing across the planet created a need for 'command-and-control' centres—economic globalisation leads to a system in which economic power is concentrated in a few key 'global cities', where many of the world economy's key functions are headquartered, such as highest-level financial firms and other producer services (Sassen, 1991). The top cities are followed in the hypothesised world city hierarchy by places that, while not of the same stature and global reach, are nevertheless said to connect large countries and vast regions to the rest of the world economy—key urban areas become critical nodes in broad webs of connectivity in the broader fabric of globalisation. Indeed, some even argue that "All cities today are 'world cities'" (King, 1990, p. 82; quoted in Robinson, 2002, p. 534). The picture emerging from this body of scholarship is that of a hierarchical world city system (Smith and Timberlake, 2001; Alderson and Beckfield, 2004; Taylor, 2004) that can be measured at various time points.

Social scientists working on urbanisation in relation to globalisation attempt to situate these cities both conceptually and empirically within the broad currents of the world political economy (for example, Timberlake, 1985; Smith, 1996; Knox and Taylor, 1995). One of the crucial longstanding questions in this literature is the relationship between the world city hierarchy and the larger global political economy (note the title of Knox and Taylor's influential edited book in 1995, *World Cities in a World-System*). In his seminal essay laying out 'the world city hypothesis' in 1986, John Friedman explicitly attempted to relate an urban area's position in the global urban hierarchy to its role in the world economy.

This is the key empirical question in this paper: how does the world city system 'articulate' with the larger structure of the world system and how does this articulation change as globalisation proceeds? With a few excellent exceptions (Alderson and Beckfield, 2004, 2007; and Alderson *et al.*, 2010, this issue), most scholarly studies fail to thoroughly examine this issue. In this article, we examine this changing relationship over three decades, along the same line as Alderson *et al.* (this issue), but using very different data. Other studies in this Special Issue attempt to study even longer-term historical change in world or regional urban hierarchies, that pre-dates the recent era of globalisation (Polèse and Denis-Jacob, Córdoba Ordóñez and Gago García). Our work and that of Alderson *et al.* are unique in the use of formal network analytical techniques and data over nearly three decades of time to explore the dynamism of both the world city system and world system. We draw on two sets of longitudinal network analyses—one examining the global city hierarchy gauged by international air travel flows, the other the structure of the world system based on international commodity trade, comparing these results for around 1977, 1995 and 2005.

Economic Globalisation and the World City/World System Nexus

As one of the early proponents of urban political economy, John Walton (1979, p. 164) called for the analysis of "distinctive vertically integrated processes passing through a network from the international level to the urban hinterland". So how does the world city system 'articulate' with other global networks? And how can it be conceived as a hierarchy 'nested' within broader structures of the world economy?

Recent research on the global urban hierarchy emphasises the role of globalisation in changing the saliency of cities and transnational actors *vis-à-vis* traditional units of authority like the nation-state. Indeed, one of the most important claims that some scholars make about globalisation is that it diminishes the role of nation-states as the

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basic units of analysis and key actors on the global stage (Strange, 1996; Rodrik, 1997). Castells' image of a rising 'network society' (1996) suggests that matrices of information flows are becoming much more crucial than the mosaic of places (where states were the key actors)—and he argues that "the most direct illustration" of this is the world city network (Castells, 1996, p. 415). Mittelman claims that globalisation is

> a historical transformation ... such that the locus of power gradually shifts in varying proportions above and below the territorial state (Mittelman, 2000, p. 6).

The world city literature also notes this 'loosening' of the old link between a state-centric world system and cities and their regions. Saskia Sassen (2002, p. 9) in "locating cities on global circuits", sees the multiplex cross-border links of contemporary globalisation as creating a "complex organizational architecture that cuts across borders and is both deterritorialized and concentrated in cities". Peter Taylor, on the other hand, argues that we must "recast" our analysis of the contemporary world system itself, moving city networks to the centre; contrasting "cities in networks" as "a space of flows, whereas nation-states form a territorial mosaic" (Taylor, 2004, p. 27). Even John Friedmann, who previously highlighted the close overlap between world city position and overall world system status, recently argued that there is a great deal of fluidity and dynamism in the global urban hierarchy (Friedmann, 1995). Both Sassen and Taylor imply changes in the relationship between world city development and mobility versus national economic development, suggesting that the two processes are becoming decoupled and disarticulated. Taylor (2004, p. 198) explicitly describes how more and more "former Third World cities" are becoming increasingly integrated high-level nodes in the world city network—and describes this as a conundrum that may challenge the basic "core–periphery model".

Yet, a number of scholars assert that globalisation should not alter the basic structure of the global urban hierarchy. For example, early research on 'peripheral urbanisation' (for example, Kentor, 1981) or 'dependent' cities (Smith, 1987) assumed that a locale's global economic position helped to define urban dynamics. The basic argument in the literature on dependent urbanisation was that cities are integral parts of countries that are embedded in hierarchical positions in the world system. Hence, the pattern of urban development—and by extension centrality in the world system of cities—was largely conditioned by the country's position in the world system. Even earlier, Stephan Hymer (1972), whose insights about the role of multinational corporations (MNCs) in the process of uneven development were pioneering, foresaw the new world urban hierarchy penetrating the traditional unequal power structure in the world system. He also posited a correspondence between the structure of the world city system and the division of labour in the world economy. As industrialisation spread to new production sites in developing countries, he expected that 'regional sub-capitals' would begin to take on the role of housing the day-to-day activities of the immediate managers of manufacturing there. However, at the top, "a few cities in advanced countries" would be centralised loci for the highest corporate decision-making (see Hymer, 1972, p. 114). Alderson and Beckfield (2004), drawing on Hymer's hypothesis, argue that global economic integration leads to a concentration in the distribution of power in the world city system, so dominant cities should be uniformly "located in core countries" (p. 815)—so, rather than being a motor for possible 'upward mobility' for non-core cities, globalisation entrenches the longstanding unequal world urban hierarchy.

Approaching the issue of the articulation of the world city system with the world

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system from a slightly different angle, Smith and Timberlake (1993, 1995a, 1995b) argued that the city system bolsters the structure of the world system, reproducing the world system's structure

> It is our view that the nature of [city] interrelations (e.g. frequency, strength, importance, dominance/subdominance) undergirds the structure of the world system, reproducing its hierarchy, and powerfully shaping social life in particular regions (Smith and Timberlake, 1995a, p. 81).

In other words, Smith and Timberlake predicted a similar isomorphism between the world city system and the world system, but they reversed the causal arrow from cities to countries to world system zones.

While the world cities literature is full of discussions of the articulation between the world city system and the world system, there is surprisingly little empirical research. The most rigorous treatment was that of Alderson and Beckfield (2004), which tested Hymer's arguments versus that of other world city theorists like Sassen, Friedmann and Taylor. Using a world city network based on 446 of Fortune Global 500 (2000) headquarters and their subsidiaries' relations among 3692 cities, they found a significant ordering effect of the world system positions on world cities. Cities located in semi-peripheral countries, on average, rank lower than cities located in core countries, whereas cities located in peripheral countries are much more likely to rank lower. In more recent work (2007), these authors further investigated the effect of the world system on world city restructuring between 1981 and 2000, and found a similar pattern for the ordering effect of the world system; in this Special Issue, they have extended that time-period through 2007 (which exactly corresponds to the years we study).

However, while Alderson and Beckfield's (2007) findings generally support the world city/world system 'articulation' thesis, they also leave open a number of additional questions. First, many of the results show a large difference between the coefficient for the periphery and semi-periphery, while others show that the semi-periphery has no significant deficit *vis-à-vis* the core. Because the models they estimate are dynamic—coefficients represent differences in mobility over time—these subtle findings indicate that there might be some convergence between the core and semi-periphery, but divergence between the core and periphery (see Alderson and Beckfield, 2007, pp. 30–31, tables 2.2 and 2.3).

Such a finding would not be surprising given the rationale developed by Hymer (1972). While he did foresee the 'reperipheralisation' of the underdeveloped world through the expansion of the multinational corporation, Hymer nevertheless noted that this would be coupled with the transformation of "the former centers of extraction and colonial/neocolonial administration [into] 'branch plant' cities" (Alderson and Beckfield, 2004, p. 816), or in other words that this would represent some level of upward mobility in locations where these transformations take place. In the context of air passenger flows, this upward mobility would come in two forms. First, it is widely acknowledged that industrialisation leads to per capita income increases, especially for countries with little initial industry (for example, Firebaugh, 2004, 2003). In turn, rising per capita incomes result in a greater proportion of disposable income that can be used for leisure travel (see Córdoba Ordóñez and Gago García, this issue). Secondly, air passenger flows to branch plant cities would also increase on account of bilateral business travel between headquarters and subsidiaries in 'branch plant' cities, especially as they begin to cluster in a smaller number of geographical locations. Moreover, to the extent that a manufacturing centre underwent a post-industrial transformation in a manner consistent with the development of producer services and

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other command-and-control functions, the rate of mobility would tend to be even higher as a consequence of the concomitant increase in business travel.

Like many other processes of capitalist expansion and development, it should not be surprising that this transformation would be uneven across zones of the world system and distinct geographical regions. First, a major mechanism for the expansion of the MNC for Hymer was "the diffusion of industrialization to developing countries and the creation of new centers of production outside the highly industrialized core of the world economy" (Alderson and Beckfield, 2004, p. 815) and we know that this diffusion has been fairly concentrated in semi-peripheral countries, and in east Asian semi-peripheral countries in particular (see Frank, 1998; Dicken, 2007; Mahutga, 2006). Indeed, recent accounts suggest that the east Asian region dominates the manufacturing landscape in the global South, increasing its share of Southern manufacturing value added from 44 per cent in 1980 to 58 per cent in 2000 (Lall, 2004). And previous longitudinal research on world city networks shows "the remarkable rise of East Asian cities" in this region over the final two decades of the 20th century (Smith and Timberlake, 2001, p. 1672) explicitly linking to the observation that "'globalisation' has come to the region, with a vengeance" (Smith, 2004, p. 399; see also Derudder *et al.*, , this issue, on the rising connectivity of Shanghai and Beijing). Finally, while there is no necessary link between the development of a manufacturing base and a transition to the kind of post-industrial urban centre typified in the global cities literature, there is some evidence that many of the currently prominent global cities were centres of manufacturing activity in earlier periods (Yusuf and Nabeshima, 2006). Thus, one would expect that the pattern of geographical concentration in command-and-control functions would lag behind but nonetheless conform to that of the manufacturing functions. All of this suggests that cities located in both the semi-periphery of the world system and the east Asian region should experience at least modest convergence with cities located in the core, especially in relation to cities located in the periphery.

In sum, the world cities literature is typically divided among two camps with respect to the relationship between the world city system and the world system and the issue of convergence/divergence in the world city system. Taken together, the work of Sassen, Taylor and Friedmann leads to two interrelated hypotheses. First, the world city system should converge as globalisation causes power to become more diffused from the traditional global cities to new locations. Secondly, the world city system should increasingly decouple from the world system. On the other hand, the work of Hymer (1972) converges with the older emphasis on 'cities in a world system' (Timberlake, 1985) or 'dependent urbanisation' (Smith, 1987) to anticipate divergence in the distribution of power in the world city system, which would be indicative of the concentration of world city dominance in cities located in core countries. This pattern of world city/world system articulation is broadly consistent with the findings of Alderson and Beckfield (2004). Further, we feel these perspectives should be supplemented with a third that integrates the historical record of capitalist development over the course of economic globalisation into a (re)interpretation of Hymer (1972). In short, we argue that economic globalisation can lead to a degree of convergence in the world city system, which is indicative of the rise of cities located in the semi-periphery of the world system and the east Asian region.

The remainder of this article brings empirical evidence to bear on this issue. We begin by measuring the centrality of a large sample of world cities and assessing the level and trend of inequality in the city-city distribution of this measure. Subsequently, we estimate

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time-series cross-sectional panel regression models designed to test the hypotheses developed earlier with respect to the relationship between a city's centrality and its location in the world system. We turn now to a discussion of the data and methods we use to test these hypotheses.

Data and Methods

Airline Passenger Data

In the past decade, the field of world city research has established the superiority of a relational approach over an attribute-based approach to examine a city system (for example, Short *et al.*, 1996; Smith and Timberlake, 1995b). Although relational data on cities are extremely difficult to obtain, international intercity air passenger flow data were the first city data to be analysed and are also the most widely used data for the creation of empirical world city networks (Keeling, 1995; Matsumoto, 2004; O'Connor, 2003; Rimmer, 1998; Smith and Timberlake, 1995b, 2001, 2002; Derudder and Witlox, 2008; see also Pirie, this issue; and Córdoba Ordóñez and Gago García, this issue). As Ma and Timberlake point out

> They are, in fact, infrastructure supported flows of people, one of the most important movements in globalization. People travel to do business (both formal and in the underground economy), to find employment, to engage in cultural exchanges, and for communal motives. Cities that are destinations for relatively more air passengers are likely to be more important on a number of theoretically significant dimensions than cities to which few people travel (Ma and Timberlake, 2008, pp. 25–26).

The international intercity air passenger flow data are obtained from the International Civil Aviation Organization (ICAO). These data are compiled annually (although quarterly summaries are available as well). They are estimates of the number of passengers flying to and from each international pair of cities included in the surveys. To obtain these estimates, the ICAO surveys airlines, using their reports of total revenue passengers flying between city A and city B when this city pair is served by more than one airline. We supplement these data with intranational city pair totals for geographically larger and more populous countries (for example, the US, Canada, Japan and China. These data are obtained from the respective national regulatory agencies). The data use city totals for urban centres with more than one major airport. There are a maximum of 338 city observations in these data across years. However, due to missing data on various independent variables, our final sample includes 212 (1977), 244 (1995) and 251 (2005) observations for a maximum of 707 city-years in the regression models that follow. The data allow us to produce a matrix of between-city passenger flows for each year.

When using these data, we are aware of several potential limitations (Derudder and Witlox, 2005; Zook and Brunn, 2006). First, the ICAO data calculate each leg of the trips, thus overestimating the power and importance of hubs. Secondly, they include travel such as tourism which some would contend is incidental to world city formation processes. Thirdly, they account for only international city pairs and not travel between domestic pairs. These are appropriate objections, but they do not preclude the use of these data. First, in the process of promoting 'their' cities, pro-growth local élites actively engage in efforts to make their cities hubs for all kinds of activities, including for air traffic. In important ways, becoming an airline hub is part-and-parcel of world city formation. Secondly, non-business-related travel for activities such as conventions and tourism is undoubtedly subject to many of the same forces that make some cities economically central. Place-promoting capitalists push 'their' cities as centres of the arts and culture

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and, to the extent that they are successful, are able to cater more effectively to the 'needs' of the higher-echelon business élites employed in the very producer service firms located in global cities. In other words, the fact that our data include leisure travel is a strength rather than a weakness, and provides a complementary perspective to those provided elsewhere (for example, Alderson and Beckfield, 2004; the work of Taylor and associates, such as Taylor *et al*., 2002). Indeed, our hypothesis—that semi-peripheral manufacturing sub-capitals should enjoy rising income and therefore leisure and business travel—is entirely consistent with this feature of our data. With respect to the third limitation, we note that the only potential consequence is that some cities would appear more central than they really are, but that this does not seem to be an issue because previous studies that produce hierarchies using the ICAO data generate descriptions of the world city hierarchy that are comparable with other estimation procedures, such as the firm-based hierarchy produced by Peter Taylor and his associates with the Globalisation and World Cities Research Network.[1] Moreover, the ICAO data are the only longitudinal data available that allow us to examine changes in the world city system over more than three decades.

Dependent Variable: Eigenvector Centrality in the Air Passenger Network

While there are many measures of centrality to choose from in the networks canon (see for example, Freeman, 1979), some of them are much better approximations of power and the overall position in a network than others. Some of the more common measures, such as degree centrality—or in-degree and out-degree centrality in the case of asymmetrical networks—are simply counts of the number of adjacent nodes or sums of the weighted ties. These measures of centrality, while elegant, do not really capture the overall position of an actor in the whole network. Consider the case of a dichotomous asymmetrical graph in which actor *i* had relations with *n*–1 others (maximum in- or out-degree centrality), but these others only had relations with *i*. Actor *i* is certainly powerful *vis-à-vis* those s/he is connected to, but is probably less powerful than an actor who is even moderately connected to the other major players in the network. Indeed, the global city literature's depiction of 'global cityness' is based on the notion that these cities function as 'command-and-control' centres and envisions a world city hierarchy in which central cities are heavily tied to each other and to geographically proximate regional 'sub-capitals' (for example, Derudder *et al*., 2003). In other words, the high level of travel between London, Tokyo and New York, as well as between the former and their regional sub-capitals, is part-and-parcel of their power and prominence (Alderson and Beckfield, 2004; Sassen, 1991). Hence, we use eigenvector centrality as our measure of centrality as shown in equation (1) (Bonacich, 1972). In equation (1), *a* is the presence/absence or size of the tie between *i* and *j*, depending on the underlying relation; *x* is the centrality of *j*. Given that *i* is the focal node, this formula weights the presence/absence or value of each tie by the centrality of the focal actor's partner. In the case of our data, a_{ij} is the number of passengers travelling between cities *i* and *j* in a given year

$$c_i = \sum_{j=1}^{n} a_{ij} x_j \tag{1}$$

Conceptually, eigenvector centrality simply weights an actor's degree centrality proportional to that of its neighbourhood so that cities that are strongly tied to other central cities are proportionally more central than those which are tied to less central cities.

We calculate centrality with equation (1) on each city network in 1977, 1995 and 2005. These values are then normalised by dividing each by the maximum eigenvector centrality

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and expressing this ratio as a percentage. One potential drawback to eigenvector centrality is that it is only valid in the context of symmetrical data. In cases where asymmetry is an important component of a data matrix, forcing symmetry loses a significant amount of information and can distort characterisations of the network. However, when networks are symmetrical or virtually symmetrical, they are equally well summarised with information from patterns of relations in the rows or the columns, since that information is largely redundant. The airline passenger flow data are highly symmetrical, with correlations between in-degree and out-degree at 0.999 ($p < 0.001$).[2]

Independent Variables

World system position. Given our empirical focus on assessing the extent to which the world system has decoupled from the world system of cities, our main independent variable is a measure of world system role and position. While one of the more frequently used measures of position is that of Snyder and Kick (1979) that was updated by Bollen (1983) and Bollen and Appold (1993)—the SKBA trichotomy—we feel this measure suffers from several weaknesses. First, the data underlying its calculation are at this point quite dated—many were collected in the early to late 1960s. Secondly, many of the types of data used to estimate the positions were debatable in terms of their inclusion into the overall measure.[3] Thirdly, the network analytical strategy they used—CONCOR—has been shown to give artifactual solutions that are inconsistent with the notion of role and position (Faust, 1988). Finally, while the latter part of the 20th century was quite dynamic in terms of upward mobility for *at least* a select group of countries (for example, Clark and Beckfield, 2009; Mahutga, 2006), the trichotomy is time invariant and is therefore likely to understate the level of coupling between the world system and the world city system over time.

As a means of estimating the effect of a dynamic core–periphery structure, we use a measure of world system position that extends the work of Nemeth and Smith (1985), Smith and White (1992) and Mahutga (2006), which includes both a large number of cases and multiple time-periods: 1965, 1980, 2000 (Mahutga and Smith, 2009). The approach quantifies the world system position of countries by estimating the degree of regular equivalence between each country pair in terms of their patterns of international trade on 15 commodity categories in the above-mentioned years and then constructing a block model of group memberships in which the within-group similarity in regular equivalence is maximised. Ultimately, world system position is operationalised as categorical dummy variables for core, semi-periphery and periphery countries. Each city is coded either 0 or 1 for each world system zone dummy variable, depending on which world system zone their country occupies in a given year. We used the 1965 world system measure to classify cities measured in 1977, the 1980 classification for cities measured in 1995 and the 2000 classification for cities measured in 2005.

UN region. Regions (United Nation's classification)—Europe, Latin America, Northern America, Oceania Asia and Africa—are represented by dummy variables, using either Asia or Europe as the baseline.

City population. City-level population data are obtained from the United Nations Population Division (United Nations, 2008). The published world urbanisation prospect data in 2007 only include cities larger than 750 000. The Population Division further supplemented data for smaller cities that are in our sample. The data are projected using the last 2–3 empirical data points (usually censuses). In sum, we have contemporaneous

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city-level population estimates for the years 1977, 1995 and 2005. These values were logged with the base 10 logarithm to reduce skew. Zero-order correlations appear in Table A1 in the Appendix.

Methods: Time-series Cross-section Regression Analyses

We use two versions of time-series cross-section regression analysis in the models we estimate. Time-series cross-section regression models are appropriate when observations are pooled over time, with each unique time-period representing a panel. The unit of observation in these models is the city-year, because cities are observed at multiple points in time. These models allow us to control for time-invariant city-level unobservables, including culture, geography and history, that do not enter the model directly. Controlling for these factors may be especially important in the context of city data where comparable cross-urban area data are sparse at best. In order to control for time-invariant city-specific unobservables, we estimate both random effect (RE) and fixed effects (FE) models. RE models simulate time-invariant unobservables by adding a city-specific component to the overall error term, which is assumed to be uncorrelated with the observed covariates. FE models estimate the time-invariant unobservables directly by estimating a unique intercept for each city.

One drawback to the RE model is that the coefficients may be biased when there is correlation between the city-specific error term and the regressors. The FE models overcome this draw back at the expense of losing all the variation between cases, which precludes the identification of coefficients on covariates that are invariant over time. This significantly reduces the amount of variation with which to identify coefficients in datasets with many cities but few time-periods such as ours, because most of the variation is between cities rather than over time.[4] In order to preserve identifying variation on both sides of the equation, we rely primarily on RE models and control for those portions of the time-invariant city-level effects that would be correlated with geographical region. However, we do provide FE estimates of the final model as a robustness check. In addition to the RE and FE panel models, we also estimate a series of lagged dependent variable models in order to test hypotheses relating world system and regional positions to *change* in centrality in the world system of cities (Alderson and Beckfield, 2007). Including the lagged dependent variable is asymptotically equivalent to modelling change scores, yielding a dynamic interpretation in which *levels* of independent variables associate with *change* in the dependent variable.

We control for unit invariant time-varying variables by controlling for $T - 1$ time-periods in all of the models that follow. We also take measures to guard against heteroscedasticity and spatially contemporaneous autocorrelation by implementing a panel-adjusted heteroscedasticity-consistent covariance matrix (Beck and Katz, 1995). Finally, because most of our data violate some central assumptions for the validity of regression analyses—including random sampling and independent observations—we checked our results against standard errors derived from bootstrap (Davidson and Hinckley, 1997; Snijders and Borgatti, 1999) and permutation (Good, 2000) resampling techniques, which were substantively identical to those presented here.

Results

Following the work of Neal (2008) and Alderson and Beckfield (2007), we begin our empirical discussion by gauging the temporal inequality trends in the distribution of eigenvector centrality across the cities in our sample. We use two measures of inequality,

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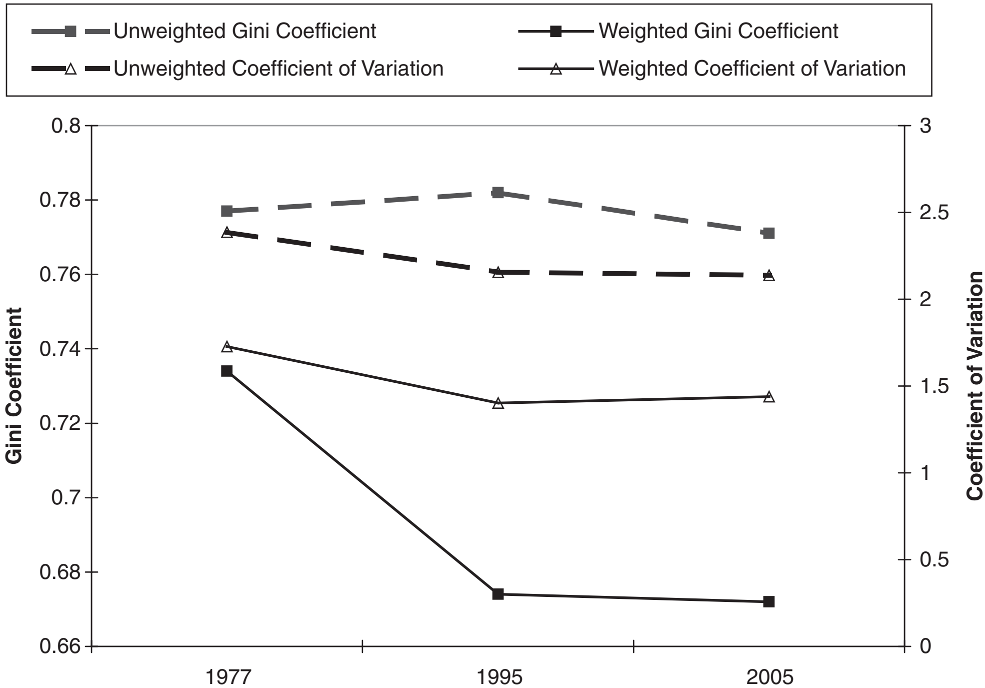

Figure 1. Inequality in eigenvector centrality of airline passenger flows, 1980–2005.

the Gini coefficient and the coefficient of variation. The Gini coefficient is a summary measure of inequality that ranges from 0 to 1, where 0 corresponds to perfect equality—each member of a population has an equally sized slice of the whole pie—and 1 corresponds to perfect inequality—one member of the population has the whole pie. However, because the distributional properties of network centrality indices are not well known and it would be difficult to observe a graph in which one vertex possessed all of the eigenvector centrality, we also report the coefficient of variation (CV). CV is measured as the ratio of the standard deviation to the mean, has no upper or lower bound and higher values indicate higher inequality. We also consider both unweighted inequality—each city's centrality score has the same impact on the summary measure of the distribution—and population weighted inequality, where each city's impact on the summary measure of the distribution is proportional to its population size. In sum, these measures both reflect the extent to which eigenvector centrality is evenly distributed across our cities, with low scores indicating relative equality and high scores indicating relative inequality. Thus, examining the trends over time gives an indication of the extent to which the city centralities are converging/diverging over time.

Figure 1 graphically displays both unweighted and population-weighted versions of the two inequality indices for each period. Two facts are quite evident in examining these summary measures. First, unlike many measures of wealth, power and prestige in the world economy, population weighted inequality in the distribution of eigenvector centrality in airline passenger flows is *lower* than unweighted income inequality (see Firebaugh, 2003; and Milanovic, 2005, for comparisons on between-country income inequality). While this may seem surprising *prima facie*,

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it actually reflects the great extent to which airline passenger travel scales with population—larger cities tend to have larger flows of people to and from them. Secondly, the inequality trend in eigenvector centrality of airline passenger flows is falling slightly over time since 1980, across all four measures.

The slight convergence observed here is in contrast to divergence in the centrality of interfirm headquarter and subsidiary relations found elsewhere (Alderson and Beckfield, 2007). One possible explanation for our different findings is that airline passenger flows are affected by much more than rising prominence in economic standing, which might be better captured with an indicator of something like centrality in the flow of business flights. Thus, one could claim that historically peripheral cities are rising in prominence on account of increasing flows of tourism or other types of leisure travel. Another explanation might be the general decrease in transport costs in recent years—as air travel becomes cheaper, the flows of people to and from cities become more widely distributed (but see Zook and Brunn, 2006, for an intriguing discussion of why this may *not* be the case). While these are all plausible—and probably additive—explanations, we now test hypotheses related to the articulation of world cities in the world system or the power of select world regions as explanations for the modest amount of convergence observed, as well as the deterritorialisation thesis more generally.

Table 1 reports the results of the regression analyses discussed earlier. In model 1, eigenvector centrality is regressed on indicators of semi-periphery and periphery, with the core as the excluded group, as well as dummy variables for 1995 and 2005. As the significantly negative effects of the semi-periphery and periphery show, the city to city network of airline passenger flows is structured in a manner that is consistent with world systems expectations: cities in core countries are more central than those in semi-peripheral and peripheral countries, and cities in semi-peripheral countries are more central that those in peripheral countries. Model 2 introduces UN world regions as controls, which slightly attenuate the salience of the world system predictors of world city centrality. In model 2, Europe is the excluded category and the coefficients for each included regional category represent the difference in regional city centrality average *vis-à-vis* Europe's, controlling for the other variables in the model. On average, each other region has fewer central cities than does Europe, with varying degrees of significance.[5] Clearly, Europe is a dominant region in the world city system. More importantly, however, the gap between the semi-periphery and the core widens slightly, while that between the periphery and the core narrows slightly. While these changes are very small and not statistically significant, they suggest that some of what appears to be world system structuration in model 1 could actually be regional structuration.

Model 3 introduces city population into the equation, with some surprising results. Holding city population constant, the gap between the semi-periphery and the core is *smaller* than that between the periphery and the core. While the difference in these gaps is not significant, this does suggest that a major explanation for lower centrality of cities in peripheral countries is demographic—their smaller size *vis-à-vis* cities located in core and semi-peripheral countries. Indeed, population explains a larger percentage of the variation than any other set of covariates in the models we estimate. Moreover, this also suggests that some very large cities in the semi-periphery—including Mexico City, São Paulo, Mumbai and Shanghai—have lower centrality than would be expected given the natural scaling of population and air passenger travel. In other words, cities embedded in semi-peripheral countries are constrained to centrality levels below those

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Table 1. Coefficients from random and fixed effects regression of normalised eigenvector centrality on select independent variables ($N = 707$)

	1	2	3	4	5	6
World system position[a]						
Semi–periphery	−3.544***	−3.721***	−3.201***	−3.246**	−4.034***	−6.147***
	(0.908)	(1.156)	(0.827)	(1.056)	(1.287)	(1.793)
x 1995	–	–	–	–	0.650	0.814
					(0.916)	(0.988)
x 2005	–	–	–	–	1.277	1.881†
					(1.011)	(1.177)
Periphery	−4.126***	−4.026***	−2.988***	−2.696**	−1.220	−3.911*
	(0.928)	(1.167)	(0.772)	(1.037)	(1.192)	(1.802)
x 1995	–	–	–	–	−2.415***	−2.140*
					(0.732)	(0.846)
x 2005	–	–	–	–	−2.375**	−1.905*
					(0.820)	(0.970)
UN world region[b]						
Asia	–	−0.694	–	−2.506*	−2.702*	–
		(1.085)		(1.147)	(1.161)	
Africa	–	−1.546†	–	−1.602†	−1.569†	–
		(0.913)		(0.876)	(0.897)	
Latin America	–	−2.271**	–	−3.125***	−3.264***	–
		(0.842)		(0.877)	(0.897)	
North America	–	−2.980†	–	−4.322*	−4.524**	–
		(1.786)		(1.757)	(1.742)	
Oceania	–	−1.297	–	−1.541†	−1.508	–
		(0.987)		(0.899)	(0.934)	
City–level controls						
City population	–	–	4.074***	4.566***	4.913***	3.531**
			(0.886)	(0.994)	(1.011)	(1.316)
City fixed effects	–	–	–	–	–	Included
Period fixed effects[c]						
1995	0.671*	0.703*	−0.044	−0.068	0.316	0.546
	(0.336)	(0.339)	(0.368)	(0.382)	(0.686)	(0.682)
2005	0.646†	0.672†	−0.736	−0.805	−0.770	−0.423
	(0.426)	(0.418)	(0.539)	(0.551)	(0.783)	(0.766)
Constant	4.872***	6.138***	−18.735***	−19.620***	−21.712***	−14.009*
	(1.022)	(1.519)	(4.585)	(4.845)	(5.010)	(7.894)
R^2	0.058	0.081	0.173	0.217	0.222	0.930

[a] Relative to core.
[b] Relative to Europe.
[c] Relative to 1980.
Notes: Coefficients are unstandardised. Numbers in parentheses are panel-corrected robust standard errors. † $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed tests).

consistent with their population size. Finally, model 4 includes both population and region. As model 4 shows, the combination of regional structuration and city population size further complicates world system structuration, although the differences in

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gaps between core/semi-periphery and core–periphery reported in models 3 and 4 fail to reach significance.[6]

While model 1 suggests that world system structuration is consistent with the hierarchical ordering of urban hierarchies, models 2-4 show that some of that structuration is conflated with regional and demographic factors. Do trends over time work in favour or against the hypothesis of world system structuration/deterritorialisation? Model 5 introduces interaction terms between the semi-periphery and periphery covariates and the time dummies for 1995 and 2005. The time trends for the semi-periphery are positive and increasing over time, but fall short of significance, while those for the periphery are significantly negative in each period, although insignificantly less so in the more recent period. In short, model 5 suggests some modest convergence between the core and semi-periphery, but divergence between the core and periphery that attenuated somewhat in the most recent period.

As already discussed, the RE models represented in 1–5 have the benefit of preserving all of the between-case variation to identify the conditional association between the covariates we include. However, the estimates of our coefficients may be biased in the case where the assumption of zero correlation between the unit-specific error term and the regressors is violated. In order to make sure that our estimates are robust to the violation of this assumption, model 6 reports results from a fixed effects regression, which precludes the identification of the regional covariates because they are time invariant. As model 6 shows, not only are the results of model 5 robust to the inclusion of city-level fixed effects, but the more recent positive time trend for the semi-periphery becomes marginally significant.

Taken together, models 5 and 6 seem to suggest that world system structuration is more determinative for the periphery than the semi-periphery because the former diverged from the core over time while the latter did not. This may suggest that some of the convergence observed in the inequality indices is due to the upward mobility of cities in the semi-periphery, which in turn could be a mechanism for the decoupling of the world city system from the world system. In order to investigate this further, we pursue two analytical strategies. First, we calculate the gaps in average city centrality between core and non-core zones of the world system, conditional on time-period, using the estimates from models 5 and 6 (Friedrich, 1982). These gaps are reported in Table 2. Across both sets of models, the gap between the semi-periphery and the core is declining secularly over time. On the other hand, the gap between the core and the periphery increases from 1980 to 1995, and then decreases inappreciably from 1995 to 2005. Thus, cities in semi-peripheral countries seem slightly more upwardly mobile, on average, than those in peripheral countries. This is consistent with the interpretation that a city's embeddedness in a semi-peripheral country is less constraining as time proceeds and that any decoupling of the world city system from the world system is driven in part by the rise of cities in the semi-periphery.

As a second means of evaluating this hypothesis, we estimate a final set of models in which we regress city centrality on its lagged centrality value—centrality from the previous period—along with indicators for core, periphery and the other controls discussed earlier and in Table 3. These lagged dependent variable models yield a dynamic interpretation, allowing us to test directly the hypothesis that cities in the semi-periphery are more upwardly mobile than those in the periphery because they are asymptotically equivalent to modelling change in world city centrality as the dependent variable. As a consequence, we lose the observation from the earliest period, reducing the sample size to 356 for the models reported in Table 3.

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Table 2. Difference in average city-level eigenvector centrality between core and non-core zones, conditional on time period

	Model 5			*Model 6*		
Relative to core	*1980*	*1995*	*2005*	*1980*	*1995*	*2005*
Semi-periphery	−4.034***	−3.384***	−2.757**	−6.147***	−5.333***	−4.266**
	(1.287)	(1.053)	(1.172)	(1.793)	(1.532)	(1.723)
Periphery	−1.220	−3.636***	−3.595***	−3.911*	−6.051***	−5.816***
	(1.192)	(1.096)	(1.092)	(1.802)	(1.664)	(1.617)

Notes: Coefficients are unstandardised. Numbers in parentheses are standard errors.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed tests).

Table 3. Lagged dependent variable models ($N = 356$)

	7	*8*	*9*
Lagged eigenvector centrality	0.869*** (0.028)	0.875*** (0.026)	0.845*** (0.031)
World system position[a]			
Core	−0.050 (0.575)	0.784 (0.713)	0.608 (0.677)
Periphery	−1.529*** (0.435)	−2.242*** (0.573)	−1.493* (0.591)
UN world region[b]			
Africa	–	−1.595** (0.608)	−1.523* (0.670)
Europe	–	−3.770*** (0.912)	−2.637*** (0.820)
Latin America	–	−2.150*** (0.640)	−2.036** (0.638)
North America	–	−2.647* (1.057)	−2.119* (0.975)
Oceania	–	−2.480** (0.857)	−1.890* (0.782)
City-level controls			
City population	–	–	1.550*** (0.393)
Period fixed effects[c]			
1995-2005	−0.778* (0.399)	−0.930* (0.423)	−1.127** (0.432)
Constant	1.807*** (0.492)	4.037*** (0.904)	−5.941* (2.321)
R^2	0.828	0.846	0.852

[a] Relative to semi-periphery.
[b] Relative to Asia.
[c] Relative to 1980–95.
Notes: Coefficients are unstandardised. Numbers in parentheses are panel-corrected robust standard errors. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed tests)

Model 7 shows the effects of the lagged dependent variable and the indicators of core and semi-periphery. This model provides strong evidence for our hypothesis—on average, the change in eigenvector centrality is 1.529 units lower for cities in the periphery than cities in the semi-periphery and cities in the semi-periphery are insignificantly *more* upwardly mobile than those in the core. Model 8 introduces the regional covariates from models 1–6, but we now test all regions against the Asian region to pursue the hypothesis that Asian cities could be driving the convergence and decoupling that we observe (Frank, 1998). As model 8 shows, cities in all UN world regions have significantly lower mobility than do cities in the Asian region, on average. Moreover, controlling for regional

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location boosts the relative level of upward mobility for cities in the semipeirphery *vis-à-vis* those in the periphery, which indicates that the semi-peripheral zone and the Asian region have somewhat independent effects and that the mobility-increasing effect of being embedded in a semi-peripheral country is not limited to those in the east Asian region. Finally, model 9 includes population into the model. The regional differences are substantively identical to model 8 and the deficit of cities in peripheral countries *vis-à-vis* those in semi-peripheral countries attenuates but remains significant. In sum, models 7 and 8 provide strong evidence in support of arguments relating semi-peripheral and Asian dynamism in the convergence of the world city system and the decoupling of the world city system from the world system.

Conclusion

The social sciences increasingly debate the significance of globalisation for the structuring of the world economy and polity. For the literature on urbanisation, this has resulted in a large and growing interest in 'world cities' and 'global cities', which situates urban processes within global political-economic structures. In turn, in the literature on global cities, scholars are keenly interested in the issue of the articulation between the world city system and the world system and the extent to which the recent pattern of economic globalisation alters this articulation.

There are two polar extremes in the answers to this question. On the one hand, some argue that globalisation is radically changing the relationship between the world city system and the world system, such that "globalization is generating a new urban hierarchy" that cuts across the traditional boundaries of core, semi-periphery and periphery (Alderson and Beckfield, 2004, p. 817). On the other hand is the claim that globalisation tends to 'reperipheralise' cities that are located in underdeveloped countries, leading to strong world system structuration of the world city system and divergence in the power of cities across world system zones.

Our analyses suggest an interpretation that steers an intermediate course between these two stylised explanations. While we do find a fairly robust association between the world city system and the world system, there is also powerful evidence of variation between 'zones' of the world system and world regions. In particular, cities in Asia and the semi-periphery tended to diverge from those outside Europe, North America and the periphery, which led to some modest convergence in the distribution of centrality across world cities. One possible explanation is that we are seeing ascending 'sub-capitals' operating as subordinated command-and-control centres for the sprawling manufacturing networks that emerge in this world system zone and geographical region (see Hymer, 1972). While this would be an important new dynamic, it is less clear what it might mean for the future of the world city hierarchy or the long-term distribution of power in the world city system: is this a basic change in the entire world city system—and a harbinger of declining inequalities between cities? Or does the greater degree of upward mobility for cities located in semi-peripheral countries *vis-à-vis* those located in peripheral countries actually signal greater continuity than change and a sort of 'shuffling' of the middle ranks of the urban hierarchy?

In order more fully to explore these notions, we pursued two analytical strategies. First, we examined the time trends in intercity inequality in the distribution of eigenvector centrality for the network of air passenger flows. Secondly, we estimated a series of panel regression models that relate city-level centrality—and how it changes —to country-level positions in the international division of labour and geographical region. Both sets of results illustrate the reality of both continuity

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and change. We observed a modest amount of convergence in the distribution of eigenvector centrality over time. The random and fixed effects models showed that, while the world city system is ordered in a manner consistent with the world systems perspective, there was variation over time in the trajectory of the periphery *vis-à-vis* the semi-periphery, where the former was diverging from the core and the latter was not. Our dynamic panel models showed that the semi-periphery did, indeed, display a greater degree of upward mobility than the periphery and that the Asian region was significantly more upwardly mobile than any other region. Moreover, these effects were independent, suggesting that the mobility-increasing effect of embeddedness within a semi-peripheral country is not limited to those in the east Asian region.

While these findings do advance our understanding of the dynamic relationship between globalisation, the structure of the world city system and the world system, they also raise some additional questions. One interpretation is that globalisation is essentially 'rebooting' the world system and that the structuration of the world system is not so much declining as it is changing. Globalisation is raising the historical prominence of semi-peripheral and east Asian cities *vis-à-vis* earlier periods, but this rise in prominence follows a logic in which these cities remain subordinated to the global command-and-control centres. On the other hand, the prospects for upward mobility for peripheral cities are as distant as ever, with these places locked ever more firmly into lower-level roles in the world economy. This view suggests a qualitatively new pattern of a very old process of world system structuration.

At the heart of the world systems understanding of macro political-economic change lies the notion that dominant—or 'core'—geographical locations in the world system are those that contain the least monopolised and often most technologically advanced production nodes in the system, but that the composition of 'core' activities changes over time (Arrighi *et al.*, 2003; Hopkins and Wallerstein, 1986).[7] Indeed, some are willing to argue that manufacturing itself is becoming peripheralised, as today's global economy represents a shift from leading *sectors* to one in which particular *functions* within sectors—the 'intangible' activities such as branding, marketing, research and development—now constitute the core of the modern world system (for example, Kaplinsky, 2005; Arrighi *et al.*, 2003). If globalising is little more than the 'peripheralisation' of the economic activity (manufacturing) that is migrating into the semi-periphery, and east Asia in particular, then the dynamism we observed among our semi-peripheral and east Asian cities might be little more than a short-term fluctuation in the longer-term trend of the economic subjugation of non-core places by core places. Yet, the social change we observe on the ground in the more dynamic semi-peripheral and east Asian cities seems to belie this interpretation.

While the rapid economic growth of east Asia was rightly termed a 'manufacturing miracle' (Gereffi and Wyman, 1990) two decades ago, the great cities of that region (and other parts of the global semi-periphery) are today much more than simple 'sub-capitals' for the supervision of local manufacturing. Indeed, there is ample evidence that places like Shanghai and Mumbai have begun to take on some of the same sorts of 'command-and-control' functions, epitomised by the prevalence of FIRE sectors, as the global cities of the core (Sassen, 2002; Taylor, 2004). In other words, a number of semi-peripheral cities—and especially those located in the east Asian region—are rising to challenge the historical dominance of those located in core countries by using their experience in manufacturing as a springboard into the intangible nodes that are hypothesised to reside at the core of the modern world system.

This raises a large question about different futures in terms of the structure of the

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world city system and the world system. Are we simply observing a 'shake up' of cities in the middle of the world system, where some upstart semi-peripheral cities are replacing older ones as sub-capitals of a new, more geographically dispersed division of labour in the manufacturing sector? Or is there a more basic contestation of core cities by semi-peripheral ones for the command-and-control functions of the world economy? Could such a contestation lead to a future world city system and world system that embody a fairly dramatic reorganisation of the geography of power and function?

If the simplest hypothesis linking manufacturing to rising global city position is correct, we would expect the most upwardly mobile semi-peripheral cities to be the preferred locations of the manufacturing activity migrating out from the global North, such as major cities in the 'four tigers'—South Korea, Taiwan, Singapore and Hong Kong in the early period—and coastal cities in China in more recent times. However, we would not expect that this upward mobility would persist as time proceeds and as these countries themselves 'deindustrialise'. On the other hand, if these cities have made a transition towards more 'command-and-control' functions in their dynamic region of the world, we would expect that upwardly mobile cities in the early period would maintain their rapid upward mobility in the second period, either because they begin to shift out of pure manufacturing nodes and into the intangible nodes that are closer to the core of the world system or because manufacturing is not uniformly peripheralised.

Table 4 lists the top 10 upwardly mobile semi-peripheral cities in each respective period, ordered by their rank mobility in the first period. The line of space separates cities that were among the top 10 in the first period from those that penetrated this group in the second period. Unsurprisingly, the top seven upwardly mobile cities in the early period were from east Asia. These cities all increased or maintained relatively high ratios of manufacturing to GDP, even in the context of slightly rising services production (Yusuf and Nabeshima, 2006). Chinese cities were not far behind in the second period, as Shanghai and Beijing ascended to the first and second rank mobility positions. Two of the remaining three cities in the early period come from prototypical semi-peripheral countries in Latin America (for example, Evans, 1979) that began their industrialisation process in the early part of the 20th century, but are now in transition to wider 'command-and-control' activities.[8]

Table 4. The ten most upwardly mobile cities from the semi-periphery

	Mobility Rank	
City	*1977–95*	*1995–2005*
Hong Kong	1	3
Seoul	2	7
Singapore	3	4
Bangkok	4	5
Taipei	5	64
Kuala Lumpur	6	59
Manila	7	39
Lisbon	8	8
São Paulo	9	9
Mexico City	10	10
Prague	12	6
Beijing	17	2
Shanghai	23	1

Notes: Cities shown in bold remain in the top 10 in both periods; cities shown in italics decline in the second period while those below the line of space appear in the top 10 in the second period only.

The mobility patterns displayed in Table 4 are broadly consistent with the second interpretation outlined earlier: 7 of the top 10 upwardly mobile cities remained in the top 10 in the later period and have been characterised as making the shift into post-industrial urban places (Fu-Lai, 2005; Park, 2008; Yusuf and Nabeshima, 2006; Ching, 2005;

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Morshido, 2000). Hong Kong is probably the most exemplary: while there is very little manufacturing done within its territory today, the city's early manufacturing firms "are now extending their competence into managerial and consultancy services [and evolving] into regional coordinators" (Fu Lai, 2005, p. 21). While our data do not allow us to speak to the future trajectory of Beijing and Shanghai, it seems more likely that their prominence will continue as they make the transition to key centres co-ordinating the rise of geographically far-flung manufacturing networks across China and into south-east and north-east Asia. Like many other cities in the dynamic east Asian region, their future growth is likely to come from non-manufacturing-based "innovative activities—especially in producer services and the creative industries" (Yusuf and Nabeshima, 2006, p. xii). Matthiessen *et al.*'s findings (this issue) on scientific bibliometric indicators and centres are consistent with such a conclusion.

While our exploration of these cases is far from conclusive, we suggest that future research could begin to disentangle the meaning of the upward mobility of semi-peripheral cities (both that observed here and that implicit in the results of Alderson *et al.*, this issue). One promising direction would involve less aggregated analyses of the kind of data used by Taylor and the GaWC network as well as those of Alderson and Beckfield (2004, 2007; see also Alderson *et al.*, this issue). In particular, we advocate for some careful sectoral boundary drawing in an effort to differentiate between those sectors that represent the command-and-control *functions* of the global economy and those that might diffuse to non-core cities without signifying any real 'upgrading' in the functional role of those cities. Indeed, in the discussion between these two sets of authors that appeared in the *American Journal of Sociology*, Peter Taylor points out that Alderson and Beckfield's (2004) approach is to aggregate all of the Fortune 500 firms, whereas the GaWC approach limits the analysis to 'global service firms' (Alderson and Beckfield, 2007; Taylor, 2006). On the one hand, Alderson and Beckfield implicitly assume that there is no difference in the meaning of centrality across sectors, while Peter Taylor believes that global service firms are the only ones that matter with respect to identifying command-and-control centres in the world city system. The truth of the matter is likely to lie somewhere in between: some sectors are certainly more consistent with 'command-and-control' functions, but the global service sector does not possess a monopoly over those functions. Assuming that a reasonable differentiation can be made between command-and-control sectors and those that are something else, it would be fruitful to compare the rise/fall of cities across such divides. To the extent that certain semi-peripheral and/or Asian cities are tending towards dominant positions in truly command-and-control sectors, this would imply that the geography of power and functionality is in a true period of transformation (for another discussion of recent changes in the world city 'command-and-control' hierarchy on the eve of the 2008 world economic crisis, see Taylor *et al.*, 2009). To the extent that they do not, this would imply that we are simply witnessing a somewhat historically novel pattern of the same old process of world system structuration.

Notes

1. See http://www.lboro.ac.uk/gawc/.
2. One referee correctly pointed out that the first principal eigenvalue has to explain the highest amount of variation relative to lower-rank eigenvalues for the eigenvector to behave as we describe. The first eigenvalue explained an increasing 19 to 22 to 23 per cent, while the second principal eigenvalue explains 8, 14 and 12 per cent, and the third eigenvalue explains 5, 6 and 6 per cent in 1977, 1995 and 2005 respectively. These values are large enough to suggest that

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eigenvector centrality does behave as we describe, but not as large as they could be, in turn suggesting that there is a significant amount of local (probably regional) structure that is important and could be modelled in future analysis. However, auxiliary analyses showed that the eigenvector centrality did capture city-to-city differences in global centrality better than degree centrality. Still, as a precaution, we estimated all of our models with continuous coreness and in-/out-degree centrality as alternative dependent variables. The results were substantively identical in every case. Scree plots of the first 10 eigenvalues are available upon request.

3. For example, many of the 'non-economic' relations do not conform to the hypothesised core–periphery structure. For a fairly thorough and recent critique of this trichotomy, see Clark and Beckfield (2009).
4. In our data, roughly 92 per cent of the variation in eigenvector centrality lies between cases.
5. One referee was concerned that North America has the largest deficit *vis-à-vis* Europe in the models reported. Subsequent analysis revealed that this is because the world system position measures are included in the model. Models that include only regions reveal that North America has the smallest deficit *vis-à-vis* Europe. Major US cities are actually not very distinct from European ones in terms of their absolute level of centrality in the world urban hierarchy—but US national leadership on 'coreness' obscures this. In other words, much of the centrality of cities in North America is explained by their country's position in the world system.
6. The difference in gaps in model 3 is 0.213, with a p-value greater than 0.496, while that in model 4 is 0.550 with a p-value greater than 0.15.
7. For example, while textile manufacturing was the cutting-edge industry during the industrial revolution, over time it became 'peripheralised' and replaced by new leading sectors (for example, O'Hearn, 1994; Schrank, 2004).
8. Lisbon, which occupies the 8th most upwardly mobile spot in both periods, is somewhat anomalous according to our explanation for upwardly mobile cities because it has a much older industrialisation history. Prague is slightly anomalous, too, since its industrialisation is also much older (Mahutga and Bandelj, 2008) and some of its rising prominence is clearly related to the socio-political processes of post-socialist transition and EU integration (for example, Bandelj, 2007).

References

Alderson, A. and Beckfield, J. (2004) Power and position in the world city system, *American Journal of Sociology*, 109, pp. 811–851.

Alderson, A. and Beckfield, J. (2007) Globalization and the world city system: preliminary results from a longitudinal data set, in: P. J. Taylor, B. Derudder, P. Saey and F. Witlox (Eds) *Cities in Globalization: Practices, Policies and Theories*, pp. 21–36. London: Routledge.

Alderson, A. S., Beckfield, J. and Sprague-Jones, J. (2010) Intercity relations and globalisation: the evolution of the global urban hierarchy, 1981–2007, *Urban Studies*, 47(9), pp. 1899–1923.

Arrighi, G., Silver, B. J. and Brewer, B. D. (2003) Industrial convergence, globalization, and the persistence of the North–South divide, *Studies in Comparative International Development*, 38(1), pp. 3–31.

Bandelj, N. (2007) *From Communists to Foreign Capitalists: The Social Foundations of Foreign Direct Investment in Postsocialist Europe.* Princeton, NJ: Princeton University Press.

Beaverstock, J. V. (2004) 'Managing across borders': knowledge management and expatriation in professional service legal firms, *Journal of Economic Geography*, 4, pp. 157–179.

Beaverstock, J. V., Hubbard P. and Short, J. R. (2004) Getting away with it? Exposing the geographies of the super-rich, *Geoforum*, 35, pp. 401–407.

Beaverstock, J. V., Smith, R. G. and Taylor, P. J. (2000) World city network: a new metageography?, *Millennial Issue of the Annals of the Association of American Geographers*, 90, pp. 123–134.

Beck, N. and Katz, J. N. (1995) What to do (and not to do) with time series cross section data, *American Political Science Review*, 89(3), pp. 634–647.

Beckfield, J. and Alderson, A. (2006) Reply: whither the parellel paths? The future of scholarship

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on the world city system, *American Journal of Sociology*, 112(3), pp. 895–904.

Bollen, K. A. (1983) World system position, dependency, and democracy: the cross-national evidence, *American Sociological Review*, 48, pp. 468–479.

Bollen, K. A. and Appold, S. J. (1993) National industrial structure and the global system, *American Sociological Review*, 58, pp. 283–301.

Bonacich, P. (1972) Factoring and weighting approaches to clique identification, Journal of Mathematical Sociology, 2, pp. 113–120.

Castells, M. (1996) *The Rise of the Network Society*. Oxford: Blackwell.

Ching, H. (2005) The development of economic structure: producer services and growth constraints, in: R. Y.-W. Kwok (Ed.) *Globalizing Taipei: The Political Economy of Spatial Development*, pp. 16–34. New York: Routledge.

Clark, R. and Beckfield, J. (2009) A new trichotomous measure of world-system position using the international trade network, *International Journal of Comparative Sociology*, 50(1), pp. 5–38.

Córdoba Ordóñez, J. A. and Gago García, C. (2010) Latin American cities and globalisation: change and permanency in the context of development expectations, *Urban Studies*, 47(9), pp. 2003–2021.

Davidson, A. C. and Hinkley, D. V. (1997) *Bootstrapping Methods and Their Application*. Cambridge: Cambridge University Press.

Derudder, B. and Witlox, F. (2005) An appraisal of the use of airline data in assessing the world city network, *Urban Studies*, 42, pp. 2371–2388.

Derudder, B. and Witlox, F. (2008) Mapping world city networks through airline flows: context, relevance, and problems, *Journal of Transportation Geography*, 16, pp. 305–312.

Derudder, B., Taylor, P. J., Wiltox, F. and Catalano, G. (2003) Hierarchical tendencies and regional patterns in the world-city network: a global urban analysis of 234 cities, *Regional Studies*, 37(9), pp. 875–886.

Derudder, B., Taylor, P. J., Ni, P. *et al.* (2010) Pathways of change: shifting connectivities in the world city network, 2000–08, *Urban Studies*, 47(9), pp. 1861–1877.

Dicken, P. (2007) *Global Shift*, 5th edn. New York: Guilford Press.

Evans, P. B. (1979) *Dependent Development*. Princeton, NJ: Princeton University Press.

Faust, K. (1988) Comparison of methods for positional analysis: structural and general equivalences, *Social Networks*, 10, pp. 313–341.

Firebaugh, G. (2003) *The New Geography of Global Income Inequality*. Cambridge, MA: Harvard University Press.

Firebaugh, G. (2004) Does industrialization no longer benefit poor countries? A comment on Arrighi, Silver, and Brewer, 2003, *Studies in Comparative International Development*, 39(1), pp. 99–105.

Frank, A. G. (1998) *ReORIENT: Global Economy in the Asian Age*. Berkeley, CA: University of California Press.

Freeman, L. C. (1979) Centrality in social networks: conceptual clarification, *Social Networks*, 1, pp. 215–239.

Friedmann, J. (1986) The world city hypothesis, *Development and Change*, 4, pp. 12–50.

Friedmann, J. (1995) The world city hypothesis, in: P. L. Knox and P. J. Taylor (Eds) *World Cities in a World System*, pp. 317–331. New York: Cambridge University Press.

Friedmann, J. and Wolff, G. (1982) World city formation: an agenda for research and action, *International Journal of Urban and Regional Research*, 6, pp. 309–344.

Friedrich, R. (1982) In defense of multiplicative terms in multiple regression equations, *American Journal of Political Science*, 26(4), pp. 797–833.

Fu-Lai, T. Y. (2005) Technological strategies and trajectories of Hong Kong's manufacturing firms, *International Journal of Technology Management*, 29(1/2), pp. 21–39.

Gereffi, G. and Korzeniweicz, M. (1994) *Commodity Chains and Global Capitalism*. Westport, CT: Praeger Press.

Gereffi, G. and Wyman, D. (1990) *Manufacturing Miracles: Paths of Industrialization in Latin America and East Asia*. Princeton, NJ: Princeton University Press.

Good, P. (2000) *Resampling Methods: A Practical Guide to Resampling Methods for Testing Hypotheses*. New York: Springer.

Hall, P. (1966) *The World Cities*. New York: McGraw-Hill.

Hill, R. C. (2009) *The spider's web: global theories of urban development*. Unpublished manuscript,

Downloaded from usj.sagepub.com at Universiteit Gent on July 29, 2010

Department of Sociology, Michigan State University.

Hopkins, T. K. and Wallerstein, I. (1986) Commodity chains in the world-economy prior to 1800, *Review*, 10, pp. 157–170.

Hymer, S. (1972) The multinational corporation and the law of uneven development, in: J. N. Bhagwati (Ed.) *Economics and World Order*, pp. 113–140. New York: Macmillan.

ICAO (International Civil Aviation Organization) (1990) *On-flight origins and destinations*. ICAO, Montreal.

Kaplinsky, R. (2005) *Globalization, Poverty and Inequality*. Cambridge: Polity Press.

Keeling, D. J. (1995) Transportation and the world city paradigm, in: P. L. Knox and P. J. Taylor (Eds) *World Cities in a World-System*, pp. 115–131. New York: Cambridge University Press.

Kentor, J. (1981) Structural determinants of peripheral urbanization: the effects of international dependence, *American Sociological Review*, 46, pp. 201–211.

King, A. (1990) *Global Cities: Post-imperialism and the Internationalization of London*. London: Routledge.

Knox, P. and Taylor, P. J. (Eds) (1995) *World Cities in a World-System*. New York: Cambridge University Press.

Lall, S. (2004) *Reinventing industrial strategy: the role of government policy in building industrial competitiveness*. G-24 Discussion Paper Series 28, United Nations Conference of Trade and Development, New York and Geneva.

Lloyd, P., Mahutga, M. D. and Leeuw, J. de (2009) Looking back and forging ahead: thirty years of social network research on the world-system, *Journal of World-Systems Research*, 15(1) (http://jwsr.ucr.edu/archive/vol15/Lloyd_etal-vol15n1.pdf).

Ma, X. and Timberlake, M. (2008) Identifying China's leading world city: a network approach, *GeoJournal*, 71, pp. 19–35.

Mahutga, M. C. (2006) The persistence of structural inequality? A network analysis of international trade, 1965–2000, *Social Forces*, 84(4), pp. 1863–1889.

Mahutga, M. C. and Bandelj, N. (2008) Foreign investment and income inequality: the natural experiment of central and eastern Europe, *International Journal of Comparative Sociology*, 29(6), pp. 429–454.

Mahutga, M. C. and Smith, D. A. (2009) *Globalization, the structure of the world economy and economic development*. Working Paper No. 52, Institute for Research on the World-System, University of California at Riverside (http://irows.ucr.edu/papers/irows52/irows52.htm).

Matsumoto, H. (2004) International urban systems and air passenger and cargo flows: some calculations, *Journal of Air Transport Management*, 10, pp. 241–249.

Matthiessen, C. W., Schwarz, A. W. and Find, S. (2010) World cities of scientific knowledge: systems, networks and potential dynamics. An analysis based on bibliometric indicators, *Urban Studies*, 47(9), pp. 1879–1897.

Milanovic, B. (2005) *Worlds Apart: Measuring International and Global Inequality*. Princeton, NJ: Princeton University Press.

Mittelman, J. (2000) *The Globalization Syndrome: Transformation and Resistance*. Princeton, NJ: Princeton University Press.

Morshido, S. (2000) Globalising Kuala Lumpur and the strategic role of the producer services sector, *Urban Studies*, 37(12), pp. 2217–2240.

Moss, M. L. and Townsend, A. M. (2000) The Internet backbone and the American metropolis, *The Information Society Journal*, 16(1), pp. 35–47.

Neal, Z. (2008) The duality of world cities and firms: comparing networks, hierarchies, and inequality in the global economy, *Global Networks*, 8, pp. 94–115.

Nemeth, R. J. and Smith, D. A. (1985) International trade and world system structure: a multiple network analysis, *Review*, 8(4), pp. 517–560.

O'Connor, K. (2003) Global air travel: toward concentration or dispersal?, *Journal of Transport Geography*, 11, pp. 83–92.

O'Hearn, D. (1994) Innovation and the world-system hierarchy: British subjugation of the Irish cotton industry, 1780–1830, *American Journal of Sociology*, 100(3), pp. 587–621.

Park, S. O. (2008) ICT clusters and industrial restructuring in the Republic of Korea: the case of Seoul, in: S. Yusuf, K. Nabeshima and S. Yamashita (Eds) *Growing Industrial Clusters in Asia: Serendipity and Science*, pp. 195–216. Washington, DC: World Bank.

Pirie, G. (2010) Trajectories of North–South city inter-relations: Johannesburg and Cape Town, 1994–2007, *Urban Studies*, 47(9), pp. 1985–2002.

Downloaded from usj.sagepub.com at Universiteit Gent on July 29, 2010

Polèse, M. and Denis-Jacob, J. (2010) Changes at the top: a cross-country examination over the 20th century of the rise (and fall) in rank of the top cities in national urban hierarchies, *Urban Studies*, 47(9), pp. 1843–1860.
Rimmer, P. J. (1998) Transport and telecommunications among world cities, in: F. C. Lo and Y.-M. Yeung (Eds) *Globalization and the World of Large Cities*, pp. 433–470. Tokyo: United Nations University Press.
Robinson, J. (2002) Global and world cities: a view from off the map, *International Journal of Urban and Regional Research*, 26(3), pp. 531–554.
Rodrik, D. (1997) *Has Globalization Gone Too Far?* Washington, DC: Institute for International Economics.
Sassen, S. (1991) *The Global City: New York, London, Tokyo*. Princeton, NJ: Princeton University Press.
Sassen, S. (Ed.) (2002) *Global Networks, Linked Cities*. New York: Routledge.
Schrank, A. (2004) Ready-to-wear development? Foreign investment, technology transfer, and learning by watching in the apparel trade, *Social Forces*, 83(1), pp. 123–156.
Short, J. R., Kim, Y., Kuus, M. and Wells, H. (1996) The dirty little secret of world cities research: data problems in comparative analysis, *International Journal of Urban and Regional Research*, 20, pp. 697–719.
Smith, D. A. (1987) Dependent urbanization in colonial America: the case of Charleston, South Carolina, *Social Forces*, 66(1), pp. 1–28.
Smith, D. A. (1996) *Third World Cities in Global Perspective: The Political Economy of Uneven Urbanization*. Boulder, CO: Westview Press.
Smith, D. A. (2004) Global cities in east Asia: empirical and conceptual analysis, *International Journal of Social Science*, 56(3), pp. 399–412.
Smith, D. A. and Timberlake, M. (1993) World cities: a political economy/global network approach, *Research in Urban Sociology*, 3, pp. 181–207.
Smith, D. A. and Timberlake, M. (1995a) Cities in global matrices: toward mapping the world-system's city-system, in: P. Knox and P. J. Taylor (Eds) *World Cities in a World-System*, pp. 79–97. New York: Cambridge University Press.
Smith, D. A. and Timberlake, M. (1995b) Conceptualising and mapping the structure of the world system's city system, *Urban Studies*, 32, pp. 287–302.
Smith, D. A. and Timberlake, M. (2001) World city networks and hierarchies, 1977–1997, *American Behavioral Scientist*, 44, pp. 1656–1678.
Smith, D. A. and Timberlake, M. (2002) Hierarchies of dominance among world cities: a network approach, in: S. Sassen (Ed.) *Global Networks, Linked Cities*, pp. 117–141. London: Routledge.
Smith, D. A. and White, D. R. (1992) Structure and dynamics of the global economy: network analysis of international trade 1965–1980, *Social Forces*, 70(4), pp. 857–893.
Snijders, T. and Borgatti, S. (1999) Non-parametric standard errors and tests for network statistics, *Connections*, 22(2), pp. 61–70.
Snyder, D. and Kick, E. (1979) Structural position in the world system and economic growth, 1955–1970: a multiple-network analysis of transnational interactions, *American Journal of Sociology*, 84(5), pp. 1096–1126.
Strange, S. (1996) *The Retreat of the State:The Diffusion of Power in the World Economy*. New York: Cambridge University Press.
Taylor, P. J. (2004) *World City Network: A Global Urban Analysis*. London: Routledge.
Taylor, P. J. (2006) Comment: parallel paths to understanding gobal intercity relations?, *American Journal of Sociology*, 112(3), pp. 881–894.
Taylor, P. J., Catalano, G. and Walker, D. R. F. (2002) Measurement of the world city network, *Urban Studies*, 39, pp. 2367–2376.
Taylor, P. J., Ni, P., Derudder, B. *et al.* (2009) Commentary: the way we were: command-and-control centres in the global space-economy on the eve of the 2008 geo-economic transition, *Environment and Planning A*, 41, pp. 7–12.
Timberlake, M. (Ed.) (1985) *Urbanization in the World-economy*. New York: Academic Press.
United Nations, Department of Economic and Social Affairs, Population Division (2008) *World Urbanization Prospects: The 2007 Revision*. New York: United Nations.
Walton, J. (1979) From cities to systems: recent research on Latin American urbanization, *Latin American Research Review*, 14, pp. 159–169.
Yusuf, S. and Nabeshima, K. (2006) *Postindustrial East Asian Cities: Innovation for Growth*. Stanford, CA: Stanford University Press.
Zook, M. A. and Brunn, S. D. (2006) From podes to antipodes: positionalities and global airline geographies, *Annals of the Association of American Geographers*, 96, pp. 471–490.

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Appendix

Table A1. Zero-order correlation coefficients for variables included in the analyses

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
1 Eigenvector centrality														
2 Semi-periphery	−0.070													
3 Periphery	−0.186	−0.462												
4 Semi-periphery x 1995	−0.023	0.487	−0.225											
5 Semi-periphery x 2005	−0.031	0.517	−0.239	−0.179										
6 Periphery x 1995	−0.107	−0.250	0.541	−0.122	−0.129									
7 Periphery x 2005	−0.089	−0.215	0.465	−0.105	−0.111	−0.075								
8 Asia	−0.003	0.212	0.039	−0.006	0.231	0.054	0.035							
9 Europe	0.192	0.000	−0.339	0.055	−0.076	−0.181	−0.162	−0.366						
10 Latin America	−0.176	0.126	0.255	0.165	0.059	0.071	0.182	−0.256	−0.328					
11 North America	0.055	−0.348	−0.226	−0.170	−0.180	−0.122	−0.105	−0.221	−0.283	−0.198				
12 Oceania	−0.039	0.212	−0.098	0.066	0.122	−0.053	−0.046	−0.096	−0.123	−0.086	−0.074			
13 Population*	0.366	0.093	−0.277	−0.017	0.180	−0.119	0.043	0.199	−0.150	−0.030	0.174	−0.017		
14 1995	0.004	0.003	0.005	0.566	−0.317	0.408	−0.185	−0.051	0.006	0.042	0.029	−0.027	−0.037	
15 2005	−0.002	0.052	−0.104	−0.305	0.588	−0.220	0.343	0.101	−0.046	0.001	0.046	0.020	0.252	−0.539

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