Network Cities: Creative Urban Agglomerations for the 21st Century

David F. Batten

Summary. The global economy is nurturing an innovative class of polycentric urban configurations: network cities. A network city evolves when two or more previously independent cities, potentially complementary in function, strive to cooperate and achieve significant scope economies aided by fast and reliable corridors of transport and communications infrastructure. Creative network cities place a higher priority on knowledge-based activities like research, education and the creative arts. The cooperative mechanisms may resemble those of inter-firm networks in the sense that each urban player stands to benefit from the synergies of interactive growth via reciprocity, knowledge exchange and unexpected creativity. Two case studies are discussed briefly—Randstad Holland and Kansai, Japan. Since much of their future dynamism may rely upon transnational human resources, it is foreseen that more network cities will transcend national borders during the next millennium.

1. Introduction

Most modern scholars of urban development acknowledge that transnational processes are having an increasingly important influence on the evolution of cities. An early observation was the recognition of an emerging system of world cities (Hall, 1966 and 1984), a kind of urban élite which is shaped in part by the new international division of labour. These cities are also thought to be controlling and coordinating global finance (Thrift, 1986) and producer and business services. The view of world cities as the ‘key nodes’ of the international urban system is a widely held one, underpinned in particular by rapid advances in the development of information technology and telecommunications.

Transnational forces are having an impact on more than just the largest metropolitan centres. Another interesting example is the ‘transfrontier metropolis’ (Herzog, 1991). The emergence of urban settlements straddling international frontiers reflects a selective integration of border territory into the circuitry of the global economic system. In certain European and American border regions, transfrontier metropolises may eventually become new centres of production and urban life.

Some urban regions are undergoing another kind of metamorphosis. Efficient corridors of infrastructure link knowledge-intensive centres to larger metropolises.
European examples include the London–Cambridge and Stockholm–Uppsala corridors. Each of these high-tech corridor developments incorporates an international airport. Since the airport–university combination turns out to be one of the most synergistic factors currently contributing to faster and more prosperous urban growth in the Swedish context (Andersson et al., 1987), such highly accessible places nurturing a higher level of knowledge-based activities may be expected to prosper in the 21st century.

In these bicentric urban systems, close links have been forged between places of complementary function, rather than simply on the basis of distance or demand thresholds. Relational linkages tend to be horizontal rather than hierarchical. The resulting urban configurations take the form of ‘corridor cities’.

From an American perspective, the notion of corridor cities is far from new. The historian Robert Fishman noted: “By the 1980s, even social scientists could not ignore the fact that the whole terminology of ‘suburb’ and ‘central city’ deriving from the era of the industrial metropolis had become obsolete” (Fishman, ‘1990). Fishman coined the term ‘New Cities’ for those sprawling regions in which the basic unit is the ‘growth corridor’ stretching 50–100 miles. These new urban regions lack a dominant single core and definable boundaries. They are multicentred.

A small but growing number of modern urban agglomerations consist of an intricate web of corridor cities whose functional and locational relationships can provide them with holistic competitive advantages over some of their monocentric rivals. One classical example is Randstad Holland. The Kansai or Kinki region of Japan is a particularly innovative case. Because of the manner in which their polycentric structure has evolved, these urban systems may be thought of as ‘network cities’. Interest in them has increased recently, following claims that certain network cities may enjoy greater diversity and creativity, less congestion and more locational freedom than monocentric cities of comparable size (see, for example, Batten, 1993; Clark and Kuypers-Linde, 1994). The potential superiority of the network city model may be even more pronounced among many of the still-growing world cities of our time, because of the advantages of concentrated deconcentration (Hall, 1984).

Urban theory remains preoccupied with the monocentric model. Nevertheless, the evidence against such an oversimplification is steadily growing. This paper attempts to strengthen the case for network cities by outlining some of their general competitive advantages and discussing two specific examples. Because the cooperative mechanisms may resemble those of inter-firm networks, the new urban theory associated with the network city model will align itself more with the economic notions of differentiated products and imperfectly competitive markets than with the classical model of perfect competition. The paper begins with a brief discussion of the dynamics of urban hierarchies.

2. The Law of Rise and Fall
Cities do rise and fall, albeit slowly in many cases. They possess vintage properties, in the sense that even large and previously prosperous ones eventually decline in the absence of sufficient renewal and revitalisation activity. The rise and fall of cities is indeed well documented in all parts of the world. To catch a glimpse of this lifecycle phenomenon, we may turn to Europe over the last millennium (see Table 1) or to the changing global hierarchy of cities over a much shorter period (see Table 2). Many cities which dominated several centuries ago are relatively small today. Others, like Mexico City and São Paolo, have grown remarkably in the space of just 50 years.

It is often argued that city size fosters innovative propensity. In the US this became known as the HVLT hypothesis (after Hoover, Vernon, Lichtenburg and Thompson), since these authors emphasised the unique advantages enjoyed by New York City in the pro-
<table>
<thead>
<tr>
<th>City</th>
<th>Population</th>
<th>City</th>
<th>Population</th>
<th>City</th>
<th>Population</th>
<th>City</th>
<th>Population</th>
<th>City</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constantinople</td>
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<td>Paris</td>
<td>275</td>
<td>London</td>
<td>700</td>
<td>Moscow</td>
<td>6480</td>
<td>Paris</td>
<td>3330</td>
</tr>
<tr>
<td>Cordoba</td>
<td>450</td>
<td>Milan</td>
<td>125</td>
<td>London</td>
<td>550</td>
<td>London</td>
<td>3330</td>
<td>Paris</td>
<td>2424</td>
</tr>
<tr>
<td>Seville</td>
<td>90</td>
<td>Bruges</td>
<td>125</td>
<td>Paris</td>
<td>530</td>
<td>Vienna</td>
<td>1662</td>
<td>London</td>
<td>7000</td>
</tr>
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<td>Palermo</td>
<td>75</td>
<td>Venice</td>
<td>110</td>
<td>Naples</td>
<td>207</td>
<td>Leningrad</td>
<td>1439</td>
<td>Leningrad</td>
<td>5500</td>
</tr>
<tr>
<td>Kiev</td>
<td>45</td>
<td>Granada</td>
<td>100</td>
<td>Lisbon</td>
<td>188</td>
<td>Madrid</td>
<td>3000</td>
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<td>3000</td>
</tr>
<tr>
<td>Venice</td>
<td>45</td>
<td>Genoa</td>
<td>100</td>
<td>Amsterdam</td>
<td>172</td>
<td>Berlin</td>
<td>3000</td>
<td>Berlin</td>
<td>2800</td>
</tr>
<tr>
<td>Regensburg</td>
<td>40</td>
<td>Prague</td>
<td>95</td>
<td>Rome</td>
<td>148</td>
<td>Rome</td>
<td>2800</td>
<td>Rome</td>
<td>2800</td>
</tr>
<tr>
<td>Thessalonika</td>
<td>40</td>
<td>Rouen</td>
<td>70</td>
<td>Venice</td>
<td>144</td>
<td>Moscow</td>
<td>1120</td>
<td>Birmingham</td>
<td>2500</td>
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<tr>
<td>Amalfi</td>
<td>35</td>
<td>Seville</td>
<td>70</td>
<td>Moscow</td>
<td>130</td>
<td>Glasgow</td>
<td>1072</td>
<td>Manchester</td>
<td>2500</td>
</tr>
<tr>
<td>Rome</td>
<td>35</td>
<td>Ghent</td>
<td>70</td>
<td>Milan</td>
<td>124</td>
<td>Liverpool</td>
<td>940</td>
<td>Budapest</td>
<td>2100</td>
</tr>
</tbody>
</table>

Sources: Hohenberg and Lees (1985) and author's estimates.
But inter-firm networks are not only propelling world cities like New York, Paris and Tokyo. Industrial districts which have already insured themselves against substantial shifts in demand by increasing their internal flexibility may wish to reinsure themselves by pooling resources with other equally flexible regions (Sabel, 1989). Whilst the supportive evidence linking size and innovative capacity is impressive, some recent observations suggest that part of the innovative growth potential which traditionally resided in larger US and European cities may now be found in smaller urban concentrations (see, for example, Norton and Rees, 1979; Hohenberg and Lees, 1985).

The innovative activity of multinational companies can be seeded in various locations simultaneously, and is by no means restricted to the creative resources of the big cities. Such a trend reversal is consistent with the ongoing march towards a global network economy. Greater internationalisation implies a weakening in the relative importance of intra-regional accessibility in favour of stronger international contacts. Mushrooming growth among firms who are sensitive to the availability of information-processing, telecommunications and air transport capacity is greatly facilitating point-to-point contacts between many dispersed locations, thereby increasing the network character of the world economy.

Furthermore, empirical studies of European urban regions clearly show that regions which have a stronger commitment to research-intensive activities and, at the same time, have access to modern communications and international air transport, are expanding their employment and income base more quickly than others. They are outperforming most of the classical cities built around manufacturing activity. It is also natural for larger cities to build stronger links to these creative centres, seeking scope economies which may be derived from new innovations and creative knowledge exchanges.

As these tendencies proliferate further, the geographical contiguity of regions and the
Table 2. Population of the world’s biggest urban areas, actual and forecast, 1950 and 2000 (in thousands)

<table>
<thead>
<tr>
<th>Rank</th>
<th>City and Region</th>
<th>Population 1950</th>
<th>City and Region</th>
<th>Population 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>New York–north-eastern New Jersey</td>
<td>12 300</td>
<td>Mexico City</td>
<td>31 000</td>
</tr>
<tr>
<td>2</td>
<td>London</td>
<td>10 400</td>
<td>São Paulo</td>
<td>25 800</td>
</tr>
<tr>
<td>3</td>
<td>Rhine–Ruhr</td>
<td>6 900</td>
<td>Tokyo–Yokohama</td>
<td>24 200</td>
</tr>
<tr>
<td>4</td>
<td>Tokyo–Yokohama</td>
<td>6 700</td>
<td>New York–north-eastern New Jersey</td>
<td>22 800</td>
</tr>
<tr>
<td>5</td>
<td>Shanghai</td>
<td>5 800</td>
<td>Shanghai</td>
<td>22 700</td>
</tr>
<tr>
<td>6</td>
<td>Paris</td>
<td>5 500</td>
<td>Peking</td>
<td>19 900</td>
</tr>
<tr>
<td>7</td>
<td>Greater Buenos Aires</td>
<td>5 300</td>
<td>Rio de Janeiro</td>
<td>19 000</td>
</tr>
<tr>
<td>8</td>
<td>Chicago–north-western Indiana</td>
<td>4 900</td>
<td>Greater Bombay</td>
<td>17 100</td>
</tr>
<tr>
<td>9</td>
<td>Moscow</td>
<td>4 800</td>
<td>Calcutta</td>
<td>16 700</td>
</tr>
<tr>
<td>10</td>
<td>Calcutta</td>
<td>4 400</td>
<td>Jakarta</td>
<td>16 600</td>
</tr>
<tr>
<td>11</td>
<td>Los Angeles–Long Beach</td>
<td>4 000</td>
<td>Seoul</td>
<td>14 200</td>
</tr>
<tr>
<td>12</td>
<td>Osaka</td>
<td>3 800</td>
<td>Los Angeles–Long Beach</td>
<td>14 200</td>
</tr>
</tbody>
</table>

relative size of places in a local context are becoming less important than they were in the past. The urban-to-rural gap is widening because of the declining emphasis on natural resources and the growing emphasis on creative activity and accessibility to innovative human resources via a coordinated system of interdependent networks. Collective creativity calls for dynamic interactions between different ideas generating some qualitatively new idea. In this new contact-intensive arena of economic activity, a networking perspective is mandatory.

3. Network Cities versus Central Place Cities

It must be clear by now that we need to address two seemingly conflicting models of the spatial distribution of economic activity: the central place model and the network model. Fascinated by apparent regularities in the siting, size and numbers of towns among regions, Walter Christaller (1933) developed the central place model to predict ideal city-size distributions and functions. Positing that each commodity has a given threshold of minimum demand as well as a fixed geographical domain beyond which people are unwilling to pay for it, Christaller suggested that only a certain proportion of all settlements will offer higher-order goods and services. If the principal marketing function of each settlement is known, a hierarchy of places can be deduced. Each node in this urban hierarchy has a hexagonal-shaped hinterland. When conceived in this way, urban systems will be organised into central places of different order depending on their functional attributes.

Christaller's ideal model rests on assumptions which are not readily found in the real world. Nevertheless, it is possible to find city-size distributions in many nations which are approximately loglinear, thereby conforming to the rank-size rule. (In some younger nations such as Australia and the US, rank-size distributions may be found within subnational states rather than at the national level.) Each city's predicted population is given by the formula \( P = Ar^c \), where \( P \) = population of the given city, \( A \) = population of the largest city in the hierarchy, and \( r \) = the size rank of the given city. An illustration of this rank-size distribution of cities may be found in France (Figure 2). Although the disproportionately large size of the primate capital, Paris, tends to skew this distribution slightly, the rest of it has remained approximately loglinear for more than 150 years.

At first glance, there seems to be a remarkable stability in this loglinear distribution. Despite vast variations in the number and size of French settlements, the rank-size rule seems to hold over a 150-year period. Similar rank-size distributions may be found in many other parts of the world. For our purpose, however, it is important to note two additional features of rank-size distributions:

(1) Some individual settlements change their rank over time—in response to changes in their growth rates, their principal functions and their degree of nodality.

(2) The upward shift in the rank-size distribution over time is closely related to the slowly increasing mobility of travellers.

Both of these observations are important if we wish to understand the respective roles played by central place cities and network cities over time.

As activity and communications evolve in the course of economic development, one would expect contrasting forces to emerge. The central place system is a strong and stable attractor in the general dynamics of urbanisation, especially when competition between urban economies may be conceived simply in terms of geographical market areas. Hence it has aided our understanding of how rural economies can support market centres of various sizes. The central place model corresponds to the classical economic model of perfect competition in a geographical context. Just as this model of economic behaviour is less favoured by economists nowadays, so it is also clear that fewer cities
and market areas of today can be drawn up according to the central place model alone.

When introducing their notion of a network system of cities, Hohenberg and Lees (1985) emphasise the idea of nodality in a network of linked settlements within which (long-distance) traders are the prime movers. Cities form the centres, nodes, junctions, outposts and relays of this network. The seeds of such a network economy were sown as far back as the 11th century, when safer trade routes triggered the revival of many medieval cities in Europe (Pirenne, 1925; Mees, 1975; Andersson, 1986; Batten and Thord, 1994). Two major concentrations of urban development stood out at that time: northern Italy and the Low Countries. Such a dual urban core cannot be explained in terms of the traditional central place hierarchy.

The various nodes of a network city combine to form a unique yet flexible exchange environment. An economist might view a network city as a heterogeneous product competing in a marketplace where imperfect competition is the prevailing mechanism. Their unique polycentric structure and flexibility of function breed monopolistic advantages. Network cities exploit some of the opportunities arising from the diseconomies of urban scale in its monocentric form. They may be distinguished from central place cities in both spatial and functional terms.
Table 3. Central place versus network systems

<table>
<thead>
<tr>
<th>Central place system</th>
<th>Network system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrality</td>
<td>Nodality</td>
</tr>
<tr>
<td>Size dependency</td>
<td>Size neutrality</td>
</tr>
<tr>
<td>Tendency towards primacy and subservience</td>
<td>Tendency towards flexibility and complementarity</td>
</tr>
<tr>
<td>Homogeneous goods and services</td>
<td>Heterogeneous goods and services</td>
</tr>
<tr>
<td>Vertical accessibility</td>
<td>Horizontal accessibility</td>
</tr>
<tr>
<td>Mainly one-way flows</td>
<td>Two-way flows</td>
</tr>
<tr>
<td>Transport costs</td>
<td>Information costs</td>
</tr>
<tr>
<td>Perfect competition over space</td>
<td>Imperfect competition with price discrimination</td>
</tr>
</tbody>
</table>

Some of the comparative attributes of the two systems are listed in Table 3.

Setting aside more sophisticated economic arguments for the time being, one rationale for network cities is compellingly simple. Although some advantages stem from the advent of more efficient long-distance communication systems, this particular rationale is founded on day-to-day mobility patterns (Westin and Östhol, 1992). For our present purpose, the travel behaviour of the French population is indicative of wider trends across middle and northern Europe. Since 1800, mobility has increased from an average of 20 m to more than 30 km per person per day (see Table 4). This is a factor of 1,500. Nevertheless, the time spent in motion by the average traveller has not changed appreciably during this century, still averaging about 1 hour per day. Thus it is largely the speed of travel which has grown significantly, fuelled by the well-known sequence of modal improvements to transport systems. The general result has been a growing degree of congestion.

The ‘one-hour rule’ is a strong constraint on the penultimate size of the monocentric city, given that congestion and pollution are factors of growing importance. If one hour is the time limit which the average urban traveller is willing to spend on commuting to work and/or to other service facilities, then the increased spatial range afforded by advances in transport technology means that a growing number of network city configurations can compete favourably with monocentric cities of equivalent population size. Although the pertinent calculations will not be presented here, transport and congestion aspects serve to underpin the comparative advantages of the network city.

In Christaller's theory of central places, growth potential is related to size. Thus the case for network cities has never been explored. Yet it is network cities that have accounted for an above-average share of urban growth in today's Europe (see Figure 3). Although some larger cities possess both network and central place characteristics, it is the smaller network cities that have counteracted the central place trend towards primacy and contributed to the size-neutrality of urban growth (see Robson, 1973; Hohenberg and Lees, 1985).

4. Randstad Holland: A Classical Network City

Although the discussion about polycentric urban development is predominantly a recent one, some network cities are rather old. A classical example is the ‘Ring City’: Randstad Holland. Shaped like a giant horseshoe, this complex urban agglomeration contains three major conurbations grouped around the cities of Amsterdam, The Hague, Rotterdam and Utrecht (Figure 4). Other smaller centres such as Delft, Haarlem and Zaandam serve as
Table 4. Changes in average mobility in France

<table>
<thead>
<tr>
<th>Year</th>
<th>Average distance (km/day)</th>
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<tr>
<td>1800</td>
<td>0.02</td>
</tr>
<tr>
<td>1900</td>
<td>1</td>
</tr>
<tr>
<td>1990</td>
<td>35</td>
</tr>
</tbody>
</table>

additional nodes, further enriching the diversity of this unique urban configuration. Randstad planners aim to preserve its agricultural ‘Green Heart’ and the spaces between its main cities.

The formation of this classical network city began in earnest with the revolution in trade and industry during the 19th century. New economic development along the Rhine and its tributaries fostered opportunities for the rapid growth of two Dutch cities to challenge Amsterdam’s primacy—The Hague as the royal residence and political capital; and Rotterdam as the port commanding the mouth of the Rhine. Rotterdam and The Hague grew from 26 per cent and 19 per cent of Amsterdam’s size, respectively, in 1800 to 102 per cent and 67 per cent by 1985. The resulting decentralised spatial structure of the Randstad, deeply rooted in the Dutch tradition of local autonomy, has been preserved, against the odds, by persistent and explicit spatial planning policies.

Today, the cities and towns have converged so closely to each other that we may speak of the Randstad as a mature network city. With Schiphol airport near its centre, it is one of the most accessible urban agglomerations in the world. Such is the international character of the Randstad that it may lay claims to being the earliest metropolitan area to possess both network city and world city characteristics (Shachar, 1994). In this situation, the relational linkages between networks at different levels are most important (Batten and Törnqvist, 1990; Batten and Thord, 1994).

There seems to be a contrast between the turntable functions of Rotterdam and Amsterdam on the one hand, and the orientation towards the national economy of The Hague and Utrecht on the other. An interesting question then arises: could Randstad’s economy be further internationalised by strengthening the functional cohesion at the network city level? Priemus (1994) explores this question taking sustainability criteria into account. A worrying feature is that about one-third of all businesses in the Randstad are now experiencing bottlenecks at their location. If the Green Heart is invaded to alleviate some of this congestion, then the Randstad might lose its unique network city character among the world cities and simply become another vast urban sprawl—a Dutch Los Angeles according to Hall (1984).

Over the last 20 years, changes in the Randstad’s production structure have been great. Amsterdam and Rotterdam have lost out heavily in terms of employment, despite the fact that growth industries are over-represented in these two cities. The explanation may lie in the changing character and connectivity of the international economy. Older industrial and port cities are of declining importance in the face of competition from a new city hierarchy; one based more on business services and higher educational skills (Andersson, 1986). While Rotterdam has suffered from the oil crises and increased international competition in manufacturing, the area around Schiphol airport has benefited. As more firms operate internationally and the value/weight ratio of goods declines further, the importance of air transport will influence the locational preferences of many more firms.

Despite its maturity, Randstad Holland still retains the inherent advantages of a classical network city. Within Europe, only London outranks it in terms of popularity for international head offices. Large areas are still attractive for new and advanced industries, especially the ‘new wing’ centred around the financial and economic complex of Amsterdam and around Schiphol airport (Jobse and Needham, 1988). The population’s desire for dispersal in search of more
space and attractive living conditions has been accommodated, but also complemented by good accessibility to nearby urban jobs and services and to the international world. This ongoing principle of concentrated de-concentration verifies the dedicated attitude of Dutch city and regional planners. It also demonstrates the durable benefits of the network city model.

5. Kansai, Japan: A Creative Network City

A fascinating network city is developing in the Kansai (or Kinki) region of Japan. After many years of competition with Tokyo, this historically powerful area of Japan appears to have recently gained greater confidence in its ability to offer attractive alternatives to the national capital. Kansai is made up of the six prefectures of Osaka, Hyogo, Kyoto, Nara, Wakayama and Shiga. These prefectures are diverse in that each has its own distinctive cultural and historical identity. Whilst this may have caused a lack of cohesiveness in the decades when Tokyo was growing more dominant, this same diversity may now unlock the key to a more prosperous future.

The core cities of the Kansai region are depicted in Figure 5. Besides Osaka, Kyoto and Kobe, strong transport links ensure that the smaller cities of Himeji, Nara, Ohtsu and Wakayama are efficiently integrated within easy reach of the larger trio. Formally known as the Keihanshin metropolitan area, the urban core of Kansai boasts a population of over 18 million people.

The immense diversity of the region can be gauged partly from the fact that it contains two former imperial capitals of Japan: Nara and Kyoto. These two delightful cities, with their remarkable temples and artistic treasures, provide an incomparable cultural richness to complement the port cities of Kobe and Osaka. Osaka is also the region’s centre of commerce and industrial activity. The striking contrasts between these cultural and commercial cities, combined with their willingness to work together towards a united vision of the future, could transform the Kansai region into one of the most exciting network cities of the next century.
Much of Kansai’s future optimism is based on a spate of recently completed infrastructure projects. There are many large-scale, long-range projects underway (see Yoshikawa, 1993). The most prominent of these is the Osaka Bay Area Development (OBD). An Association to promote this major development was established by the local business community. Their ‘Grand Vision’ was announced to the public in 1991. Its aim of consolidating a wide range of urban functions (located in different centres) captures the very essence of a creative network city. With a view to nurturing a ‘cosmo-creative metropolis’, the ‘Grand Vision’ prescribes the following metropolitan requirements:

1. A creatively diversified environment for all citizens through the amalgamation of various urban functions for living, working, learning and playing;
2. The formation of cultural and knowledge ‘corridors’ which promote interaction among creative minds;
3. An international ‘around-the-clock’ city for global citizens (facilitated by the opening of the 24-hour Kansai International Airport in September 1994);
4. A restructuring of the old industrial structure along with the incubation of new business opportunities;
5. The provision of ‘nature-rich’ amenities for the citizens; and
6. The sophistication of a polycentric urban structure.

The ‘Grand Vision’ will try to limit commuting time to a maximum of 1 hour. Families will also be encouraged to live or work in a larger city during weekdays, but to visit and stay in another nearby city over the weekend. New logistical systems needed to foster this creative network city take the shape of a giant horseshoe, not unlike Randstad Holland’s ring configuration. These corridor development plans are even referred to collectively as the ‘Osaka ring conurbation’.
The novel network city potential will combine the economic and social diversity of Osaka, Kyoto and Kobe with the environmental and recreational richness of Awaji Island and the unique features of Shikoku Island. If the proposed channel between Wakayama and southern Awaji Island is realised, a complete loop around Osaka Bay would be established.

Today the Osaka Bay Area has four types of port:

(1) the two traditional seaports of Kobe and Osaka;
(2) Kansai International Airport;
(3) a telecommunications port known as the Teleport; and
(4) a knowledge port known as the Kansai Cultural and Scientific Research City.

Businessmen emphasise the openness of Kansai people to new ideas, compared with Tokyo. They also point to their ability to make quick decisions and their talent for identifying new business opportunities. With the recent opening of the around-the-clock Kansai International Airport, Osaka Bay Area can develop an effective gateway to the international business community. The creative potential of such a diverse network city should help Kansai to face the 21st century with a much greater degree of confidence.

6. Concluding Remarks

It has been said that the economic geography of the modern industrial world can be represented as a patchwork of dense production agglomerations linked together by an extensive system of interregional transactions (Scott, 1992). There is a similar patchwork of creative urban agglomerations developing at some key locations around the world which offer a unique combination of characteristics: an attractive, culturally diverse environment, advanced R&D and educational facilities, a flexible and creative workforce, improving
accessibility to the outside world, and a dynamic vision of the future.

At some of these locations, network cities are developing from the premise that nearby urban partners can benefit from the dynamic synergies of interactive growth via reciprocity, knowledge exchange and unexpected creativity. They can also achieve significant scope economies aided by fast and reliable corridors of transport and communications infrastructure. The more creative ones place a higher priority on knowledge-based activities like research, education and the creative arts. It is thus not surprising to learn that seven of the ten most creative European regions of today are corridor or network cities (see Table 5). In these urban systems, close links have been forged between places of complementary function, rather than simply on the basis of distance or demand thresholds.

Within the above collection of creative regions, many R&D units operate in corporations whose production activities are based on knowledge engineering and a new systems architecture (rather than the factory-oriented engineering of the industrial era). They are contact-intensive and may eventually form a network of their own at the global level: an international C-network as described by Andersson (1986). Since much of their future dynamism may rely upon transnational human resources, it is foreseen that the more creative network cities will transcend national borders during the next century.

References

transfrontier metropolis, Urban Studies, 28, pp. 519–534.

Appendix

The following rudimentary comparative framework captures some elements of the descriptive discussion outlined earlier. Note that the present model is simplistic; the choice of variables has been motivated by a future intention to describe the relatively slow processes of network adjustment which form the substructure or 'arena' on which other faster change processes take place. Such a differentiation of variables according to their relative speeds of change is important in order to appreciate the interdependent dynamics of urban development.

Let \( X = a(b(P + G)^2 - P^3 - G^3) \) (1)

where \( P = z(P' + D) \), \( G = z'G' \); \( X \) measures the level of economic activity; \( P' \) measures the size of the city's economically active population (workers and customers); \( D \) measures the size of its external customer network; \( G' \) measures the city's stock of infrastructure; \( a \) is an index of technological efficiency; \( b \) is an index of scale of economic activity; \( z \) is an index of human skills; and \( z' \) is an index of infrastructure quality.

Equation (1) defines a production function for our city of interest. \( D \) is intended to reflect the role (if any) of the city as an international market centre. The size of its customer network should be measured on the relative scale of international links in comparison with local and regional links. Thus it might be weighted according to the ratio of international to intra-national economic activity.

Economic activity \( X \) reaches its maximum when both marginal productivities are zero, which occurs when

\[ P = G = 4b/3. \]

The technically optimal scale is achieved when marginal and average productivities are equal, i.e. when

\[ (P^3 + G^3)/b(P + G)^2 = b/2. \]

The term \( 2PG \) accounts for synergistic interactions between the local population, external customers and infrastructure.

It is illustrative to consider a situation in which \( G = 0 \). This might correspond to a simple agrarian economy lacking any significant infrastructure links to the outside world. Then the model reduces to the following:

\[ X = a(bP^2 - P^3) \] (2)

This function is plotted in Figure 6. It satisfies the 'regular ultra passum law' proposed by Frisch.
(1965), in so much as it contains a zone of increasing returns to scale and a zone of decreasing returns to scale. Puu (1985) proposed this functional form as a modification to Hotelling’s population growth model.

Such a simplified model was the basis of a comparative analysis of the three different urban configurations depicted in Figure 1 (see Batten, 1993). Each city’s stage of development in the urban lifecycle was defined by its position along the $X-P$ curve in Figure 6. In this simplified economy, the technically maximal scale occurs when $P = 2b/3$. Three zones of productivity may be identified:

(a) increasing returns to scale: $P < b/2$;
(b) decreasing returns to scale: $b/2 < P < 2b/3$; and
(c) decreasing output: $P > 2b/3$.

Even in the case of a rudimentary economy with no infrastructure links to the outside world, some interesting findings emerged:

1. When $P < b/2$, a network city possessing nodes of different sizes is more productive than one with nodes of equal size.
2. When $P = 2b/3$, the bicentric corridor city is as productive as a monocentric city of equivalent size.
3. When $P > 2b/3$, a network city is more productive than its monocentric counterpart, and one with nodes of equal sizes outperforms one where the nodal sizes differ.

It should be stressed that the analytical framework outlined above is unacceptably simple. Amenity attractiveness, commuting distances and congestion effects should also be considered. In its dynamic form, the model visualised would also include additional interactive terms to cater for migration, trade and other networking activities.