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John I. Carruthers

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Summary. This paper examines the impact that alternative state planning frameworks have on five dimensions of urban development: density, the spatial extent of urbanised land area, property value, public expenditures on infrastructure and population change. The objectives of the analysis are threefold. First, the background discussion provides a brief overview of urban sprawl as a public policy problem and outlines how state growth management programmes attempt to respond to it. Secondly, the empirical analysis examines the effects of growth management in a cross-section of metropolitan counties during the 1982–97 time-period. The five outcome measures are modelled in a simultaneous equations framework in order to test several specific hypotheses about how state land-use policies affect the character of urban growth. Thirdly, the results of the empirical analysis are described within the context of previous research on the effectiveness of growth management. The findings suggest that state growth management programmes with strong consistency requirements and enforcement mechanisms hold much promise for reducing urban sprawl, while programmes that do not require consistency and/or have weak enforcement mechanisms may inadvertently contribute to it.

1. Introduction

Mounting concern over the consequences of urban sprawl in US metropolitan areas has led to widespread expansion of state-based land-use planning programmes over the past 15 years. Beginning in the late 1980s, numerous states have recently adopted, or revised existing, legislation mandating a consistent set of goals and standards for local land-use plans. By the year 2001, at least 11 states—Arizona, Florida, Georgia, Maine, Maryland, New Jersey, Oregon, Rhode Island, Tennessee, Vermont and Washington—had adopted comprehensive state-wide growth management legislation and several others had adopted narrower legislation covering specific sub-state areas (Burby and May, 1997). Compared with earlier state land-use reforms, which focused primarily on environmental protection, these 'second wave' programmes incorporate a wide range of 'quality of life' concerns and place a major emphasis on limiting urban sprawl (DeGrove, 1992; Weitz, 1999). Although specific requirements and enforcement mechanisms vary from state to state, a common objective is to co-ordinate the planning activities of local governments in a way that produces a uniform framework for dealing

John I. Carruthers is in the School of Planning, University of Arizona, 1040 North Olive, PO Box 210075, Tucson, Arizona 85721–0075, USA. Fax: 520 626 7311. E-mail: jcarruth@u.arizona.edu. *The author wishes to thank Christine Bae, Hilda Blanco, J. W. Harrington, Gudmundur Ulfarsson and Paul Waddell at the University of Washington and Laura Huntoon at the University of Arizona for their helpful comments and suggestions. Support for this research was provided by the Lincoln Institute of Land Policy and the Drachman Institute for Land and Regional Development Studies.*

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with the pressures of rapid population growth and land development. By creating a better match between the local scale of land-use regulation and the regional scale of growth pressures, state planning mandates seek to increase the overall quality of planning across metropolitan areas (Bollens, 1993; Carruthers, 2002).

Despite their considerable promise for reducing sprawl, growth management programmes remain controversial because there is little rigorous empirical evidence of their effectiveness. Moreover, critics suggest that growth management may even lead to severe negative impacts by promoting lower urban densities, inflating property markets and/or slowing population growth—although the latter may be perceived by some as a positive outcome. Given the ambiguity surrounding growth management, serious questions remain regarding programmes' ability to deliver their intended results. Do state planning programmes have a substantive impact on the outcome of urban development? If so, which outcomes imply that growth management has been effective? And, finally, what policy characteristics account for a programme's relative success or failure?

This paper responds to these questions by examining the impact that alternative state planning frameworks have on five dimensions of urban growth: density, the spatial extent of urbanised land area, property value, public expenditures on infrastructure, and population change. The objectives of the analysis are threefold. First, the background discussion provides a brief overview of urban sprawl as a public policy problem and outlines how state growth management programmes attempt to respond to it. Secondly, the empirical analysis examines the effects of growth management in a cross-section of metropolitan counties during the 1982–97 time-period. The five dimensions are modelled in a simultaneous equations framework in order to test several specific hypotheses about how state land-use policies affect the outcome of development. Thirdly, the results of the empirical analysis are described within the context of previous research on the effectiveness of growth management. The findings suggest that state growth management programmes with strong consistency requirements and enforcement mechanisms hold much promise for reducing urban sprawl, while programmes that do not require consistency and/or have weak enforcement mechanisms may inadvertently contribute to it.

2. Background

2.1 Fragmentation and Sprawl

Urban sprawl consists of spatially expansive, discontinuous, suburban-style development and is often characterised as the result of rapid, unplanned and/or unco-ordinated growth (Nelson *et al.*, 1995). It is variously composed of low-density, single-use, scattered, strip and leapfrog developments and has been extensively criticised for being inefficient, inequitable and environmentally insensitive (see, for example, Ewing, 1997; Burchell, 1998; Downs, 1999). In particular, sprawl is faulted for contributing to excessive commuting and transport costs, raising the cost of providing infrastructure and other public services, promoting socioeconomic segregation through inequitable land and housing markets, hastening the consumption of natural open space, including resource lands and wildlife habitats, and numerous other 'quality of life' problems (Downs, 1992, 1994; Knaap and Nelson, 1992; Orfield, 1997; Pendall, 1999; Rusk, 1999; Bruekner, 2000; Carruthers and Ulfarsson, 2001). But despite these criticisms, straightforward solutions have not been forthcoming for planners and other advocates of alternative development patterns. Instead, urban sprawl continues to represent the dominant mode of growth in many US metropolitan areas, presenting one of the most vexing problems faced by contemporary urban and regional policy.

Among the many factors that contribute to the endurance of urban sprawl are lifestyle choices favouring single-family housing, automobile ownership, low-rise workplaces

and small local governments (Downs, 1994). Together, along with rising incomes that enable people to pursue them, these preferences perpetuate sprawl through a self-reinforcing cycle that creates a continuous demand for suburban living environments (Bruekner, 2000). And while each factor contributes to the problem, preferences for small local governments play an especially important role by fuelling the process of political fragmentation and, in turn, undermining the overall ability of land-use planning to guide the growth of metropolitan areas. Fragmentation occurs through the formation of new local governments as residents attempt to gain a greater degree of autonomy from surrounding jurisdictions. Once obtained, a community's independence is largely embodied in its ability to regulate land use and control the rate and composition of new development within its boundaries (Lewis, 1996).

The resulting division of authority contributes to urban sprawl by establishing low overall densities and creating inconsistencies among the land-use plans of adjacent jurisdictions. First, communities often draw on zoning and other land-use controls to enforce their residents' preferences for suburban living, especially single-family housing. In addition to shaping the physical environment, this approach to land-use regulation helps to secure enduring property values, quality public services and other amenities for local residents. But, by definition, low-density zoning also spreads out metropolitan areas, and has often been labelled 'exclusionary' due to the physical and socioeconomic limits it places on growth (Fischel, 1985, 1990; Altshuler and Gomes-Ibanez, 1993; Pendall, 2000). Secondly, as an extension, locally oriented land-use regulation may create increased growth and congestion in other areas by forcing new development elsewhere (Fischel, 1985; Downs, 1999). Adding to the problem, communities often adopt growth controls in response to one another as they attempt to limit their participation in regional growth patterns (Glickfield and Levine, 1992; Shen, 1996). Development ends up being directed to newly formed communities located at the urban fringe, where land is inexpensive and development is deliberately allowed to proceed with minimal regulation. The cumulative effect is urban sprawl, as unco-ordinated growth is shifted from community to community, hastening the spatial expansion of the metropolitan area as a whole (see Carruthers and Ulfarsson, 2002, and Carruthers, 2001, for detailed analyses of the situation described here).

In sum, urban sprawl may be characterised as the combination of a physical pattern of development and the lifestyle choices and political institutions that reinforce it. Political fragmentation plays an especially important role because, by dividing authority among many local governments, it undermines the overall ability of land-use planning to shape the outcome of metropolitan growth. While some communities may freely co-operate with their neighbours, others remain focused on their own wellbeing, unwilling to address growth-related problems that extend beyond their borders. Within this context, sprawl has evolved as a serious public policy problem with no straightforward solution due to the mismatch between the local scale of land-use regulation and the regional scale of growth pressures that occurs under a decentralised system of land-use governance (Bollens, 1993).

2.2 The Role of State Growth Management Programmes

State growth management programmes evolved out of the environmental movement of the late 1960s and early 1970s. This 'quiet revolution' in land-use reform initiated state involvement in local planning practices by taking back certain land-use powers granted to local governments through legislation based in the federal government's 1924 Standard Zoning Enabling Act. In most cases, the result was a double veto system where the state reserved pre-emptive authority over land-use decisions made at the local level (Bollens, 1992). Because of their broad scope, these powers were reserved primarily

for critical environmental areas and developments deemed to be of greater than local importance. Since that time, numerous states have extended their involvement in land-use planning through legislation aimed at shaping communities' responses to growth more directly. Building on the environmental focus of early programmes, the so-called 'second wave' of state growth management programmes identified specific requirements for local plans and focused on containing urban sprawl by accommodating growth through co-ordinated, well-planned land use (DeGrove, 1992; Nelson and Peterman, 2000). These programmes were significant because they were designed to incorporate a broad set of concerns relating to the fiscal, social, political and environmental pressures of growth. The guiding principle behind this move was that individual communities acting in their own self-interest cannot be expected to take consistent action in the face of rapid population growth and land development. Instead, as described above, due to political fragmentation, metropolitan areas are planned incrementally through countless land-use decisions—a process that ultimately contributes to urban sprawl (Gale, 1992; Porter, 1997; Weitz, 1999).

Contemporary state growth management programmes respond to this problem by mandating goals and standards for local land-use plans, prescribing the use of specific policy instruments for regulating the outward pace of development and using enforcement mechanisms aimed at ensuring uniform compliance among jurisdictions. First, although the key feature of state planning mandates is that local governments prepare land-use plans, specific consistency requirements vary from state to state. Vertical consistency requires plans to be consistent with state-defined policy objectives; horizontal consistency requires local plans to be consistent with one another; and internal consistency requires consistency between local plans and development regulations—especially the zoning ordinance. Vertical and horizontal consistency requirements work to co-ordinate local planning practices, while internal consistency requirements are intended to ensure that plans are carried out once they have been prepared. The strongest state planning frameworks require all three types of consistency, but weaker frameworks require fewer, or only encourage consistency (Gale, 1992; Burby and May, 1997; Weitz, 1999). In addition to comprehensive planning, certain states prescribe the use of specific policy instruments, including urban growth boundaries and/or concurrency requirements, to regulate the outward expansion of urban development. In these cases, communities must designate urban growth areas and provide infrastructure to support new development before it is allowed to proceed (Knaap and Nelson, 1992; Nelson *et al.*, 1995; Knaap and Hopkins, 2001). Finally, where earlier programmes mostly used pre-emptive authority to obtain compliance from local governments, contemporary state planning mandates generally follow either a conjoint or co-operative approach (Bollens, 1992, 1993; DeGrove, 1992). In a penalty-based conjoint framework, local governments are required by law to prepare land-use plans and may be subject to strict sanctions, including temporary loss of funding and/or authority to approve development proposals, if they fail to meet state-defined standards. This compares with the more flexible co-operative framework, where planning is voluntary and incentives, such as additional state funding, are the primary means of enforcing prescribed standards. In both cases, communities may be eligible for financial aid and/or technical assistance from the state government in order to increase the quality of their plans.

Despite the successes attained over the past decade, state growth management programmes remain controversial on several fronts. First, as already mentioned, local autonomy is largely embodied in the ability to regulate land use. Local governments have traditionally had wide latitude to adopt and implement land-use regulations (or not), according to their individual orientation towards growth. Even though they are endowed with this authority by state enabling

legislation, local officials have become accustomed to thinking of these powers as being theirs by right, a sentiment that is often mirrored by residents (Gottdiener and Neiman, 1981; Kelly, 1993; Porter, 1997). Secondly, as an extension, local inconsistencies remain a major problem, even within well-established frameworks (Burby and May, 1997). Enforcing state growth management legislation is a difficult and time-consuming task that grows increasingly complicated as mandates become more strict; in Oregon, for example, it took 12 years for all jurisdictions to develop plans meeting the standard of the state review process. Finally, although there is evidence that state planning mandates work to increase the quality of local plans, little is known about the eventual impact on the outcome of urban development. Although numerous studies have documented localised effects consistent with the expectations of growth management, few have produced results that are generalisable to other cases.[1] Moreover, critics of growth management argue that it may promote, rather than limit, sprawl (especially where urban containment is involved), inflate property values and/or reduce population growth in affected regions (Richardson and Gordon, 2001). In short, serious questions remain about whether or not state-based growth management produces its intended effects, even as it continues to gain momentum and political support.

3. Analytical Framework

An analytical framework developed in previous research (Carruthers, 2002) provides a foundation for evaluating the impacts of state land-use legislation. The framework argues that three key factors influence the effects that growth management has on the outcome of urban development. First, as described in the background discussion, the overarching purpose of state planning programmes is to co-ordinate the planning activities of local governments. This is achieved through legislation mandating a comprehensive set of standards and objectives for local land-use plans, but specific requirements and enforcement mechanisms vary from programme to programme. The combination of policies embodied by a given growth management programme may therefore be characterised according to the specific consistency requirements, urban containment policies and enforcement mechanisms mandated by state legislation. Secondly, given their objective of promoting regulatory consistency, political fragmentation represents the main countervailing influence on the success of state growth management programmes. The more fragmented the institutional setting of a region, the less the overall consistency of land-use regulation and the more likely it is to be affected by urban sprawl. Finally, the effects of policies and political fragmentation converge through the mediating influences of regional land markets. Land markets are the keystone of the process because they represent the medium through which the locational decisions of households and land developers shape metropolitan spatial structure. State growth management policies and fragmentation interact to influence where new development occurs by creating supply constraints within the land market, depending on the degree of variation among the land-use regulations of individual jurisdictions. When land-use controls are implemented uniformly, these effects are minimised but, under more decentralised systems, growth is directed to areas that remain comparatively free from regulation. Demand factors also play an important role because, like all markets, the land market responds to the tastes and preferences of individual consumers.

The effects of growth management may be observed through its impacts on urban form and property values and, in turn, their impacts on infrastructure expenditures and population change. First, urban form is observed in two dimensions: density and the spatial extent of urbanised land area. These outcomes are particularly important because, together, they act as direct measures of the degree to which metropolitan areas sprawl. Both measures are necessary to get a clear picture of urban form because sprawl is characterised by the spread of development (land

area) in addition to its bulk (density). Secondly, property values are affected as land-use policies become capitalised into land and housing values—either by creating benefits or by denying development opportunities. Thirdly, infrastructure expenditures are indirectly affected through policies' impacts on urban form; for this reason, planners and other advocates of growth management argue that compact development patterns are necessary for efficient service provision. Finally, growth management may affect population change if policies act to increase property values enough to price people out of land and housing markets. This issue merits careful investigation because little is known about how state-based planning programmes influence growth rates—if at all.

The analytical framework is presented graphically in Figure 1. The figure includes an arrow across the top (marked regulatory consistency) illustrating that state growth management programmes affect the planning activities of local governments through their

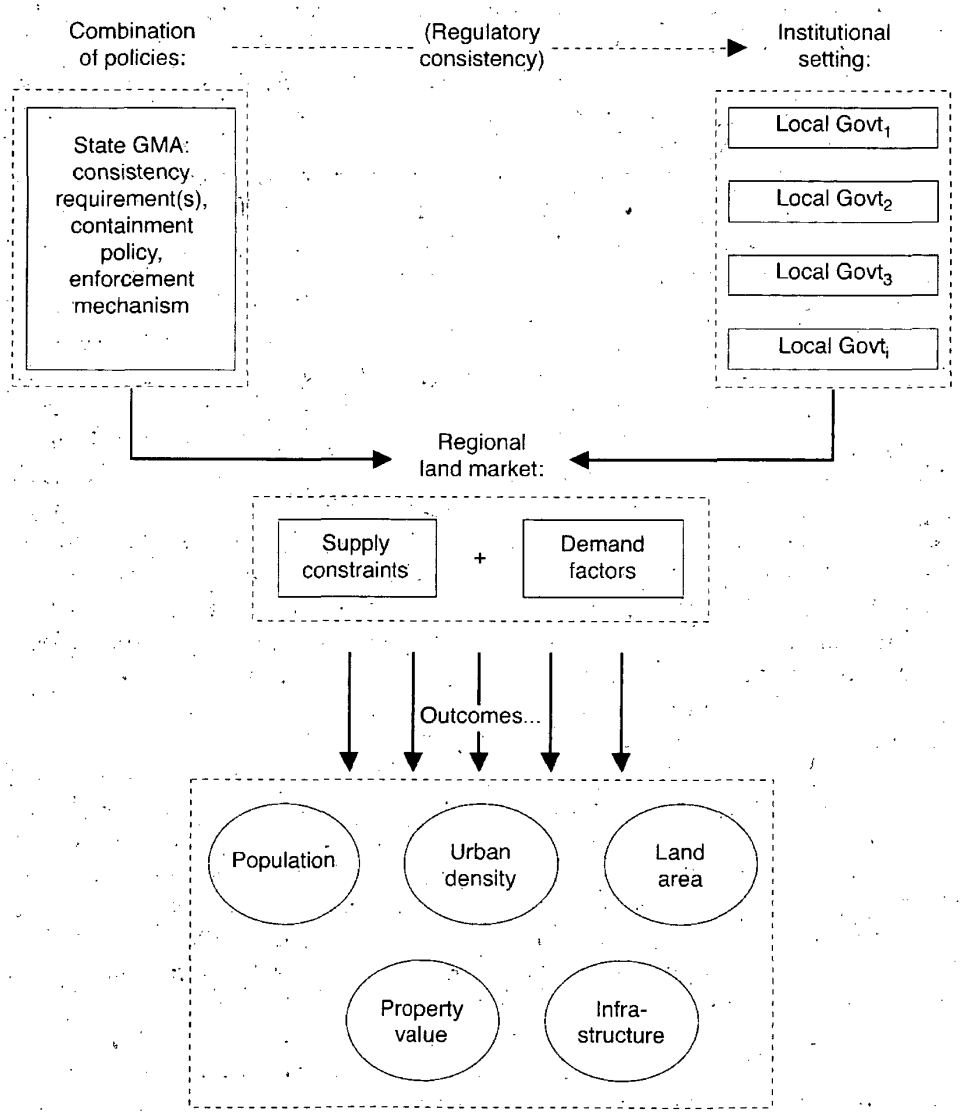

Figure 1. Analytical framework for evaluating regulatory growth management programmes. *Source:* adapted from Carruthers (2002).

consistency requirements and/or other guidelines.[2] Growth management is therefore characterised as a combination of policies that are implemented within an existing institutional setting; measured as the degree of fragmentation among local land-use authorities. Even though state planning programmes are carried out via local land-use regulations, the two boxes act as separate inputs into the regional land market because the same combination of policies is likely to produce different results under an alternative institutional setting—that is, depending on the complexity of the underlying political landscape. In turn, households and land developers respond via the regional land market, which is shaped by supply and demand factors. For example, developers attempt to minimise their variable costs by building in locations with relatively less restrictive land-use regulations; ultimately, this savings is passed on to home-buyers. Although there is good evidence that this process is at work (see Carruthers and Ulfarsson, 2002), little is known about whether or not state land-use legislation alters the outcome in any way.

Within this context, the effectiveness of growth management programmes may be gauged based on the following criteria:

—Do state planning mandates reduce urban sprawl? If so, their impacts should manifest in increased densities and less urbanised land area.
—How do state planning mandates affect property markets? Programmes that promote regulatory consistency and the accommodation of new development should have little impact on property values because they explicitly remove the opportunities and constraints that arise in land markets via political fragmentation.
—Do changes in density, the spatial extent of urbanised land area and property values affect the cost of infrastructure? If planners are correct, greater densities and lesser amounts of urbanised land lead to a reduction in public expenditures.
—And, finally, do high property values slow population growth? If so, growth management programmes that raise property values may appropriately be criticised for their exclusionary consequences—especially if they also fail to limit sprawl (Fischel, 1990; Richardson and Gordon, 2001).

The following empirical analysis investigates these questions.

4. Empirical Analysis

4.1 Data-set and Variables

The empirical analysis focuses on 283 metropolitan counties, observed at 4 points in time: 1982, 1987, 1992 and 1997 (total $n = 1132$). This includes all metropolitan counties (1998 Census definition) located in Arizona, California, Colorado, Florida, Georgia, Idaho, Nevada, New Mexico, North Carolina, Oregon, Tennessee, Texas, Utah and Washington. These states were selected in order to capture as much geographical diversity as possible while at the same time retaining similarity in underlying growth processes during the study period. Specifically, all 14 states have experienced significant population gains over the past two decades and, as a result, are among the most rapidly urbanising in the nation.[3] This is illustrated in Table 1, which lists growth characteristics for each, including net population change, percentage population change and percentage change in urbanised land between 1982 and 1997. Tennessee is the only state included that grew by less than 20 per cent during the study period; Nevada and Arizona top the national ranking at 90 per cent and 58 per cent respectively. At the same time, each of the states experienced considerable land development over the 15-year time-period (at least a 30 per cent increase in urbanised land), although there is wide variation in the magnitude of that change with respect to population growth. At one end of the spectrum lies Tennessee, which gained urban land at nearly four times the rate it gained people and, at the other end, lies Nevada, which gained people at over twice the rate it gained urbanised land.

In addition to these factors the states were

Table 1. Selected growth characteristics for rapidly growing states, 1982–97

State	Population 1982	Population 1997	Net population change 1982–97	Percentage population change 1982–97	Percentage change urbanised land 1982–97
Arizona	2 889 861	4 552 207	1 662 346	57.52	37.00
California	24 820 009	32 217 708	7 397 699	29.81	31.85
Colorado	3 061 564	3 891 293	829 729	27.10	33.58
Florida	10 471 407	14 683 350	4 211 943	40.22	58.49
Georgia	5 649 792	7 486 094	1 836 302	32.50	67.18
Idaho	973 721	1 210 638	236 917	24.33	37.20
Nevada	881 537	1 675 581	794 044	90.07	40.12
New Mexico	1 363 823	1 722 939	359 116	26.33	47.59
North Carolina	6 019 101	7 428 672	1 409 571	23.42	59.57
Oregon	2 664 922	3 243 254	578 332	21.70	27.91
Tennessee	4 646 041	5 378 433	732 392	15.76	57.55
Texas	15 331 415	19 355 427	4 024 012	26.25	36.28
Utah	1 558 314	2 065 397	507 083	32.54	40.74
Washington	4 276 552	5 604 105	1 327 553	31.04	34.34

Sources: US Bureau of the Census (1998); col. 6: US Department of Agriculture, *National Resources Inventory* (1997).

chosen to represent a variety of orientations towards land use. Although most of the states do not have growth management programmes, Florida, Georgia, Oregon and Washington do.[4] Moreover, California has a comprehensive planning mandate, although it is not considered a growth management state since its planning framework emphasises a locally oriented approach to growth control (Fulton, 1999). Pooled across states and years of observation, the data-set enables a comparative analysis of alternative planning frameworks by including counties subject to four different growth management programmes, a state comprehensive planning mandate and no state-based planning requirements. After accounting for dates of adoption, 382 observations (33 per cent) are subject to some form of state land-use legislation. The longitudinal structure of the data-set also captures many counties before and after state planning programmes were implemented; for example, Washington's growth management act (GMA) was adopted in 1990, so half of the state's observations (from 1982 and 1987) were made before the programme came into being. These features, combined with the significant state land-use reforms that occurred during the late 1980s and early 1990s, make the data-set ideal for studying the impacts of growth management. The following paragraphs provide descriptions of the dependent and independent variables collected for each county.

The conceptual model (Figure 1) identifies a set of five interdependent outcome measures for evaluating the effectiveness of state planning programmes: urban density (d), measured as the number of jobs and people per acre of developed land;[5] the spatial extent of urbanised land area (a), measured as acres of developed land; property value (v), measured as total locally assessed property value per acre of urbanised land;[6] expenditures on infrastructure (e), measured as per capita public outlays on roadways and sewer systems; and population (p). The form of the interdependency among these variables is given by

$$d = \mathrm{f}(v, \mathbf{x}) \quad (1a)$$

$$a = \mathrm{f}(d, p, \mathbf{x}) \quad (1b)$$

$$v = \mathrm{f}(d, \mathbf{x}) \quad (1c)$$

$$e = \mathrm{f}(d, a, v, \mathbf{x}) \quad (1d)$$

$$p = \mathrm{f}(v, \mathbf{x}) \quad (1e)$$

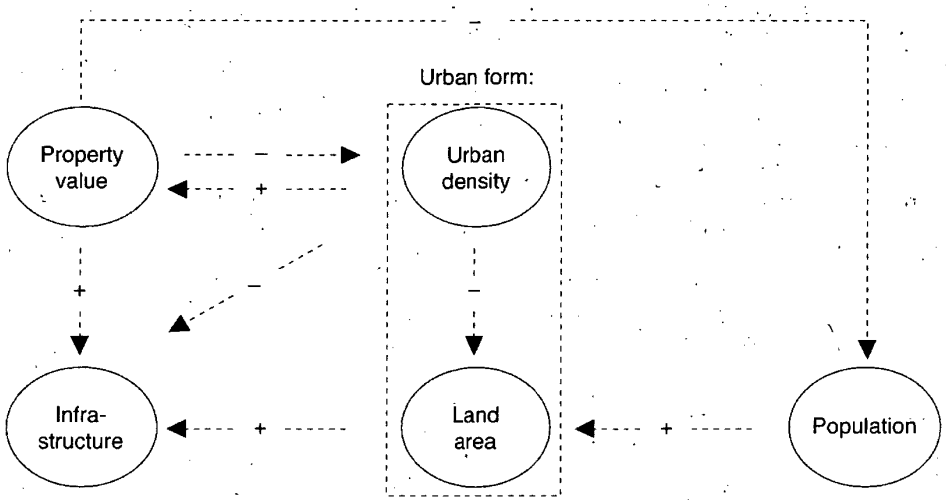

Figure 2. Interdependency in outcome measures of metropolitan development.
Source: adapted from Carruthers (2002).

where **x** represents a vector of exogenous variables that is different in each equation.

The variables are hypothesised to be linked in the following ways. First, density and property value are a function of one another; the higher the property value, the denser the development, and the denser the development, the greater the property value. Secondly, the spatial extent of urbanised land area is influenced by density, which determines the area that each unit of development occupies, and population, which, other things being equal, determines the size of the urbanised area directly. Thirdly, expenditures on infrastructure are influenced by density, which affects the marginal cost of delivering services, urbanised land area, which determines the extent of the roadways and sewers needed, and property value, which determines the amount of tax revenues available for investing in capital facilities. Finally, population change is influenced by property value because people's ability to locate in a given area depends on whether or not they can afford to do so. The relationships are shown graphically in Figure 2, with the variables that growth management is expected to influence directly shaded in gray. With the exception of property value's influence on population, the same relationships have been successfully applied in previous research (Carruthers and Ulfarsson, 2001, 2002).

The conceptual model also provides direction for specifying the independent, or exogenous, variables (the vector **x** in the equations above), including variables representing the presence of state land-use policies, the institutional setting and land market characteristics. First, the combination of policies affecting a given county is measured as the length of time state planning mandates have been in place. Modelling growth management in continuous form—as opposed to the more common indicator, or dummy, variable approach—enables observation of how the effectiveness of policies changes over time. The result is five 'growth management' variables, including one each for the mandates in California, Florida, Georgia, Oregon and Washington, which embody the combinations of policies depicted in Table 2. The policy variables are expected to act on density, urbanised land area and property values; as discussed above, infrastructure expenditures and population are affected indirectly through changes in the other variables. Secondly, the institutional setting is measured in four ways: per capita municipalities, per capita special districts, and by indicator variables marking counties containing a central

Table 2. Characteristics of selected state comprehensive planning mandates

State	Date	Consistency requirements	Prescribed containment policies	Enforcement mechanism	Mandated plans
California	1934	Internal	None	Conjoint	Cities, counties
Florida	1985	Vertical, horizontal, internal	Concurrency	Conjoint	State, cities, counties, regions
Georgia	1989	None	None	Co-operative	State, regions
Oregon	1975	Vertical, internal	UGB	Conjoint	Cities, counties, Portland region
Washington	1990	Horizontal (for counties), internal	UGB	Conjoint	Cities, counties

Sources: Bollens (1992); Gale (1992); and Burby and May (1997).

city and where city and county governments have been consolidated. The first two are measured at time $t-1$ while the latter two are measured at time t, and all four are expected to influence each of the outcome variables except for population (see Carruthers and Ulfarsson, 2002).[7] Finally, the regional land market is characterised by per capita income, representing demand and taste, and the percentage of the county area dedicated to agricultural production, the main source of competition for urban land. Income is expected to lower densities, spread out metropolitan areas (more urbanised land) and raise property values, while agricultural land is expected to reduce the spatial expansion of urban areas.

In addition to the factors identified in the conceptual model, two others are important determinants of the outcome measures. First, capital investments in previous time-periods, including roadways and sewers, are hypothesised to influence the spatial expansion of metropolitan areas by 'paving the way' for new growth. Because it takes time for builders to respond to new investments, spending at time $t-1$ is expected to affect the spatial extent of urbanised land area at time t. Secondly, the analysis controls for two basic geographical characteristics: population at time $t-1$, as the most important determinant of population at time t, and county land area, because bigger territories can be expected to hold larger amounts of urbanised land. The influences that these and all other exogenous variables are expected to have on each of the relevant dependent variables are summarised in Table 3; descriptive statistics and data sources for all variables are shown in Table 4.

4.2 Econometric Specification

The relationships in (1) describe a system of simultaneous equations that are contemporaneously correlated and related through the endogenous variables. In order to estimate the equations within an econometric framework, two accommodations must be made. First, because of the interdependency among the dependent variables—density and property value are endogenous and all five are simultaneously determined—estimating the functions equation-by-equation using ordinary least squares (OLS) will result in biased coefficients. Instead, the equations are estimated using three-stage least squares (3SLS) regression, which makes use of assumptions similar to those of OLS: the individual dependent variables are assumed to be linear in parameters functions of the endogenous and exogenous explanatory variables and a random disturbance term; the disturbance terms are assumed to have a mean of zero, constant variance (homoscedasticity) and to be uncorrelated with each other (no autocorrelation), except that they can be contemporaneously correlated across equations. Contempo-

Table 3. Expected effects of explanatory variables on density, urbanised land area, property value, infrastructure expenditures and population

	Density	Urbanised land	Property value	Infrastructure	Population
Endogenous variables					
Population	n/a	+	n/a	n/a	n/a
Density	n/a	−	+	−	n/a
Urbanised land (acres)	n/a	n/a	n/a	+	n/a
Property value ($100/acre)	+	n/a	n/a	+	−
Growth management programme					
Age of California mandate (years)	+ / −	+ / −	+ / −	n/a	n/a
Age of Georgia mandate (years)	+ / −	+ / −	+ / −	n/a	n/a
Age of Florida mandate (years)	+ / −	+ / −	+ / −	n/a	n/a
Age of Oregon mandate (years)	+ / −	+ / −	+ / −	n/a	n/a
Age of Washington mandate (years)	+ / −	+ / −	+ / −	n/a	n/a
Institutional setting					
Per capita municipalities (1000s), $t-1$	+ / −	+ / −	+ / −	+ / −	n/a
Per capita special districts (1000s), $t-1$	+ / −	+ / −	+ / −	+ / −	n/a
Central-city indicator	+ / −	+ / −	+ / −	+ / −	n/a
Consolidated indicator	+ / −	+ / −	+ / −	+ / −	n/a
Land market characteristics					
Per capita personal income	−	+	+	n/a	n/a
Percentage of county area in farms	n/a	−	n/a	n/a	n/a
Infrastructure					
Spending on roadways ($1000/capita), $t-1$	n/a	+	n/a	n/a	n/a
Spending on sewers ($1000/capita), $t-1$	n/a	+	n/a	n/a	n/a
Geographic characteristics					
Population, $t-1$	n/a	n/a	n/a	n/a	+
Size of county (acres)	n/a	+	n/a	n/a	n/a

Table 4. Descriptive statistics and data sources

	Mean	Median	Standard deviation	Data source
Endogenous variables				
Density	5	4	4.38	NRI, REIS
Urbanised land (acres)	73 893	503 50	86 817.7	NRI
Property value ($100/acre)	58 530	33 608	94 698.04	Census of Governments, REIS
Population	289 338	118 964	639 119	REIS
Spending on roadways ($1000/capita)	112.80	96.61	75.41	Census of Governments, REIS
Growth management programme				
Age of California mandate (years)	—	—	—	Burby and May (1997)
Age of Georgia mandate (years)	—	—	—	Burby and May (1997)
Age of Florida mandate (years)	—	—	—	Burby and May (1997)
Age of Oregon mandate (years)	—	—	—	Burby and May (1997)
Age of Washington mandate (years)	—	—	—	Burby and May (1997)
Institutional setting				
Per capita municipalities (1000s), $t-1$	0.08	0.05	0.105	Census of Governments, REIS
Per capita special districts (1000s), $t-1$	0.13	0.09	0.15	Census of Governments, REIS
Central-city indicator	—	—	—	State and Metropolitan Area Data Book
Consolidated indicator	—	—	—	American Places Dictionary
Land market characteristics				
Per capita personal income	130 59	12 697	3 141.76	REIS
Percentage of county area in farms	39	35	25.69	Census of Agriculture
Infrastructure				
Spending on roadways ($1000/capita), $t-1$	73	65	51.44	Census of Governments, REIS
Spending on sewers ($1000/capita), $t-1$	35	23	39.35	Census of Governments, REIS
Geographical characteristics				
Population, $t-1$	261 520	105 963	595 723.76	REIS
Size of county (acres)	1 364	713	2 412.77	Census of Governments

raneous correlation means that the error terms of each equation are correlated, allowing for system-wide 'shocks' that affect all equations at once. Overall, this effect is beneficial but special care must be taken because a specification error in one or more equations leads to a system-wide bias. See Pindyck and Rubinfield (1991) for a detailed discussion of systems estimation, or Kennedy (1998) for a non-mathematical overview of the methodology and assumptions involved.

Secondly, in order to accommodate the longitudinal structure of the data-set, the model is specified using a fixed effects method, adding constant terms for the years 1987, 1992 and 1997, and 13 of the states—one from each group is omitted in order to avoid perfect multicollinearity with the overall intercept. The temporal fixed effects control for unobserved effects shared by observations during a given year across all locations, while the locational fixed effects control for unobserved effects shared by observations located in a given state across all time-periods. Of particular concern in the latter case are state-wide policies besides growth management that land use patterns, including annexation regulations and economic development programmes. Because the fixed effects capture the influence of all excluded factors associated with a given time-period or location, the approach also helps to minimise any omitted variable bias that may affect the parameter estimates.

The econometric specification of (1) therefore takes the following functional form

$$d_{it} = \alpha_d + \lambda_{dj} + \tau_{dt} + \gamma_d \mathbf{z}_{dit} + \beta_d \mathbf{x}_{dit} + \varepsilon_{dit} \quad (2a)$$

$$a_{it} = \alpha_a + \lambda_{aj} + \tau_{at} + \gamma_a \mathbf{z}_{ait} + \beta_a \mathbf{x}_{ait} + \varepsilon_{ait} \quad (2b)$$

$$v_{it} = \alpha_v + \lambda_{vj} + \tau_{vt} + \gamma_v \mathbf{z}_{vit} + \beta_v \mathbf{x}_{vit} + \varepsilon_{vit} \quad (2c)$$

$$e_{it} = \alpha_e + \lambda_{ej} + \tau_{et} + \gamma_e \mathbf{z}_{eit} + \beta_e \mathbf{x}_{eit} + \varepsilon_{eit} \quad (2d)$$

$$p_{it} = \alpha_p + \lambda_{pj} + \tau_{pt} + \gamma_p \mathbf{z}_{pit} + \beta_p \mathbf{x}_{pit} + \varepsilon_{pit} \quad (2e)$$

where, i extends over all counties; t extends over the four time-periods 1982, 1987, 1992 and 1997, j extends over the 14 states; and the subscripts, d, a, v, e and p represent the urban density, urbanised land area, property value, infrastructure expenditure and population equations respectively. In these equations, α represents the overall constant; λ represents the locational fixed effects; τ represents the temporal fixed effects; γ represents a vector of estimable coefficients on the endogenous variables; β represents a vector of estimable coefficients on the exogenous variables; $\mathbf{z}$ and $\mathbf{x}$ respectively represent vectors of appropriate endogenous and exogenous variables; and ε represents the error term.

4.3 Estimation Results

The results of the empirical model are presented in Table 5, which shows the three-stage least squares (3SLS) parameter estimates and *t*-statistics for the dependent variables in each of their relevant equations.[8] The analysis tests eight sets of hypotheses corresponding to the groups of independent variables listed in the table. The first set relates to the interdependency among the five dependent variables. Consistent with the findings of previous research, the model upholds the hypothesised relationships among the dependent variables. Density and property value positively influence one another; the spatial extent of urbanised land area is negatively influenced by density and positively influenced by population; and the amount of money spent on infrastructure is positively influenced by property value and urbanised land area (Carruthers and Ulfarsson, 2002). The only previously untested relationship also fulfills expectations, with property value negatively influencing population—fewer people locate in counties with high property values. Each of these relationships is significant at better than a 99 per cent confidence interval.

The second set of explanatory variables concerns the influence of state growth management policies on the three outcome variables that they are hypothesised to affect directly. The equations reveal substantive differences in the effectiveness of each of the state-based programmes accounted for in the model. California's planning mandate has led to lower overall urban densities and higher

Table 5. 3SLS estimates of density, land area, property value, infrastructure and population equations

	Density		Urbanised land		Property value		Infrastructure		Population	
	Coefficient	*T*-statistic	Coefficient	*T*-statistic	Coefficient	*T*-statistic	Coefficient	*T*-statistic	Coefficient	*T*-statistic
Constant	5.22$^{\#\#\#}$	15.76	26 494.87$^{\#\#\#}$	3.85	− 97 623.41$^{\#\#\#}$	− 16.06	66.46$^{\#\#\#}$	6.28	15 878.99$^{\#\#\#}$	5.26
Endogenous variables										
Density	—	—	− 4 015.84***	− 4.55	18 775.88***	41.12	− 9.75***	− 3.75	—	—
Urbanised land (acres)	—	—	—	—	—	—	3.75E-05**	1.42	—	—
Property value ($100/acre)	5.34E-05***	40.96	—	—	—	—	1.04E-03$^{\#\#\#}$	9.71	− 0.10***	− 4.00
Population	—	—	0.12***	61.40	—	—	—	—	—	—
Growth management programme										
Age of California mandate (years)	− 0.14$^{\#\#\#}$	− 4.71	247.41$^{n/s}$	0.51	2 500.18$^{\#\#\#}$	4.58	—	—	—	—
Age of Georgia mandate (years)	− 0.13$^{\#\#\#}$	− 2.89	− 806.18$^{n/s}$	− 1.06	2 681.96$^{\#\#\#}$	3.16	—	—	—	—
Age of Florida mandate (years)	− 0.01$^{n/s}$	− 0.18	1 380.86$^{\#\#\#}$	2.38	187.87$^{n/s}$	0.29	—	—	—	—
Age of Oregon mandate (years)	0.08$^{\#}$	1.44	− 827.94$^{n/s}$	− 0.95	− 1 027.17$^{n/s}$	− 1.05	—	—	—	—
Age of Washington mandate (years)	− 0.09$^{n/s}$	− 1.05	632.98$^{n/s}$	0.43	1 677.20$^{n/s}$	1.00	—	—	—	—
Institutional setting										
Per capita municipalities (1000s), $t-1$	− 3.21$^{\#\#\#}$	− 4.84	− 61 593.15$^{\#\#\#}$	− 5.91	60 590.95$^{\#\#\#}$	4.71	− 2.56$^{n/s}$	− 0.11	—	—
Per capita special districts (1000s), $t-1$	− 4.10$^{\#\#\#}$	− 8.33	− 15 675.71$^{\#\#}$	− 1.67	77 920.53$^{\#\#\#}$	7.79	− 6.14$^{n/s}$	− 0.29	—	—
Central-city indicator	0.71$^{\#\#\#}$	5.55	14 663.55$^{\#\#\#}$	6.83	− 13 256.82$^{\#\#\#}$	− 5.26	33.69$^{\#\#\#}$	6.84	—	—
Consolidated indicator	2.10$^{\#\#\#}$	4.84	23 960.36$^{\#\#\#}$	2.35	− 39 721.45$^{\#\#\#}$	− 4.50	46.67$^{\#\#\#}$	2.31	—	—
Land market characteristics										
Per capita personal income	− 2.63E-03***	− 10.39	3.01$^{\#\#\#}$	7.69	4.88$^{\#\#\#}$	11.53	—	—	—	—
Percentage of county area in farms	—	—	− 80.49**	− 1.76	—	—	—	—	—	—
Infrastructure										
Spending on roadways ($1000/capita, $t-1$	—	—	60.72**	2.85	—	—	—	—	—	—
Spending on sewers ($1000/capita, $t-1$	—	—	86.92**	3.43	—	—	—	—	—	—
Geographic characteristics										
Population, $t-1$	—	—	—	—	—	—	—	—	1.07***	525.41
Size of county (acres)	—	—	0.01***	5.66	—	—	—	—	—	—

Locational effects									
Arizona	1.96$^{\#\#\#}$	4.92	−10 758.41$^{n/s}$	−1.27	−36 752.05$^{\#\#\#}$	−4.75	90.27$^{\#\#\#}$	6.18	33 882.36$^{\#\#\#}$	4.47
California	5.93$^{\#\#\#}$	3.78	−45 970.43$^{\#\#}$	−1.78	−104 361.8$^{\#\#\#}$	−3.59	−57.26$^{\#\#\#}$	−5.22	21 064.45$^{\#\#\#}$	4.19
Colorado	4.05$^{\#\#\#}$	12.02	−19 495.62$^{\#\#\#}$	−3.48	−75 982.01$^{\#\#\#}$	−11.71	117.66$^{\#\#\#}$	8.52	−3 988.66$^{n/s}$	−0.69
Florida	−0.72$^{\#\#\#}$	−2.62	−13 127.47$^{\#\#\#}$	−2.80	13 158.78$^{\#\#\#}$	2.52	−6.17$^{n/s}$	−0.84	11699.48$^{\#\#\#}$	3.06
Georgia	1.83$^{\#\#\#}$	7.86	−19 539.93$^{\#\#\#}$	−4.57	−34 730.64$^{\#\#\#}$	−7.91	15.54$^{\#\#\#}$	2.08	−6 993.57$^{\#\#\#}$	−1.94
Idaho	1.37$^{\#\#\#}$	2.49	−23 779.56$^{\#\#\#}$	−2.59	−26 118.3$^{\#\#\#}$	−2.42	6.37$^{n/s}$	0.32	−2 077.31$^{n/s}$	−0.20
New Mexico	1.43$^{\#\#\#}$	3.58	−30 935.95$^{\#\#}$	−4.73	−26 565.39$^{\#\#\#}$	−3.45	56.75$^{\#\#\#}$	4.03	6 803.39$^{n/s}$	0.91
Nevada	4.16$^{\#\#\#}$	7.45	−57 072.17$^{\#\#\#}$	−4.77	−77 985.61$^{\#\#\#}$	−7.11	151.48$^{\#\#\#}$	7.00	44 972.39$^{\#\#\#}$	4.36
North Carolina	0.03$^{n/s}$	0.13	−15 325.77$^{\#\#\#}$	−4.01	−383.60$^{n/s}$	−0.10	−43.88$^{\#\#\#}$	−6.16	−7 363.91$^{\#\#\#}$	−1.94
Oregon	−0.29$^{n/s}$	−0.34	−10 668.53$^{n/s}$	−0.76	−547.27$^{n/s}$	−0.03	49.52$^{\#\#\#}$	3.97	−2 881.44$^{n/s}$	−0.46
Tennessee	1.94$^{\#\#\#}$	8.84	−22 150.16$^{\#\#\#}$	−6.05	−36 379.06$^{\#\#\#}$	−8.65	45.46$^{\#\#\#}$	5.23	−13 161.17$^{\#\#\#}$	−3.19
Utah	4.24$^{\#\#\#}$	9.75	−7 642.45$^{n/s}$	−0.93	−79 846.97$^{\#\#\#}$	−9.11	48.88$^{\#\#\#}$	2.54	2 067.56$^{n/s}$	0.25
Washington	−0.08$^{n/s}$	−0.22	−15 147.32$^{\#\#\#}$	−2.37	159 310$^{n/s}$	0.22	40.35$^{\#\#\#}$	3.62	6 524.37$^{n/s}$	1.16
Temporal effects										
1987	−0.48$^{\#\#\#}$	−2.98	−3 143.93$^{n/s}$	−1.18	9 089.41$^{\#\#\#}$	2.90	8.90$^{\#\#}$	1.54	−2 293.32$^{n/s}$	−0.78
1992	−0.47$^{\#\#\#}$	−2.68	−1 980.50$^{n/s}$	−0.67	8 835.96$^{\#\#\#}$	2.59	6.21$^{n/s}$	1.02	−2 728.58$^{n/s}$	−0.92
1997	−0.09$^{n/s}$	−0.41	1 925.26$^{n/s}$	0.53	1 610.53$^{n/s}$	0.40	13.32$^{\#\#\#}$	2.11	−8 181.73$^{\#\#\#}$	−2.78
Number of observations		1 131		1 131		1 131		1 131		1 131
Adjusted R^2		0.81		0.89		0.86		0.2		0.99
Durbin–Watson Statistic		2.08		2.10		2.07		2.12		1.77

Notes: One-tailed test: *indicates significant at the 10 per cent level; **indicates significant at the 5 per cent level; ***indicates significant at the 1 per cent level; $^{n/s}$indicates not significant. Two-tailed test: $^{\#}$indicates significant at the 10 per cent level; $^{\#\#}$indicates significant at the 5 per cent level; $^{\#\#\#}$indicates significant at the 1 per cent level; $^{n/s}$indicates not significant.

property values, while having no direct effect on the spatial extent of urbanised land area. Florida's mandate has had only one significant impact, which must be viewed as negative given the goals of growth management—the state's mandate has worked to *increase* the spatial extent of urbanised land area. Georgia's planning mandate has not had a desirable impact either; since the programme's adoption, urban densities in the state have declined and property values have risen. Oregon's planning mandate, the most effective of those examined here, has led to greater densities and lower property values (after controlling for density), but it has not directly affected the spatial extent of urbanised land. Finally, Washington's growth management act has not had a significant effect on any of the outcome variables; although the parameter estimate in the density equation carries a negative sign, the standard errors (not shown) indicate that the influence may just as well be positive. This apparent lack of effectiveness may change over time since the programme is relatively new—by the end of the study period, it had only been in place for seven years.

The remaining sets of explanatory variables have been discussed in detail in previous research (Carruthers and Ulfarsson, 2002), so only a summary of their effects is given here. First, political fragmentation (measured as per capita municipalities and per capita special districts) is associated with lower urban densities, higher property values and lesser amounts of urbanised land, but has no significant effect on infrastructure expenditures. Central city and counties with consolidated city–county governments are denser, contain greater amounts of urbanised land, have lower property values and are associated with greater infrastructure expenditures. Secondly, land market characteristics, including per capita personal income and the percentage of the county land area dedicated to farms, play an important role. Consistent with expectations, income works to lower densities, spread out development (more urbanised land) and increase property values; as a source of competition, farming lowers the amount of urbanised land. Thirdly, spending on infrastructure, including roadways and sewers, at time $t-1$, leads to greater amounts of urbanised land at time t, illustrating the influence that public investment decisions may have by 'paving the way' for growth. Fourthly, geographical characteristics, including population at $t-1$ and county size, help to account for population at time t and the amount of urbanised land, respectively. Fifthly, the locational fixed effects, which capture an amalgamation of unobserved effects associated with each given state, continue to demonstrate the significant place-to-place differences in the outcome of urban development. Compared with earlier work (Carruthers and Ulfarsson, 2002), the present analysis has 'broken' growth management out of these fixed effects; further research is needed to examine other state-to-state differences, including economic development policies and other factors that may affect growth patterns. Because these variables capture the cumulative influences of all omitted variables particular to their respective states, they have no straightforward interpretation. Finally, the temporal fixed effects capture time-specific changes in the outcome variables. All of the variables just described—except for some of the locational and temporal fixed effects—are significant at a minimum of a 90 per cent confidence interval.

5. Discussion

5.1 Comparison of State Planning Frameworks

The most striking finding of the empirical analysis is that the results—based on an econometric model generalising across over 1000 observations—are almost entirely consistent with previous case studies focusing on individual state planning frameworks. The following paragraphs elaborate on these connections by working through each of the state growth management variables and locating the results within the context of existing research on growth management. Only the

states with comprehensive planning mandates are discussed because it is reasonable to expect outcomes in their counties to differ from counties where no growth management is present.

California. The parameter estimates for California's planning mandate, which requires cities and counties to produce plans but has no vertical or horizontal consistency requirement, show that it has worked to decrease densities, raise property values and indirectly slow population growth. These outcomes are consistent with the expectations of the analytical framework; although the state requires local governments to plan and encourages them to control their own growth (see Fulton, 1999), it does not require them to co-ordinate with one another. As a result, the influence of political fragmentation is amplified through the 'porous' land market created by a purely localised approach to growth management (Landis, 1992). For example, Glickfield and Levine (1992) document that over 71 per cent of all jurisdictions in the state have adopted one or more growth control policies, including development-permitting caps, growth boundaries and low-density zoning. Moreover, many of the growth control communities have adopted multiple policies—the state average is 1.93 per jurisdiction—creating a very complicated and inconsistent regulatory landscape. In fact, much of the evidence of growth management's negative impacts comes from research based on locally implemented growth controls in California (see Fischel, 1990, for a thorough review). The criticisms based on the findings of these analyses are not misplaced, except for their failure to acknowledge the local scale from which policies are implemented. That is, the problems that have arisen through growth control in California are directly linked to the inconsistencies that emerge when communities are required to plan without co-ordinating with one another. This effect is illustrated in an analysis of the San Francisco Bay region finding that the cumulative effect of local growth controls over the 1980–90 time-period was the displacement of 150 000 people, or 20 per cent of the region's total population growth (Shen, 1996). Through land market processes, growth was forced into relatively less restrictive areas at the urban fringe, hastening the spatial expansion of the metropolitan region as a whole. In this way, California's planning mandate may have contributed to sprawl in some areas instead of reducing it by promoting a fragmented approach to growth management. Even so, the state is very large and encompasses a wide variety of social and political climates, so further research is needed before this generalisation may be extended beyond the Bay area.

Florida. Florida's planning mandate, which requires plans at the municipal, county and regional levels along with vertical, horizontal and internal consistency, has proved to be surprisingly ineffective. The only significant impact that it has had must be viewed as negative, especially given the goals of growth management—the state's mandate has worked to *increase* the spatial extent of urbanised land. This finding is consistent with previous evaluations, which have documented that Florida's growth management act has fallen well short of expectations and possibly even promoted leapfrog development through its concurrency requirements (Porter, 1997; Blanco, 1998). In particular, the state requires transport concurrency, meaning that roadways must be of sufficient capacity for new development to proceed. But state funds for expanding capacity in already built-up areas have not been forthcoming, effectively preventing infill and redevelopment from taking place in existing urban centres. Instead, growth has been forced to exurban areas where capacity has yet to be reached, spreading out metropolitan areas and contributing to urban sprawl (Nicholas and Steiner, 2000). Another factor that almost certainly limits the success of Florida's growth management programme is widespread non-compliance among local jurisdictions. In a recent survey, Deyle and Smith (1998) find substantial variation in the degree to which communities meet their

planning requirements, a situation that is reinforced through selective application of the state's coercive powers. Ultimately, although Florida's growth management act is very comprehensive in scope, it cannot be expected to succeed in the absence of state support and uniform application.

Georgia. The parameter estimates for Georgia's planning mandate, which encourages, but does not require, local governments to produce plans consistent with those developed by regional planning organisations, show that it has been completely ineffective from the stand-point of growth management. The programme was adopted in 1989, mostly as a response to sprawl in the Atlanta region (Nelson *et al.*, 1995) but, since that time, urban development in Georgia has continued to grow less dense and property values have risen. Nelson (2000) reports similar findings in a comparison of Atlanta and Portland, Oregon, and notes that housing prices have risen comparably in both metropolitan areas, even though urban containment plays a major role in increasing the density of development in the latter. Like California, one reason for these outcomes may be the lack of uniformity that arises through a purely locally oriented approach to land-use planning. In any case, the result is not surprising, given that the state lacks any coercive mechanism for enforcing its policies and that no consistency—including internal consistency—is required among local governments. Even if local governments produce land-use plans according to the standards of state legislation, they are not required to carry them out (Weitz, 1999). As a result, land developers have every opportunity to avoid regulation by locating in areas that exercise minimal control over new growth.

Oregon. Oregon's planning mandate, based on vertical and internal consistency and urban growth boundaries, stands out because it has produced results that live up to the expectations of growth management. The parameter estimates for the mandate are positive and significant in the density equation and negative in the urbanised land equation, although the latter is not significant within acceptable tolerances. Of particular note is the finding that, after controlling for density and other relevant factors, the state's planning programme has not had a significant effect on property values—an outcome entirely consistent with growth management's emphasis on accommodating new development. While further investigation is needed before Oregon's property markets are fully understood, it is likely that this effect is at least partially explained by the fact that the state's growth management programme specifically addresses the issue of housing supply. While urban growth boundaries are used to constrain land markets, Oregon requires that communities accommodate growth through high-density zoning districts (Knaap and Nelson, 1992). So, while land may be more expensive in Oregon due to the increased densities created by growth management, the effect is balanced out by creating an abundance of housing supply with high-density zoning. And while concern has been voiced over the rapid growth in housing prices in Portland over the past 10 years, this effect is more likely to be due to the city's bull real estate market than anything else (Phillips and Goodstein, 2000). Finally, it is important to note that, although Oregon has one of the most successful growth management frameworks in the country, it has also one of the oldest, having been implemented in the early 1970s and gone through a number of major revisions since (Knaap and Nelson, 1992; Nelson *et al.*, 1995; Weitz, 1999). The programme's overall effectiveness lends optimism to the younger state-wide frameworks discussed here that have yet to produce their desired effects, because time is clearly an important ingredient.

Washington. Washington's growth management act, which was adopted in 1990, is the newest of those evaluated in this analysis. The mandate requires internal consistency for all local governments, horizontal consistency among adjacent counties and, like Oregon's programme, prescribes the use of

urban growth boundaries. With its blend of requirements for jurisdictional co-operation, containment policies and strict coercive enforcement mechanisms, Washington's growth management act is considered to be exemplary of 'second wave' state planning programmes (DeGrove, 1992; Gale, 1992; Weitz, 1999). Even so, the parameter estimates for the mandate reveal that it has had little impact since its adoption: density, urbanised land area and property values all remain unaffected. But this apparent lack of results is likely to stem from the programme's youth; as Porter (1997) notes, and the present analysis has demonstrated through its modelling approach, a key factor in the effectiveness of state planning programmes is time. Unlike Georgia's mandate, which has no 'teeth', Washington's mix of policies holds much promise for reducing urban sprawl. Further evaluations will be required as the programme matures but, given the success of growth management in Oregon, it is reasonable to expect that similar effects may eventually emerge in Washington as long as the programme continues to be consistently enforced.

The impact that each of the states' planning programmes has on infrastructure expenditures and population change can be inferred through the interdependency of the outcome measures. Infrastructure expenditures are affected by changes in density (negative), urbanised land area (positive) and property value (positive), so any effects of growth management must be traced through these variables. Oregon's programme is the only one that has led to significantly more compact urban areas, and may have produced a more cost-effective urban form through this route. Conversely, Florida has probably incurred greater infrastructure costs due to the leapfrogging associated with its concurrency requirement. On the other hand, instead of reducing costs, communities may also increase their revenues; the countervailing influences that density and property value have on infrastructure expenditures suggests that California and Georgia may have broken even with respect to spending on infrastructure. Meanwhile, population change is affected by property value because people's ability to locate in a given area depends on whether or not they can afford to do so. In this way, California and Florida's planning mandates may have limited population growth in their states' communities and, while it is unlikely that Oregon's growth management programme has encouraged population growth, it may have promoted housing supply in a way that makes it relatively more affordable to locate there. Each of these findings must be interpreted as preliminary, however, since the present analysis does not allow precise measurement of growth management's influence on infrastructure expenditures and population change.

5.2 Policy Recommendations and Directions for Future Research

The conclusions drawn in the discussion above point to three basic policy characteristics that account for the success of state growth management programmes. First, consistency requirements appear to play a major role. Requiring (or even encouraging) communities to plan without also requiring them to co-ordinate with one another and/or to carry out their plans only magnifies the effects of political fragmentation. In California and Georgia, traditional approaches to local land-use regulation remain in place, perpetuating urban sprawl and exclusionary housing markets. On the other hand, Oregon's vertical and internal consistency requirements have worked to ensure that jurisdictions develop plans according to state-defined goals and standards *and* carry them out once they are complete. The contrast in results achieved through programmes with and without consistency requirements provides good evidence in favour of standardising local land-use planning practices. Secondly, it is also clear from the analysis that enforcement plays a major role in determining the effectiveness of state land-use legislation. In Florida, for example, where plans must be vertically, horizontally and internally consist-

ent, the state approval process was still incomplete more than 10 years after the requirements were put in place (Porter, 1997). Although this slow pace is at least partially attributable to the complexity of meeting all three requirements, it also illustrates that growth management may be an all-or-nothing endeavour. That is, it does little good to enact policies that are too complicated, time-consuming and/or expensive to enforce; both the appropriate resources and political willpower must be in place in order to ensure that growth management regulations are carried out once adopted. Finally, the effects of Florida's concurrency requirement suggest that urban growth boundaries represent a more appropriate mechanism for regulating the outward pace of development. Although similar effects have yet to be observed in Washington, Oregon's growth boundaries have for the most part succeeded in containing urban development and promoting higher densities (Weitz and Moore, 1998; Kline and Alig, 1999). In sum, the implications for policy are straightforward: in order to be effective, state growth management programmes should incorporate a firm, but parsimonious, set of consistency requirements, rigorous enforcement mechanisms and growth boundaries, rather than concurrency, as a method of urban containment. Programmes with these elements hold much promise for reducing urban sprawl, while programmes that do not may inadvertently contribute to it.

Several directions for future research follow from this conclusion. First, the major variable that has not been taken into account in this analysis is the degree to which states, public interest-groups and/or other parties ensure that requirements for local governments are enforced. Although the analysis took a variety of policy attributes into account—including enforcement mechanisms—it did not attempt to account for the conviction behind them. Oregon, for example, has very strict laws ensuring that its growth management provisions are implemented. If local governments fail to meet prescribed standards, the state's Land Conservation and Development Commission (LCDC), which is responsible for reviewing plans, may even charge them for the time it spends obtaining their compliance (Weitz, 1999). So, not only does the state have rigorous mechanisms for enforcing growth management, it has the willpower to ensure that they are carried out. In more locally oriented systems, where citizens are responsible for ensuring that communities follow state law, compliance will almost certainly vary from jurisdiction to jurisdiction. Research has found that many people view involvement in local planning activities as a form of political activism (Gottdiener and Neiman, 1981) so it is reasonable to expect that local governments will follow the rules more closely where this is a priority. In the case of California, the situation might be very different with uniform political participation, but clearly this is not the case. Although this aspect of the problem does not invalidate the findings of the analysis, it points to the need to examine more carefully the underlying social and political factors that affect the success of growth management programmes.

Secondly, while consistency requirements, enforcement and urban containment all appear to make a difference, further analysis is needed in order to gauge the relative influence of each—especially for the different types of consistency. The question is significant because it holds direct implications for where states should concentrate their efforts. Thirdly, future projects may benefit from examining additional outcome measures; urban form, property value, service expenditures and population change are only a few of the many indicators which may be used to evaluate the impacts of growth management policies. Alternative outcome measures might include 'quality of life' factors, such as environmental indicators, neighbourhood desirability, the quality of public services, affordability and even economic performance. These factors are important because citizen support for growth management rests heavily on whether or not it leads to benefits that they experience directly. Fourthly, while the present analysis focused

on four well-known growth management states (and one state with a comprehensive planning mandate), future research should be directed at evaluating the effectiveness of other frameworks, including those of Maine, Maryland, New Jersey, Rhode Island, Tennessee and Vermont. The Northeastern states, in particular, merit careful investigation; they were not included here because the growth-related pressures they face are qualitatively different than those experienced by states located on the west coast and in the sunbelt. Finally, alternative research designs are needed to test fully the impacts of growth management. The econometric analysis presented here provides one type of information by generalising across observations and time-periods. The fact that the findings are consistent with more qualitative evaluations is encouraging and points to the need for further evaluations that test the research hypotheses on a case-by-case basis. Ultimately, a combination of alternative research designs drawing on a consistent analytical framework will be necessary in order to develop a well-rounded understanding of the impacts of state growth management programmes.

6. Summary and Conclusion

A common objective of state growth management programmes is to reduce urban sprawl by co-ordinating the planning activities of local governments in a way that creates greater regulatory consistency across metropolitan areas. This paper examined their success in meeting this goal by analysing the impacts of alternative state and regional planning frameworks on five measurable outcomes of urban development: density, urbanised land area, property value, public expenditures on infrastructure, and population change. First, the background discussion provided an overview of urban sprawl as a public policy problem, including the role that political fragmentation plays in contributing to it and how state and regional planning frameworks have responded. Secondly, the empirical analysis examined the impacts of five state comprehensive planning mandates—in California, Florida, Georgia, Oregon and Washington—while controlling for the influence of political fragmentation and other relevant factors. Finally, the results of the empirical analysis were described within the context of previous research on the effectiveness of growth management. The conclusions drawn in this discussion suggest that state-based planning programmes with strong consistency requirements and enforcement mechanisms hold much promise for reducing urban sprawl, while programmes that do not require consistency may inadvertently contribute to it.

Notes

1. Nearly all of the empirical research on the impacts of growth management has focused on Oregon (see, for example, Knaap and Nelson, 1992; Weitz and Moore, 1998; Kline and Alig, 1999; Phillips and Goodstein, 2000). While these studies have produced valuable information, little is known about how Oregon compares with other states with and without growth management.
2. The arrow also represents the direction of inquiry of the previous research examining whether or not state planning mandates affect the quality of local land-use plans (Burby and May, 1997).
3. Many other states have also experienced large gains in urbanised land, but the underlying process is different than in those included here. For example, Northeastern cities have experienced some of the most dramatic sprawl in the nation during recent years even with little population growth, due to residents relocating from traditional core areas to outlying suburbs and exurbs (Fulton *et al.*, 2001). In contrast, the rate and scale of population growth in the states included in the empirical analysis suggest that the urbanisation they have experienced is the result of in-migration, not the relocation of existing residents.
4. Arizona and Tennessee also have state-wide growth management programmes, but they were not in place during the study period; Arizona's programme was adopted in 2000 and Tennessee's programme was adopted in 1998.
5. Overall density (employment plus population) is used because the amount of developed land depends on both residential and non-residential land uses.

6. Property values for 1997 are estimated values because the Census of Governments stopped collecting the variable after 1992. The estimation procedure is straightforward. It involves taking the ratio of the amount of property tax collected to total assessed property value for each county in the data-set in 1992 (both variables come from the Census of Governments) and then using the ratio to estimate assessed property values for 1997. In other words, for county X, if, in 1992, total property tax collected = \$100 and total assessed property value = \$1000, the ratio is 0.10. The total assessed property value for 1997 can be estimated by applying this number: if total property taxes collected = \$200, the total assessed property value for the county is estimated at \$2000. This is an imperfect measure but, since the variable has been cancelled, there is no alternative. The values were tested carefully in order to ensure consistency with values observed in 1982, 1987 and 1992, and extensive sensitivity testing was conducted in order to ensure that the variable performed as expected within the econometric model.
7. Because of the way the data-set is structured—with the dependent variables observed in 1982, 1987, 1992 and 1997—the time-lag involved is 5 years. Variables corresponding to time $t-1$ were therefore observed in 1977, 1982, 1987 and 1992.
8. For comparison, the system was also estimated equation-by-equation with ordinary least squares (OLS). In the absence of endogeneity and contemporaneous correlation across equations, the two techniques would have delivered identical solutions (Pindyck and Rubinfield, 1991). Since the 3SLS and OLS parameter estimates and t-statistics were different for most of the explanatory variables and theory that suggests the endogenous relationships exist, the OLS estimates are assumed to suffer from simultaneous equations bias and the 3SLS estimates are taken to portray the correct relationships.

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