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International experience of public infrastructure delivery in support of housing growth

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ABSTRACT

This paper compares planning and funding arrangements for public infrastructure delivery in support of new housing development in the UK, Australia, Germany, the Netherlands, Canada, the US, and Hong Kong/Mainland China. It examines the roles and responsibilities of different levels of government, the extraction of financial contributions from the development process (mainly funded through increases in land value), and the level of involvement of private and public actors in infrastructure delivery and land value capture (LVC). Three linked questions provide a basis for comparison of the cases: first, what arrangements are in place, in terms of planning hierarchy and responsibility, for coordinating infrastructure delivery (and how do these relate to funding arrangements); second, how are local contributions extracted from the development process or through the acquisition and sale of land; and lastly, what inferences can be drawn regarding the relative power of public and private actors in this process and to what extent is public interest prioritized/served through prevailing approaches to value extraction. The paper contributes international experience to debates on optimizing planning approaches for infrastructure delivery while maximizing public benefit from land value.

1. Introduction

This paper compares arrangements for *infrastructure* delivery in support of housing growth in the United Kingdom, Australia, Germany, the Netherlands, Canada, the United States and Hong Kong/China. Each country faces its own challenges in relation to housing consumption, affordability and future supply and each has evolved a distinctive approach to infrastructure funding, planning, and provision. The broader complexities, and local nuances, of housing delivery are relegated in this paper behind a targeted focus on examining general experiences of infrastructure delivery through a comparative lens. Through that lens, we hope to shed light on several critical concerns including the role of government versus the private sector in funding and delivering infrastructure to support growth; the potential strengths or limitations of mandatory versus voluntary development contributions towards local amenities, and the implications of land value capture versus impact offset models as a means of financing public facilities.

Our focus is on enabling and supporting infrastructures: those *up-front investments* – in basic services, including power, water and sewage, and also in transport – needed to open up land for development and the *essential services* – from schools to healthcare – that new populations require. What constitutes infrastructure for housing development is listed later in this paper, in Table 2. Our fundamental concern is with the arrangements for supporting infrastructure investment through the development process in different countries and how private value is transformed into a source of public infrastructure investment under those various arrangements. Our aim is to contribute a comparative view, showing how different countries deal with the capture or transformation of private value in the service of public interest. This aim is achieved in four parts. The first sets a framework for comparison in

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relation to broader traditions of comparative research in urban and housing studies and the particular challenges surrounding the role of government versus the market in infrastructure planning, funding, and delivery. At the root of the infrastructure challenge are questions of government policy, land ownership and capturing land value rises to fund infrastructure. Those challenges are mediated by planning systems, which may be unable to work across boundaries or plan in timeframes or geographies suited to long-term, integrated, infrastructure delivery. The paper briefly examines the planning and funding of infrastructure, mainly in countries where land is in private ownership, but also in situations of public ownership – where investment in transport and basic services can be recouped through land disposal on lease arrangements. This part concludes by identifying questions that then frame an analysis of international experiences. The second part of the paper then briefly describes the background to this research and the pragmatic reasons for assembling the selected cases. This is followed, in the third part, by seven cases. These are presented as vignettes that outline the structures and processes of infrastructure planning before detailing funding arrangements for financing and providing the infrastructure needed to support new housing development. The fourth and final part of the paper distils contrasting national experiences into commonalities, differences and potential lessons: what can be learnt from different responses to infrastructure challenges and whether it might be possible to draw generalised implications for supporting new housing supply, notwithstanding the embeddedness of different approaches to planning and funding infrastructure in different socio-political and administrative contexts.

The paper seeks to expose the wide range of arrangements adopted to fund infrastructures. Its message is thus that there are many ways of providing mechanisms to generate the money for the construction of infrastructures required for development. The scope of this work does not, however, make it possible to explore systematically factors responsible for the adoption of these different arrangements, nor does the paper investigate the consequences of different infrastructure funding formulas on the nature of urban development (such as density levels), its stimulation or control and on housing affordability. Still, it is possible to surmise from the presentation of vignettes, describing funding arrangements in the selected countries, that these arrangements reflect national and sub-national institutional structures and that they present different equilibria between public and private sector initiative in matters of urban development. The vignettes also point to the capacity of different infrastructure funding mechanisms of either reinforcing private market trends or subsidizing affordable housing.

2. A comparative perspective on infrastructure delivery

Comparative research can offer new insights into the causes and potential solutions to common policy challenges, provided that contextual differences are recognised (Kemeny & Lowe, 1998; Stephens, 2011). Such differences include underlying institutional structures and systems of governance, as well as historically evolved patterns of urban development and housing provision (Gurran et al., 2016). For instance, countries with strong central government traditions of intervention in the planning, funding, and delivery of major facilities and networks (transport, energy and water) – including the United Kingdom, many European nations, and Hong Kong/China - may see different patterns of urban development to those where central governments have had minor engagement in urban and regional affairs – including the United States and Australia. But irrespective of these traditions, the planning, financing and delivery of infrastructure is complex in many countries: assessments of the need for major infrastructure can take many years, involve hundreds of stakeholders, and cross different jurisdictional and national boundaries.

Nationally significant projects to increase airport capacity, build new power stations or supply water from new reservoirs can inflame public passions and often rely on the exercise of executive power at the highest level to push them through. Regional or sub-regional infrastructure that enables and supports new housing development – the focus of this paper – often runs into similar challenges concerning their planning, financing and delivery. Jurisdictional boundaries may be crossed; multiple stakeholders need to be consulted; different interests may be advanced or injured; and finance will need to be raised to meet the costs of delivering new infrastructure. There may also be tensions between different parts of the state responsible for certain types of infrastructure (e.g. education, healthcare and transport).

Bringing together planning programmes of works – major transport, education, health and community facilities – and aligning these with spatial strategies for housing and urban growth, is a critical but notoriously difficult challenge for governments, who must navigate different agencies, funding cycles, and strategic priorities (Stead & Meijers, 2009). Adding to these challenges has been the shift away from large-scale public financing and provision of infrastructure in most nations under several decades of neo-liberalism, which has seen preferences for ‘user pays’ models and private sources of finance; the privatisation of public services and an emphasis on market-led rather than publicly planned modes of development (Sager, 2011).

In this context, land-use planning has arguably become more important than ever, as a key lever for coordinating the development process (UNECE, 2008) and for ensuring that the public services (or at least shared services), on which private development depends, are in place. The planning system also has an important role in ensuring that infrastructure capacity within established urban areas is sufficient to promote inner-city renewal rather than suburban expansion (Stimson & Taylor, 1998).

Scale is critically important in infrastructure delivery, requiring decisions at city, regional and national levels. However, spatial planning rarely influences budget decisions of governments and struggles to coordinate the investments and actions of state or regional agencies (Gallent, 2008). Bringing together the many interests and facilitating joined-up decision-making across multiple sectors is a key challenge for effective spatial planning (Morphet, 2016; Stead & Meijers, 2009). Frequently, the responsibility for this process, and certainly the impacts, falls to the local level. When local authorities are responsible for schools, policing, housing assistance and or other community facilities, resistance to new development is arguably more likely to arise (see for example Crook & Monk, 2011; Wear, 2016).

Infrastructure investment will increase the development potential of land value, thereby increasing market interest in sites allocated in a zoning ordinance or plan. Landowners will, in many instances, have done little or nothing to ‘earn’ that rise in the value of their land. In the UK, Winston Churchill summarised the link from infrastructure to land value more than a hundred years ago:

> Roads are made, streets are made, railway services are improved, electric light turns night into day, electric trams glide swiftly to and fro, water is brought from reservoirs a hundred miles off in the mountains - and all the while the landlord sits still […] To not one of those improvements does the land monopolist contribute, and yet by every one of them the value of his land is sensibly enhanced. He renders no service to the community, he contributes nothing to the general welfare; he contributes nothing even to the process from which his own enrichment is derived.
>
> Churchill (1909)

This past failure to contribute ‘even to the process from which his own enrichment is derived’ triggered a range of national responses, usually during the transition to more comprehensive planning systems after 1945. Land nationalisation was one response, converting Churchill's private monopoly into a public one and enabling direct land value capture (LVC) from the uplift. More frequently, a removal of automatic development rights was accompanied by mechanisms to extract value during the consenting or rezoning of land for development. These have ranged, at different times and in different countries,

from general levies, to fees and tariffs linked to the projected costs of infrastructure – seeking a 'fair' contribution from landowners and developers (with developers treating that contribution as part of overall development cost and the landowner accepting a lower price for their land). They have also included direct contributions, with developers required to provide some infrastructure (in kind) during the development process.

Across different countries, there has been a longstanding concern for the efficacy of this mixed approach to infrastructure funding: seeking the right level of general public investment in economic infrastructure, and extracting acceptable contributions from developers and landowners - acceptable, that is, to those private interests and also to local electorates. Those countries that have brought land into public ownership have invested in infrastructure and then recouped costs (and sought additional benefit) from the sale of leases. These have sometimes taken a public welfare position on a continuum of benefit. Countries that appear more circumspect in the levering of contributions, continually reassessing the viability of public demands and at pains to not offend the power of private interest, can appear to occupy a very different position on that continuum, viewing development *per se* as a public benefit, even where local infrastructure contributions are less and the burden of infrastructure cost is met through general taxation.

In relation to land use planning and infrastructure provision, a series of studies in the early 2000s examined broad differences in land use planning systems of the United States and the United Kingdom (Carruthers, 2002; White & Allmendinger, 2003), and compared regulatory mechanisms for funding infrastructure through systems of development control and growth management (Saxer, 2000). Such work highlights different underlying traditions of government intervention in the land use planning and development process (from the British system of nationalised development rights to the North American approach to zoning and codified entitlements) and distinctions between the notion of land value 'capture' for public benefit versus the need to offset the wider 'impacts' of private development.

Further, this work pointed to the ways in which different traditions of government intervention in assembling land and delivering infrastructure for housing – ranging from strong models for public land development through to an entirely regulatory approach based on development controls and infrastructure charges – may influence urban form and housing outcomes. For instance, strong government involvement in land assembly and development (acquiring land at rural or industrial prices, providing infrastructure and services, and recouping costs through final sales) is likely to promote more contained urban form, as well as efficient and equitable servicing. Alternatively, when infrastructure provision is coordinated through a regulatory planning framework (i.e. controls and charges applying to developers of private land), perverse outcomes may occur. For example, development charging regimes which impose levies on the basis of housing density (i.e. per dwelling unit) rather than land area (i.e. per hectare/acre), may unintentionally promote urban sprawl and encourage developers to prioritize high end, detached homes able to attract a high profit margin. By contrast, comparisons across the different localised systems of development control and infrastructure charging in the United States alone highlighted the ways in which impact fees (levied to offset the impact of new development on local facilities and services) can support new housing projects that might otherwise not go ahead (Mathur et al., 2004).

Overall, the wider literature on planning, housing, and infrastructure delivery highlights a number of themes relevant to more detailed, country level investigation. These include the different roles and structures of government (national, state/metropolitan, or local) in relation to land use planning and infrastructure provision (Tewdwr-Jones & McNeill, 2000) and whether models are primarily 'proactive' – with strong government involvement in land assembly and infrastructure delivery; or 'reactive' – using land use regulations to coordinate the development process. The literature also highlights different ways of justifying public infrastructure contribution requirements from private developers and their clients, ranging from the need to ensure that private development accounts for the public costs generated via user pays systems or impact fees (Evans-Cowley & Lawhon, 2003); or whether the high values associated with land use planning decisions and infrastructure investment can and should be 'captured' for public benefit (Crook et al., 2016). Similarly, regulatory certainty in charging requirements is important, meaning that obligations must be signalled in advance and consistently applied, if they are to be factored into land acquisition decisions and thus passed back to sellers through lower land prices. Voluntary mechanisms, which may be appealing in some situations, can also undermine certainty and are not easily factored into land acquisition decision. Finally, the literature highlights the importance of system efficiency in the delivery of new infrastructure to service housing development, which is essential to avoid blockages in new housing supply (Ruming et al., 2011).

3. International case studies

Situated in the above debates, this paper compares infrastructure delivery arrangements across seven countries in 2019. The aim of the comparison is to reveal how different patterns of public land ownership and alternative mechanisms for land value capture might affect the speed and general efficacy of infrastructure planning in support of housing development. The focus is placed on roles and responsibilities, the extraction of contributions from the development process (funded through increases in land value), and the contribution of private and public actors in infrastructure delivery and LVC. Later discussion, in Section 4, is structured around three key questions:

1. What arrangements are in place, in terms of planning hierarchy and responsibility, for coordinating infrastructure delivery (and how do these relate to funding arrangements)?
2. How are local contributions extracted from the development process or through the acquisition and sale of land?
3. What inferences can be drawn regarding the contribution of public and private actors in this process and whether the public interest is prioritized/served through prevailing approaches to value extraction?

The paper draws on a series of overviews of national arrangements from collaborating authors, who have each considered how particular patterns of land ownership and planning culture incubate different approaches to planning, delivering and paying for the infrastructure needed to support new development.[1] Additionally, each overview considered who pays for infrastructure provision and how; what compensation and incentive arrangements are in place; what role national or regional spatial plans play in coordinating infrastructure delivery; and how LVC mechanisms operate in practice. These questions reflected the key themes arising in the comparative literature on land use planning, housing, and infrastructure provision as outlined above.

Each of the countries studied have developed different models for financing and delivering infrastructure, within wider contextual differences defined by historically evolved systems of governance, urban settlement, and planning. There were three reasons for the particular selection of the comparator countries. The first was a pragmatic reason: the project's funder directed us to look at countries of interest, either because of similarities with the UK (the funder's primary focus) or

[1] Earlier versions of the summaries presented here were commissioned by the Institution of Civil Engineers (UK) as part of a study looking at the connections between housing delivery and different kinds of supporting infrastructure – from the utilities to the relief roads needed bring land forward for development. Recourse to international cases was intended to provide insights into alternative governance, finance and value capture arrangements.

because of perceived innovations in infrastructure practice. The second was to capture a broad range of experiences and situations, all in advanced economies. Australia and Hong Kong were chosen for their shared experiences and historic ties with the UK; China (and also Hong Kong) for state control over land; Germany and the Netherlands for practices known to differ from those found in the UK, and for stronger sub-national planning frameworks; Canada and the USA for their tradition of zoning ordinances and irregular use of development permits; and the USA for its push towards financialised infrastructure funding. The third reason related to local awareness of the importance of co-ordinated infrastructure delivery to the expansion of housing supply (in response to critical affordability challenges), and to the identification of deficiencies in existing practice. Research in all of our case studies has drawn attention to the dependence of housing supply on public infrastructure delivery: this is true in the UK (Baker & Hincks, 2009; Gurran et al., 2016; Morphet, 2010), Australia (Gurran et al., 2009), Germany and the Netherlands (Lord et al., 2015), Canada (Filion, 1996), the USA (Skidmore, 2014), and in China, extending to Hong Kong (Wu, 2015). Wu (2015) has highlighted the pivotal role planning systems play in the coordination of infrastructure investment and delivery, providing development actors with the certainty and confidence they need to advance housing supply. In the UK, Barker (2006) has attributed housing supply deficiency to infrastructure uncertainty: the same link was the motive behind work undertaken by the Institution of Civil Engineers in 2019 (ICE, 2019).

But overall, the choice of cases was a pragmatic one: gaining insights into different experiences of infrastructure planning, finance and delivery to inform UK practice. The cases were commissioned by the Institution for Civil Engineers in 2019 and are brought together here in a comparative frame.

Key models for infrastructure financing or provision to support new housing development, used in each of the case study countries, are noted in Table 1 and discussed in greater detail in the sections that follow. Differences in government structures across the case studies means that such comparison is necessarily broad brush - the models identified in Table 1 reflect *dominant approaches* in each country rather than a comprehensive catalogue of infrastructure financing and provision used across all housing development scenarios. The approach we have taken is necessarily a macro one, focused on the general features of infrastructure planning in each country – followed by a comparative discussion of those features and how they shape outcomes. There is some reference to detail as sub-national jurisdictions occasionally deviate from national practice. However, in a discussion of this length and nature it is not possible to explore all potential deviations and idiosyncrasies across seven countries: and for that reason, we provide an analysis which is necessarily generalised. Likewise, the amount of historic context for each case is also limited. The general frameworks in which infrastructure issues are addressed are noted in the vignettes, but these are each end-states of sometimes protracted and complex historic development over tens if not hundreds of years. Jurisdictional arrangements may reflect compromises borne of past conflict or civil strife; they may be products of particular constitutional settlements. Likewise, control of land and the willingness to challenge or override private interest will be rooted in social and political history, in the story of nation states, in local culture and sometimes in episodes of dramatic political upheaval. Each country has reached its current end-state by its own path. It is impossible to traverse those paths in a discussion of this nature, and yet each is the subject of its own extant literature.

Therefore, we are confined to *country summaries*, which are first presented separately, respecting the context embedded 'narrative' of each case in its entirety. The cases are then compared in Section 4, structuring the discussion around the key questions outlined above.

Table 1
Models for infrastructure financing/provision to support housing development.
Source: the authors.

Type/name	Description	Country/ies
Direct government provision	Funded by bonds, local property/state tax, and other revenues	All
Community Infrastructure Levy (CIL)	Fixed charge for local infrastructure	UK (England)
Development contributions	Set by local formula (household size, land area, or capital investment value), must be paid by developer as a condition of planning permission	AUST, CAN (Ontario)
Impact fees	Paid to offset the 'impact' of the development on the need for local infrastructure, facilities or services	US
Land lease stipulation	Paid by developers to county/municipal Housing and Construction Departments, for local basic infrastructure linked to residential development. Developers provide infrastructure within residential sites.	China
Property value capture	No separate charge for infrastructure. Costs reflected in the price of new land sold (technically leased) by government (which owns all land in the city) to developers, and in rents of existing residential properties incurring government rates (property tax).	HK
Negotiated agreements	Negotiated through the planning approvals process, for the provision of infrastructure, affordable housing, health, and schools. Although negotiated, the developer must enter into such an arrangement.	UK, CAN (Ontario)
Voluntary agreements	Negotiated agreements for infrastructure/public benefits as monetary payments, capital works, and or land. There is no mandatory requirement for the developer to enter into the agreement.	AUS, NL
Urban Development Contract (Staedtebaulicher Vertrag)	Investor provides or pays for necessary infrastructure including schools and kindergartens, relating to the specific development project.	GER
Urban Development Procedure (Staedtebauliche Entwicklungsmassnahme)	Allows for speedy transformation e.g. of brownfield land and for rapidly meeting the demand for housing and employment, for public amenities and associated facilities in situations of high public interest. Land prices frozen at pre-development levels; private land acquired (possibly even by expropriation) at price level prior to speculative development expectations.	GER
Project based land use plan	On the basis of a project and infrastructure plan agreed with the municipality, the project developer undertakes to complete the plan within a certain period and fully or partly carries planning and land improvement costs.	GER, CAN (Ont)
Building claims model	Private developers who have bought land from the original owners sell this land to the municipality in exchange for the right to buy serviced plots on which they can build.	NL
Joint ventures for land development[a]	A company is established to undertake land development, with the shares divided between developers and the municipality. The company acquires land and services it, then sells the serviced land for development.	NL, China

[a] Joint ventures are now being used in England for local authority-led direct delivery of housing.

3.1. The United Kingdom

The UK is devolved into four administrations, each with separate responsibility for infrastructure delivery. In some sectors – including transport and energy – this is within the overall legislative framework agreed at the EU level. Scotland, Wales and Northern Ireland all have single plans for their territories that incorporate infrastructure investment plans. Within England, there are a number of institutions and agencies responsible for infrastructure provision including Government Departments and their agencies such as Highways England and the Environment Agency.

Units of local government have up to three tiers, with those units working together in different ways. London, for example, has its own strategic authority and an elected mayor with a range of transport and planning powers. There are also ten 'combined authorities' outside of London, with variable powers over planning, transport and heritage. England's regional planning apparatus was dismantled after 2010, being substituted – in some places – by a mix of combined authorities and 'local enterprise partnerships' (LEPs). Elsewhere, groups of local authorities have combined to form dedicated transport bodies. This spatial heterogeneity is complicated further by the presence of both 'unitary' and two-tier authorities, with either consolidated or separated powers over infrastructure. Town or parish councils add to this complexity, with signs that there will be future devolution of responsibility to this lowest tier – as government rolls out its programme of increased 'localism'. Local planning within Scotland, Wales and Northern Ireland has been subject to periodic reviews and takes similar albeit different forms. Scottish local government has recently been the subject of new legislation which will make it outwardly similar to the English system. In Wales, the Well-being of Future Generations Act 2015 has implications for planning and infrastructure that relate, for example, to the mitigation of climate risk.

The funding for UK infrastructure is derived mainly from general taxation, private sector investment and utility consumers. Taxation is used to provide funding for some transport infrastructure such as roads, much of which is channelled through Highways England (and equivalents). Some sub-national road schemes are funded through local 'deals' with the Combined Authorities or LEPs, which may also be able to access funds for housing through the Housing Infrastructure Fund (HIF), operated by Homes England. The private sector invests in energy, some water management and supply, telecommunications, and some education and health services. Consumers fund investment through their utility payments for energy, telecommunications and water.

The extraction of funding for infrastructure through planning and development processes has a long history. In 1947, all development rights in land were placed within a regulatory planning system, which provided an opportunity to capture a proportion of rising land value. Initially this was accomplished through a betterment levy linked to land value uplift, collected for government by the Land Commission. Different forms of levy and land tax appeared and disappeared over the next 30 years, with government eventually abandoning the idea of nationally administered systems of LVC.

Local arrangements for extracting contributions from developers to mitigate the effects of development were introduced via Section 52 of the 1971 Town and Country Planning Act, later revised and updated in Section 106 of the 1990 Town and Country Planning Act. Legal agreements can be reached with developers, as a condition of planning permission, that deliver 'voluntary' contributions to housing, infrastructure and others forms of mitigation. Use of agreements has been variable and there is a history of inconsistency in how they are used. To overcome this piecemeal approach, the Government introduced a Community Infrastructure Levy (CIL) in 2008. The intent was to establish a common approach to collecting developer contributions, but local concerns (over CIL's impact on development viability in the years following the Global Financial Crisis) resulted in patchy use. In London, however, the Mayor was able to use specific powers to piggy-back fees on all additional floor space created through the planning system. This provided a source of funding for London's east-west 'Crossrail' using the argument that London Boroughs would eventually benefit through improved accessibility and increases in rateable values.

Beyond Government funding, local authorities and other public agencies are able to borrow for infrastructure investment from the Public Works Loans Board (at close to sovereign rates) and the European Investment Bank. Loans are then serviced through developer contributions and/or increased revenue from local Council Tax. National capital expenditure on infrastructure totalled nearly £95 billion in 2019/20 (HM Treasury, 2019) while local authorities collected £6 billion through s106 agreements and CIL in 2016/17 (Lord et al., 2018).

3.2. Australia

Australia has a three-tiered system of government defined by a national ('Commonwealth') level, six states and two self-governing territories, as well as local government. The States and Territories have primary responsibility for land-use planning, according to their own legislative frameworks, although local governments play an important role in making local plans (designating land-uses and defining specific development controls) and assessing development proposals. Responsibility for infrastructure funding and delivery straddles all three levels, with the Commonwealth funding and delivering major interstate highways and telecommunications, the states' responsible for health, education, transport, policing, social housing, and the environment, and local government managing local roads, (local) community services such as libraries, childcare and recreational centres, waste, and open space. Water and energy utilities are provided by regional or local corporations, regulated by the States and Territories.

Infrastructure is funded in three ways: from direct government funding (from tax revenues); through borrowing; or from local government rate (property tax) revenue. States and territories receive tied and untied grants from the Commonwealth for capital expenditure on health, social housing, and some transport projects. Increasingly, the Commonwealth is developing an infrastructure planning and funding capacity (Infrastructure Australia, 2018) and has recently established the National Housing Infrastructure Facility, to help finance infrastructure to support housing development (such as energy, transport, water or sewerage, or telecommunications). Public/private partnerships are often used to fund major infrastructure projects, particularly in relation to roads and transport, with user charges (tolls and fares) used for partial recovery of upfront costs.

Lastly, contributions are sought from developers to pay for the shared or public infrastructure requirements associated with their development. Initially, development contributions were limited to basic services – roads, drains, sewerage and water, and sometimes open space. Contributions were levied by local government within parameters set by States and Territories. Different approaches to local development contributions were enabled by the States and Territories – ranging from a comprehensive list of items (NSW, Victoria, Queensland) to more limited requirements for car parking and open space (South Australia) (Gurran, 2011).

The states have also established strong parameters within which local contributions can be collected. This balances the need to secure or recoup funding for basic services, supporting new housing and urban development against risks that onerous requirements will threaten viability and discourage growth. There has also been a new trend over the past decade, for states to add their own contribution requirements to those imposed by local government.

Australia's largest state of NSW provides a good example of how state and local contribution requirements and actual infrastructure provision – by state or local government, or by the developer themselves – may overlap. Both local and state governments can require development contributions, which are used to fund local capital works

or facilities. Although controversial, Voluntary Planning Agreements (VPA) are used as a means of allowing developers to be certain that the timing of infrastructure provision would be in line with the wider completion and marketing of their project.

Housing development contexts and patterns of land ownership affect the financing, provision, and sequencing of infrastructure provision in Australia. In the major cities there is a preference for inner urban intensification, through brownfield renewal projects often resulting in major mixed-use centres. State land development corporation ('Urban Growth') plays a role in coordinating land assembly and any additional infrastructure requirements. In Greenfield areas, a variety of arrangements exist, depending on land ownership. Under the 'precinct acceleration protocol', developers may install infrastructure upfront to service their own projects, being recouped for excess contributions subsequently as new development takes place.

3.3. Germany

In Germany, land-use planning and the provision of infrastructure is a public responsibility, shared by three levels of government – the federal level, the states or regional governments ('Länder') and the cities and communities. The rules structuring the connections between housing and infrastructure are enshrined in the Basic Law (constitution) of the Federal Republic and specified in the Federal Building Code (FBC). Their application and translation into implementation are shaped by the particular complexity of German local government, which is a consequence of urban poly-centricity and the degree of municipal and regional autonomy. These features were created in the post-war period but have deeper roots in the patchwork of 'micro-states' preceding the German nation state.

The overall rules of the framework are set at federal level, implemented by 16 Länder and currently 7240 local/municipal communities in 633 sub-regional groups of communities ('Kreise'). These principles are translated into a sequence of *plans* cascading down from the federal, the regional, and the sub-regional to the local level. The degree of autonomy and discretion at these lower levels of government create flexible but complex rules.

Variegated patterns of recovering development infrastructure costs have evolved from this context. These include state grants, developer charges, various planning agreements and means of *recouping betterment*, all of which have been the subject of intense debate and constant reform for decades. Other forms of public activity in the development process - e.g. through the acquisition and sale of land, strategies for social housing, co-operatives and self-help structures - can vary ways in which infrastructure is provided.

Commonly, the process of infrastructure development begins with development charges levied on owners through mechanisms such as the Communal Levies Act (Kommunales Abgaben-Gesetz, KAG). Generally, landowners pay a maximum of 90% (for instance if the site is to be developed for the first time) and the local authority pays a minimum of 10%. However, a range of special local and state laws are used by local authorities to vary charging levels for landowners for the improvement of already existing infrastructure. These include state legislation which requires owners and developers to share costs of land improvement for initial or additional provision, particularly for roads and utilities (electricity, water and sewage) and allow municipalities to contract out land improvement to third parties (e.g. section 124 FBC).

As a consequence of unification in 1990, and the shortage of public funds in cities and communities, an array of new planning instruments has been introduced to deal specifically with the provision of infrastructure, such as contracts linked to project and infrastructure plans. Combining the aims of paying for infrastructure cost and involving private actors in the development process, two of the most important planning agreements are the urban development contract (Städtebaulicher Vertrag, section 11 FBC) and the urban development procedure (Städtebauliche Entwicklungsmaßnahme, section 165 FBC). The first allows for the full repayment or provision by the investor of the associated necessary infrastructure including schools and kindergartens. Designed for situations in which there is a public interest in comprehensive speedy implementation, the latter allows for freezing land prices at the pre-development level and for the acquisition or even expropriation of private land at price levels preceding speculative development expectations. Another example is the project-based binding land-use plan. Such plans permit the municipality to grant permission for projects where, on the basis of a project and infrastructure plan agreed with the municipality, the project developer undertakes to complete the plan within a certain period and fully or partly assumes planning and land improvement costs.

Different mechanisms for LVC through *planning gain* have been developed in various cities and have enjoyed a degree of success in prospering cities such as Munich, Hamburg, Berlin and Stuttgart, but are facing difficulties of implementation in municipalities under economic pressure, as LVC simply requires considerable planning gains. The discussion on how to proceed from here ranges from the already widely applied urban development contracts to a broader approach of applying LVC to all planning cases. This, however, also implies compensation for losses in land values, which is primarily the case in less prosperous regions.

3.4. The Netherlands

Spatial planning decisions in the Netherlands are made at the national, regional and local levels. At each of these levels, a range of EU policies (e.g. affecting competition, economic development, agriculture, nature protection, and air quality) impact on planning policy and practice (Evers & Tennekes, 2016). Dutch municipalities have long been involved in *active land development* for new residential and commercial areas. Until the 1990s, the most widely used approach to land development involved a municipality (or a municipal land company) acquiring land from its owners, subdividing it for different purposes, servicing the land and providing infrastructure. Serviced land would then be sold to developers, housing associations (for social housing), owner-occupiers or others (e.g. schools). The price at which land was sold to housing associations was determined by government regulation.

Since the mid-1990s, three broad approaches for active land development, often combined within a single development area, have been deployed to pursue active land policies: (i) the building claims model; (ii) joint ventures; and (iii) the concession model (Cahill, 2018).

The *building claims model* involves property developers voluntarily selling land to the municipality. In return, the municipality commits to selling a specified amount of serviced land to the developer later in the process (Needham, 2014). The municipality then services the land and installs infrastructure for the whole development area. Developers subsequently buy land from the municipality at a set price and can choose when to build (Van der Krabben & Jacobs, 2013).

Joint ventures involve establishing a company to undertake land development, with the shares divided between developers and the municipality. The company acquires land and services it, then sells the serviced land for development. The shareholders agree, among themselves, as to whom the land will be sold and at what price. The profits on land development are divided proportionately among the shareholders.

The *concession model* comes closest to the commercial development model used for large projects in many countries. The land is acquired, serviced and developed by one or more developers. Negotiations take place between the municipality and the developers regarding the arrangements for land servicing and how this is financed and on the content of the plan.

Under new legislation in 2008, municipalities were given enhanced powers to recover the costs of betterment (the increased value of property due to the implementation of a plan), even in situations where they do not own the land. The legislation also gave municipalities the

authority to require private developers to include a certain amount of affordable housing in developments. While these changes have given municipalities greater ability to achieve their objectives in situations where they do not own land, most municipalities continue to use a public land development strategy in order to keep tight control over developments (Van der Krabben & Jacobs, 2013).

Where a land-use plan has been adopted, compulsory purchase (eminent domain) powers can be used, if they are needed, to implement development set out in a plan. For example, compulsory purchase powers can be used if a landowner is unwilling to develop their land in accordance with the plan or to sell to the municipality. Procedures exist to establish the appropriate level of financial compensation for the land owner. These compulsory purchase powers mean that landowners generally tend to cooperate in implementing a land-use plan.

3.5. Canada

In Canada, legislation pertaining to municipalities and land-use planning is a provincial and territorial jurisdiction. Accordingly, there are thirteen different legal and regulatory contexts governing the relationship between housing development and the provision of infrastructure. In reality, these tend to be quite similar. The example given here is that of the most populous province, Ontario, which is briefly contrasted with Quebec, whose approach to residential infrastructure funding has, until recently, most contrasted with the nation-wide norm.

The majority of housing developments requiring new infrastructure are suburban subdivisions. In Ontario, a developer must submit a subdivision plan to the municipal planning department, which is generally expected to reflect prevailing zoning by-laws and depict the layout of the proposed development, including streets, parks and schools. The agreement issued by the municipality specifies the responsibilities of the developer, which typically involve the construction of local infrastructure (roads, water and sewage pipes, landscaping of the public realm etc.). The infrastructure must meet municipal standards as it is municipalities that assume ownership and undertake maintenance once completed. Construction costs are passed onto purchasers of buildings within the subdivision. Other infrastructure, such as roads, public transit, schools, libraries, water treatment and sewage capacity, are funded by charges levied on new residential and commercial development with amounts set according to types of residential units and volume of commercial space.

This system assures the funding of local infrastructure required for new residential developments without affecting the tax burden or debt-load of a municipality, but fails to address their broader geographical and temporal impacts. Major transportation investments, such as rail and expressways, are not funded through this system and rely on contributions from provincial and federal governments, whose willingness to pay varies according to their financial situations and political priorities. Consequently, in large urban regions, a transportation infrastructure deficit at the metropolitan scale is a source of congestion and public resentment. From a temporal perspective, while developer involvement in the provision of local infrastructure and development charges secure the financial health of growing suburban municipalities, this situation is reversed when they are built and mature. They then rely on tax revenues for repairs and infrastructure upgrading, causing taxes to increase, making it difficult to compete with developing municipalities for new investments.

Most local infrastructure in the Province of Quebec was, until recently, built by municipalities, relying on tax revenues generated by new developments to service debt. A lack of responsibility for residential infrastructure drove a proliferation of small developers, increased competition and lower housing prices. However, responding to concerns about the municipal financial burden, provincial legislation now permits reliance on development charges for infrastructure funding.

3.6. The United States

Infrastructure planning and finance in the United States is highly decentralised, with states and cities assuming greatest responsibility. States vary in the extent to which they rely on tax revenue, fees, debt, and federal grants to fund various types of infrastructure. Funding for different types of infrastructure, together with trends in funding levels and needs for additional infrastructure investment are outlined below. The various ways in which state and municipalities have used development fees to finance certain types of infrastructure to accommodate residential and non-residential growth are also discussed.

State and local governments own more than 90% of all non-defence public infrastructure and fund more than 75% of maintenance and improvements (McNichol, 2019). Overall, state and local governments account for nearly 75% of all public infrastructure spending, and 42% of total public and private spending. States and local governments are responsible for more than 90% of total infrastructure spending on drinking water, more than 75% on schools, and more than 50% on highways, and mass transit. Nearly half of the federal government's direct support for infrastructure focuses on highways and almost 80% of all private infrastructure investment involves energy and telecommunications.

State and local governments draw from four basic sources to fund infrastructure. These are (as of 2017), dedicated fees (such as gas taxes, water fees), surpluses, and other state funds (39%), federal funds (28%) bond proceeds (27%), and general funds (5%). However, individual states vary widely in their reliance on these sources. While some states rely heavily on debt to finance infrastructure, 12 states do not do so at all, and bond financing makes up less than 10% of capital projects in 16 states (ibid.). States that do not use bonds to finance infrastructure typically adopt a 'pay-as-you-go' approach, in which they rely primarily on taxes, fees, grants and other sources.

Local governments vary in the extent to which they rely on property taxes and other sources of general revenue as opposed to various types of fees and exactions charged to the developers of new residential and non-residential property to provide infrastructure. Many communities utilize general obligation bonds, which are generally covered by property tax revenue, to finance infrastructure improvements. Others, including about 60% of all cities with more than 25,000 residents, require new residential and non-residential developments to bear most of the cost of new or improved infrastructure. With impact fees and similar exactions, developers help pay for the cost of roads, schools, libraries, and other infrastructure that is required to serve new development (see Been, 2005).

Federal infrastructure spending fell from 1% to 0.5% of GDP from 1982 to 2017 and capital spending as a share of state GDP declined in 41 of 50 states between 2002 and 2016 (McNichol, 2019). This lack of federal, state and local infrastructure spending is reflected in a large and growing gap between infrastructure needs and current spending levels. The American Society of Civil Engineers rates the overall condition of US infrastructure as a 'D' (poor). It estimates that the cost of improving the condition of this infrastructure to a 'B' (good) rating by 2025 will total $4.6 trillion, of which only about 55% has been committed (American Society of Civil Engineers, 2017).

3.7. Hong Kong and mainland China

State ownership of land in both Hong Kong and cities in Mainland China enables infrastructure development to be efficient and financially viable. This is because land assembly is state-led and the controlled sale of leases generates intense competition and high demand (and returns) for land investment, sustaining significant public revenues. In Hong Kong, a spatial planning policy of developing a composite urban form, comprising a main urban area and nine decentralised but well-connected and public transport-based new towns, facilitates high-density and high-rise development (Gurran et al., 2016). This urban form

Table 2
Scale of core responsibility for funding/planning infrastructure for housing development.
Source: the authors.

Scale of primary government responsibility	Country
Local government	
Roads/parking, open space, community facilities	All
Schools	UK (Limited), GER, NL, US, HK/China
Police	GER, NL, CAN, US, HK/China
Health	GER, NL, HK/China
Public transport	UK (Limited), GER, CAN, HK/China
Utilities	GER, NL, CAN, US (Limited), HK/China
Affordable housing	UK, AUS (Limited), GER, NL, CAN (Limited), HK/China
Metropolitan/state/provincial	
Regional roads	All
Open space/recreation	GER, NL, CAN, US
Schools	AUS, CAN, HK/China
Police	UK, AUS, GER, CAN, US
Health (hospitals etc.)	UK, AUS, GER, NL, CAN, US, HK
Public transport	All (UK Limited)
Utilities	AUS, GER, CAN, US
Affordable housing	UK (policy setting and funding role), AUS, GER (+Federal funds), CAN
Federal/national	
Major roads	UK, AUS, GER, NL, US, HK/China
Public transport	UK, GER, US

enables large infrastructure projects to be constructed and operate on market principles and to be profit-making, whether government-owned, privately-owned or operated on public-private partnership models. The financial model of the SAR's mass transit railway system, Rail-and-Property, is an exemplar of utilizing the earnings from high-density property development above or around transport nodes, permissible by the district land use zoning plans, to subsidize railway construction and operation.

Apart from land premiums collectable at the time of land lease transaction, post-sale land value appreciation due, for example, to improved accessibility, is captured by quarterly collection of rates from property owners at 5% of market rental value. There is no specific betterment tax. However, increasing public participation in the planning process after 1997 – which broadens the focus of decision-making, emphasizing livability and the quality of urban landscape – has arguably diluted the time-efficiency and cost-effectiveness ethos and has lengthened the cost recovery period of some of the city's mega-transport projects.

Similarly, cities in mainland China employ Hong Kong's high-rise development models especially for large gated-community projects or new towns, supported by a similar land-use zoning system. Residential developers are responsible for the construction costs of on-site basic infrastructure - such as power, water and sewerage - whereas local governments or state-owned urban investment corporations are responsible for the construction of off-site infrastructure, including communication and public utilities including transport, education and healthcare (Urban-Rural Planning Law, 2007; Li & Chiu, 2017). The developers pay basic infrastructure costs to county-level or municipal Housing and Construction Departments or Bureaus, which contract infrastructure projects to local state-owned urban investment corporations or state-owned infrastructure companies. In principle, local governments need to use land revenues paid by developers to construct and provide more capital-intensive public utility projects. In practice, however, local governments tend to use land revenues to fund other projects (Chien & Woodworth, 2018). Thus, it is commonplace to see big developers obtaining additional land from local governments to build these facilities in order to attract more home-buyers, and charge the local governments for the construction costs. Mega infrastructure projects such as high-speed rail and underground mass transits to support the opening up of new development areas are funded, constructed and operated by national government organizations, and are usually subsidized. Currently the national government is formulating a land tax system similar to Hong Kong's, with the aim of generating continued public revenue from property.

4. Discussion and conclusions

Infrastructure delivery occurs at the interface between public power and private interest, often being an outcome of negotiation and compromise. Private enterprise expects the state to coordinate and (sometimes) deliver an infrastructural framework for development. Even where public planning is derided as a hindrance to housing supply and economic development, developers themselves greatly value the public coordination of infrastructure investment (Gallent et al., 2019).

In this concluding section, we return to our three guiding questions and the different processes set out in our seven cases. The first focus is *scale* – the governance/planning hierarchy and implications for funding sources and arrangements. The second focus is LVC – how is this achieved and with what discernible outcomes. And the final focus returns to the interface between *public power and private interest*: which system or systems derive greatest public contribution from rising land values. Moreover, how effectively do the case study countries deal, at a macro-level, with the capture or transformation of private value in the service of public interest?

4.1. Scale: national/centralised; localised, or mixed

As summarised in Table 2, there are similarities and differences across the seven cases in terms of the scale at which core responsibility for financing and providing different types of infrastructure occurs.

The UK, for example, has complex government structures both locally and through devolution to the nations (and London). Additionally, there are diverse agency responsibilities and some groups of authorities working jointly across jurisdictions. The UK is characterised by a patchwork of contrasting geographies, from combined authorities, with additional central funding allocations, to small civil parishes able to claim funding precepts for local projects. The pace of government rescaling has been frenetic since 2010, with the loss of the centrally-led regional tier and subsequent search for new strategic arrangements. The funding model, in contrast, has been more stable with tax expenditure remaining the dominant source of funds for major projects. There continues, however, to be a discursive focus on local 'cost recovery' through planning agreements or variable charges on different types of development, although some housing development has been removed from this regime through further planning deregulation. Australia has a more stable governmental hierarchy, split between the national, states/territories and local authorities. Responsibility for infrastructure of varying types is shared, with a mix of tax spending, borrowing and developer contributions supporting investment. The states and territories set the frameworks for local authorities seeking contributions, leading to variable practice. A move to voluntary, negotiated, agreements – drawing inspiration from the UK – has brought welcome flexibility, but also a degree of uncertainty for both developers (how much will they need to pay?) and authorities (how much will they receive?).

The German system of government is built on poly-centricity that translates into four tiers of government: federal, Länder, and 600-plus groupings of 7000-plus separate municipal communities. These have considerable local autonomy which underpins a complex mosaic of cost recovery for infrastructure: ranging from local agreements to public land acquisition and disposal. Local development charges are central to the German system, with emphasis placed on landowners meeting the infrastructure costs of development. The Netherlands has a municipal-level focus on active land development integral to which is

infrastructure delivery. However, municipal land companies – acquiring, servicing and selling land – have given way to partnership working with the private sector. The claims approach is a voluntary version of the compulsory purchase model of the 1990s; joint venture (public/private) companies share risk and benefit; and the concession model of strategic land development empowers private companies, under the watchful eye of municipal government.

The responsibility for planning and coordinating infrastructure in Canada rests with the provinces and territories, which oversee a land-use zoning system. That system requires would-be developers to present 'subdivision' plans, detailing land use mix and infrastructure provision, with costs met through onward sale of residential and commercial property. Municipal authorities are then asked to approve those plans and, later on, take responsibility for managing or maintaining infrastructure. The model seems positive, with costs shared by development beneficiaries. However, strategic infrastructure falls outside the model and its costs fall, rather, directly on the tax-payer - as does the cost of maintenance.

The USA's 'decentralised' approach to coordinating infrastructure delivery (orchestrated at a state level) may appear relatively high-level to European eyes. There is also a strong sectoral split. The federal government funds highways while energy and telecommunications are dominated by the private sector. Local government pays the costs not met by federal funding or private investment from property taxes and general revenue rather than from development charges. Finally, Hong Kong and mainland China are an outlier in this group, marked by state ownership of land and power exercised at city level. Premiums from leases pass responsibility for local infrastructure to developers. Off-site infrastructure (energy, power and so on) costs are met from lease revenues and rates, with that infrastructure thereafter delivered by state urban investment corporations.

Scaling of government function and infrastructure responsibility is an outcome of history, external influence and historic ties. Political preferences towards local empowerment or decentralised approaches to strategic planning, are also important. The UK and Germany display similar complexities in local government, but in Germany this has produced a wider array of funding approaches, whereas the UK remains centralised – albeit with a recurrent political focus on LVC. They are joined by the Netherlands, which has a similarly localised focus but applies approaches to infrastructure funding that are more standard, evolving away from direct public control to fairly clear partnership approaches. Canada and the USA operate their infrastructure programmes at similar scales, both resulting in deficits in strategic provision. Australia shares much of the Netherlands' and Canada's clarity, but its adoption of local UK practices has introduced new uncertainties into its model. Hong Kong/China is an outlier – marked by strong central control, which brings costs that are discussed below.

4.2. Rationales and approaches to infrastructure financing: public versus developer/user pays; impact mitigation; or land value capture

Table 3 summarises the rationales for, and approaches to, infrastructure financing across the case study countries. As shown, broad based public financing of core transport and social infrastructure continues in all jurisdictions, but a variety of other models are used to a greater or lesser degree.

For the UK, the headline figure of 6% of infrastructure funding coming from charges and agreements, at the point of development, belies considerable opacity in the scale of LVC. Government infrastructure investment derives, in part, from taxes on developers and transaction land tax (i.e. Stamp Duty). This means that (indirect) LVC from land (and the process of land development) is higher than the headline and there is no hypothecation. This is true of all the case study countries. Australia has a system of LVC set at the state-territory level. There is no national framework and a mosaic of local arrangements, bound by state legislation, which, in New South Wales include a defined system for voluntary planning agreements. These agreements are varied for development context and mixed use, resulting in flexibility but also making it difficult to size the overall contribution of LVC.

In Germany, local development charges require landowners to meet *up to* 90% of infrastructure costs, but there is considerable variability in contribution. Urban development contracts require the partnership between landowners and developers to meet the cost of enabling infrastructure. These contracts sit beside 'planning gain' instruments and work well in prospering cities, but fare less well elsewhere. In the Netherlands, there is more limited engagement with ad hoc arrangements for LVC from private land – compared to a strong preference for public land development strategies, where land is either brought into public ownership or under the ownership of a joint venture.

Canada's preoccupation with local and direct enabling infrastructure had produced a strategic infrastructure deficit. Tax payers primarily fund and maintain major infrastructure, which has been a cause of dispute and public resentment. Quebec has moved towards development charging, but in the context of its particular cost recovery model which contrasts with Ontario's insistence on private provision, agreed in the sub-division plans. In the United States, 60% of all cities with more than 25,000 residents require developers to bear the cost of new or upgraded infrastructure. Levied charges can help pay for roads and schools for example, but this is always overshadowed by federal support and private investment in energy, recouped from customers. Finally, the conception of 'betterment' (and its capture) does not always resonate in Hong Kong and China. This is because rises in land value are not diverted from private owners and captured for public benefit. Rather, development costs are simply 'recovered' through the sale of leases and collection of rates. This approach is being further developed with a land tax system, similar to that of Hong Kong, being rolled out in the mainland.

LVC is a 'diversion' of value from the private sector. In most systems, there is uncertainty surrounding how much is diverted, through a

Table 3
Rationales and approaches to infrastructure financing for residential development.
Source: the authors.

Approach	Application
Public financing (general revenue)	All: Transport, schools, police, recreation; community and health facilities
Land value capture/recoupment of costs from private developers (impact fees/contribution requirements)	Local development infrastructure: AUS, GER, CAN, US; Major transport infrastructure: UK and AUS (partial)
Public provision; recoup costs through land sales	GER, NL, HK/China
Mixed – public/private partnership (e.g. private development of public land, transferred at residual/commercial value)	GER, NL, HK/China UK, AUS, US (primarily limited to public housing renewal)
Private provision; transfer to public ownership/management	GER, CAN, AUS, NL (residential subdivision)
Private provision, private ownership and access (e.g. gated estates; recreation/community facilities provided onsite/internal to building)	All (limited to particular types of development, such as apartment buildings/ gated estates)
Public provision – transfer to private operation (funded through sale/user pays)	AUS, GER, US (transport infrastructure)

mix of development charges, agreements and local land/transaction taxes. But many countries – including the UK, Australia, Germany, Canada and the US – place great emphasis on central funding, which greatly exceeds local 'exactions'. This results in a perennial debate centred on the balance of general/public versus local/private contributions and, more specifically, on whether landowners fairly contribute to their 'own enrichment'. That debate is far less relevant in Hong Kong/China and, perhaps more surprisingly, the Netherlands. State land ownership in the former precludes the need for 'diversion' while voluntary transfers of ownership, to a public entity or joint venture, in the latter mean that similar public benefits accrue – with that model seemingly gaining acceptance where alternatives are limited.

4.3. Public power and community benefits versus private interest

Finally, it was suggested above that infrastructure delivery happens at the interface between public power and private interest, and *how* it happens is indicative of the power of government to fairly extract and apportion public benefit. Many systems are opaque, making it difficult to measure the direct contribution of developers and landowners to infrastructure provision. This is the case in the UK, where opacity arguably serves key interests. It has been proposed recently (Bowie, 2017) that Stamp Duty Land Tax (paid by buyers of land and property) should be converted into a capital gains tax on vendors, helping clarify the contribution of LVC to meeting infrastructure costs and more fairly taxing the beneficiaries of uplift. In Australia, like the UK, the interface is where bargains are struck with arrangements designed to suit development and market context. Power similarly rests with capital, able to assess and estimate financial tolerance. This is often the case with systems seeking 'flexible' LVC/diversion from private land, where the public sector has to 'negotiate' value without full disclosure of financial information. Germany has local variability but the development charges model reveals an emphasis on the private sector enabling infrastructure, especially through urban development contracts. There is a potential consensus that direct beneficiaries of land development should bear infrastructure costs. That is also the case in the Netherlands, which represents a half-way house between the complexities presented by private land ownership and opportunities afforded by public ownership. Its 'active' land development models put the public sector in the lead. Canada has a scale dilemma: a seemingly neat way to deliver local infrastructure breaks down at higher levels, with cost burdens falling (disproportionately) on the taxpayer. However, it is not clear whether development-based funding is 'fairly' balanced against tax at higher levels, and whether the overall level of LVC is high. Power balances are difficult to discern for the US: funding sources vary across infrastructure sectors, with the federal government focused on roads, private enterprise on supply utilities, and local administrations on service infrastructure. Local 'exactions' (charges) are small compared to federal investment and private speculation (and competition) in chargeable utilities. There is less diversion of private value in land and more emphasis on recovering costs through, for example, future tax increments.

In terms of the power to extract public benefit, Germany seems to join the Netherlands in its clear intent to identify the biggest beneficiaries of development and ensure that they shoulder the burden of infrastructure cost. But is Hong Kong/China, with its foundation of land in state ownership, the clearest expression of public power? It is a very different case study, illustrating state rather than pubic power, achieved through retained control over land, state investment corporations, and tax levied on property owners. But public power and benefit is arguably something different: public participation, needed to define and steer that benefit, has been weak. It has gained a foothold in Hong Kong since 1997, but has added to development costs and is unlikely to be replicated in mainland China. The state defines the public good, containing the power of enterprise and recycling (financial) benefit through state-controlled companies. This culture differs considerably from that of other advanced economies.

The practice that might inspire other countries is that of *voluntary transfers of ownership*, contracting development, and onward sale of serviced land by public entities or joint ventures. These achieve full cost recovery and, perhaps, contributions for off-site infrastructure. Similar approaches have worked well in the past and include the UK's New Town Development Corporations. The insistence that land must remain in private ownership, and value diverted to public benefit, is an opaque and increasingly contested means of delivering infrastructure needed to support housing development. But the inefficiencies of that approach (generated by complex 'work arounds' and incessant political debate, which is repositioned with each change of government) are matched by municipal over-reliance on land finance in China (Liu et al., 2018) and the risk of unsustainable and inefficient use of land (Zheng et al., 2014) produced by exclusive state control. Between these two monoliths, nimbler consensus-based approaches would seem to offer a way forward for infrastructure delivery in support of coordinated housing growth.

The paper has revealed a wide variety of ways to fund infrastructures. Although with different levels of efficacy, these all make it possible to foster development by adjusting the provision of infrastructures to needs generated by urban growth. The research has revealed a wide variety of arrangements, made even more complex by their numerous interconnections within different national contexts. While it is beyond the scope of this research to measure the impact of different infrastructure funding arrangements, we acknowledge their repercussions on planning capacity, the level of development, social equity and housing affordability. Each of these arrangements either promotes higher levels of planning coordination or more market-oriented forms of development. They can also serve to stimulate development by providing infrastructures required by urban growth. Moreover, depending on the origins of infrastructure funding, they add to the cost of housing thus impeding its affordability, or contribute to lower its cost when involving public sector subsidies. Extensive infrastructure programmes, which underpin rapid urban development, contribute to reduce housing cost by increasing its supply. Further research could explore how the individual infrastructure funding arrangements and their combinations identified in this paper can contribute to different planning, social and economic objectives. In practice, opportunities for policy reform are limited by political, economic, and legal contexts and path dependencies. But we hope to extend the policy imagination by shedding light on the variety of policy options available to governments seeking to support new housing supply by removing infrastructure obstacles.

CRediT authorship contribution statement

All authors contributed equally to the writing of this paper.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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