



Original scientific paper

The Socio-Economic Value of Urban Green Infrastructure: Statistical Equations for Assessing Perceived Urban Economic Growth

^{*1} Shad Sherzad Jawhar , ² Nawaz Nadhim Omar , ³ Federico Luis del Blanco García

^{1 & 3} Universidad Politécnica de Madrid, Madrid, Spain

¹ Architecture Engineering Department, Tishk International University, Sulaymaniyah, Iraq

² Architecture Engineering Department, Tishk International University, Erbil, Iraq

¹ E-mail: shad.jawhar@alumnos.upm.es , ² E-mail: nawaz.dabbagh@tiu.edu.iq , ³ E-mail: federicoluis.delblanco@upm.es

¹ ORCID: <https://orcid.org/0000-0002-3702-7800> , ² ORCID: <https://orcid.org/0009-0003-9057-6168> , ³ ORCID: <https://orcid.org/0000-0002-7907-6643>

ARTICLE INFO:

Article History:

Received: 14 June 2026
Revised: 9 September 2026
Accepted: 22 September 2026
Available online: 29 September 2026

Keywords:

urban economy;
urban green infrastructure;
economic valuation;
structural equation modelling;
Kurdistan Region of Iraq.

This article is an open-access article distributed under the terms and conditions of the Creative Commons Attribution 4.0 International License (CC BY).



Publisher's Note:

The *Journal of Contemporary Urban Affairs* remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

ABSTRACT



Erbil and Sulaymaniyah, in the Kurdistan Region of Iraq, are converting green land into built land, and the valuation methods that would say what is lost presume property markets and environmental accounts that neither city keeps. This study measures the socio-economic value that residents and businesses attribute to urban green infrastructure and links it, through three equations, to their perception of the city's economic growth. Three quantities are kept apart: perceived contribution, stated willingness to pay, and actual growth, which the design does not observe. A dual-frame survey of 1,593 residents and businesses supplies a composite structural model in which green endowment is associated with five value channels, and the channels with perceived growth, measured by the one item that does not name greenery. The model explained 43% of that item's variance; wellbeing and productivity carried the largest coefficient ($\beta = 0.231$). A model-weighted indicator stood at 58.4–60.6 across the four groups and anchors, through stated willingness to pay, to 6,975–7,145 dinars per household monthly, a stated rather than a revealed amount. Measurement was invariant across three language versions. The chain is offered as a proposition for testing in other data-scarce cities rather than as a transferable property.

JOURNAL OF CONTEMPORARY URBAN AFFAIRS (2026), 10(2), 498–526.

<https://doi.org/10.25034/jcua.2026.v10n2-11>

www.jcua.com

Copyright © 2026 by the author(s).

Highlights:

- Wellbeing and productivity is the widest of five perceived value channels
- Three equations link green endowment to perceived urban economic growth
- All five channels are associated with perceived economic growth
- Access, not quality, separates the two cities on property-value confidence
- Perceived green value anchors to 6,975–7,145 dinars per household monthly

Contribution to the field statement:

The article gives urban economy research a three-equation chain that turns an affordable survey into a group-comparable, willingness-to-pay-anchored indicator of perceived green value where market data cannot be used, and gives the Kurdistan Region of Iraq its first survey-based estimate of what residents and businesses attribute to green infrastructure.

* **Corresponding Author:** Shad Sherzad Jawhar

Universidad Politécnica de Madrid, Madrid, Spain

Email address: shad.jawhar@alumnos.upm.es

How to cite this article? (APA Style)

Jawhar, S. S., Omar, N. N., & Del Blanco García, F. L. (2026). The socio-economic value of urban green infrastructure: Statistical equations for assessing perceived urban economic growth. *Journal of Contemporary Urban Affairs*, 10(2), 498–526. <https://doi.org/10.25034/jcua.2026.v10n2-11>

1. Introduction

Erbil and Sulaymaniyah are building over their own shade. Both cities have grown at a pace their planning institutions were never designed to manage, and much of that growth has been fed by exactly the land that carried their parks, orchards and street trees (Hassan et al., 2025; Kemec & Abdalkarim, 2023; Salih et al., 2026). A municipality that removes an asset is normally expected to say what the asset was worth, and in most of the urban world somebody can answer. Here the answer is missing. A structured search run for this study on 3 September 2026, of the Crossref index of DOI-registered publications and of a general web search engine, combined each city's name and its variant spellings (Erbil, Hawler; Sulaymaniyah, Sulaimaniyah, Sulaimani, Slemani) with green space, green infrastructure, park, valuation, willingness to pay, economic value and property value; it returned accessibility, equity, distribution, housing and land-use studies for the two cities (Hassan et al., 2025; Kemec & Abdalkarim, 2023; Khoshnaw, 2023; Salih et al., 2026) but no study measuring what urban green infrastructure contributes to either city's economy or what its users would pay for it. Decisions of real consequence are therefore made under a familiar bias, the one the bid-rent tradition describes, in which the priced use of land outbids the unpriced one whatever their true relative worth (Alonso, 1964; Godoi et al., 2025; Odhengo et al., 2024).

The setting sharpens the stakes. Iraq's post-2003 urban growth has concentrated in these two cities, drawing migration and investment into housing programmes and land conversion at the edge (Jawhar & Atakara, 2026; Khoshnaw, 2023; Salih et al., 2026). Green provision has not kept pace, and what exists is unevenly reachable (Hassan et al., 2025; Kemec & Abdalkarim, 2023), while municipal budgets follow oil rather than a locally argued case for any asset (Abdullah & Gray, 2022). An unpriced asset does not merely lose arguments; it never gets to make one.

Three families of method already value urban greenery, and the contribution claimed here has to be placed against each. Hedonic models read the value of parks and trees out of property transactions (Caprioli et al., 2023; J. Li et al., 2024; Sachs et al., 2023; Sohn et al., 2020); contingent valuation asks people what green space is worth and disciplines the answers statistically (Gelo & Turpie, 2021; Kalfas et al., 2022; Liang et al., 2025; Zhou et al., 2021); ecosystem accounting converts canopy and runoff retention into accounts a treasury can read (Costadone et al., 2024). Composite and partial least squares modelling has meanwhile been used widely to explain how residents perceive and use green space (Halkos et al., 2021; Refisch et al., 2024). What none of these does is join the last two: the stated-preference studies return an amount without a model of why the asset is worth paying for, and the perception models return coefficients without an amount. The gap this study addresses is therefore not only that no one has valued green infrastructure in these two cities, which is a geographical fact, but that the urban-amenity framework in which greenery acquires a price (Albouy, 2016; Alonso, 1964; Roback, 1982) has no estimable form where the price layer is missing, and the survey methods that do work there have not been given the structure of that framework. The construction proposed below, a composite structural model of the channels through which the urban economy's own agents perceive green value, closed by an equation that anchors a model-weighted indicator to stated willingness to pay, is the bridge. Section 2.2 sets out what it inherits from the amenity framework and what it gives up.

One image runs through the paper and is meant only as an aid to reading. For centuries the cities of this region drank from karez, underground channels that carried water from the foothills into fields and households, shared and counted by turns but entered in no account until they ran dry (Al-Manmi et al., 2019). Urban green infrastructure is treated here as a channel system of that kind: value is hypothesised to move through it along several routes at once, and the model's job is to measure the routes.

The aim is to measure the socio-economic value that residents and businesses in Erbil and Sulaymaniyah attribute to urban green infrastructure and to link it, through statistical equations estimated on live survey data, to their perception of the city's economic growth. The dependent

construct is that perception and nothing more; the design observes no product series, transaction or rent, and the paper uses the phrase perceived urban economic growth wherever the outcome is meant. Three questions organise the work. Which socio-economic channels carry perceived green value in these cities? How strongly is each associated with perceived growth of the urban economy? And does the pattern hold from one city to the other, and from households to the firms that live with it? Section 2 develops the theory and hypotheses, Section 3 the cases, instrument and equations, Section 4 the results, and Sections 5 and 6 discuss and conclude.

The study sits inside urban economics on four grounds. What the model explains is perceived urban economic growth, so its object is the urban economy as its agents read it rather than vegetation or satisfaction with parks (Batty, 2022). The people supplying the data are that economy's constituent agents, households carrying demand, labour and housing choices and firms carrying investment, employment and location decisions (Grimes et al., 2023; X. Li & Xiao, 2024), so surveying both in parallel treats the urban economy as the joint fact the two populations produce. Every channel is a mechanism the field already recognises: amenity capitalised into property values (Ledraa & Aldubikhi, 2025; Sohn et al., 2020), the pull of attractive streets on custom and enterprise (Hwang & Park, 2026; Suhartanto et al., 2026), green employment and livelihoods (Froy et al., 2022; Q. Li et al., 2024), the fiscal base that capitalised value supports (Back & Collins, 2022; Vejchodská et al., 2022), and the productivity of a workforce whose surroundings support its wellbeing (Patino et al., 2023; Wu et al., 2022). And the output is an instrument of urban economic management: a comparable indicator, anchored to a stated amount, for an asset class that municipal allocation currently treats as free.

2. Theoretical Background and Hypotheses

2.1 Urban green infrastructure as an economic asset

Urban green infrastructure means the connected stock of a city's vegetated and open spaces — parks, street trees, gardens, stream corridors, peri-urban belts — planned and managed as infrastructure rather than as leftover land (Godoi et al., 2025; Monteiro et al., 2020). That reading carries an economic implication the planning literature has accepted faster than the budgetary one: an asset delivering services should appear somewhere in the accounts of the economy consuming them (Ramyar et al., 2021; Russo, 2024). The services are well documented, from recreation and cooling to the quieter work of informal green space (Basu & Nagendra, 2021; Luo & Patuano, 2023), and so is the economic footprint wherever anyone has looked: urban forest construction associated with measurable growth in China (H. Ai & Zhou, 2023), green infrastructure investment shifting city-scale environmental outcomes (K. Ai & Yan, 2024), and property markets from Singapore to Seville to Riyadh capitalising nearby greenery into prices (Dell'Anna et al., 2022; Ledraa & Aldubikhi, 2025; Ramírez-Juidías et al., 2022; Song et al., 2025). An asset with that record, left unpriced, is predictably undersupplied; municipal officers themselves rank the missing economic case among the first obstacles to delivering green programmes (Back & Collins, 2022; Meerow, 2020).

2.2 The amenity in urban economics, and what survives without prices

Urban economics has a settled account of how an amenity acquires a price, and it is worth stating before explaining what this study keeps of it. In the spatial-equilibrium tradition an amenity is priced through the wages people accept and the rents they pay to live near it: households and firms move until the differentials exhaust the advantage, so the value of a city's quality of life can be read from its wage and rent gradients (Albouy, 2016; Roback, 1982). Beneath that sits the bid-rent logic in which every parcel goes to the use that can pay most for it, which is the mechanism by which an unpriced park loses to priced housing (Alonso, 1964). On the fiscal side, the value that public assets capitalise into land is what land value capture instruments are designed to recover for the treasury that created it (Vejchodská et al., 2022). Each of these frames is estimable only through a price layer — wages, rents, transactions or assessed values — and it is that layer, not the theory, that Erbil and Sulaymaniyah lack. What survives without prices is the structure: an endowment, channels through which it becomes economic value, and a growth outcome. The study keeps the structure and replaces the price layer with

the measured judgement of the agents whose bids the price layer would otherwise record. That substitution has a cost the paper accepts openly. A capitalisation coefficient estimated from transactions is a market fact; a property-value confidence score is a belief about that fact, and the two need not agree. What the substitution buys is estimability, and with it comparability: because every group is measured with one instrument, the same coefficient can be estimated for two cities and two populations, which a hedonic model fitted to two unlike registries cannot do. The model is therefore a member of the amenity family rather than a departure from it, and its claims are claims about perceived value, disciplined by the reliability, invariance and predictive tests of Section 3, not about the equilibrium prices the family's other members estimate.

2.3 Valuation where the data run out

Each established valuation family has entry requirements. Hedonic pricing needs many observed transactions with reliable attributes, and its recent refinements deepen rather than relax that need (Caprioli et al., 2023; J. Li et al., 2024; Sachs et al., 2023; Sohn et al., 2020). Stated-preference methods need careful design and defensible sampling but not markets, which is why contingent valuation remains the workhorse of the developing-city literature (Combrinck et al., 2020; Gelo & Turpie, 2021; Kalfas et al., 2022; Liang et al., 2025; Malik et al., 2021; Sabyrbekov et al., 2020; Zhou et al., 2021). Emerging-market hedonic work exists, but leans on unusually good local data or pairs the price model with survey evidence, the transaction layer alone being too thin (Combrinck et al., 2020; Ledraa & Aldubikhi, 2025; Song et al., 2025). Ecosystem accounting needs biophysical measurement and standing institutions (Costadone et al., 2024). Reviews reach the same conclusion: economic valuation is the least developed part of green infrastructure research, and least developed where urbanisation is fastest (Ersoy Mirici, 2022; Zheng et al., 2026).

The criticisms of stated preference in a low-income setting are well rehearsed: hypothetical bias inflates amounts, protest zeros conceal value, payment vehicles carry politics. So are the countermeasures, which the developing-city literature applies as standard (Gelo & Turpie, 2021; Liang et al., 2025; Malik et al., 2021). What that literature rarely does is place the disciplined answers inside a structural model of the urban economy, leaving stated amounts free of any account of why the asset is worth paying for. This study anchors the willingness-to-pay item to a model-weighted indicator, equation (3) below, so that the stated amount carries an account of what it is paying for, and Section 4.3 reports how far the anchored figure moves under alternative weightings and treatments of the zero responses.

In cities where only the survey family can operate, two disciplines keep perception-based economics honest. The first is psychometric: constructs must be measured reliably, validated against one another, shown to be invariant across the groups and language versions compared, and shown to predict out of sample, as in any composite modelling exercise (Halkos et al., 2021; Refisch et al., 2024). The second is distributional: green value capitalises unevenly and can displace the residents it was meant to serve, so a valuation study should say for whom the value arrives, not only how much of it there is (Stuhlmacher et al., 2022; Xiao et al., 2026). The design below answers the first with a full measurement and invariance protocol, and the second by estimating every relationship separately for two cities and two populations. It rules out two shortcuts: benefit-transfer coefficients imported from unlike economies, and any monetary claim not anchored in the surveyed populations themselves.

2.4 Model and hypotheses

Figure 1 sets out the model. At the source sits urban green infrastructure endowment (UGE), a second-order formative composite of two dimensions: perceived green quality (GIQ) — condition, maintenance, safety, character — and perceived green accessibility (GIA), reachability on foot and by the car journeys these cities actually make (Hassan et al., 2025; Kemec & Abdalkarim, 2023; Russo, 2024; Shi et al., 2020). Five channels follow, and they were chosen by a rule rather than by intuition: the urban economy is treated as five constituencies through which an amenity can enter the accounts, and one channel is specified for each. Households hold property, so amenity capitalisation as

households and firms experience it is property-value confidence (PVC), the belief, grounded in the hedonic record, that green surroundings hold and raise the worth of premises (Ledraa & Aldubikhi, 2025; J. Li et al., 2024; Sohn et al., 2020; Zhou et al., 2021). Firms choose locations and draw custom, so the pull of green settings on enterprise — footfall, firm location, retention of people who can choose where to work — is business attraction and custom (BAC) (Grimes et al., 2023; Hwang & Park, 2026; X. Li & Xiao, 2024; Suhartanto et al., 2026). The labour market absorbs green work directly, from maintenance and horticulture to the informal livelihoods green space hosts, which is employment and livelihoods (EML) (Froy et al., 2022; Q. Li et al., 2024; Luo & Patuano, 2023; Mell, 2022; Sopelana et al., 2025). The public sector taxes the values the other channels create, which is municipal fiscal capacity (MFC) (Back & Collins, 2022; Meerow, 2020; Vejchodská et al., 2022). And human capital is renewed by everyday contact with green surroundings, running to life satisfaction and working capacity, which is wellbeing and productivity (WBP) (Halkos et al., 2021; Nordbø & Nordh, 2025; Patino et al., 2023; Refisch et al., 2024; Wu et al., 2022, 2023). These five are the household, firm, labour-market, public-finance and human-capital entries that the amenity literature on greenery reports (Ersoy Mirici, 2022; Godoi et al., 2025; Roback, 1982); biophysical services such as cooling and flood retention are not channels of their own, because they reach the urban economy through these five and are the province of ecosystem accounting where it exists (Costadone et al., 2024). The rule also fixes the number: one channel per constituency keeps the instrument answerable in one sitting, and collapsing them would average away the differences the comparative hypotheses need.

The outcome the channels lead to is perceived urban economic growth (UEG), the respondents' assessment as economic agents of their city's direction (Batty, 2022). It is measured by the single item that asks about growth without naming greenery, "This city's economy has been growing". The instrument also carries three items that ask directly whether greenery contributes to, would speed, or would attract investment to the city's economy; because they name the predictor, a construct containing them would partly restate the hypothesis in the outcome, so they are kept out of the model, reported descriptively as attributed contribution, and used only in the sensitivity comparison of Section 4.4. A single-item outcome is a deliberate trade: it gives up the reliability estimate a multi-item block would provide and accepts attenuation of every path into it, in exchange for an outcome that owes nothing to the vocabulary of the predictors. That outcome is the honest choice rather than a proxy of convenience: no official city-level product series exists here, informal activity would escape one if it did, and the perception of agents who hire, invest and relocate is itself part of how urban growth happens (Halkos et al., 2021; Odhengo et al., 2024).

Three configurations were open, and the figure shows the one adopted. A direct-only model, endowment to perceived growth with no channels, would reproduce the amenity framework's reduced form and say nothing about mechanism; a full-mediation model would assert that every route from greenery to perceived growth runs through the five constituencies named, which the instrument cannot guarantee; the partial-mediation model adopted here estimates the five channels and keeps a residual direct path (H3), so that whatever the channels fail to carry is measured rather than assumed away. Section 4.4 compares the three on explained variance and out-of-sample loss. The direction of the arrows is theoretical: an amenity is prior to its capitalisation in the equilibrium account (Albouy, 2016; Roback, 1982), and a household's or firm's reading of what greenery does for property, custom, work, the budget and wellbeing is logically prior to its reading of the city's growth. A single-wave survey cannot exclude the reverse, that agents who believe the economy is growing think better of its greenery, and Section 5.2 treats that as a rival explanation rather than a settled matter.

The hypotheses follow the figure. H1a–H1e: endowment is positively associated with each channel — quality and access together with property-value confidence (a), business attraction and custom (b), employment and livelihoods (c), municipal fiscal capacity (d), wellbeing and productivity (e). H2a–H2e: each channel is positively associated with perceived urban economic growth. H3: a residual direct association between endowment and perceived growth remains after the channels. All eleven structural

hypotheses are directional and positive. H4 and H5 are comparative and non-directional. H4 holds where at least one structural path differs between Erbil and Sulaymaniyah after adjustment for multiplicity, cities whose economic bases differ enough — an administrative, public-sector-fed capital against a trading and cultural centre — to make transfer an empirical question rather than an assumption (Abdullah & Gray, 2022; Khalaf et al., 2022). H5 holds on the same rule between residents and businesses, the two frames reading the same infrastructure through different economic interests (X. Li & Xiao, 2024; Zhou et al., 2021). A difference counts as confirmatory only where the composites it runs through pass compositional invariance between the groups compared; otherwise it is reported as exploratory. For both, the located difference rather than the count is the finding.

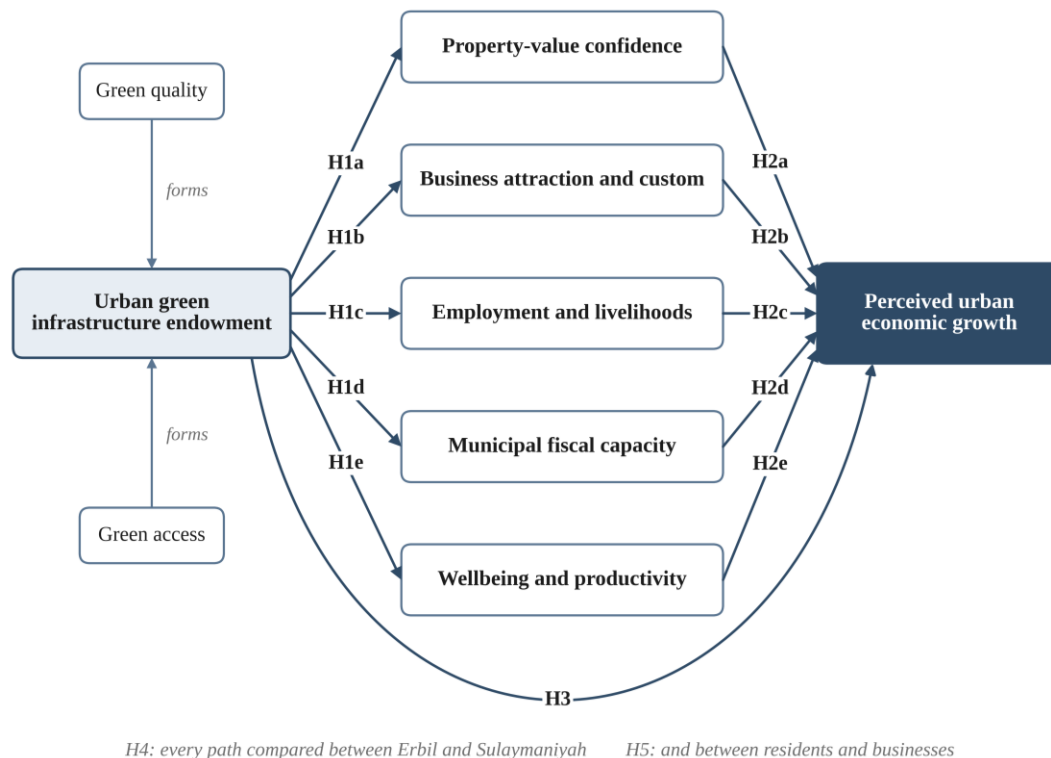


Figure 1. The conceptual model. *Source: prepared by the authors in CorelDRAW.*

Note: All eleven structural paths are hypothesised positive. H4 and H5 are non-directional and apply to every path shown.

3. Materials and Methods

3.1 Two live cases: Erbil and Sulaymaniyah

The study ran as a live survey investigation in the two largest cities of the Kurdistan Region of Iraq, chosen because they hold the region's population and its decisions, and because their economic characters differ in a way the model can use. Erbil has an estimated 1.6 million people on a built-up area of about 431 km² and Sulaymaniyah about 1.1 million on 451 km² (Hassan et al., 2025). Erbil, the administrative capital, carries a services economy built on government employment, with the vulnerabilities of an oil-fed fiscal system behind it (Abdullah & Gray, 2022). Sulaymaniyah leans on trade, culture and its universities, with a commercial street life its residents evaluate in strongly place-bound terms (Khalaf et al., 2022). Their green endowments differ in kind more than in count. Erbil holds 496 mapped green spaces, 75 of them above half a hectare and six above eight hectares, on a city surface of which roughly 17% is vegetated; Sulaymaniyah holds 634, 61 above half a hectare and four above eight hectares, with roughly 48% of its surface vegetated, much of it foothill and orchard rather than park (Hassan et al., 2025). Both are car-dependent, and 95% of Erbil's population and 85% of Sulaymaniyah's can reach a large green space within fifteen minutes' travel (Hassan et al., 2025); in Erbil, four-fifths of residents are within a fifteen-minute walk of a neighbourhood park but under half are within five (Kemec & Abdalkarim, 2023). Both cities are converting open and agricultural

land at their edges under sustained residential demand (Kemec & Abdalkarim, 2023; Khoshnaw, 2023; Salih et al., 2026). Fieldwork ran from January to May 2026, both cities in the same window by the same protocol.

The two urban forms differ in ways the instrument must respect. Erbil is organised by ring roads around the citadel, its greenery concentrated in a few set-piece parks and corridor planting, so access runs through deliberate journeys; Sulaymaniyah's interleaves with its commercial spine and foothill edges, so contact is incidental to daily movement (Hassan et al., 2025; Khalaf et al., 2022). Municipal responsibility differs too, and H4 tests whether these differences show in the estimates.

3.2 Instrument, sampling and fieldwork

One instrument serves both cities in two frames. The resident form addresses households, the business form owners and managers of enterprises, and the two share a measurement core so every construct in Figure 1 is estimated identically in both populations, with only the economic vantage point changed. Table 1 gives each construct, its indicator codes and item stems, and the studies each item was developed from. All model items use five-point agreement scales; the willingness-to-pay anchor asks for a monthly amount in Iraqi dinars toward a named improvement of the respondent's nearest green space, and demographic and firm descriptors close the form. The instrument was drafted in English, translated into Kurdish (Sorani) and Arabic and back-translated independently, discrepancies reconciled by committee. A pilot of $n = 30$ per city preceded the main run; its cases were not carried into the analysis, and the item stems in Table 1 are those fielded after it. Respondents chose the language of the form: 1,307 completed it in Kurdish, 205 in Arabic and 81 in English, and Section 4.3 tests measurement invariance across the three versions. The form took a median of 20.9 minutes to complete.

Table 1: Constructs, indicators and item stems. *Source: prepared by the authors from the cited studies.*

Code	Item stem (resident form)	Developed from
Green quality (GIQ)		
GIQ1	The green spaces near me are well maintained	Kemec & Abdalkarim, 2023; Russo, 2024
GIQ2	They feel safe to use at most hours	Basu & Nagendra, 2021
GIQ3	Their planting suits this climate	Shi et al., 2020
GIQ4	They are attractive places to spend time	Halkos et al., 2021
Green access (GIA)		
GIA1	I can reach a green space easily on foot	Hassan et al., 2025
GIA2	Reaching one by car or public transport is practical	Hassan et al., 2025
GIA3	Green spaces are fairly spread across the city	Kemec & Abdalkarim, 2023; Shi et al., 2020
Property-value confidence (PVC)		
PVC1	Greenery nearby raises what property here is worth	Ledraa & Aldubikhi, 2025; Sohn et al., 2020
PVC2	A greener street makes premises easier to sell or let	J. Li et al., 2024; Zhou et al., 2021
PVC3	Buyers and tenants here notice green surroundings	Dell'Anna et al., 2022
Business attraction and custom (BAC)		
BAC1	Green, pleasant streets bring businesses more custom	Hwang & Park, 2026
BAC2	Green surroundings help attract and keep good staff	Grimes et al., 2023
BAC3	New businesses prefer the greener parts of the city	X. Li & Xiao, 2024
Employment and livelihoods (EML)		
EML1	Green spaces support jobs in this city	Froy et al., 2022
EML2	Maintaining greenery creates steady local work	Mell, 2022; Sopelana et al., 2025
EML3	Green places host small trades and livelihoods	Luo & Patuano, 2023
Municipal fiscal capacity (MFC)		
MFC1	Greenery strengthens the value base the city can tax	Back & Collins, 2022
MFC2	Money spent on green space returns value to the municipality	Meerow, 2020
MFC3	Cutting green budgets would cost the city more later	Back & Collins, 2022
Wellbeing and productivity (WBP)		

Code	Item stem (resident form)	Developed from
WBP1	Time in green space restores my energy for work	Wu et al., 2022
WBP2	Green surroundings improve daily life in this city	Patino et al., 2023; Wu et al., 2023
WBP3	People work better in a greener environment	Nordbø & Nordh, 2025; Refisch et al., 2024
Perceived urban economic growth (UEG)		
UEG1	This city's economy has been growing	Batty, 2022
UEG2	Green infrastructure contributes to this city's economic growth	H. Ai & Zhou, 2023
UEG3	Investing in greenery would speed the city's economy	K. Ai & Yan, 2024
UEG4	A greener city would attract more investment	X. Li & Xiao, 2024
Valuation anchor		
WTP1	Monthly amount, in dinars, toward improving the nearest green space	Gelo & Turpie, 2021; Kalfas et al., 2022

Note: The business form mirrors each stem from the establishment's vantage point. UEG1 is the outcome item; UEG2–UEG4 measure attributed contribution and are not in the structural model (Section 2.4).

Sampling was by quota within strata. Each city was divided into five residential strata defined by urban zone and four business strata defined by commercial location type, eighteen in all, listed in Table 2 with the number of valid responses each returned. Resident quotas were set from the district population distribution and business quotas from the registered activity mix, with targets of 500 resident and 300 business responses per city; the shares actually achieved are those of Table 2. Within a stratum, households were approached at their homes and establishments at their premises, and trained enumerators administered the form there, returning where it could not be completed at the first visit: 60% of the valid forms were completed at the first visit, 28% at the second and 11% at the third, and the visits were spread across four bands of the day. Of the 2,600 forms distributed, 1,677 came back and 1,593 passed screening. The analysis file records completed forms only, so the 923 forms not returned cannot be separated into refusals and non-contacts, and the return rates in Table 3 are the only non-response measure the study can report. The sample is therefore a quota sample rather than a probability sample, and the achieved distribution in Table 2 is what population inference has to be read against: all inference below is model-based and conditional on the achieved sample, the rates in Table 3 are return rates on distributed forms rather than response rates in the survey-methodology sense, and no post-stratification weights were applied, because the frame shares needed to compute them are the quota targets themselves rather than an independent census. Because one instrument measures predictors and outcome at a single sitting, the design carries procedural defences against common method bias, and their limits are stated in Section 4.4 (Podsakoff et al., 2024).

Three design details carry weight later. The willingness-to-pay item uses a payment-card format in dinars spanning the realistic monthly range, a familiar municipal-improvement vehicle, and an explicit zero with a follow-up separating genuine zeros from protest answers; amounts enter the analysis only after that screening (Gelo & Turpie, 2021; Kalfas et al., 2022). The business frame samples at establishment level — the shop, workshop, office or firm premises — and its respondent answers for location and premises decisions, because those are the decisions green surroundings could plausibly enter (Hwang & Park, 2026; X. Li & Xiao, 2024). And every scale item names the respondent's own surroundings rather than greenery in the abstract, anchoring the composite scores to the endowment these cities actually administer (Basu & Nagendra, 2021; Zhou et al., 2021).

Table 2: Sampling strata and achieved sample. *Source: authors, tabulated from the survey data in Python 3.11 with pandas 3.0.*

City	Frame	Sampling stratum	n	Share of frame sample (%)
Erbil	Residents	Inner ring, citadel and old core	87	17.9
		Second and third ring bands	146	30.0
		Outer ring bands and new housing	166	34.1
		Ankawa and northern quarters	49	10.1
		Peri-urban edge	39	8.0
Erbil	Businesses	Bazaar and central retail	87	29.9

City	Frame	Sampling stratum	n	Share of frame sample (%)
Sulaymaniyah	Residents	Arterial and ring-road commerce	101	34.7
		Offices and services	67	23.0
		Workshops and light industry	36	12.4
		Bazaar and central quarters	99	19.3
		Salim Street corridor and inner belt	145	28.3
		Northern and university quarters	135	26.4
		Foothill quarters toward Azmar and Goizha	82	16.0
Sulaymaniyah	Businesses	Peri-urban edge	51	10.0
		Mawlawi and bazaar retail	98	32.3
		Salim Street and arterial commerce	88	29.0
		Offices and services	77	25.4
		Workshops and light industry	40	13.2
Total			1593	

Note: Residential strata are urban zones; business strata are commercial location types. Share of frame sample = stratum responses ÷ responses in that city and frame. Quota targets were 500 resident and 300 business responses per city; Erbil finished 13 and 9 short of them respectively.

3.3 The equations and their estimation

Three equations carry the analysis, and they are written out because the reader of a quantitative claim is owed the machinery. The first is the measurement layer. Every construct in the model is a composite formed from its indicators:

$$\xi_c = \sum_{k=1}^K w_{ck} x_{ck}, \quad c \in \{GIQ, GIA, PVC, BAC, EML, MFC, WBP, UEG\} \quad (1)$$

where ξ_c is the composite score of construct c , x_{ck} its k -th standardised indicator ($k = 1, \dots, K_c$, the number of indicators in that block), and w_{ck} the outer weight estimated for it; for the outcome $K_c = 1$, so ξ_{UEG} is the standardised UEG1 item and its weight is unity. The second-order endowment composite UGE is formed from the GIQ and GIA scores in the same way, by the disjoint two-stage procedure (Crocetta et al., 2021). In the structural layer the same composites are written η where they are endogenous. The second equation is the structural layer, one line for the channels and one for the outcome:

$$\eta_m = \gamma_m \xi_{UGE} + \zeta_m, \quad m = 1, \dots, 5; \quad \eta_{UEG} = \sum_{m=1}^5 \beta_m \eta_m + \gamma_0 \xi_{UGE} + \zeta_{UEG} \quad (2)$$

where η_m is channel m of the five (PVC, BAC, EML, MFC and WBP in that order), γ_m its association with endowment, β_m its association with perceived urban economic growth, γ_0 the residual direct path (H3), and ζ terms the structural residuals; Table 6 reports all eleven coefficients in a single column headed β . The third equation is the valuation bridge, the study's own construction. The perceived green value indicator for population group g is the path-weighted mean of the five channel scores, rescaled to a 0–100 range, and its monetary expression anchors the indicator to the stated willingness to pay of the same group:

$$PGVI_g = 100 \cdot [\sum_m \hat{\beta}_m \bar{s}_{mg}] / [\sum_m \hat{\beta}_m]; \quad V_g = (PGVI_g / 100) \cdot \bar{W}_g \quad (3)$$

where the sums run over the five channels, $\bar{s}_{mg}$ is the group mean of channel m on the unit interval, each item rescaled from the five-point metric as $(\text{score} - 1)/4$ before averaging, $\hat{\beta}_m$ is the pooled channel-to-growth estimate of Table 6 — the same weights serve every group, so that the indicator compares groups on their scores and not on their coefficients — and $\bar{W}_g$ is the group's mean stated willingness to pay. The residual direct path γ_0 is left out of the weighting because it names no channel a policy could act on. What V_g returns is a stated amount scaled by the indicator. It is not a welfare measure, a consumer surplus or a hedonic price differential, and the paper does not call it a price: it is a willingness-to-pay-anchored indicator of perceived socio-economic value, comparable across the groups measured with the same instrument and nothing more. Because a constructed indicator is only as defensible as its sensitivity to the constructions in it, three things are varied in Section 4.3: the weighting rule (path weights against equal weights and against weights proportional to each channel's correlation with the outcome), the treatment of the zero responses in $\bar{W}_g$, and the statistic used for $\bar{W}_g$. The model is estimated by composite-based path modelling. Outer weights and composite scores are re-estimated against one another under an alternating least-squares scheme with a path-weighting inner

proxy until convergence (Hair & Alamer, 2022; Hair et al., 2020); reflective blocks take correlation weights, the formative endowment layer regression weights, and the second-order construct is built from its dimensions by the disjoint two-stage route (Crocetta et al., 2021). The estimator was implemented for this study in open code, written in Python 3.11 with the NumPy 2.4, SciPy 1.17 and pandas 3.0 libraries, and the code is available with the data as the Data Availability Statement sets out, so that every quantity reported can be reproduced without a licence; nothing below depends on a commercial package. Evaluation follows the standard sequence: indicator loadings and weights, composite reliability by both the conventional coefficient (ρ_c) and the consistent coefficient (ρ_A), convergent validity, then discriminant validity by the heterotrait–monotrait ratio (HTMT) in its original and corrected (HTMT2) form (Becker et al., 2023; Roemer et al., 2021); for the single-item outcome the ratio is undefined and the item's correlation with each composite is reported instead. Because the purpose is assessment rather than pure theory testing, predictive relevance is established twice: by blindfolding at an omission distance of $D = 7$, and by ten-fold cross-validated comparison of the model's out-of-sample loss on the outcome item against the indicator-average and linear-model benchmarks (Chin et al., 2020; Lienggaard et al., 2021), reported both for prediction from the earliest antecedent, which uses only the endowment items, and from the direct antecedents, which uses the channel scores. Measurement invariance across cities, frames and language versions is established by the MICOM procedure before any pooling, and the contrasts of H4 and H5 follow it (Cheah et al., 2023).

Settings are declared here so the results are reproducible without correspondence. Each composite is estimated in the mode its measurement theory implies: channel constructs reflectively, the endowment layer formatively (Becker et al., 2023). Structural intervals come from 10,000 bootstrap resamples with a construct-level sign-change correction, reported as bias-corrected and accelerated bounds in the tables and with percentile bounds beside them in the analysis workbook, so no conclusion depends on the flavour of interval (Hair & Alamer, 2022); invariance and group contrasts use 5,000 permutations each. A structural hypothesis is supported only when its 95% interval excludes zero in the hypothesised direction; effect sizes f^2 are read against the conventional bands of 0.02, 0.15 and 0.35, and no claim in Sections 5 and 6 rests on a path with f^2 below 0.02. The eleven structural tests are pre-specified directional hypotheses and are reported with intervals rather than adjusted p-values. The city contrasts and the frame contrasts form two families of eleven tests each; because each family puts eleven path differences to the test at once, a nominal 5% threshold would flag roughly one difference that is not there, so each family carries a Benjamini–Hochberg adjustment and the decision reads the adjusted value. This costs power on individual contrasts, and the cost is accepted deliberately. Screened cases are dropped rather than imputed. Every criterion and decision rule named here was fixed before the data arrived, with one exception that is declared: the outcome was re-specified from four items to the single clean item after pre-submission review of the draft, for the reason given in Section 2.4, and the four-item estimates are kept in Section 4.4 so the reader can see what the change did.

4. Results

4.1 Sample and measurement quality

Fieldwork returned $N = 1,593$ usable responses — 487 residents and 291 businesses in Erbil, 512 and 303 in Sulaymaniyah — from 2,600 distributed forms. Of those, 1,677 came back, a return rate of 64.5% on distributed forms, and screening removed 5.0% of the returns, so 61.3% of what was distributed entered the model. Sulaymaniyah met both quotas; Erbil finished thirteen responses short of the resident quota and nine short of the business one. Table 2 gives the achieved sample by stratum and Table 3 profiles the four groups. Measurement behaved as required. Every indicator loading on the seven multi-item constructs cleared the 0.708 guideline, the lowest standing at 0.843, so no item fell in the 0.40–0.70 range where retention depends on what removal does to composite reliability and average variance extracted (Hair et al., 2020); Cronbach's α (0.843–0.884), the consistent reliability coefficient ρ_A (0.846–0.885), composite reliability (0.905–0.920) and convergent validity (AVE at

least 0.742) cleared their thresholds for every construct, in the ordering $\alpha \leq \rho_A \leq \rho_C$ that a composite of near-equal loadings should show (Hair et al., 2020). Discriminant validity held under both the original and corrected heterotrait–monotrait criteria, the highest ratio standing at 0.675 against the conservative 0.85 bound (Roemer et al., 2021); the outcome is a single item, for which the ratio is undefined, and its correlation with the channel composites runs no higher than 0.520 and with the endowment composite 0.579, well inside the same bound. Tables 4 and 5 carry the detail, Table 4 with the mean and standard deviation of every item, including the three attribution items that are not modelled. The two second-order weights are close (0.565 and 0.556, bootstrap intervals [0.519, 0.610] and [0.511, 0.602]; VIF between the two dimensions 1.53), so the endowment composite is near the mean of its two dimensions, which is why Section 4.4 drops to the first-order composites when it comes to locate a city difference. The common-method checks at the foot of Table 4 are read in Section 4.4 (Podsakoff et al., 2024).

Table 3: Sample profile by city and frame. *Source: authors, tabulated from the survey data in Python 3.11 with pandas 3.0.*

Profile line	Erbil residents	Erbil businesses	Sulaymaniyah residents	Sulaymaniyah businesses
Forms distributed	750	525	780	545
Forms returned	511	307	539	320
Valid responses	487	291	512	303
Return rate (%)	68.1	58.5	69.1	58.7
Female (%)	47.2	not asked	45.1	not asked
Age distribution (%)	32 / 29 / 27 / 12	not asked	33 / 32 / 24 / 11	not asked
Tertiary education (%)	34.5	not asked	36.3	not asked
Modal household income band (residents)	0.9–1.5 million (24%)	not asked	0.5–0.9 million (22%)	not asked
Modal business sector	—	Retail/wholesale (32%)	—	Retail/wholesale (35%)
Micro and small firms (%)	—	76.6	—	75.6
Modal tenure band (years)	3 to 5 years	3 to 5 years	3 to 5 years	3 to 5 years

Note: Return rate = forms returned ÷ forms distributed; the difference between forms returned and valid responses is the screening loss. Age bands: 18–29 / 30–44 / 45–59 / 60+; income bands in Iraqi dinars per month; micro and small firms are the two smallest staff bands. Quota sample; no post-stratification weights were applied.

Table 4: Measurement model. *Source: authors, computed from the survey data in Python 3.11 with NumPy 2.4, pandas 3.0 and SciPy 1.17.*

Construct	Ind.	Mean	SD	L/W	α	ρ_A	CR	AVE
GIQ	GIQ1	2.88	1.27	0.878	0.884	0.885	0.920	0.742
	GIQ2	2.91	1.28	0.843				
	GIQ3	2.90	1.29	0.854				
	GIQ4	2.89	1.28	0.869				
GIA	GIA1	3.15	1.28	0.897	0.861	0.862	0.915	0.783
	GIA2	3.16	1.24	0.875				
	GIA3	3.12	1.27	0.881				
PVC	PVC1	3.44	1.19	0.895	0.849	0.850	0.909	0.768
	PVC2	3.44	1.19	0.870				
	PVC3	3.42	1.18	0.863				
BAC	BAC1	3.36	1.21	0.888	0.848	0.849	0.908	0.767
	BAC2	3.34	1.22	0.874				
	BAC3	3.36	1.22	0.865				
EML	EML1	3.25	1.18	0.876	0.843	0.846	0.905	0.761
	EML2	3.29	1.21	0.886				
	EML3	3.26	1.20	0.856				
MFC	MFC1	3.08	1.27	0.878	0.844	0.849	0.906	0.762
	MFC2	3.08	1.25	0.890				
	MFC3	3.09	1.23	0.851				
WBP	WBP1	3.54	1.16	0.885	0.854	0.855	0.911	0.774
	WBP2	3.51	1.17	0.891				

Construct	Ind.	Mean	SD	L/W	α	ρA	CR	AVE				
UEG	WBP3	3.55	1.17	0.863	single item	—	—	—				
	UEG1	3.22	1.25	1.000								
UGE (second order)	GIQ / GIA	—	—	w = 0.565 [0.519, 0.610] / 0.556 [0.511, 0.602]; VIF between the two dimensions 1.53								
Attributed contribution (not modelled)	UEG2	3.19	1.27	—								
	UEG3	3.17	1.28	—								
	UEG4	3.22	1.24	—								
	Common-method checks	Harman first factor 39.0% (23 model items; 40.4% with the three attribution items); maximum full-collinearity VIF 2.66; no marker item										

Note: Mean and SD on the five-point metric; L/W = loading or weight; α = Cronbach's alpha; ρA = Dijkstra–Henseler consistent reliability coefficient; CR = composite reliability (pc); AVE = average variance extracted; VIF = variance inflation factor. Loadings from the first stage; the second-order row carries the weights of the second stage with 95% bias-corrected and accelerated bootstrap intervals and the VIF between the two dimensions. UEG1 is a single-item construct, so its loading is unity and no reliability coefficient exists for it; UEG2–UEG4 are reported for completeness and enter no estimate. The first-factor share is reported by convention only; Section 4.4 sets out what the common-method evidence here can and cannot support.

Table 5: Discriminant validity (HTMT below the diagonal, HTMT2 above; item–composite correlations for the single-item outcome). *Source: authors, computed from the survey data in Python 3.11 with NumPy 2.4, pandas 3.0 and SciPy 1.17.*

	GIQ	GIA	PVC	BAC	EML	MFC	WBP	UEG
GIQ	—	0.674	0.580	0.550	0.479	0.475	0.632	r = 0.516
GIA	0.675	—	0.580	0.548	0.484	0.498	0.632	r = 0.516
PVC	0.580	0.581	—	0.432	0.345	0.415	0.447	r = 0.445
BAC	0.551	0.548	0.432	—	0.319	0.363	0.441	r = 0.429
EML	0.481	0.485	0.346	0.321	—	0.284	0.377	r = 0.384
MFC	0.476	0.499	0.416	0.364	0.285	—	0.414	r = 0.379
WBP	0.633	0.631	0.448	0.442	0.377	0.415	—	r = 0.520
UEG	r = 0.516	r = 0.516	r = 0.445	r = 0.429	r = 0.384	r = 0.379	r = 0.520	—

Note: Conservative threshold 0.85, liberal 0.90; the highest ratio observed is 0.675. The two criteria agree to within 0.002 in every cell. The UEG row and column give the correlation of the UEG1 item with each composite, since a single-item construct has no monotrait correlations to form the ratio.

4.2 Structural estimates

The substantive reading comes first and the diagnostics after it. The two cities' residents and businesses who judged their green endowment more favourably also judged each of the five channels more favourably, and by a wide margin: a one standard deviation rise in the endowment composite goes with a rise of between 0.466 and 0.612 standard deviations in the channel composites (H1a–H1e, Table 6, Panel A), largest for wellbeing and productivity and smallest for employment. Every channel is in turn associated with perceived urban economic growth after the other four and the direct path are held constant (H2a–H2e), so the value respondents attribute to greenery does not sit in one mechanism a single decision could switch off. The channels are not equal. Wellbeing and productivity carries the largest coefficient, $\beta = 0.231$ [0.180, 0.280], and its lead is a tested result rather than a ranking read off a column: its difference from each of the other four channels, between 0.099 and 0.142, carries a bootstrap interval clear of zero (Table 6, Panel B). The other four lie in a band between 0.089 and 0.132 whose members the design cannot separate. A residual direct path remains (H3), $\beta = 0.196$ [0.136, 0.256]; composite mediators under-transmit, so a model of this shape inflates the direct path even where no further mechanism exists, and H3 is read as an unmediated residual rather than as evidence of specific mechanisms beyond the five channels. Put together, the total association between perceived endowment and perceived growth is 0.579 of a standard deviation, of which 66% travels through the channels (total indirect effect 0.383) and the rest directly; the specific indirect paths run from 0.042 through the fiscal channel to 0.141 through wellbeing and productivity, each with an interval clear of zero. In a city with no environmental accounts, this is the finding: the urban economy's own agents connect their green surroundings to their reading of the city's economic direction, mainly

through what greenery does for daily life and working capacity and only after that through property, custom, work and the municipal base.

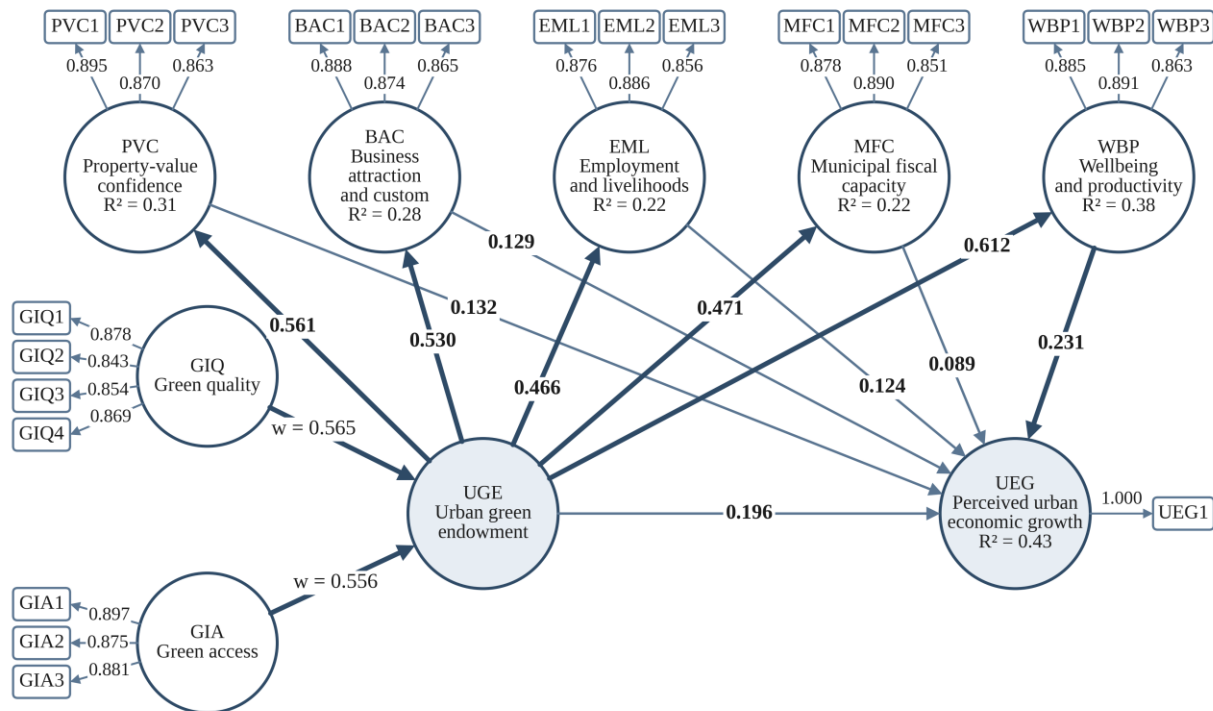


Figure 2. The estimated structural model. *Source: authors, drawn from Table 6 in Python 3.11 with Matplotlib 3.10.*

Note: Standardised coefficients; line weight follows the coefficient in two bands, heavy for $\beta \geq 0.20$ and light below it; a dashed line would mark an interval including zero, and no path required it. w = second-order weights; R^2 inside each endogenous construct; rectangles are indicators with their loadings, UEG1 being the single outcome item with its loading fixed at unity. Table 4 carries the same loadings with their reliabilities.

The model explained $R^2 = 0.429$ of the variance in perceived urban economic growth and $R^2 = 0.218$ – 0.375 of the five channels. Figure 2 carries the same estimates on the model itself, and it is read as follows. Each circle is a construct, with the variance explained inside it, and each small rectangle an indicator, its loading printed beside the arrow that joins it to its construct; the two heavy arrows on the left carry the second-order weights by which quality and access form the endowment; the five arrows fanning upward carry the H1 coefficients and the five converging on the outcome the H2 coefficients; the straight line along the bottom is the direct path, and the single item on the right is the outcome as measured. A heavy line marks a coefficient of 0.20 or more and a light line one below it, so the figure shows at a glance that the endowment's association with every channel is heavy, that only the wellbeing channel's association with growth is, and that the direct path is the one other heavy line into the outcome. The loadings on the figure are those of Table 4, which adds the reliabilities and the attributed-contribution items that enter no estimate. Collinearity stayed below concern: the largest inner-model variance inflation factor is 2.59 (the endowment composite in the outcome block) and the largest full-collinearity factor 2.66, both under the 3.3 bound (Table 6, Panel C).

Predictive relevance held for every endogenous construct by blindfolding ($Q^2 = 0.165$ – 0.289 for the channels and 0.421 for the outcome), and the cross-validated comparison gives a two-part answer that is reported in full because it bears on what the model is for. Predicted from the earliest antecedent, so that only the seven endowment items are used to predict the outcome item of a held-out case, the model's average loss of 0.667 beat the indicator-average benchmark (1.001, $p < 0.001$) but not an unrestricted linear regression of the outcome item on the nineteen endowment and channel items (0.585, $p < 0.001$); that benchmark sees the channel items, which the earliest-antecedent prediction by construction does not, so the comparison is not an even one, but the convention reports it and it is

reported. Predicted from the direct antecedents, so that the held-out case's own channel scores are used, the model's loss of 0.577 is lower than the indicator-average benchmark's (1.001, $p < 0.001$) and lower than the linear-model benchmark's (0.587, $p < 0.001$) (Lienggaard et al., 2021). The model therefore predicts perceived growth out of sample as well as an unrestricted regression when given the same information and worse when given less, which is what a structural model with five intermediate constructs should do; it is an explanatory instrument with adequate predictive relevance, not a forecasting tool, and Section 5 uses it as the former.

Table 6: Structural estimates, indirect effects and predictive assessment. *Source: authors, computed from the survey data in Python 3.11 with NumPy 2.4, pandas 3.0 and SciPy 1.17.*

Panel A — Structural paths (10,000 bootstrap resamples)						
H	Path	β	t	95% BCa CI	f ²	Decision
H1a	UGE → PVC	0.561	30.5	[0.522, 0.595]	0.459	Supported
H1b	UGE → BAC	0.530	29.3	[0.493, 0.564]	0.392	Supported
H1c	UGE → EML	0.466	23.6	[0.426, 0.503]	0.278	Supported
H1d	UGE → MFC	0.471	24.1	[0.432, 0.508]	0.285	Supported
H1e	UGE → WBP	0.612	38.7	[0.581, 0.643]	0.600	Supported
H2a	PVC → UEG	0.132	5.6	[0.084, 0.177]	0.020	Supported
H2b	BAC → UEG	0.129	5.9	[0.086, 0.171]	0.021	Supported
H2c	EML → UEG	0.124	5.7	[0.080, 0.165]	0.021	Supported
H2d	MFC → UEG	0.089	4.1	[0.046, 0.131]	0.010	Supported
H2e	WBP → UEG	0.231	9.1	[0.180, 0.280]	0.057	Supported
H3	UGE → UEG	0.196	6.4	[0.136, 0.256]	0.026	Supported
Panel B — Indirect effects, total effect and channel contrasts						
	Quantity	Estimate	t	95% BCa CI		
	UGE → PVC → UEG	0.074	5.5	[0.047, 0.100]		
	UGE → BAC → UEG	0.068	5.7	[0.045, 0.092]		
	UGE → EML → UEG	0.058	5.5	[0.037, 0.078]		
	UGE → MFC → UEG	0.042	4.0	[0.022, 0.062]		
	UGE → WBP → UEG	0.141	8.8	[0.110, 0.172]		
	Total indirect effect	0.383	16.2	[0.335, 0.428]		
	Total effect of UGE on UEG	0.579	34.4	[0.545, 0.611]		
	Direct share of total effect	33.8%				
	WBP – PVC, β to UEG	0.099	2.8	[0.028, 0.169]		
	WBP – BAC, β to UEG	0.102	2.9	[0.033, 0.169]		
	WBP – EML, β to UEG	0.107	3.1	[0.039, 0.175]		
	WBP – MFC, β to UEG	0.142	4.1	[0.074, 0.212]		
Panel C — Explained variance, collinearity and predictive assessment						
	Construct	R ²	Q ² (D = 7)	Inner-model VIF	Full-collinearity VIF	
	PVC	0.315	0.241	1.50	1.53	
	BAC	0.281	0.215	1.42	1.45	
	EML	0.218	0.165	1.28	1.31	
	MFC	0.222	0.167	1.32	1.33	
	WBP	0.375	0.289	1.63	1.72	
	UEG	0.429	0.421	—	1.75	
	UGE	—	—	2.59	2.66	

CVPAT, earliest antecedent loss on UEG1: model 0.667, indicator average 1.001 ($p < 0.001$), linear model 0.585 ($p < 0.001$)

CVPAT, direct antecedents loss on UEG1: model 0.577, indicator average 1.001 ($p < 0.001$), linear model 0.587 ($p < 0.001$)

Note: CI = bias-corrected and accelerated bootstrap interval from 10,000 resamples; f^2 = effect size; t on the bootstrap standard error. The β column of Panel A carries γ_m for H1a–H1e, β_m for H2a–H2e and γ_0 for H3 in the notation of equation (2). Panel C: Q^2 by blindfolding at omission distance 7; inner-model VIF regresses each predictor of the outcome on the other predictors of that block; full-collinearity VIF regresses each construct on all others, the two dimensions excluded for the endowment composite they form; out-of-sample loss is the mean squared error on the standardised UEG1 item over ten folds, for the model, the indicator-average benchmark and a linear regression of UEG1 on the nineteen endowment and channel items; earliest-antecedent prediction uses only the endowment items of a held-out case, direct-antecedent prediction its channel scores as well; p from a paired comparison of case-level losses.

4.3 Cities, frames, language versions and the indicator

Measurement invariance was assessed with the MICOM procedure before any group comparison (Table 7). Configural invariance holds by construction, since every group carries the same indicators, weighting mode and algorithm settings, and the single-item outcome is compositionally invariant by construction. Compositional invariance held for every first-order composite between the cities and between the frames; the composite that fell below the 5% permutation quantile is the second-order endowment composite, between the cities ($c = 0.9922$ against a quantile of 0.9967) and between the frames ($c = 0.9933$ against 0.9964), a correlation above 0.99 that counts as a difference only because the permutation distribution at this sample size is that tight. Equal means failed across the cities for GIQ, GIA, EML and UGE and equal variances for MFC; across the frames equal means failed for none and equal variances for none. These are differences between the groups rather than obstacles to comparing them, but they rule out pooling. The procedure licenses path comparison only where compositional invariance holds, so every contrast that touches the endowment composite in either comparison is reported as exploratory, and the located city difference is re-tested in Section 4.4 on first-order composites that pass (Cheah et al., 2023).

The instrument was fielded in three languages, and a city contrast is only interpretable as a city contrast if the Kurdish, Arabic and English forms measure the same thing. Table 7, Panels C to E, report the same procedure pairwise across the three versions, with the caution that the English group is small (81 forms) and its permutation quantiles correspondingly loose. Compositional invariance held for every composite in every pair: the lowest correlation between composites formed with the two versions' weights is 0.9991 between Kurdish and Arabic, 0.9983 between Kurdish and English and 0.9945 between Arabic and English, none below its quantile. Equal means failed between the Kurdish and Arabic forms for GIQ, WBP and UGE, between Kurdish and English for none and between Arabic and English for none; equal variances failed for none, MFC and UEG and MFC respectively. Partial measurement invariance therefore holds across the language versions: the composites are formed the same way whichever form was completed, and where the versions differ it is in the level of the scores, which is a difference between the people who chose each language rather than in the measurement. Language and city remain partly confounded in the sense that the Arabic and English forms were not evenly spread across the cities, and Section 5.3 keeps that in the limitations; what the test rules out is the sharper worry, that a city difference is an artefact of translation.

On that footing, one of the eleven paths differed between the cities after adjustment — H1a, adjusted $p = 0.002$; two before adjustment, H1a and H1c — and one differed between the frames — H1e, adjusted $p = 0.002$; four before adjustment, H1a, H1e, H2a and H2c. Table 8 carries the coefficients of all four groups beside the contrasts. H4 is supported on H1a, the association between endowment and property-value confidence, stronger in Erbil at 0.634 against 0.495, and no difference was detected on the other ten paths, which is not the same as showing them equal; because H1a runs through the endowment composite, which failed compositional invariance between the cities, the support is provisional until the re-test of Section 4.4, where it survives on invariant composites. The one frame difference — H1e, the association between endowment and wellbeing and productivity, stronger among residents at 0.672 against 0.516 — runs through the endowment composite, which failed compositional invariance between the frames, so H5 is not claimed as supported: the frame contrasts stand as exploratory findings to be re-tested on a design that measures the two populations with composites that pass, and Section 5 treats them accordingly. Figure 3 sets the two cities' coefficients side by side with their own bootstrap intervals, and the difference concentrates in the property-value confidence channel.

Table 7: Measurement invariance across cities, frames and language versions (MICOM). *Source: authors, computed from the survey data in Python 3.11 with NumPy 2.4, pandas 3.0 and SciPy 1.17.*

Panel A — Erbil against Sulaymaniyah (n = 778 / 815)



Construct	c	5% quantile	Δ mean [95% PI]	Δ log variance [95% PI]
GIQ	0.9999	0.9998	-0.195 [-0.095, 0.099]†	-0.016 [-0.095, 0.097]
GIA	1.0000	0.9998	-0.119 [-0.097, 0.097]†	0.002 [-0.103, 0.102]
PVC	0.9999	0.9996	-0.052 [-0.099, 0.100]	-0.025 [-0.109, 0.115]
BAC	1.0000	0.9995	-0.076 [-0.099, 0.097]	0.013 [-0.110, 0.111]
EML	1.0000	0.9993	-0.104 [-0.101, 0.096]†	0.040 [-0.112, 0.109]
MFC	1.0000	0.9993	-0.034 [-0.098, 0.099]	0.129 [-0.104, 0.105]†
WBP	1.0000	0.9997	-0.056 [-0.099, 0.099]	0.023 [-0.112, 0.114]
UEG	1 (single item)	—	-0.037 [-0.099, 0.093]	0.079 [-0.096, 0.099]
UGE	0.9922†	0.9967	-0.176 [-0.095, 0.099]†	-0.019 [-0.102, 0.102]
Panel B — Residents against businesses (n = 999 / 594)				
Construct	c	5% quantile	Δ mean [95% PI]	Δ log variance [95% PI]
GIQ	1.0000	0.9998	-0.033 [-0.099, 0.099]	-0.007 [-0.101, 0.105]
GIA	1.0000	0.9998	-0.017 [-0.100, 0.099]	-0.070 [-0.106, 0.105]
PVC	0.9997	0.9996	0.006 [-0.098, 0.101]	0.043 [-0.115, 0.120]
BAC	0.9997	0.9995	-0.032 [-0.101, 0.100]	-0.070 [-0.108, 0.114]
EML	0.9997	0.9993	0.024 [-0.103, 0.103]	-0.066 [-0.109, 0.116]
MFC	1.0000	0.9992	-0.048 [-0.100, 0.101]	0.076 [-0.105, 0.108]
WBP	1.0000	0.9997	-0.030 [-0.102, 0.106]	-0.001 [-0.119, 0.125]
UEG	1 (single item)	—	-0.053 [-0.102, 0.104]	0.041 [-0.100, 0.104]
UGE	0.9933†	0.9964	-0.028 [-0.099, 0.101]	-0.024 [-0.107, 0.109]
Panel C — Kurdish against Arabic form (n = 1,307 / 205)				
Construct	c	5% quantile	Δ mean [95% PI]	Δ log variance [95% PI]
GIQ	0.9998	0.9996	0.159 [-0.151, 0.149]†	-0.028 [-0.143, 0.161]
GIA	1.0000	0.9996	0.139 [-0.145, 0.146]	0.042 [-0.150, 0.153]
PVC	0.9999	0.9991	0.048 [-0.142, 0.148]	-0.118 [-0.169, 0.175]
BAC	1.0000	0.9989	0.143 [-0.146, 0.151]	-0.043 [-0.158, 0.171]
EML	0.9998	0.9984	0.085 [-0.146, 0.147]	-0.065 [-0.159, 0.172]
MFC	0.9991	0.9982	0.099 [-0.146, 0.149]	-0.012 [-0.151, 0.169]
WBP	0.9998	0.9994	0.155 [-0.143, 0.152]†	-0.021 [-0.164, 0.177]
UEG	1 (single item)	—	0.134 [-0.144, 0.148]	-0.134 [-0.148, 0.154]
UGE	0.9991	0.9929	0.167 [-0.148, 0.147]†	0.043 [-0.154, 0.167]
Panel D — Kurdish against English form (n = 1,307 / 81)				
Construct	c	5% quantile	Δ mean [95% PI]	Δ log variance [95% PI]
GIQ	0.9996	0.9990	0.021 [-0.227, 0.232]	-0.062 [-0.216, 0.248]
GIA	0.9996	0.9990	0.010 [-0.225, 0.233]	-0.081 [-0.209, 0.254]
PVC	1.0000	0.9976	0.119 [-0.222, 0.223]	-0.141 [-0.243, 0.288]
BAC	0.9997	0.9968	0.025 [-0.227, 0.226]	0.046 [-0.232, 0.273]
EML	0.9998	0.9952	0.139 [-0.223, 0.230]	0.128 [-0.235, 0.287]
MFC	0.9991	0.9951	-0.083 [-0.224, 0.221]	-0.275 [-0.225, 0.260]†
WBP	0.9997	0.9984	0.132 [-0.224, 0.219]	-0.055 [-0.242, 0.292]
UEG	1 (single item)	—	0.035 [-0.226, 0.223]	-0.224 [-0.207, 0.251]†
UGE	0.9983	0.9808	0.017 [-0.228, 0.230]	-0.086 [-0.223, 0.264]
Panel E — Arabic against English form (n = 205 / 81)				
Construct	c	5% quantile	Δ mean [95% PI]	Δ log variance [95% PI]
GIQ	0.9998	0.9990	-0.138 [-0.261, 0.258]	-0.034 [-0.242, 0.256]
GIA	0.9996	0.9992	-0.129 [-0.253, 0.256]	-0.124 [-0.245, 0.285]
PVC	0.9999	0.9984	0.071 [-0.272, 0.278]	-0.024 [-0.284, 0.318]
BAC	0.9997	0.9975	-0.118 [-0.253, 0.269]	0.089 [-0.266, 0.289]
EML	0.9994	0.9965	0.054 [-0.253, 0.253]	0.193 [-0.288, 0.317]
MFC	0.9991	0.9972	-0.182 [-0.262, 0.265]	-0.263 [-0.259, 0.284]†
WBP	0.9999	0.9985	-0.023 [-0.253, 0.261]	-0.034 [-0.286, 0.314]
UEG	1 (single item)	—	-0.099 [-0.278, 0.271]	-0.091 [-0.224, 0.244]
UGE	0.9945	0.9794	-0.150 [-0.256, 0.258]	-0.129 [-0.251, 0.270]

Note: c is the correlation, on the pooled sample, between the composites formed with the two groups' weights, read against the 5% quantile of its permutation distribution; the single-item outcome is invariant by construction. Δ mean is the difference of the pooled-weight composite means, first-named group minus second, and Δ log variance the log ratio of their variances, each with its 95% permutation interval (PI); † = criterion not met. Panels A and B use 5,000 permutations of the full sample; each language pair is permuted within the respondents who completed one of its two versions.

Table 8: Multigroup contrasts between cities and between frames. *Source: authors, computed from the survey data in Python 3.11 with NumPy 2.4, pandas 3.0 and SciPy 1.17.*

Panel A — Cities (Benjamini–Hochberg within the family of eleven)					
Path	β Erbil	β Sulaymaniyah	$\Delta\beta$	p	p adj.
H1a UGE → PVC	0.634	0.495	0.139	< 0.001	0.002
H1b UGE → BAC	0.566	0.495	0.071	0.054	0.197
H1c UGE → EML	0.512	0.419	0.093	0.020	0.112
H1d UGE → MFC	0.486	0.460	0.025	0.520	0.714
H1e UGE → WBP	0.610	0.616	−0.006	0.855	0.855
H2a PVC → UEG	0.140	0.115	0.025	0.590	0.721
H2b BAC → UEG	0.133	0.122	0.011	0.807	0.855
H2c EML → UEG	0.083	0.151	−0.068	0.108	0.296
H2d MFC → UEG	0.055	0.121	−0.066	0.142	0.312
H2e WBP → UEG	0.262	0.194	0.068	0.181	0.327
H3 UGE → UEG	0.247	0.169	0.078	0.208	0.327
Panel B — Frames (Benjamini–Hochberg within the family of eleven)					
Path	β residents	β businesses	$\Delta\beta$	p	p adj.
H1a UGE → PVC	0.589	0.512	0.077	0.042	0.116
H1b UGE → BAC	0.538	0.524	0.014	0.687	0.772
H1c UGE → EML	0.466	0.473	−0.007	0.870	0.870
H1d UGE → MFC	0.483	0.454	0.029	0.465	0.649
H1e UGE → WBP	0.672	0.516	0.156	< 0.001	0.002
H2a PVC → UEG	0.168	0.068	0.100	0.040	0.116
H2b BAC → UEG	0.117	0.151	−0.033	0.472	0.649
H2c EML → UEG	0.088	0.188	−0.101	0.029	0.116
H2d MFC → UEG	0.081	0.099	−0.017	0.702	0.772
H2e WBP → UEG	0.240	0.202	0.038	0.462	0.649
H3 UGE → UEG	0.219	0.157	0.062	0.338	0.649

Note: $\Delta\beta$ = Erbil minus Sulaymaniyah and residents minus businesses; p from 5,000 permutations, the smallest attainable value being 0.0002; p adj. = Benjamini–Hochberg within each family of eleven. Group sizes: Erbil 778, Sulaymaniyah 815, residents 999, businesses 594. Contrasts on paths that run through the endowment composite, which failed compositional invariance in both comparisons, are exploratory (Section 4.3).

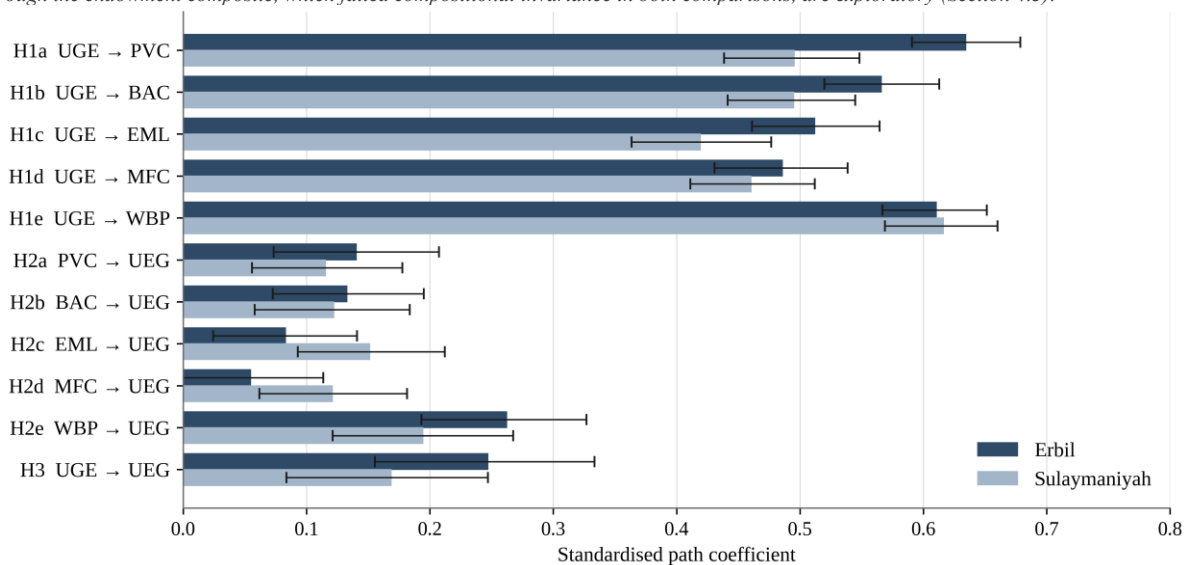


Figure 3. Path coefficients compared across the two cities. *Source: authors, computed from the survey data in Python 3.11 with NumPy 2.4, pandas 3.0 and SciPy 1.17 and charted in Microsoft Excel 365 (2026).*

Note: UGE = urban green infrastructure endowment; PVC = property-value confidence; BAC = business attraction and custom; EML = employment and livelihoods; MFC = municipal fiscal capacity; WBP = wellbeing and productivity; UEG = perceived urban economic growth. Erbil in the darker bars, Sulaymaniyah in the lighter. Whiskers are 95% percentile bootstrap intervals from 2,000 resamples within each city. H1a is the only contrast that differs after adjustment; the group coefficients are those of Table 8.

The perceived green value indicator from equation (3) stands at 58.4 for Erbil residents, 58.8 for Erbil businesses, 60.1 for Sulaymaniyah residents and 60.6 for Sulaymaniyah businesses (Table 9; Figure 4). The bootstrap intervals of the four values overlap throughout, so the 2.2-point spread is a description rather than a tested difference. The weighting rule matters little here: the path weights lie between 0.126 and 0.328 against 0.200 under equal weighting, the departure coming almost entirely through the wellbeing channel, and an equal-weighted indicator lands within 1.2 of a point of the path-weighted one in every group, a correlation-weighted one within 0.7 (Table 9), so the weighting is auditable rather than consequential in this setting; it would diverge further where the channels differ more. Anchored to stated willingness to pay, the four values correspond to 6,975 and 7,145 Iraqi dinars per household per month in the two cities and 22,001 and 20,313 per firm, about US\$5.4, 5.5, 16.9 and 15.6 at the official rate of 1,300 dinars to the dollar, which the Central Bank of Iraq has held since February 2023 and fixed again for the 2026 budget (Central Bank of Iraq, 2026; Shafaq News, 2026). The anchoring amounts are the group means of stated willingness to pay — 11,936 dinars per household and 37,422 per firm each month in Erbil, 11,896 and 33,510 in Sulaymaniyah — formed after the follow-up item removed protest answers from the 407 zero responses; against the modal household income bands in Table 3 they amount to roughly 1% of monthly income in Erbil and 1–2% in Sulaymaniyah.

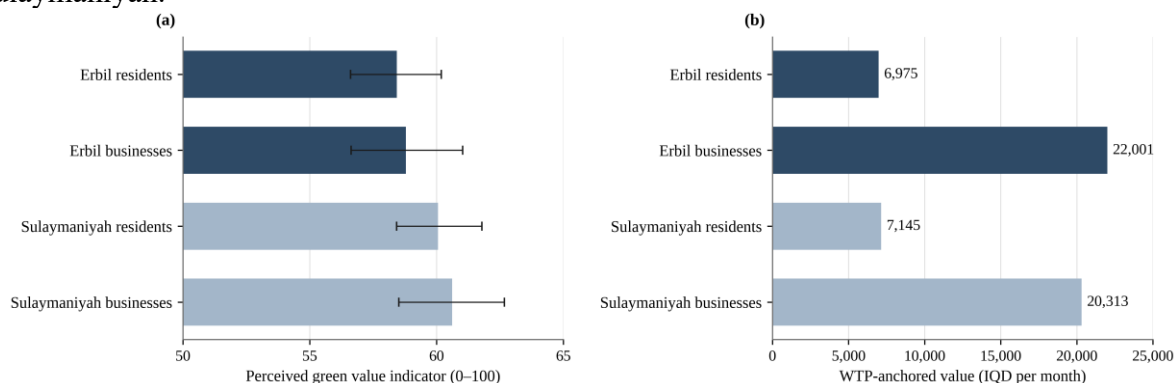


Figure 4. The perceived green value indicator (a) and its WTP-anchored value (b) by city and population group. *Source: authors, computed from the survey data in Python 3.11 with NumPy 2.4, pandas 3.0 and SciPy 1.17 and charted in Microsoft Excel 365 (2026).*

Note: Panel (a) is the indicator of equation (3) on its 0–100 range, with 95% bootstrap intervals. In panel (b) resident bars are dinars per household per month and business bars dinars per firm per month; the two are not directly comparable, and no interval is drawn because the anchor is a group mean carried into the figure rather than a resampled quantity. Erbil in the darker bars, Sulaymaniyah in the lighter.

Two further sensitivities concern the anchor rather than the weights, and both move the dinar figure without touching the indicator. First, the treatment of the zero responses. The reported means keep the genuine zeros and drop only the answers the follow-up item coded as protests, so the anchored value under any other rule is bounded by two extremes that need no further assumption: had every zero been retained as genuine, the household values could fall by at most 29% in Erbil (to 4,927 dinars) and 27% in Sulaymaniyah (to 5,247), and the firm values by at most 22% and 21% (to 17,087 and 16,090); had every zero been removed, they could rise by at most 42% and 36% (to 9,874 and 9,729) and by 29% and 26% (to 28,329 and 25,645). The bounds are wide because 407 of 1,593 respondents answered zero, and they are the honest size of the protest problem in a setting where the payment vehicle is a municipal charge. Second, the statistic. The card bounds the distribution above, so the mean is not pulled by a tail of implausible amounts, which is the usual reason for preferring the median; the full distribution of card steps in each group is given in Table 9, Panel C, where the median answer falls on the second positive step in every group once the zeros are retained, and the questionnaire released with the data carries the amount attached to each step, so a reader can re-anchor every figure to the median or to a trimmed mean. The indicator separates the four groups by only 2.2 points, while the anchored amounts separate firms from households by a factor of three and reverse the city ordering among firms;

the indicator and the money answer different questions, and only the indicator is comparable across groups. Across the cities that comparison is licensed, since all five channel composites passed compositional invariance; across the frames it is read with the endowment caveat above. Table 9, Panel B, gives the twenty channel means the indicator is built from.

Table 9: The perceived green value indicator. *Source: authors, computed from the survey data in Python 3.11 with NumPy 2.4, pandas 3.0 and SciPy 1.17.*

Panel A — The indicator, three weighting rules, and its anchoring							
Group	n	PGVI, path- weighted (0–100)	95% CI	Equal weight s	Correlati on weights	Mean stated WTP (IQD)	WTP- anchored value (IQD / US\$)
Erbil residents	487	58.4	[56.6, 60.2]	57.3	57.7	11,936	6,975 / 5.4
Erbil businesses	291	58.8	[56.6, 61.0]	57.8	58.1	37,422	22,001 / 16.9
Sulaymaniyah residents	512	60.1	[58.4, 61.8]	59.0	59.4	11,896	7,145 / 5.5
Sulaymaniyah businesses	303	60.6	[58.5, 62.7]	59.5	59.9	33,510	20,313 / 15.6
Panel B — Group means of the channel scores on the unit interval (̄smg) and the weights							
Group		PVC	BAC	EML	MFC	WBP	
Path weights		0.187	0.183	0.176	0.126	0.328	
Correlation weights		0.206	0.199	0.178	0.176	0.241	
Erbil residents		0.601	0.573	0.549	0.515	0.626	
Erbil businesses		0.601	0.584	0.559	0.519	0.625	
Sulaymaniyah residents		0.616	0.596	0.588	0.517	0.634	
Sulaymaniyah businesses		0.613	0.602	0.567	0.540	0.651	
Panel C — Payment-card answers: share of each group at each step (%), zeros before protest screening							
Group	0	1	2	3	4	5	6–7
Erbil residents	29.4	20.5	11.7	10.9	10.3	8.8	8.4
Erbil businesses	22.3	24.4	13.1	10.3	13.7	8.2	7.9
Sulaymaniyah residents	26.6	17.2	11.9	15.4	13.3	8.2	7.4
Sulaymaniyah businesses	20.8	25.7	15.8	10.2	9.6	11.6	6.2

Note: PGVI from equation (3) with the pooled Table 6 coefficients as weights; 95% CI from 2,000 bootstrap resamples propagating both the coefficients and the group means; equal weights set each channel at 0.200 and correlation weights set each in proportion to the channel's correlation with the outcome item. Mean stated willingness to pay is the group mean after the follow-up item removed protest answers from the zero responses; the anchored value is the indicator divided by 100 and multiplied by that mean, in Iraqi dinars per household (residents) or per firm (businesses) per month, with the US dollar equivalent at the official rate of 1,300 IQD per dollar. Panel B gives the group means of the five channel scores on the unit interval, from which the indicator is computed, and the two model-based weight vectors. Panel C gives the share of each group at each step of the payment card, step 0 being the explicit zero, before the protest screening.

4.4 Robustness

The first question is what the change of outcome did. Three of the four growth items in the instrument name greenery, and a construct built from all four was the outcome in an earlier version of this analysis; Table 10, Panel A, sets the two specifications side by side. With the four-item outcome the model explained $R^2 = 0.573$; with the single clean item it explains 0.429, a drop of 0.145 that is partly the overlap of vocabulary the four-item construct shared with its predictors and partly the attenuation of a single-item outcome whose reliability cannot be estimated, so the drop is an upper bound on the overlap. Nothing changes in kind. All five channels stay open with intervals clear of zero, the residual direct path holds, and the wellbeing channel leads by a wider margin than before (0.231 against 0.225); the four narrower channels move from a band of 0.141–0.152 down to one of 0.089–0.132 and reorder inside it. The four-item construct is not returned to: an outcome that repeats the predictor's name is not an outcome, whatever it does to R^2 .

The second question is whether the configuration of Figure 1 is preferable to the alternatives named in Section 2.4, and Table 10, Panel B, answers it on this outcome. A direct-only model explains $R^2 = 0.335$ with a coefficient of 0.579, which is the reduced form; adding the five channels and dropping the direct path explains 0.414; keeping both explains 0.429, and the direct coefficient falls from 0.579

down to 0.196 when the channels enter, which is the pattern partial mediation predicts. Out of sample, with direct-antecedent prediction, the hypothesised model's loss of 0.577 is lower than the direct-only model's (0.666, $p < 0.001$) and than the full-mediation model's (0.592, $p = 0.002$). The channels therefore add information about perceived growth that the endowment alone does not carry, and the direct path adds information the channels do not; neither alternative is as good on this evidence. What the comparison cannot do is order the arrows, and it is not claimed to.

The third question is the located city difference, which runs from the composite that failed compositional invariance, so it was re-tested on the two first-order composites that pass cleanly. Perceived quality behaves identically in the two cities: GIQ to property-value confidence stands at 0.324 in Erbil against 0.324 in Sulaymaniyah, permutation $p = 0.991$. The whole difference sits in access, where GIA to property-value confidence runs 0.389 against 0.229, a gap of 0.160 with $p = 0.002$ and, adjusted within the family of these two re-tests, $p = 0.004$. H4 therefore survives on invariant composites, and it gains an address: what separates these two urban economies in the estimates is not how well their greenery is judged but how reaching it is associated with belief about what premises are worth.

Common method variance was addressed by design and cannot be cleared by test. The design separated the two frames, guaranteed anonymity and anchored every stem to the respondent's own surroundings rather than greenery in the abstract, but it did not separate the measurement of the channels from the outcome in time or in format, the outcome block followed the channel blocks in a fixed order, and no marker variable was fielded. The tests available afterwards are weak. The source this study follows treats the single-factor test as uninformative (Podsakoff et al., 2024), so the 39.0% first-factor share in Table 4 is reported for convention and given no weight, and full-collinearity variance inflation factors, at a maximum of 2.66 against the 3.3 bound, are consistent with no dominant method factor without establishing its absence. Method variance therefore remains a limitation stated in Section 5.3 rather than a hypothesis tested and cleared.

Table 10: Sensitivity of the estimates to the outcome specification and the structural configuration. *Source: authors, computed from the survey data in Python 3.11 with NumPy 2.4, pandas 3.0 and SciPy 1.17.*

Panel A — Outcome specification: single clean item (main model) against the four-item construct

Path	β , UEG1 only	95% BCa CI	β , four items	95% BCa CI	Difference
H2a PVC → UEG	0.132	[0.084, 0.177]	0.144	[0.104, 0.184]	−0.012
H2b BAC → UEG	0.129	[0.086, 0.171]	0.152	[0.115, 0.190]	−0.023
H2c EML → UEG	0.124	[0.080, 0.165]	0.146	[0.109, 0.183]	−0.023
H2d MFC → UEG	0.089	[0.046, 0.131]	0.141	[0.103, 0.177]	−0.052
H2e WBP → UEG	0.231	[0.180, 0.280]	0.225	[0.182, 0.268]	+0.006
H3 UGE → UEG	0.196	[0.136, 0.256]	0.240	[0.186, 0.293]	−0.044
R ² of the outcome	0.429		0.573		−0.145
Q ² of the outcome	0.421		0.437		−0.016

Panel B — Alternative structural configurations for the UEG1 outcome (10-fold cross-validation)

Configuration	R ²	Direct path β	Loss, earliest antecedent	Loss, direct antecedents	p vs hypothesised model
Direct only (no channels)	0.335	0.579	0.667	0.666	< 0.001
Full mediation (no direct path)	0.414	—	0.673	0.592	0.002
Partial mediation (hypothesised)	0.429	0.196	0.667	0.577	—
Linear-model benchmark (19 items)	—	—	0.585	0.587	< 0.001
Indicator-average benchmark	—	—	1.001	1.001	< 0.001

Note: Panel A: the same estimator on the same cases with the outcome measured by UEG1 alone (main model) and by all four UEG items (earlier specification); CI = 95% bias-corrected and accelerated bootstrap interval from 10,000 resamples. Panel B: each configuration estimated on the UEG1 outcome; out-of-sample loss is the ten-fold cross-validated mean squared error on the standardised item, earliest-antecedent prediction using only the endowment items of a held-out case and direct-antecedent prediction its channel scores as well; p from a paired comparison of case-level losses against the hypothesised model. With one exogenous construct, every earliest-antecedent prediction is a linear function of the endowment score, so the three configurations cannot be separated in that column and the direct-antecedent column is the informative one.

5. Discussion

5.1 What the associations show

Read strictly as associations in a single-wave perceptual survey, the results say three things. First, in both cities and both populations, a more favourable judgement of the green endowment goes with a more favourable judgement of each of the five channels, and each channel with a more favourable reading of the city's economic direction; all eleven intervals exclude zero, and the pattern survives the change to an outcome that never names greenery. Second, the channels differ in size in a way the data can carry: wellbeing and productivity, at $\beta = 0.231$ with $f^2 = 0.057$, is separated from each of the other four by an interval clear of zero, while the other four, between 0.089 and 0.132 with no effect size above 0.021, cannot be separated from one another. Third, the pattern is largely shared: one path in eleven differs between the cities after adjustment, and the difference sits in access rather than quality; the frame difference on H1e is exploratory. These are the findings, and the rest of the section is interpretation of them and then inference from them, kept apart.

5.2 Interpretation, and the rival explanations

The interpretation the model was built to test is that the urban economy's agents attribute value to green surroundings through the five constituencies named, and that in these two cities the attribution runs chiefly through daily life and working capacity rather than through property. Against the international record that ordering sits where the thin-registry literature would put it rather than where the mature-market literature does. Property-led capitalisation dominates work on deep property markets (Dell'Anna et al., 2022; J. Li et al., 2024; Sohn et al., 2020; Song et al., 2025); here property-value confidence sits in the block of four narrow channels and cannot be ranked within it, which is itself what a registry recording transactions unevenly would predict. The lead of wellbeing and productivity echoes other data-scarce cities where use value and street commerce run ahead of asset prices (Basu & Nagendra, 2021; Khalaf et al., 2022; Liang et al., 2025; Odhengo et al., 2024). If the interpretation is right, a valuation built on property prices alone would recover a fraction of what residents and firms attribute to the asset. The city-level evidence from China — urban forest construction associated with growth (H. Ai & Zhou, 2023), green investment with emissions (K. Ai & Yan, 2024) and greening with employment (Q. Li et al., 2024) — sets the upper bound of ambition for sustained green investment, and the indicator built here is an instrument for testing, in later waves, whether these cities move that way.

The associations are open to other readings, and a discussion in urban economics owes them a hearing. Residential and firm sorting is the first: households who value greenery choose greener neighbourhoods and firms that benefit from green streets locate on them, so the people reporting a favourable endowment may be those already disposed to read the economy through it, and the association would then measure selection rather than any effect of greenery. Neighbourhood socio-economic status is the second: the greener parts of both cities are on the whole the better-off ones, income shapes both the quality of local greenery and optimism about the economy, and the model carries no neighbourhood income term. Land-value differences and accessibility inequality are related versions of the same confound, since where land is dear greenery is better kept and its owners more confident, and where access is poor both the endowment and the economic outlook are judged worse (Kemec & Abdalkarim, 2023; Shi et al., 2020). Reverse causality is the fourth: agents who believe the city is growing may think better of everything in it, greenery included, so that the arrow from endowment to perceived growth in Figure 1 runs partly the other way. Common method variance is the fifth, and Section 4.4 has already said it cannot be excluded. Two of these can be examined with the present data and were. Language of form is not the explanation, since compositional invariance

held across the three versions. And the city difference is not a quality difference, since it disappears on quality and concentrates on access. The rest cannot be settled with a cross-section, and the paper does not settle them: what it claims is that the associations are consistent with the channel model, robust to the specification of the outcome, and larger through wellbeing than through property, and that each rival reading would predict a different pattern that a longitudinal, spatial or quasi-experimental design could test. Repeated waves of this instrument, paired with a satellite greenery layer and a neighbourhood income term, is the design that would separate them, and it is set out in Section 5.3.

What the construction contributes beyond the established approaches is then stated at its proper size. Against amenity capitalisation it gives up the market fact and keeps the structure, which is what makes the same coefficient estimable in two cities that no hedonic model could fit alike. Against stated preference it adds to the amount an account of what the amount is paying for, in the form of a model-weighted indicator whose weights are tested paths rather than the analyst's choice, and Section 4.3 shows the weights to be auditable and, here, nearly inconsequential. The indicator is comparable across groups measured with one instrument; the anchored value is a stated amount and is not a welfare measure. That is the offer, and the paper makes no larger one.

5.3 Policy inference, limits and the forward programme

Three implications follow, each conditional on the interpretation of Section 5.2 holding, and the located finding leads. First, the two cities part on a single path after adjustment, endowment to property-value confidence, stronger in Erbil (0.634 against 0.495), and Section 4.4 places the whole of that gap in access rather than quality. If the association is read as the model reads it, then in Erbil, where set-piece parks such as Sami Abdulrahman are reached by deliberate journeys, the marginal return is in access to the parks that exist — the routes, crossings and transport that shorten the journey; in Sulaymaniyah, where greenery is met incidentally along the commercial spine of Salim Street and the foothill edges, it is in the quality of that incidental greenery. Second, the fiscal channel is the narrowest of the five: its interval excludes zero ($\beta = 0.089$) but its effect size, $f^2 = 0.010$, falls below the 0.02 floor Section 3.3 set for any claim in this section, so the estimates do not on their own support putting greenery into the language of the base that funds it (Back & Collins, 2022; Meerow, 2020; Vejchodská et al., 2022), and no budget inference is drawn from them. What the fiscal side can use is the stated amount of Section 4.3, 1–2% of a household's monthly income, which is the size of the case a maintenance budget can make, and which is stated rather than revealed. Third, the frame contrasts, exploratory as they are, point to a municipal choice: the association between endowment and wellbeing is stronger among households than among firms (H1e, 0.672 against 0.516), so greenery for households and greenery for commerce may be different programmes (Grimes et al., 2023; Hwang & Park, 2026; Suhartanto et al., 2026). Because every estimate exists per city and per frame, repeated waves of the same instrument would make a greening programme that raises the indicator while displacing the people who generated it detectable, which the gentrification record shows is no hypothetical failure (Stuhlmacher et al., 2022; Xiao et al., 2026); a single wave cannot.

The limits are these. The evidence is perception, disciplined by the measurement, invariance and predictive tests but perception still, and no observable economic quantity — a transaction, a rent, a registry entry — enters the model; the monetary anchor is stated rather than revealed preference, and every dinar figure moves with the treatment of the 407 zero responses. The design is cross-sectional, so the paths are associations under theory and the rival explanations of Section 5.2 stand. The outcome is a single item, chosen so that it owes nothing to the predictors' vocabulary, at the price of an unestimable reliability and attenuated paths into it. All 23 model items are positively worded agreement statements, with no reverse-coded or balanced items, so acquiescence cannot be separated from agreement, and a single-sitting instrument cannot rule out method variance for the reasons Section 4.4 gives (Podsakoff et al., 2024). The sample is a quota sample of two cities chosen for contrast rather than representativeness, unweighted, with the strata and achieved distribution reported

in Table 2 for the reader to judge; the Arabic and English forms were not evenly spread across the cities, so language and city remain partly confounded even though the measurement was shown to be invariant across the versions. The forward programme addresses each in turn: repeated waves to move the indicator into time, a satellite greenery layer and a neighbourhood income term to test the sorting and status explanations, balanced and reverse-coded items with a marker variable, a probability sample with post-stratification, and a hedonic replication as registries mature (Ersoy Mirici, 2022; Zheng et al., 2026).

6. Conclusions

This article set out to measure the socio-economic value that residents and businesses of two cities attribute to their urban green infrastructure, cities that cannot consult a market for the answer, and to leave behind equations rather than an estimate alone. Its contribution is three things kept separate. Methodologically, it offers a three-equation chain — composites, structure, valuation bridge — that turns a survey the city can afford into a group-comparable indicator of perceived green value anchored to a stated amount, with its weights drawn from tested paths and shown to be auditable; the chain is estimable where the amenity framework's own instruments are not, and it keeps that framework's structure. Empirically, it gives the Kurdistan Region of Iraq its first survey-based estimates of this kind: five channels all associated with perceived urban economic growth, wellbeing and productivity the widest of them, one path in eleven differing between Erbil and Sulaymaniyah and that difference located in access rather than quality, and an indicator of 58.4–60.6 across the four groups that anchors to 6,975–7,145 dinars per household and 20,313–22,001 per firm each month. For policy, it gives municipalities a stated, comparable number to set beside the priced uses competing for the same land, and a baseline against which later waves can show whether greening programmes raise the indicator and for whom.

None of this is a price, and the article has been careful not to call it one: the anchored value is what the surveyed populations say they would pay, scaled by what they attribute to the asset, and it is not a welfare measure or a hedonic differential. Nor is the chain a transferable property. It has been estimated in two neighbouring cities of one region, under one institutional setting, and the invariance it passed was between those groups and language versions; whether it holds in cities of different institutions, economies, climates and forms is a proposition, and the paper offers the instrument, the equations and the open code as the means of testing it. The karez that watered these cities survived for centuries because someone maintained what nobody priced; a measured account of what their successors are worth is the least a city can do before it builds over them.

Acknowledgements

The authors thank the residents and business owners of Erbil and Sulaymaniyah who gave their time to the survey, and the enumerators who administered the forms in both cities.

Funding

This research received no external funding.

Institutional Review Board Statement

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Participation was voluntary and anonymous; informed consent was obtained from every respondent, in the language of administration, before the form was completed; business-frame respondents consented in a personal capacity as informants for their establishment; and no personally identifying information was collected.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The de-identified survey dataset, the questionnaire in its three language versions with the payment card, the analysis code (with its declared random seed, 20260831, so that two runs over the same file return the same digits) and the workbook that reproduce every reported quantity are available from the corresponding author on reasonable request.

CRedit Author Statement

Shad Sherzad Jawhar: Conceptualization; Methodology; Software; Formal analysis; Visualization; Writing – original draft; Writing – review & editing. Nawaz Nadhim Omar: Investigation; Data curation; Validation; Project administration; Writing – review & editing. Federico Luis del Blanco García: Supervision; Validation; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

References

- Abdullah, S., & Gray, T. (2022). Political constraints on economic diversification in the Kurdistan Region of Iraq. *Energy Policy*, 171, Article 113274. <https://doi.org/10.1016/j.enpol.2022.113274>
- Ai, H., & Zhou, Z. (2023). Green growth: The impact of urban forest construction on economic growth in China. *Economic Modelling*, 125, Article 106366. <https://doi.org/10.1016/j.econmod.2023.106366>
- Ai, K., & Yan, X. (2024). Can green infrastructure investment reduce urban carbon emissions: Empirical evidence from China. *Land*, 13(2), Article 226. <https://doi.org/10.3390/land13020226>
- Albouy, D. (2016). What are cities worth? Land rents, local productivity, and the total value of amenities. *Review of Economics and Statistics*, 98(3), 477–487. https://doi.org/10.1162/REST_a_00550
- Al-Manmi, D. A., Hamamin, D. F., & Salih, A. O. (2019). Karezes, abandoned and endangered water resources in semi-arid regions: Case study from Sulaymaniyah city, Iraq. *Iraqi Bulletin of Geology and Mining*, 15(1), 91–104. <https://ibgm-iq.org/ibgm/index.php/ibgm/article/view/369>
- Alonso, W. (1964). *Location and land use: Toward a general theory of land rent*. Harvard University Press. <https://doi.org/10.4159/harvard.9780674730854>
- Back, P., & Collins, A. M. (2022). Negotiating the green obstacle course: Ranking priorities and problems for municipal green infrastructure implementation. *Urban Forestry & Urban Greening*, 67, Article 127436. <https://doi.org/10.1016/j.ufug.2021.127436>
- Basu, S., & Nagendra, H. (2021). Perceptions of park visitors on access to urban parks and benefits of green spaces. *Urban Forestry & Urban Greening*, 57, Article 126959. <https://doi.org/10.1016/j.ufug.2020.126959>
- Batty, M. (2022). On economic and urban growth. *Environment and Planning B: Urban Analytics and City Science*, 49(9), 2293–2296. <https://doi.org/10.1177/23998083221136851>
- Becker, J.-M., Cheah, J.-H., Gholamzade, R., Ringle, C. M., & Sarstedt, M. (2023). PLS-SEM's most wanted guidance. *International Journal of Contemporary Hospitality Management*, 35(1), 321–346. <https://doi.org/10.1108/IJCHM-04-2022-0474>
- Caprioli, C., Bottero, M., & De Angelis, E. (2023). Combining an agent-based model, hedonic pricing and multicriteria analysis to model green gentrification dynamics. *Computers, Environment and Urban Systems*, 102, Article 101955. <https://doi.org/10.1016/j.compenvurbsys.2023.101955>
- Central Bank of Iraq. (2026). *Exchange rates*. Retrieved September 3, 2026, from <https://cbi.iq/page/144>

- Cheah, J.-H., Amaro, S., & Roldán, J. L. (2023). Multigroup analysis of more than two groups in PLS-SEM: A review, illustration, and recommendations. *Journal of Business Research*, 156, Article 113539. <https://doi.org/10.1016/j.jbusres.2022.113539>
- Chin, W., Cheah, J.-H., Liu, Y., Ting, H., Lim, X.-J., & Cham, T. H. (2020). Demystifying the role of causal-predictive modeling using partial least squares structural equation modeling in information systems research. *Industrial Management & Data Systems*, 120(12), 2161–2209. <https://doi.org/10.1108/IMDS-10-2019-0529>
- Combrinck, Z., Cilliers, E. J., Lategan, L., & Cilliers, S. (2020). Revisiting the proximity principle with stakeholder input: Investigating property values and distance to urban green space in Potchefstroom. *Land*, 9(7), Article 235. <https://doi.org/10.3390/land9070235>
- Costadone, L., Lai, T.-Y., Hurskainen, P., & Kopperoinen, L. (2024). Co-creating urban ecosystem accounting: Physical and monetary accounts of runoff retention service provided by urban green spaces. *Ecosystem Services*, 65, Article 101576. <https://doi.org/10.1016/j.ecoser.2023.101576>
- Crocetta, C., Antonucci, L., Cataldo, R., Galasso, R., Grassia, M. G., Lauro, C. N., & Marino, M. (2021). Higher-order PLS-PM approach for different types of constructs. *Social Indicators Research*, 154(2), 725–754. <https://doi.org/10.1007/s11205-020-02563-w>
- Dell'Anna, F., Bravi, M., & Bottero, M. (2022). Urban green infrastructures: How much did they affect property prices in Singapore? *Urban Forestry & Urban Greening*, 68, Article 127475. <https://doi.org/10.1016/j.ufug.2022.127475>
- Ersoy Mirici, M. (2022). The ecosystem services and green infrastructure: A systematic review and the gap of economic valuation. *Sustainability*, 14(1), Article 517. <https://doi.org/10.3390/su14010517>
- Froy, F., Heroy, S., Uyarra, E., & O'Clery, N. (2022). What drives the creation of green jobs, products and technologies in cities and regions? Insights from recent research on green industrial transitions. *Local Economy*, 37(7), 584–601. <https://doi.org/10.1177/02690942231170135>
- Gelo, D., & Turpie, J. (2021). Bayesian analysis of demand for urban green space: A contingent valuation of developing a new urban park. *Land Use Policy*, 109, Article 105623. <https://doi.org/10.1016/j.landusepol.2021.105623>
- Godoi, N. M. I., Gomes, R. C., & Longo, R. M. (2025). Contributions of urban green spaces to cities: A literature review. *Sustainable Environment*, 11(1), Article 2464418. <https://doi.org/10.1080/27658511.2025.2464418>
- Grimes, A., Badenhorst, S., Maré, D. C., Poot, J., & Sin, I. (2023). Quality of life, quality of business, and destinations of recent graduates: Fields of study matter. *The Annals of Regional Science*, 70(1), 55–80. <https://doi.org/10.1007/s00168-022-01117-x>
- Hair, J. F., & Alamer, A. (2022). Partial least squares structural equation modeling (PLS-SEM) in second language and education research: Guidelines using an applied example. *Research Methods in Applied Linguistics*, 1(3), Article 100027. <https://doi.org/10.1016/j.rmal.2022.100027>
- Hair, J. F., Howard, M. C., & Nitzl, C. (2020). Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. *Journal of Business Research*, 109, 101–110. <https://doi.org/10.1016/j.jbusres.2019.11.069>
- Halkos, G., Leonti, A., & Sardanou, E. (2021). Activities, motivations and satisfaction of urban parks visitors: A structural equation modeling analysis. *Economic Analysis and Policy*, 70, 502–513. <https://doi.org/10.1016/j.eap.2021.04.005>
- Hassan, Y. N., Mohammed, H. A., Abuhayya, M., & Jombach, S. (2025). Assessing travel-time accessibility to urban green spaces in car-dependent cities: Evidence from Erbil and Sulaimaniyah, Kurdistan Region of Iraq. *Land*, 14(9), Article 1886. <https://doi.org/10.3390/land14091886>



- Hwang, G., & Park, J. (2026). The role of streetscape quality in coffee shop location shifts: A case study of the Hongdae retail district in Seoul. *Journal of Retailing and Consumer Services*, 91, Article 104730. <https://doi.org/10.1016/j.jretconser.2026.104730>
- Jawhar, S. S., & Atakara, C. (2026). Post-2000 urban sprawl in Erbil, Iraq: Impacts on urban form, socioeconomic dynamics, culture, and quality of life. *African and Asian Studies*. Advance online publication. <https://doi.org/10.1163/15692108-bja10099>
- Kalfas, D., Chatzitheodoridis, F., Loizou, E., & Melfou, K. (2022). Willingness to pay for urban and suburban green. *Sustainability*, 14(4), Article 2332. <https://doi.org/10.3390/su14042332>
- Kemec, S., & Abdalkarim, S. H. (2023). Accessibility analysis of urban green space: The case of Erbil city. *ICONARP International Journal of Architecture and Planning*, 11(1), 24–44. <https://doi.org/10.15320/iconarp.2023.231>
- Khalaf, O. A., Ja'afar, N. H., Harun, N. Z., Mohammed, N., & Ali, O. H. (2022). What makes an attractive user-friendly street? Exploring perceptions of Mawlawi shopping street environment in the context of Sulaymaniyah city, Iraq. *Planning Malaysia*, 20(21). <https://doi.org/10.21837/pm.v20i21.1090>
- Khoshnaw, R. (2023). Evaluating mixed land use and connectivity: A case study of five neighborhoods in Erbil city, Iraq. *Sustainability*, 15(19), Article 14265. <https://doi.org/10.3390/su151914265>
- Ledraa, T., & Aldubikhi, S. A. (2025). Unveiling the value of green amenities: A mixed-methods analysis of urban greenspace impact on residential property prices across Riyadh neighborhoods. *Buildings*, 15(12), Article 2088. <https://doi.org/10.3390/buildings15122088>
- Li, J., Ossokina, I. V., & Arentze, T. A. (2024). The impact of urban green space on housing value: A combined hedonic price analysis and land use modeling approach. *Journal of Sustainable Real Estate*, 16(1), Article 2432758. <https://doi.org/10.1080/19498276.2024.2432758>
- Li, Q., Ge, J., & Fan, H. (2024). Unveiling the impact of synergy between digitalization and greening on urban employment in China. *Scientific Reports*, 14(1), Article 27773. <https://doi.org/10.1038/s41598-024-79112-9>
- Li, X., & Xiao, L. (2024). The impact of urban green business environment on FDI quality and its driving mechanism: Evidence from China. *World Development*, 175, Article 106494. <https://doi.org/10.1016/j.worlddev.2023.106494>
- Liang, H., Zhu, L., Liu, H., Yan, Q., & Gu, Y. (2025). Valuing urban green spaces: A decade of access and residents' willingness to pay in Shanghai. *Land*, 14(9), Article 1835. <https://doi.org/10.3390/land14091835>
- Liengaard, B. D., Sharma, P. N., Hult, G. T. M., Jensen, M. B., Sarstedt, M., Hair, J. F., & Ringle, C. M. (2021). Prediction: Coveted, yet forsaken? Introducing a cross-validated predictive ability test in partial least squares path modeling. *Decision Sciences*, 52(2), 362–392. <https://doi.org/10.1111/dec.12445>
- Luo, S., & Patuano, A. (2023). Multiple ecosystem services of informal green spaces: A literature review. *Urban Forestry & Urban Greening*, 81, Article 127849. <https://doi.org/10.1016/j.ufug.2023.127849>
- Malik, A., Zubair, M., & Manzoor, S. A. (2021). Valuing the invaluable: Park visitors' perceived importance and willingness to pay for urban park trees in Pakistan. *Ecosphere*, 12(1), Article e03348. <https://doi.org/10.1002/ecs2.3348>
- Meerow, S. (2020). The politics of multifunctional green infrastructure planning in New York City. *Cities*, 100, Article 102621. <https://doi.org/10.1016/j.cities.2020.102621>
- Mell, I. (2022). Examining the role of green infrastructure as an advocate for regeneration. *Frontiers in Sustainable Cities*, 4, Article 731975. <https://doi.org/10.3389/frsc.2022.731975>
- Monteiro, R., Ferreira, J., & Antunes, P. (2020). Green infrastructure planning principles: An integrated literature review. *Land*, 9(12), Article 525. <https://doi.org/10.3390/land9120525>

- Nordbø, E. C. A., & Nordh, H. (2025). Green space visitation: A capacity builder for self-perceived health and subjective wellbeing among urban citizens. *Urban Forestry & Urban Greening*, 107, Article 128777. <https://doi.org/10.1016/j.ufug.2025.128777>
- Odhengo, P., Lutta, A. I., Osano, P., & Opiyo, R. (2024). Urban green spaces in rapidly urbanizing cities: A socio-economic valuation of Nairobi City, Kenya. *Cities*, 155, Article 105430. <https://doi.org/10.1016/j.cities.2024.105430>
- Patino, J. E., Martinez, L., Valencia, I., & Duque, J. C. (2023). Happiness, life satisfaction, and the greenness of urban surroundings. *Landscape and Urban Planning*, 237, Article 104811. <https://doi.org/10.1016/j.landurbplan.2023.104811>
- Podsakoff, P. M., Podsakoff, N. P., Williams, L. J., Huang, C., & Yang, J. (2024). Common method bias: It's bad, it's complex, it's widespread, and it's not easy to fix. *Annual Review of Organizational Psychology and Organizational Behavior*, 11(1), 17–61. <https://doi.org/10.1146/annurev-orgpsych-110721-040030>
- Ramírez-Juidías, E., Amaro-Mellado, J. L., & Leiva-Piedra, J. L. (2022). Influence of the urban green spaces of Seville (Spain) on housing prices through the hedonic assessment methodology and geospatial analysis. *Sustainability*, 14(24), Article 16613. <https://doi.org/10.3390/su142416613>
- Ramyar, R., Ackerman, A., & Johnston, D. M. (2021). Adapting cities for climate change through urban green infrastructure planning. *Cities*, 117, Article 103316. <https://doi.org/10.1016/j.cities.2021.103316>
- Refisch, M., Kurz, K., & Hartmann, J. (2024). Urban green space usage and life satisfaction during the Covid-19 pandemic. *Applied Research in Quality of Life*, 19(3), 1139–1171. <https://doi.org/10.1007/s11482-024-10279-z>
- Roback, J. (1982). Wages, rents, and the quality of life. *Journal of Political Economy*, 90(6), 1257–1278. <https://doi.org/10.1086/261120>
- Roemer, E., Schuberth, F., & Henseler, J. (2021). HTMT2—An improved criterion for assessing discriminant validity in structural equation modeling. *Industrial Management & Data Systems*, 121(12), 2637–2650. <https://doi.org/10.1108/IMDS-02-2021-0082>
- Russo, A. (2024). Renaturing for urban wellbeing: A socioecological perspective on green space quality, accessibility, and inclusivity. *Sustainability*, 16(13), Article 5751. <https://doi.org/10.3390/su16135751>
- Sabyrbekov, R., Dallimer, M., & Navrud, S. (2020). Nature affinity and willingness to pay for urban green spaces in a developing country. *Landscape and Urban Planning*, 194, Article 103700. <https://doi.org/10.1016/j.landurbplan.2019.103700>
- Sachs, A. L., Boag, A. E., & Troy, A. (2023). Valuing urban trees: A hedonic investigation into tree canopy influence on property values across environmental and social contexts in Baltimore, Maryland. *Urban Forestry & Urban Greening*, 80, Article 127829. <https://doi.org/10.1016/j.ufug.2022.127829>
- Salih, A. M., Erfani, G., & Larimian, T. (2026). Mass housing planning and environmental considerations: Case studies of post-war urban redevelopment in Erbil city, Kurdistan. *Local Environment*, 31(2), 117–137. <https://doi.org/10.1080/13549839.2025.2496161>
- Shafaq News. (2026, January 8). *Iraq fixes 2026 budget at 1,300 dinars per dollar*. <https://shafaq.com/en/Economy/Iraq-fixes-2026-budget-at-1-300-dinars-per-dollar>
- Shi, L., Halik, Ü., Abliz, A., Mamat, Z., & Welp, M. (2020). Urban green space accessibility and distribution equity in an arid oasis city: Urumqi, China. *Forests*, 11(6), Article 690. <https://doi.org/10.3390/f11060690>
- Sohn, W., Kim, H. W., Kim, J.-H., & Li, M.-H. (2020). The capitalized amenity of green infrastructure in single-family housing values: An application of the spatial hedonic pricing method. *Urban Forestry & Urban Greening*, 49, Article 126643. <https://doi.org/10.1016/j.ufug.2020.126643>



- Song, L., Lou, J., & Liu, K. (2025). Exploring the economic value of urban green spaces: A dual-perspective analysis inside and outside residential communities. *Journal of Urban Planning and Development*, 151(3), Article 05025022. <https://doi.org/10.1061/JUPDDM.UPENG-5458>
- Sopelana, A., Urrea-Uriarte, S., Landa Oregi, I., Gonzalez Ochoantesana, I., Tatar, M., & Nacu, A. (2025). Prioritising critical factors for local economic development in urban regeneration strategies. *Urban Science*, 9(9), Article 342. <https://doi.org/10.3390/urbansci9090342>
- Stuhlmacher, M., Kim, Y., & Kim, J. E. (2022). The role of green space in Chicago's gentrification. *Urban Forestry & Urban Greening*, 71, Article 127569. <https://doi.org/10.1016/j.ufug.2022.127569>
- Suhartanto, D., Pangarso, A., Brien, A., Chen, B., & Chaerunisa, K. A. (2026). Experiencing the crowded green: How satisfaction shapes visitors' behavioural outcomes in urban parks. *Journal of Hospitality and Tourism Insights*. Advance online publication. <https://doi.org/10.1108/JHTI-10-2025-1249>
- Vejchodská, E., Barreira, A. P., Auziņš, A., Jürgenson, E., Fowles, S., & Maliene, V. (2022). Bridging land value capture with land rent narratives. *Land Use Policy*, 114, Article 105956. <https://doi.org/10.1016/j.landusepol.2021.105956>
- Wu, W., Chen, W. Y., Yun, Y., Wang, F., & Gong, Z. (2022). Urban greenness, mixed land-use, and life satisfaction: Evidence from residential locations and workplace settings in Beijing. *Landscape and Urban Planning*, 224, Article 104428. <https://doi.org/10.1016/j.landurbplan.2022.104428>
- Wu, W., Tan, W., Wang, R., & Chen, W. Y. (2023). From quantity to quality: Effects of urban greenness on life satisfaction and social inequality. *Landscape and Urban Planning*, 238, Article 104843. <https://doi.org/10.1016/j.landurbplan.2023.104843>
- Xiao, Y., Cen, L., & Li, H. (2026). Green equity or green gentrification? State-led urban park development in Shanghai, 2000–2020. *Urban Forestry & Urban Greening*, 116, Article 129225. <https://doi.org/10.1016/j.ufug.2025.129225>
- Zheng, H., Wei, Y., Wu, S., & Yang, K. (2026). Urban green space and its socio-economic and demographic determinants: A meta-analysis for urban sustainability. *Sustainability*, 18(13), Article 6905. <https://doi.org/10.3390/su18136905>
- Zhou, K., Song, Y., & Tan, R. (2021). Public perception matters: Estimating homebuyers' willingness to pay for urban park quality. *Urban Forestry & Urban Greening*, 64, Article 127275. <https://doi.org/10.1016/j.ufug.2021.127275>



How to cite this article? (APA Style)

Jawhar, S. S., Omar, N. N., & Del Blanco García, F. L. (2026). The socio-economic value of urban green infrastructure: Statistical equations for assessing perceived urban economic growth. *Journal of Contemporary Urban Affairs*, 10(2), 498–526. <https://doi.org/10.25034/ijcua.2026.v10n2-11>