Metroscope: A Forecast Allocation Model & Policy Assessment Tool

A Brief Model Description

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Data Resource Center
Metro

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Metroscope: A Forecast Allocation & Land Use Policy Assessment Model

A brief description of its input requirements, its theoretical model underpinnings and a limited description of what it does.

Introduction.

Metroscope's main purpose is to systematically predict where employment and housing are more likely in the Portland-Vancouver MSA to locate based on a given set of supply assumptions (i.e., capacity), market demand factors and regional-level macro-economic forecast. Supply is determined based on measured estimates of employment and housing capacity. This capacity is calculated from estimates of vacant and refill land. Local zoning is overlayed on vacant and refill land to determine its status for accommodating housing or employment. Local zoning determines the housing capacity. Local zoning determines the density allowed for employment purposes. Future household and employment projections will only allocate forecasted growth where capacity exists to accommodate the quantity of projected growth.

Market demand for housing and employment purposes are derived from Metro's regional macroeconomic model. This model (described below) describes the region's total or overall amounts of growth in future years. Metroscope's role is to find an economically efficient distribution of this regional growth and to allocate this growth down to smaller geographic units (e-zones and census tracts).

The location choice for this market demand for housing is dependent on:

1. The location and amount of housing capacity, type of housing, by census tract
2. Household characteristic (i.e., HIA composition)
3. Proximity to work locations/choices
4. Relative home prices

Households according to their HIA characteristics will seek out housing choices that meet their desires and affordability.

In the same way, the supply of land to accommodate businesses and industry growth follows a similar method of estimation. The employment land supply accounts for vacant and refill land and their zoning designation.

The market demand for employment land need follows a parallel algorithm of employment land choice:

1. The location and amount of industrial & commercial land by e-zone
2. Industry characteristics (i.e., by SIC)
3. Proximity to labor force, proximity to industry clusters & agglomeration
4. Relative real estate prices

Employment by SIC are grouped together into building type affinities and these types are then matched up against the available supply to accommodate this demand. Jobs will seek

out locations that have the capacity to accommodate them and at the same time maximizes the desired location characteristics for each industry.

Regional Control Totals – Metro Regional Macro Model

Key Outputs from regional model as Inputs to Metroscope Land Use Allocation Model:

1. **HOUSEHOLDS**: Number of future households by HIA (household size, income, age)
- 7 household sizes – 1 person to 7 + persons in household
- 16 income categories – same as 2000 Census income bins
- 7 age categories – same as 2000 Census
2. **JOBS**: Employment forecasts by Standard Industrial Classification (SIC)
- Metroscope uses 15 SIC categories – mainly at 1 digit SIC plus a few 2 digit SIC divisions to improve model estimation

The regional macro model is an econometric model with over 300 equations that mimic the long-run structure of key components of the regional economy, e.g., employment by SIC, wage rates by SIC, personal income components, synthesized regional productivity, population (and components-births & deaths), migration and households. The regional model is structured to select and maximize the use of all available regional data.

784 HIA categories are derived from the regional macro model. First, population by age is projected using a cohort-survival technique similar to the Census cohort component model. Future year birth rates and death rates derived from the U.S. Census and age-calibrated to Portland rates (i.e., births and deaths). Assuming household formation factors, the number of future households are derived from the population forecast.

Individual components of HIA are forecasted. The distribution of each H, each I, and each A are controlled to its respective target regional forecast. The initial distribution or seed matrix for each H, each I, and each A is taken from the 2000 Census. The Census SF 1 and SF 3 gives us the marginal or initial control totals. For future years, the regional macro model provides the marginals. Future marginals are generated from minimizing the sum of squared differences in the distribution of each of the marginals (i.e. H, I , and A) for each category. Finally, the joint distribution of H, I, and A are generated from Census Public Use Microsample (PUMS) data. A joint distribution of HIA is derived from iterative proportionally fitting the H, I, and A marginals for each PUMA in the region. PUMA's are described by the Census. These regional joint distributions are the inputs to the Metroscope housing/household allocation choice model component.

In the employment allocation choice model component of Metroscope, the SIC industry level forecasts are directly fed into the nonresidential location model as employment by industry.

Metroscope Housing Choice and Location Allocation Model Component

Key Inputs and Assumptions:

- HIA forecast
- Assessor data describing the already built environment
- Existing employment locations or clusters – concentration of where jobs exist
- Travel times to and from each census tract (Metroscope's native household location choice zones)
- Zoning (assumes year 2000)
- Vacant Land in Acres
- Redevelopment and Infill in Acres
- Urban Renewal site locations
- UGB/UGA housing adds

Equations (Behavioral Estimators)

- Construction cost functions – describes housing development behavior
- Tenure Choice functions – (own or rent)
- Housing Type Choice functions – (SF detached, SF attached, MFR)
- Housing Location Preference functions
- Household Utility/Consumption Preference functions (categories assumed from survey of consumer expenditures)

Household Allocation:
Household allocations to Metroscope zones (i.e., census tracts) are performed simultaneously to equilibrate demand for housing for tenure choice, housing type choice, location preference choice for every zone in the region given the constructed supply of housing for each demanded type. If a zone(s) has a surplus demand, real estate prices automatically increment up until the demand shrinks and the supply increases to match supply = demand. Demand decreases in this example because of higher prices, but the housing supply rises because of higher relative prices as more suppliers (builders) enter the market with product to sell at these higher prices. Note also that at higher prices, the demand choices for every HIA will also readjust or change to the higher prices. Households will reformulate their choice of tenure, housing type, and location based on the ability to afford housing subject to their household utility function.

Household location choice(s) are also a function of distance to available employment opportunities (as based on the household's primary worker). This we derive initially from an employment geocode and in later years is determined by the employment allocation component. In addition to access to work opportunities, the accessibility of the household to other zones for recreation and commercial activities is also implemented in the location choice.

Demand Calculations:
Each HIA category is described by a function and this function is empirically estimated to indicate an HIA category's propensity for tenure choice, housing type choice, a preferred location choice and subject to each household's (by HIA) utility function. Households demand housing so the unit of reference is housing. For example, typically a large household, of middle age and of above average income will tend to desire to own a SF detached home out in the suburbs assuming they have kids. The choice of location is dependent on not only the HIA structure of the household, but also the availability of the type and quantity of housing, the attraction to jobs, and a neighborhood attraction quotient.

Supply Calculations:
The quantity and type of housing in each zone is determined primarily from the amount of vacant land (as measured by the RLIS vacant land study) and the endogenously estimated amount of redevelopment and infill (refill) land available in each future year. Zoned density limits the amount or number of additional houses that can be added in each zone. How much land gets developed in future years is also determined by the cost of home construction, but is limited by zoned capacity. This cost function calculates how much housing can be profitably constructed given a relative price of real estate in future years. Higher or excess demand will generate upward price movement which will entice more home construction in the reference zone. Less demand produces less home construction in response to the relatively lower demand.

Urban renewal assumptions can also be added to the supply assumptions to increase housing capacity.

Metroscope Employment Location Choice and Allocation Model Component

Key Inputs and Assumptions:

- Job forecast by SIC
- Assessor data describing the already built environment
- Existing employment locations or clusters – concentration of where jobs exist
- Travel times to and from each census tract (Metroscope's native household location choice zones)
- Zoning (assumes year 2000)
- Vacant Land in Acres
- Redevelopment and Infill in Acres
- Urban Renewal site locations
- UGB/UGA employment adds

Equations (Behavioral Estimators)

- Construction cost functions – describes commercial & industrial development behavior
- Building Type Choice functions by SIC – 6 building types

- Job Location Preference function – 3 types
- Square Foot per Employee (SFE)
- Floor-to-Area Ratios (FAR)

Building Types:

1. General Industrial
2. Tech/Flex
3. Warehousing / Distribution
4. Office
5. Retail
6. Institutional (Medical & Government, Schools)

Job Location Preferences – Attraction propensities per industry to:

1. Housing or Households – for labor market and retail market
2. Total Employment Activity – economic/market agglomeration factors
3. Same Industry – clustering

Employment forecast Allocation:

Demand for real estate and the supply of real estate are balanced everywhere across the region. This balance is achieved iteratively by raising or lowering relative real estate prices in order to strike an equilibrium between supply and demand for each of the 6 Metroscope designated real estate types. For example, higher prices in the case of demand will either cause select industries to substitute from a deficit real estate type to another real estate type with surplus or reduce demand by increasing density of SFE and/or FAR or to drive demand to the next best location. Meanwhile in this example higher prices will induce more nonresidential real estate construction in the reference zone and thus supply. At the same time that these demand and supply forces are acting on the reference zone, zones throughout the rest of the region will also be reacting and adjusting the supplies and demands of each and every zone. A final equilibrium is iteratively approached when all the demand and supply in all zones are equal.

In addition, location choice also considers the housing choice location of its workers (i.e. housing). Workers will as permits tend to choose employment closer to where they already live given equal choices. Therefore transportation accessibility among zones is also factored into the function for location choice as well as total housing availability.

Employment Demand:

Employment is translated into the demand for building square footage and acres demand (i.e., using SFE and FAR). Initial starting values are derived from observed densities per Metro's 1999 Employment Density Study and calibrated/validated using various commercial real estate reports. The SFE and FAR are endogenous and as relative prices in each employment zone (Ezone) fluctuates up (or down) these density parameters adjust accordingly. Therefore new construction in the future in say a high price regime will generate demand for higher density development.

As the square footage demand and densities are calculated, the choice of building type is also simultaneously chosen. Through empirical estimates and literature derived parameters, each SIC has a designated propensity for each of the six building types. Substitution is allowed between building types by each SIC as is dependent on market mechanisms mimicked by Metroscope. (Note: The densities of these building types are endogenously derived).

Choice of employment location is from the viewpoint of the business owner making site location choices. An employer in a certain SIC considers a variety of factors including site cost, a "work shed" or access to a labor force, retail opportunities or retail density, transportation accessibility, zoning, agglomeration forces, and like-cluster activities. Different SIC's are said to have different needs. Metroscope incorporates what we know about how each SIC has different degrees of attraction or requirement for various factors in location choice. Some industries will have a greater propensity to be attracted by greater concentrations of households (i.e., some industries want to be closer to households for workforce attractiveness reasons or closer to retail opportunities), or by an industry cluster (i.e., some industries prefer to locate closer to suppliers to business-to-business transactions, or research and development ideas), or agglomeration (i.e., some industries need to be close to large employment concentrations to foster general business-to-business transactions and relationships).

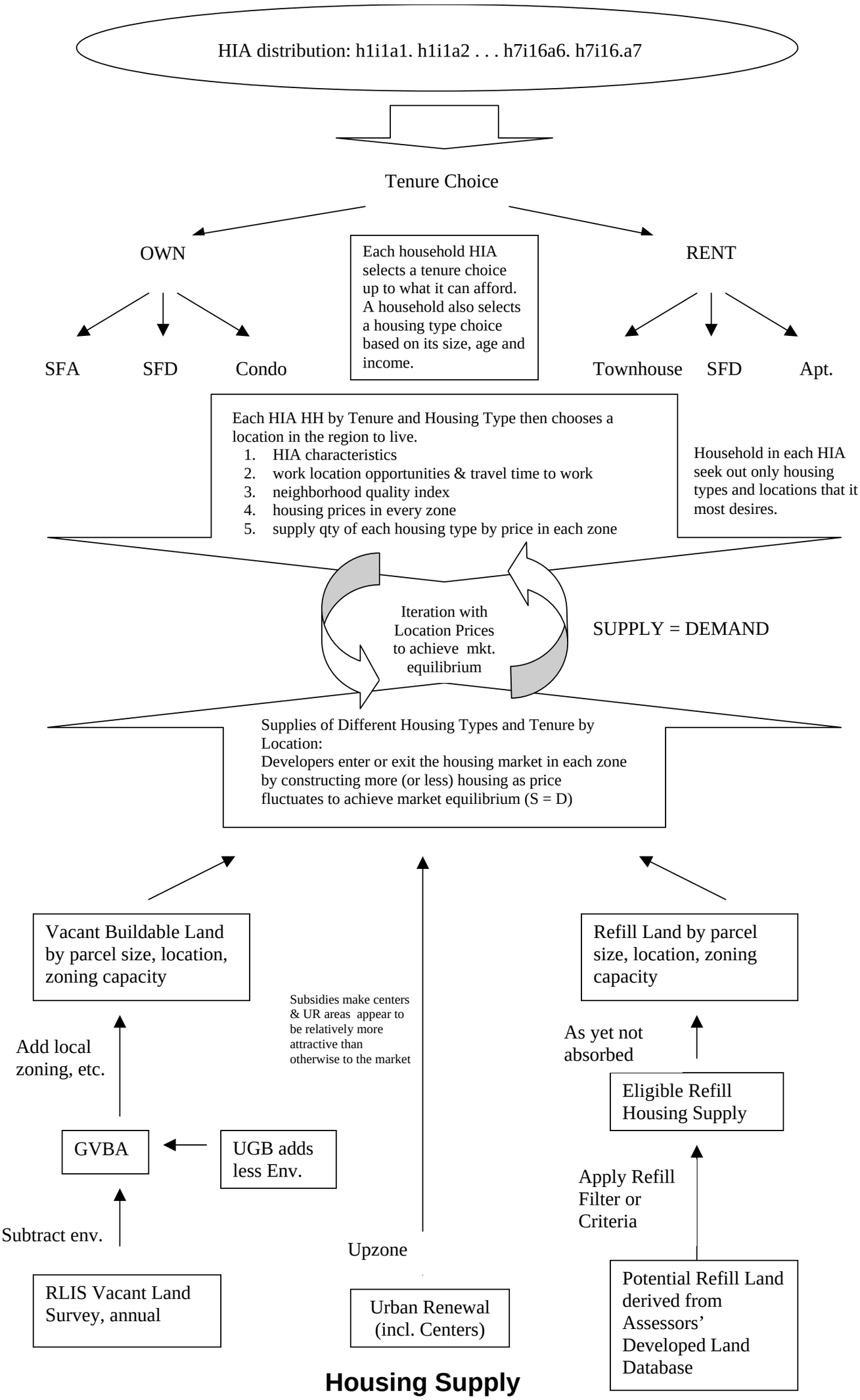
Supply Calculations:
Both vacant land and refill land are considered in the supply. Zoning determines the legal allowable density (while current densities are given as the initial starting values). More real estate construction comes online in future years subject to price, density as result of price fluctuations, and more redevelopment and infill may become available as price points for potential refill land are realized with the aforementioned price changes.

How much real estate gets constructed during the forecast is also dependent upon a cost of construction function. As prices increase (or decrease) the amount of construction will rise and fall accordingly. In addition zoning also dictates what kinds of nonresidential structures can be built. For example, if the zoning only allows industrial buildings, only industrial real estate types get constructed in that zone.

However, the choice or propensity of employment types that can locate in these real estate can be shifted though this substitution is generally inelastic and the density change is also inelastic. In other words, each SIC has a proclivity towards a certain type of building (6 are used in Metroscope), but this supply of real estate by type does not strictly limit itself to just industrial or just retail for example. The supply is flexible and can be accommodated by redevelopment and/or infill to meet the projected demand.

Finally, location choice is also tied-in with housing choice. Workers will tend to choose employment closer to where they already live given equal choices. Therefore transportation accessibility among zones is also factored into the function for location choice.

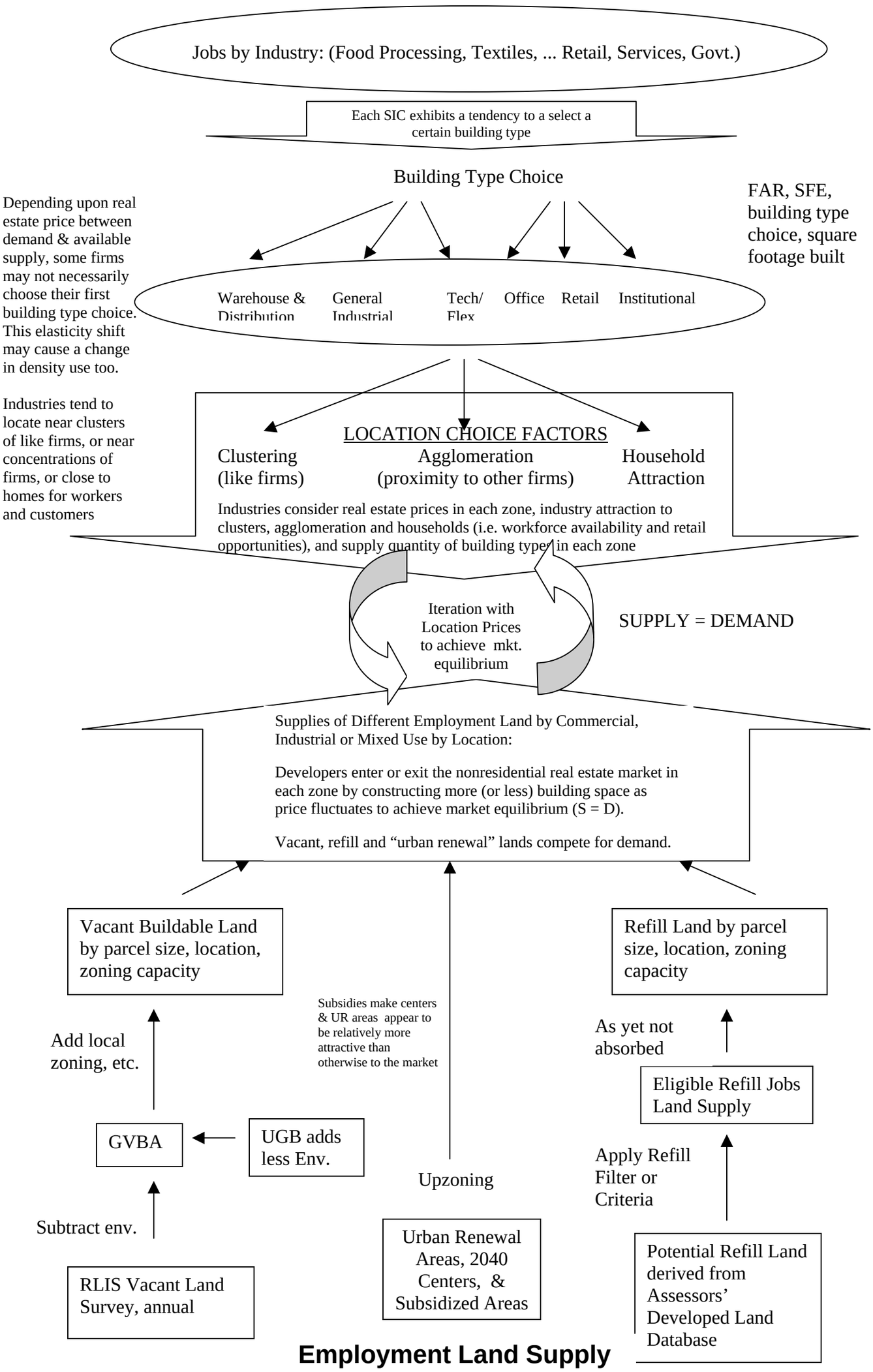
METROSCOPE RESIDENTIAL MODEL
Housing Choice Demand



Housing Supply

METROSCOPE NON-RESIDENTIAL MODEL

Employment Real Estate Demand



Employment Land Supply

Metro Data Resource Center, Richard Bolen, Division Manager
Oversees GIS, forecasting, and research division for Metro.

Metroscope Program Author/Developer: Sonny Conder, Principal Regional Planner
Primarily responsible for research and development of the Metroscope land use model, refill study and database, and principal investigator of Metro land use studies.

Metroscope Software Developer: Jim Cser, Assistant Regional Planner
Primarily responsible for software development, coding and day-to-day operations of the Metroscope model.

Regional Land Information System Data Manager: Carol Hall
Primarily responsible for managing the RLIS land use database, vacant land inventory, and providing raw inputs to Metroscope's supply/capacity database.

Transportation Demand Forecasting: Dick Walker, Travel Forecasting Division Manager
Oversees transportation modeling, forecasting and travel demand studies.

Regional Macro-economic Model Developer: Dennis Yee, Chief Economist
Primarily responsible for development, maintenance and operations of the regional macro-economic model. Oversees the Metroscope program.