

The Infill Puzzle

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today

A Model of Structure Density with FAR Multipliers

Consider a developer with a lot of land size L . The allowable buildable area is governed by a neighborhood-specific Floor Area Ratio (FAR) F_j . The developer chooses between building a single-family dwelling (SFD) or an infill project (e.g., a duplex).

Let $m_j \geq 1$ be a policy parameter representing the FAR “multiplier” or “bump” granted to infill projects.

The resulting structure sizes are: - **SFD Size:** $S_{SFD} = LF_j$ - **Total Infill Size:** $S_{TotalInf} = LF_j m_j$ - **Individual Infill Unit Size ($n = 2$):** $S_{unit} = \frac{LF_j m_j}{2}$

The market price function for square footage in neighbourhood j remains:

$$V_j(S) = \alpha_j S + \frac{1}{2} \beta_j S^2$$

where $\beta_j < 0$ represents the concavity of the price-space relationship.

The Infill Condition

The developer chooses Infill if the revenue gain exceeds the additional construction costs C :

$$2 \cdot V_j\left(\frac{LF_j m_j}{2}\right) - V_j(LF_j) > C$$

Substituting the price function:

$$2 \left[\alpha_j \left(\frac{LF_j m_j}{2} \right) + \frac{1}{2} \beta_j \left(\frac{LF_j m_j}{2} \right)^2 \right] - \left[\alpha_j (LF_j) + \frac{1}{2} \beta_j (LF_j)^2 \right] > C$$

Expanding and rearranging:

$$\alpha_j LF_j (m_j - 1) + \beta_j (LF_j)^2 \left[\frac{1}{4} m_j^2 - \frac{1}{2} \right] > C$$

Implications

Case 1: FSR Neutrality ($m_j = 1$) When the regulator provides no additional floor area for density, the condition simplifies to:

$$-\frac{1}{4}\beta_j(LF_j)^2 > C$$

As previously noted, in this regime, the price level α_j drops out. Infill is driven strictly by the concavity β_j . In wealthy areas where demand for volume is linear ($\beta_j \rightarrow 0$), infill is economically impossible regardless of how high land prices (α_j) are.

Case 2: The Density Bonus ($m_j > 1$) When an FAR bump is introduced, the price level α_j becomes a primary driver of infill. Because $m_j - 1 > 0$, higher land values (α_j) scale the incentive to densify.

Proposition: In the absence of a significant FAR bonus ($m_j \approx 1$), the “Infill Puzzle” is explained by the luxury of linearity: wealthy buyers’ willingness to pay a constant PPSF for large volumes removes the “Slicing Premium” necessary to offset multi-unit construction costs. Infill thus gravitates toward middle-market neighborhoods where budget constraints induce the necessary concavity.

4. US Expansion: ATTOM Field Strategy (scripts/02_attom_us_cities.R)

Using **ATTOM** to get the “Slope” for Portland/Minneapolis.

Key ATTOM Fields: * **PropertyAddressFull:** To extract Postal/Zip. * **SalesPriceAmount:** Your Y variable. * **AreaBuilding:** Your X variable (Living SqFt). * **PropertyTypeAddress:** Filter for 1001 (Single Family).

```
“r library(data.table) library(fixest)
```

1. Load ATTOM Sales

```
dtAttom <- fread(“data/raw/attom_portland_sales.csv”)
```

2. Extract Price per SqFt

```
dtAttom[, ppsf := SalesPriceAmount / AreaBuilding]
```

3. Clean

```
dtAttom <- dtAttom[AreaBuilding > 500 & SalesPriceAmount > 100000]
```

4. Extract Census Tract (if not in data, use Zip or Spatial Join)

If using Zip:

```
m_slopes <- feols(ppsf ~ AreaBuilding | ZipCode, data = dtAttom)
```

5. Extract the ‘estimate’ (The Concavity Signal)

```
dtSlopes <- as.data.table(broom::tidy(m_slopes)) dtSlopes <- dtSlopes[grepl("AreaBuilding",  
term)] dtSlopes[, geo_id := gsub("ZipCode:", "", term)]
```

6. Merge with Portland Permits

PORTLAND: ‘Building Permits Issued’ via ArcGIS Hub

```
dtPermits <- fread("data/raw/portland_permits.csv") # Look for ‘New’ and ‘Duplex’ in  
description dtPermits[, isInfill := grepl("Duplex|Triplex", Description, ignore.case=T)]
```