# Appraisal Adjustment Method Details

This document explains in detail how Synapse by Spark works. Synapse is a tool that quickly and accurately calculates results based on the data the appraiser uploads and their preferences for calculations. The appraiser can see all of those results and then either utilize those results or other methods of their own to form an opinion on a particular adjustment. Synapse **does not** tell the appraiser what to adjust for but simply performs the calculations and presents those results to the appraiser for them to form an opinion of their own.

## 1) Transactional Adjustments

Transactional adjustments are those that are based on a feature of the transaction (rather than a feature of the property). For example, was it arm's length? Was it a distressed sale? Was it cash equivalent? Were there seller concessions involved and what were the property rights transferred (fee simple, leasehold, etc). In order to obtain accurate adjustments, these must be adjusted for in a specific order and once these are all accounted for then (and only then) are the other adjustments (for property features) calculated. See The Appraisal of Real Estate (14th Edition) and Valuation by Comparison: Residential Analysis and Logic.

Synapse allows these transactional adjustments to be accounted for prior to feature adjustments. The following are the Transactional Adjustments that Synapse will allow the appraiser to calculate and adjust for prior to calculating the "property feature" adjustments.

1. **Property Rights:** Property Rights are accounted for prior to all other adjustments. Synapse can automatically remove any properties with Leasehold financing prior to calculating all other items. Later, Synapse will provide calculated results on Leasehold properties which may help form an opinion on the adjustment for Leasehold versus Fee Simple properties.
2. **Financing Terms:** Financing Terms are accounted for second. Synapse can automatically remove any properties with non-Cash Equivalent financing from future calculations as they can skew the adjustment results. Later, Synapse will provide calculated results on those non-cash equivalent financing properties which can assist in forming an opinion on the adjustment for various different financing types, if needed. It also allows you to define which types of financing are non-cash equivalent.
3. **Conditions of Sale - Distressed Sales:** Distressed Sales fall under the Conditions of Sale category as a Transactional Adjustment and are accounted for third. Synapse can automatically remove all REO and/or Short Sale properties from calculations as they can adversely affect the results. Later, Synapse will provide results to assist in forming an opinion on an adjustment for REO and/or Short Sale properties.
4. **Conditions of Sale - Seller Concessions:** Seller Concessions also fall under the Conditions of Sale category of Transactional Adjustments (although some appraisers consider them to fall under Financing Terms but both are legitimate) and are accounted for fourth. Synapse can automatically adjust for seller concessions by deducting the amount of the seller concession from the sale price for each individual sale.

5. **Market Condition (aka Time):** Market Condition (time) adjustments are accounted for last among the transactional adjustments. Synapse automatically adjusts for time based on the Contract Date but this can be modified to use Sale Date. Synapse performs multiple analyses on the sale prices over time to determine the trend line that best fits the data (e.g. Polynomial-4, Polynomial-3, Polynomial-2, Linear, Logarithmic). It will then apply time adjustments based on the formula for that line to adjust all sales to the effective date. NOTE: The polynomial option requires 10 properties per inflection point. Polynomial-4 has 3 inflection points so it can only be utilized if there are 30+ sales. ALTERNATIVELY, the appraiser can manually select whichever trend line they prefer from the drop-down in the Detail section. Last, they can also choose to type their own adjustment (e.g. 1% per month).

## 2) Property Feature Adjustments

The appraiser can calculate results for as many or as few adjustments as they would like and do that based on any of the available adjustment methods (see below). The appraiser can also calculate these results on multiple datasets and even refine those datasets by filtering them to only include properties that meet certain criteria.

Once the results are visible, the appraiser can exclude results that are so low or high that they are not reasonable. These excluded results are the results that the appraiser does not want to place any weight or consideration on when determining the adjustment for a feature.

**Model:** When the appraiser selects an adjustment for a particular property they can elect to model that adjustment to other adjustment analyses that have not yet been determined. This will allow the appraiser to essentially adjust the sales prices of each sale to the subject property based on the adjustment they determined. So, if the lot size adjustment is determined and then modeled, then other adjustment features that are modeled based on that lot size adjustment will have their calculations revised to reflect the adjusted sale prices.

-For example, if the appraiser determines the lot size adjustment to be $3/sqft, then the appraiser can have other features recalculated assuming that lot size adjustment of $3/sqft so that all analyzed properties will have essentially equal (normalized) lot sizes.

-The appraiser can include or exclude any analyzed features from Modeling to see how modeling impacts certain features. The features that are modified based on modeling will be noted for the appraiser both in Synapse and in the digital workfile.

-In addition, modeling does impact the number of Pairs for the Paired Sales Analysis (e.g. when GLA is modeled, it is no longer a feature that “differs” so potentially many more properties can be a match). In order to analyze only true matched pairs (not the added matched pairs from modeling) there is an adjustment method called True Paired Sales which only uses true matched pairs even after modeling, regardless of whether modeling would have added more “matches”. Adjusted Paired Sales allows for the additional (non-true) matched pairs to be analyzed.

## Adjustment Methods

**Allocation:** For the allocation method, the appraiser can choose what percentage of the total sales price of a property they want to apply to any particular feature a certain percentage of the sale price of a property is allocated to each feature. Based on that allocation, the result for each property analyzed is calculated and then the median and/or average of those is determined and that is the potential adjustment for the feature analyzed, based on allocation.

- Example: Sale price is $400,000, GLA is 3,000 square feet, and GLA percentage is set to 35%.

  $400,000 * 35% = $140,000
  $140,000 / 3,000 sqft = **$47/sqft** (rounded) potential GLA Adjustment

**Grouped Data (aka Grouped Matched Pairs):** This method involves grouping the data (sales) into two categories based on the feature being measured. The average or median price of the first group is compared to the average or median price of the second. The difference in those two prices is the potential adjustment for the feature being measured.

- Example: Median sale price of properties with swimming pools is $400,000 and the median sale price of properties without swimming pools is $380,000.

  $400,000 - $380,000 = **$20,000** potential swimming pool adjustment
- Example: Average sale price of properties with GLA between 1,800sqft and 2,000sqft is $200,000 and the average GLA is 1,892sqft, and the average sale price of properties with GLA between 2,000sqft and 2,200sqft is $215,000 and the average GLA is 2,120.

  Price Difference: $215,000 - $200,000 = $15,000
  GLA Difference: 2,120sqft - 1,892sqft = 228sqft
  $20,000 / 228sqft = **$66/sqft** potential GLA adjustment

**Paired Sales (True):** A method of comparing two properties that are considered to be the same in all features except for one. In theory, the difference in the sales price of each property is an approximation of the value difference (or adjustment) for the one feature in which the properties differ. For this analysis, all properties that were analyzed are compared against each other to find all "pairs" and then the average and median of the results of all of those pairs is found.

- Example: Property A: $300,000 | GLA: 2,500sqft

  Property B: $310,000 | GLA: 2,600sqft
  Property C: $305,000 | GLA: 2,500sqft

  Pair 1 (A & B): ($310,000 - $300,000) / (2,600sqft - 2,500sqft) => $100/sqft
  Pair 2 (A & C): ($305,000 - $300,000) / (2,500sqft - 2,500sqft) => $0/sqft
  Pair 3 (B & C): ($310,000 - $305,000) / (2,600sqft - 2,500sqft) => $50/sqft

  Average: ($100 + $0 + $50) / 3 = **$50/sqft** potential GLA adjustment

**NOTE:** The appraiser can choose to remove outliers based on the common statistical method which is: **1.5 * Interquartile Range**. This means that any result from a pair that is outside of that range is removed from the list of pairs results prior to calculating the average or median result. **Interquartile Range** is defined as the third quartile minus the first quartile of all pairs results.

**Paired Sales (Adjusted):** This is the same as True Paired Sales except that if a property differs in more than one feature (True Paired Sales requires that only one feature is different) and the appraiser is confident they can adjust for any of those differing methods so that the result is only one differing method this would allow for an "Adjusted Pair". Adjusted Pairs will nearly always have more data points since it allows for more than one differing feature (non-perfect matches).

- Example: Using the True Paired Sales example above but modeling bathrooms, now we have another property that is a pair. It had a different bath count but now that baths are modeled and the bath price was adjusted for, Property D is considered a pair.

  Property D: $295,000 | GLA: 2,400sqft
  Pair 4 (A & D): ($300,000 - $295,000) - (2,500sqft - 2,400sqft) => $50/sqft
  Pair 5 (B & D): ($310,000 - $295,000) - (2,600sqft - 2,400sqft) => $75/sqft
  Pair 6 (C & D): ($305,000 - $295,000) - (2,500sqft - 2,400sqft) => $100/sqft

  Average: ($100 + $0 + $50 + $50 + $75 + 100) / 6 = **$63/sqft** potential GLA adjustment

**Sensitivity Analysis:** This method is predicated on the theory that the best adjustment is the one that results in the smallest range of adjusted sales prices for all sales analyzed. It "plugs in" an adjustment and calculates what the sales price would be if that were the adjustment and it does that for every sale. Then it determines the range (difference between the low and high) of the adjusted sales prices. In Synapse, there is a setting to trim off the high and low amounts when determining the range to remove odd properties from spoiling the calculation. It repeats that process to test every possible adjustment. The adjustment that leads to the smallest range of adjusted prices is the final result.

- Example: Subject: 2,000sqft, Comp 1: $200,000 | GLA 2,075sqft, Comp 2: $185,000 | GLA: 1,900sqft, Comp 3: $206,000 | GLA 2,150 sqft

  **Test: $75/sqft**
  Comp 1: $200,000 - (2,075sqft - 2,000sqft) * $75/sqft) = $194,375
  Comp 2: $185,000 - (1,900sqft - 2,000sqft) * $75/sqft) = $192,500
  Comp 3: $200,000 - (2,075sqft - 2,000sqft) * $75/sqft) = $194,750 => **Range: $2,250**
  **Test: $80/sqft**
  Comp 1: $200,000 - (2,075sqft - 2,000sqft) * $80/sqft) = $194,000
  Comp 2: $185,000 - (1,900sqft - 2,000sqft) * $80/sqft) = $193,000
  Comp 3: $200,000 - (2,075sqft - 2,000sqft) * $80/sqft) = $194,000 => **Range: $1,000**
  **Test: $85/sqft**
  Comp 1: $200,000 - (2,075sqft - 2,000sqft) * $85/sqft) = $193,625
  Comp 2: $185,000 - (1,900sqft - 2,000sqft) * $85/sqft) = $193,500
  Comp 3: $200,000 - (2,075sqft - 2,000sqft) * $85/sqft) = $193,250 => **Range: $375**
  **Test: $90/sqft**
  Comp 1: $200,000 - (2,075sqft - 2,000sqft) * $90/sqft) = $193,250
  Comp 2: $185,000 - (1,900sqft - 2,000sqft) * $90/sqft) = $194,000
  Comp 3: $200,000 - (2,075sqft - 2,000sqft) * $90/sqft) = $192,500 => **Range: $1,500**

  Smallest range is $375 so **$85/sqft** is the potential GLA adjustment

**Depreciated Cost:** This method determines a potential adjustment by subtracting depreciation from the cost to build an improvement with the result being the value (adjustment) for the feature being measured. The difference between cost and value is depreciation so if the cost to build an improvement and the depreciation can be determined with relative accuracy then the result is the potential adjustment for that feature.

- Example #1: Dwelling physical depreciation is noted as 25% (e.g. effective age of 18 divided by 60 years economic lifespan), cost data shows the cost to build a full bath of the same quality is $12,000.

    $12,000 * 25% = $3,000 depreciation
    $12,000 - $3,000 = **$9,000** potential Full Bath Adjustment

- Example #2: Dwelling physical depreciation is noted as 30%, GLA is 3,000 square feet with Stepping set to 10% (meaning 2,700sqft and 3,300sqft properties were also analyzed), total cost to build 3,000 sqft dwelling is $307,350, total cost to build 2,700sqft dwelling is $278,316 and total cost to build 3,300sqft dwelling is $336,006. Synapse will also remove the cost of the kitchen (for GLA and Stories adjustments) in order to remove any effect they have on the cost results.

    Depreciate all 3 dwelling costs and remove kitchen costs:
    -3,000sqft dwelling = $307,350 * 30% (physical depreciation) => $92,205
        Kitchen for this quality is 11.5%: $307,350 * 11.5% => $35,345
        $307,350 - $92,205 (phys. depr.) - $35,345 (kitchen) = $179,800
    -2,700sqft dwelling = $278,316 * 30% => $83,495
        Kitchen for this quality is 11.5%: $278,316 * 11.5% => $32,006
        $278,316 - $83,495 (phys. depr.) - $32,006 (kitchen) = $162,815
    -3,300sqft dwelling = $336,006 * 30% => $100,802
        Kitchen for this quality is 11.5%: $336,006 * 11.5% => $38,641
        $336,006 - $100,802 (phys. depr.) - $38,641 (kitchen) = $196,563

    ($179,800 - $162,815) / 300 sqft (difference in size) = $56.62/sqft
    ($196,563 - $179,800) / 300 sqft (difference in size) = $55.88/sqft
    Average: ($56.62 + $55.88) / 2 = **$56/sqft** potential GLA adjustment (NOTE: this result would have been $67/sqft if the kitchen were not subtracted out).

The appraiser can also choose to apply a % Remaining Economic Life (REL) adjustment to more accurately reflect depreciation for certain items. For example, if a Covered Patio depreciates twice as fast an appraiser can apply a 50% REL adjustment. So, if the remaining economic life is 44 (with a lifespan of 60), that would be multiplied by 50% resulting in a REL of 22. This means that the effective age is modified to 38 (60 - 22). This results in a physical depreciation rate of 63% (38 / 60) so if the cost to build the patio is $6,000, then the depreciated cost (and potential adjustment) is $2,280 ($6,000 * 63%).

Last, an additional depreciation amount can also be applied to handle other types of depreciation which can be helpful for features like swimming pool. This can either be an additional percentage or an additional dollar amount that is simply subtracted from the result.

**Survey:** In this method, Synapse notes the adjustment that residential real estate appraisers are using for properties in the same area. Data will only be displayed if at least five appraisers have adjusted for the feature in question in that geographic area. Typically the average and/or median of those results is the potential adjustment based on the survey method.

- Example: Peer 1 says swimming pool would typically increase value by $11,000
  Peer 2 says swimming pool would typically increase value by $16,000
  Peer 3 says swimming pool would typically increase value by $10,000

  Average of peers = **$12,000** potential swimming pool adjustment (rounded)

**Simple Regression Methods Utilized**

**Ordinary Least Squares Regression (OLS):** Among the most common of all types of simple regression, this method minimizes the sum of the squares of the differences between a variable and it's predicted value (called the residual). One of the results of this regression method is the slope of a line that can be drawn through the data points. That slope is the potential adjustment based on this method.

Note: There are multiple ways to calculate the slope from OLS regression. The algebraic method utilizing standard deviation was utilized.

- Formulas/Steps: First, calculate the following formulas in order. The first is to get standard deviation $\sigma$ (for x and y), then z-score, and then the correlation coefficient *r*.

  $$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2} \qquad z = \frac{x-\mu}{\sigma} \qquad r = \frac{1}{N}\sum_{i=1}^{N} z_i^{x} z_i^{y}$$

  Now, calculate the slope (referred to as *a* or *m*) which is the potential adjustment:

  $$\mathrm{m} = r\left(\frac{\sigma_y}{\sigma_x}\right)$$

  Calculate b (what y is when x = 0):

  $$\mathrm{b} = \mu_y - (m * \mu_x)$$

- Squaring *r* results in what is known as $r^2$ which is a measure of how well the line determined by the above steps "fits" the datapoints. This number will be between 0 and 1 with 1 being a line where each datapoint lies on that line. It should be noted that a low $r^2$ DOES NOT mean that the slope of the line (the potential adjustment) is a poor measure of the adjustment.

**Theil-Sen Regression:** This simple regression method finds the slope of every possible line that can be drawn between every pair of data points if they were plotted on a chart. It then takes the median of all of the slopes of those lines and that is the potential adjustment based on this method. Since this method utilizes the median, it does reduce the impact of outliers on the data. NOTE: In Theil-Sen we use the Kendall rank correlation coefficient referred to as tau (**τ**) instead of the standard *r* correlation coefficient. We square that to get the equivalent of $r^2$ which is $\boldsymbol{\tau}^2$. In addition, there is no standard deviation for this type of regression.

Formula for **τ**: $\frac{2 * ((\textit{number of positive slopes}) - (\textit{number of negative slopes}))}{N * (N-1)}$

- Example: Property A: $200,000 | GLA 2,000 sqft, Property B: $210,000 | GLA 2,100 sqft, Property C: $195,000 | GLA 1,900 sqft.
  Line 1: Slope of A and B = ($210,000 - $200,000) / (2,100 sqft - 2,000 sqft) => $100/sqft
  Line 2: Slope of A and C = ($195,000 - $200,000) / (1,900 sqft - 2,000 sqft) => $50/sqft
  Line 3: Slope of B and C = ($195,000 - $210,000) / (1,900 sqft - 2,100 sqft) => $75/sqft
  The median of the slopes is $75 so the potential GLA adjustment is **$75/sqft**.

**Least Absolute Deviation (LAD):** This simple regression method determines every line that can be drawn between each pair of data points (similar to Theil-Sen). For each of those lines, the distance of the remaining data points to the line is calculated using the absolute value. All of those distances are then added up and the slope of the particular line that results in the smallest sum of absolute values for the residuals (deviation) is the potential adjustment result based on this method.
NOTE: Standard deviation and the correlation coefficient of *r* are calculated differently in LAD regression. For standard deviation we instead use Mean Absolute Deviation (formula below). For *r* we instead use the formula above in OLS for the slope but use slope and standard deviation to solve for *r*. See below for the associated formulas.

$$Mean\ Absolute\ Deviation = \frac{1}{N}\sum_{i=1}^{N} |\ x_i - \mu\ |$$

$$r = m * \frac{\sigma_x}{\sigma_y}$$

- Example using the above data from Theil-Sen:
  Line 1: 200,000 - (100 * 2,000) => 0
  Line 2: 200,000 - (50 * 2,000) => 100,000
  Line 3: 210,000 - (75 * 2,100) => 52,500

Calculate the sum of the absolute values of the remaining datapoints (in this example, there is only one additional datapoint).

Line 1: y = (100 * 1,900) + 0 => |190,000 - 195,000| = 5,000
Line 2: y = (50 * 2,100) + 100,000 => |205,000 - 210,000| = 5,000
Line 3: y = (75 * 2,000) + 52,500 => |202,500 - 200,000| = 2,500
The lowest sum of the absolute deviations is $2,500.
The slope of that line is $75 so the potential adjustment is **$75/sqft**.

**Least Median of Squares:** A form of simple regression that is very similar to OLS regression except that instead of taking the average of the squares of the residuals, this method utilizes the median of the squares of the residuals. As a result this method tends to be a bit more robust to outliers than OLS regression. Similar to OLS an outcome is the slope of a line that can be drawn through the data points. That slope is the potential adjustment based on this method.

- All formulas are the same as ordinary least squares regression except for the standard deviation formula which uses Median instead of Average:

$$\sigma = \sqrt{MEDIAN[(x_i - \mu)^2]}$$

**Robust Simple Regression:** If any of the above Simple Regression methods has the word "Robust" in front of it that means that during the calculations, when the average of all of the data points is subtracted from the data point in question, instead the median of all data points is subtracted from the data point in question. This tends to make a particular regression method somewhat more "robust" to outliers (meaning less impacted by outliers).

- In any of the formulas noted above substitute MEDIAN [x] for $\mu$.

**Modified Quantile Regression:** This is a modified type of Robust Least Squares regression where, instead of using the 50th percentile of the data (the median), multiple percentiles are tested to find the one that results in the best measure of fitness (the one with the highest $r^2$).

In this method Synapse will test 10% up to 90% (in increments of 10%) and use it in Robust Least Squares as $\mu$ (see the above Robust Simple Regression for clarification). After all nine tests are run, the results are analyzed and the slope (result) from the one that resulted in the highest $r^2$ is the final result.

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**Error:** It can be helpful to know how closely the result that is predicted from each method matches the actual data and Synapse aims to provide error scores to assist with that. There are also methods like standard deviation and $r^2$ that can be used (and will be provided), however, standard deviation measures only one variable against the average of that variable and $r^2$ is also not a result that can be calculated in Paired Sales and Sensitivity methods. Synapse will calculate error based on examining both variables (the feature being analyzed and the price) and the error score will work in all methods (except Depreciated Cost since that method does not examine real properties and sale prices).

**Mean Absolute Error (MAE)**: MAE essentially finds the average of the difference between the price and the predicted price (or result). Following is the basic formula, although it is calculated slightly differently in each category of methods. Lower error scores are better because it means that there was less variance (error) between the actual data and result.

Paired Sales Methods: MAE is determined on the actual pairs that were found. In this case, *x* is the sale price of each property and $\mu$ is the result from that paired sales analysis.

$$MAE = \frac{1}{N} * \sum_{i=1}^{N} |x_i - \mu|$$

Sensitivity: MAE uses the same formula as paired sales (immediately above), however, with sensitivity, $\mu$ is the average of all sale prices that have been adjusted to the subject based on the sensitivity result.

Regression Methods: MAE is calculated using residuals (the difference between the actual sale price and the predicted sale price) so *y* is the prediction and *x* is the true value.

$$MAE = \frac{1}{N} * \sum_{i=1}^{N} |y_i - x_i|$$

**Standard Error of the MAE**: The Standard Error of the MAE simply divides the MAE by the square root of the total number of properties in the dataset. NOTE: in the case of Paired Sales, it divides by the square root of the number of pairs.

If the MAE for Paired Sales is 1,000 for Dataset 1 and 1,200 for Dataset 2 this initially looks like the MAE is better for Dataset 1, however, if Dataset 1 has only 4 pairs and Dataset 2, has 25 pairs, it may mean that we should place more weight on Dataset 2 even though the error score is a bit higher. The same applies to other methods in the sense that an error result from regression, for example, on 10 datapoints may be less reliable than regression on 50 datapoints even if their MAE numbers are the same.

Here is the formula for the Standard Error of the Mean Absolute Error:

$$Standard\ Error\ of\ MAE = \frac{MAE}{\sqrt{N}}$$