REMI PI+ v2.4

User's Guide

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I. Introduction

This user's guide is intended to serve as a broad overview of the software interface of PI+ version 2.4. Contained within this document are descriptions and screenshots that map out the overall lay-out of the application and also highlight some of the specific functionality available in different areas of the product.

II. Overview of the Home Window

The main PI+ application window is the initial jumping off point for all analyses performed with the REMI model. This home window is the central location for creating and managing forecasts, changing general settings, making customizations, examining detailed information specific to your model regions, and finding in-software support material. There are six major sections to the home window, each accessible via tiles located on the left-hand side of the screen.

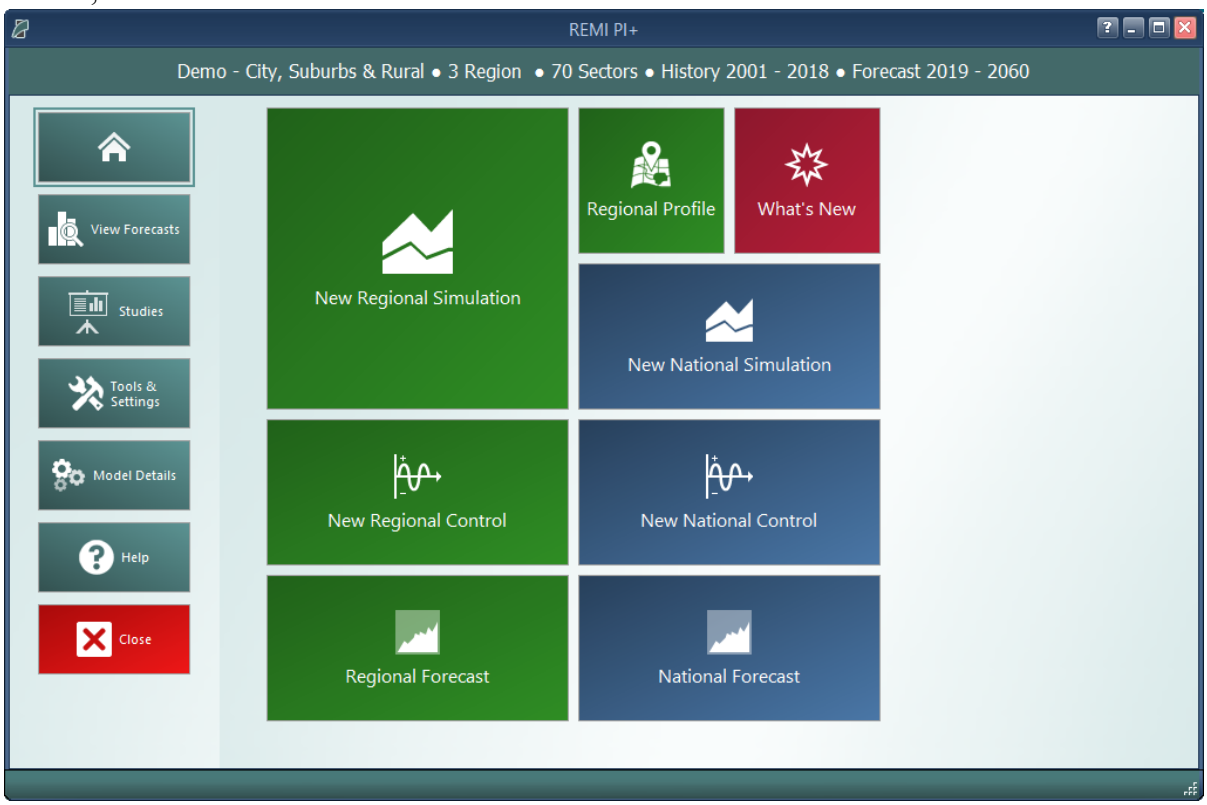


Figure 1: PI+ Home Window

Home Screen

The first section of the home window, which will be the first thing seen once PI+ has finished launching, is the home screen. The home screen's purpose is to provide quick and simple access points for starting your use of the REMI model to simulate policy change. By clicking on the appropriate tile, you are able to start creating any one of the four types of forecasts available in PI+: regional simulations, national simulations, regional controls, and national controls. In some cases, you may be prompted to choose a baseline for your new forecast from the Forecast List. Your new forecast will open in a separate window, called the Forecast Window.

If you are interested in exploring REMI's default control forecasts that form the basis of your model, you can dig directly into the data by clicking on the **Regional Forecast** or **National Forecast** tiles. The selected forecast will be opened in a special Forecast Window that shows only the Results section. Some specific tables, maps, and data visualizations have been specially chosen to display REMI's baseline forecasts and provide informative profiles of the national and regional economies.

Another way of examining baseline data and visualizing differences between your model regions is to visit the Regional Profile tool, also accessed from the home screen by clicking on the **Regional Profile** tile.

Regional Profile

The **Regional Profile** tool features a combination of a regional map with several tabs of tables and charts describing last-history-year data for major economic and demographic concepts for each region. This tool is useful for learning about the specific economic and demographic characteristics of your model regions. Many of the tables contain location quotients, which make it easy to identify unique regional attributes in comparison to national averages. Additionally, our newly updated map is capable of displaying an internet-based **OpenStreetMaps** layer using the **Map Layers** button, which could prove useful for investigating regional geography.

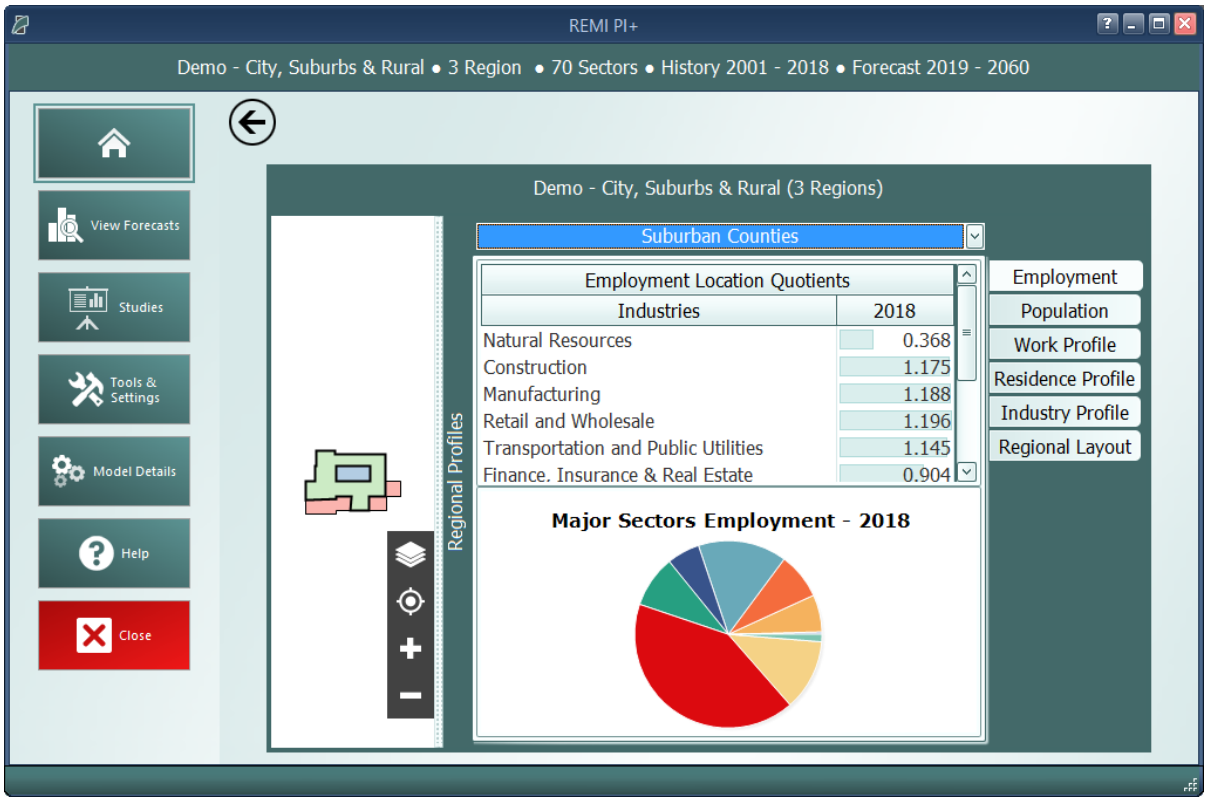


Figure 2: Regional Profile

What's New

The **What's New** tile will open up a new window to show a summary of the latest changes that have been made to PI+ so that you won't miss out on any new features when you get a new version.

Forecast List

The Forecast List, accessed by clicking on the **View Forecasts** tile, is the central location for everything to do with forecast management. The Forecast List will show every forecast you have created with the model. Forecasts are not opened automatically, so a large list of forecasts will not inherently cause any increased operating overhead for PI+. This also means that if a forecast file does get damaged it will not prevent viewing of other forecasts unless they were dependent on them as a Control.

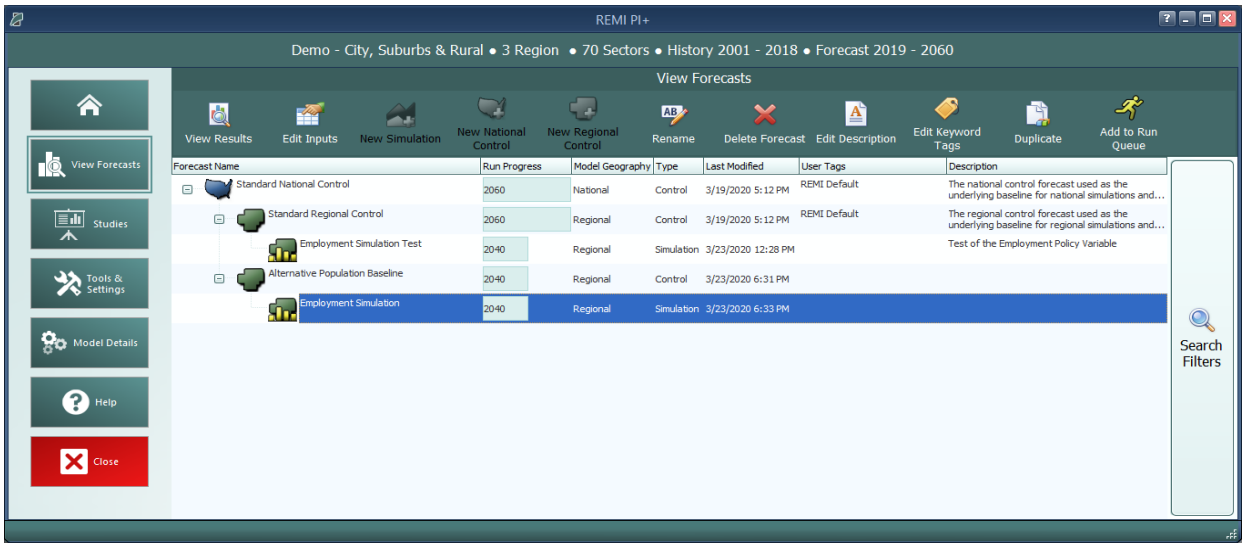


Figure 3: Forecast List

The Forecast List organizes forecasts in a tree structure. Each forecast appears underneath its parent baseline control, with the **Standard National Control** and **Standard Regional Control** at the top. Selecting a forecast in the list will activate buttons above the list depending on the forecast selected and what options are available to it. For control forecasts, buttons for creating new control or simulation forecasts will become active depending on the type of control forecast selected. All forecasts in the list can be opened for viewing in their respective Forecast Window. Depending on whether a forecast being opened already has been run, the Forecast Window will open to either the Inputs List or the Results section.

Other actions that can be taken for forecasts on the Forecast List are renaming, deleting, adding or editing a description, adding or editing keyword tags, and duplicating. Tags and descriptions are new features that should be useful for organizing your forecasts now that they are all contained in the same place. For further ease of use when the forecast list becomes long, there are search filters that can quickly hide all forecasts that you are not currently interested in seeing.

Add To Run Queue

Click on the **Add to Run Queue** button while a forecast is selected to add it to a queue of forecasts that will be run in order. This can be useful if you need to update several forecasts in a larger model that will take a long time without needing to attend to the model during the process. In **Figure 4** below you can see an example of this queue. When you have filled the queue, click the **Start Run** button.

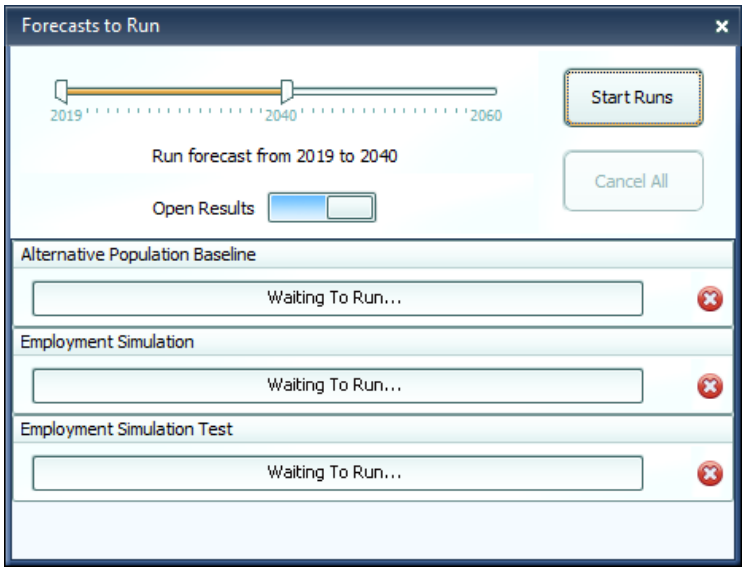


Figure 4: Add to Run Queue

Search Filters

Clicking on the right-hand **Search Filters** panel on the Forecast List pops open a set of useful options for filtering down the list of known forecasts. There are filters for viewing only national or regional forecasts, for hiding all simulations or all controls, for seeing only forecasts modified within a recent time period, for hiding study related forecasts, and lastly, an auto-complete search filter for retrieving forecasts with information matching the search terms.

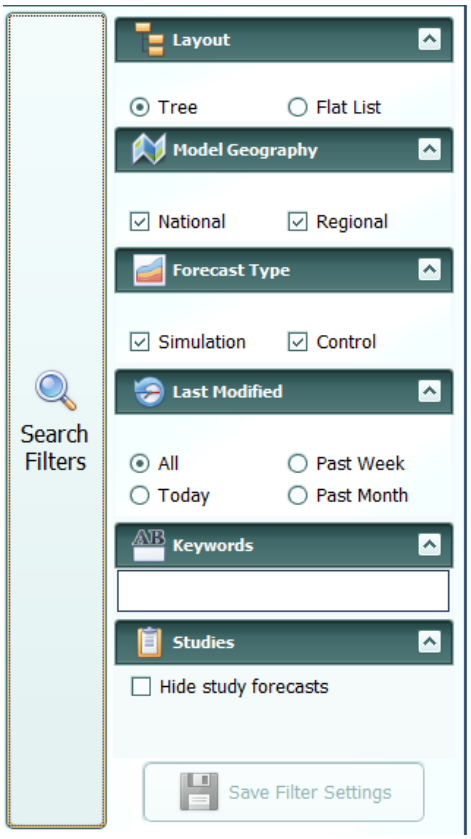


Figure 5: Search Filters

Studies

Studies are a feature designed to simplify certain projects that involve many forecasts and to provide special multiple-forecast result views. There are several study types (some product-specific), each of which requires different inputs and produces different results. Every type of study has a convenient interface for specifying the relevant inputs that will be used to create each of your forecasts, all in one place. The study editor also has a section for previewing what forecasts would be created based on your current set of inputs and allows for giving names to each not-yet-created forecast in advance. Once satisfied with the study's forecasts, you can run them all automatically, one after the next, and then view the unique results of the study. Every forecast created by a study is still a regular forecast that can be opened as normal to view its individual inputs and results.

Our goals with this feature are to facilitate the quick creation of large numbers of forecasts and to begin offering built-in sets of results that involve comparisons between forecasts. There is great potential for new types of studies with unique results in future versions, so make sure to tell REMI about other types of studies that would help you!

Study List

The study list can be found by clicking the **Studies** tile on the home window. Similar to the forecast list, the study list allows you to create new studies and manage your saved ones. Saved studies display their associated forecasts beneath them and these forecasts can be opened from the study list screen for convenience. Note that if you would like to keep your study-generated forecasts separate from your normal forecasts, there is a savable option on the main forecast list to hide all study-generated forecasts from view. The study list is shown below in **Figure 6**.

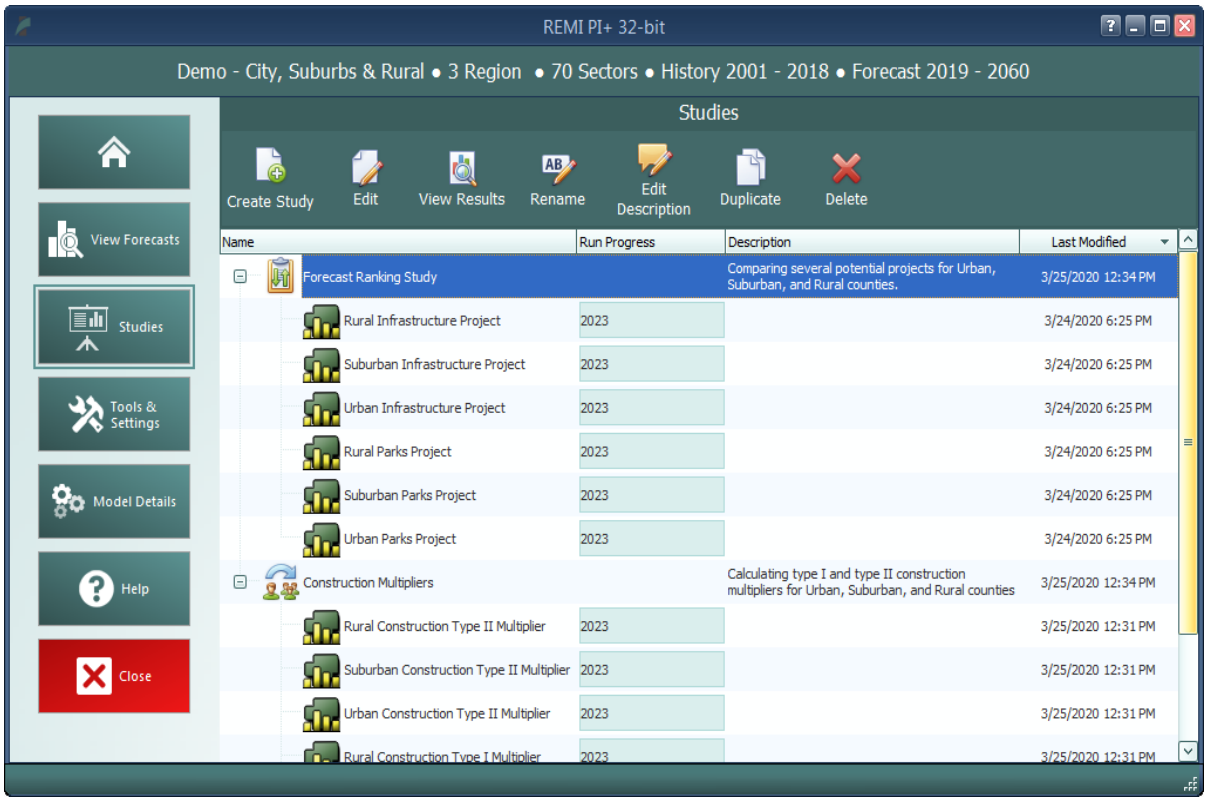


Figure 6: Studies List

Study Editor Window

The window used to create and edit studies is divided into three sections: **Inputs**, **Forecasts**, and **Results**. The inputs and results sections are unique to each type of study, so you will want to see the relevant sections for each type of study further down for more. Unlike the inputs and results sections, the forecasts section shown in **Figure 7** is largely the same for each study type. This tab hosts the study forecast list, which previews the forecasts to be created by the study (or shows created forecasts if the study has already run). The forecasts section also has an editor that is used to select the control forecast that all of the study's forecasts should use as a baseline and the **Run Study** button. Running a study will open a forecast run queue window, shown in **Figure 8**, similar to the one that can be accessed on the main forecast list of the home screen. Each forecast in the study will be run one after the next for the selected range of years. If a study has already been

run previously, then attempting to run again will first prompt you to choose whether the previous set of forecasts should be deleted entirely or just disconnected from the study.

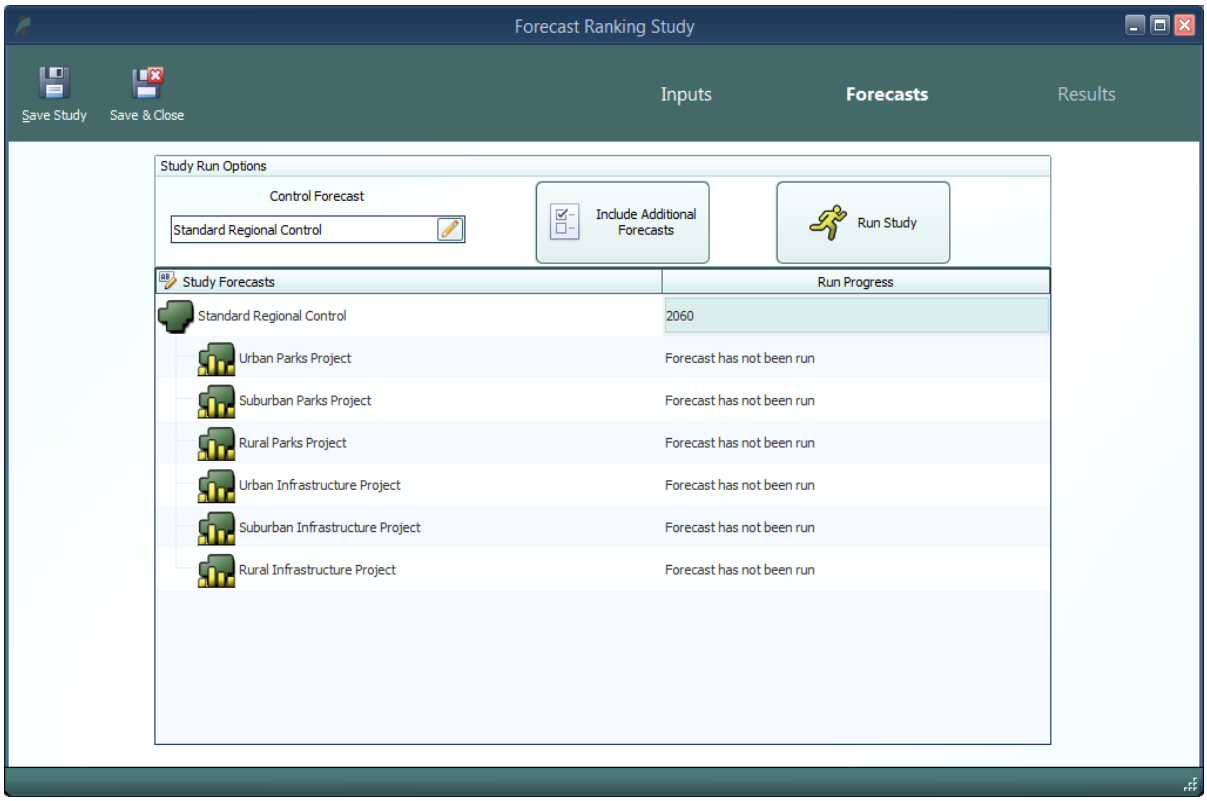


Figure 7: Forecast Ranking Forecasts

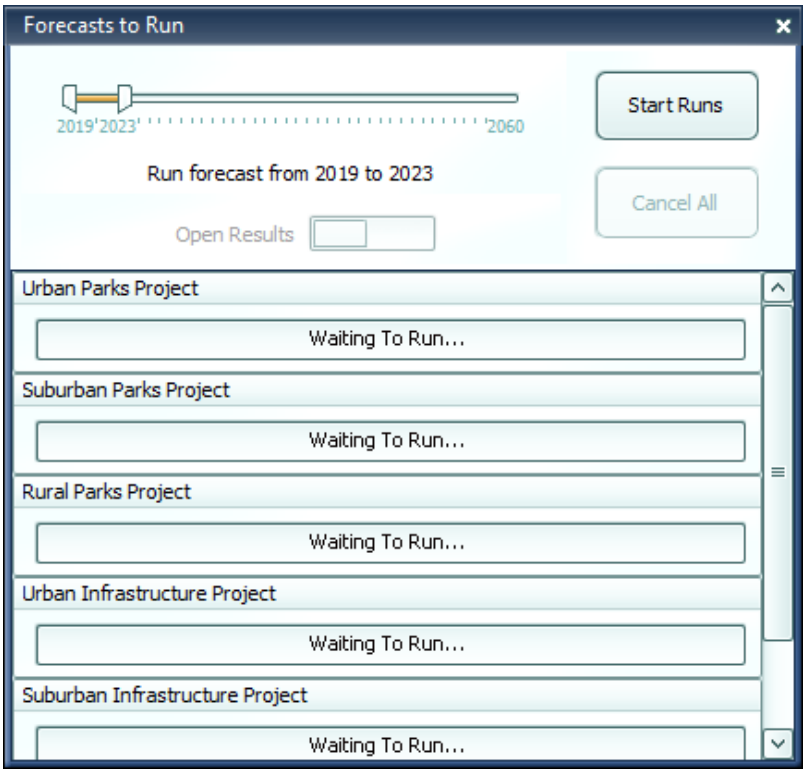


Figure 8: Forecast Queue

Forecast Ranking Study

Forecast ranking studies are the most flexible of our current study types. Their main purpose is to allow for scoring and ranking forecasts in a highly customizable way, based on both their model results and on outside data that you can associate with forecasts. However, this type of study is also the best to use for mass-creation of forecasts and generally comparing results for many forecasts at once.

Inputs

The first section of the forecast ranking study editor is the inputs list, as displayed in **Figure 9**. Policy variable inputs can be selected manually or imported from XML export files using the buttons at the top right. Multiple files can be imported simultaneously by multi-selecting on the file selection window. Each group of policy variables that are selected or imported will be listed as one item in the inputs list, labelled with a default name for the forecast that would be created using those inputs when the study is run. These default names can be edited so that when forecasts actually get created, they will already be named. To view policy variables themselves rather than just future forecast names, double click or use the **View** button on the right with an item selected. Note that, in order to edit any particular group of policy variables, you must first view the group and then click the edit button that appears in the grid. There are several other buttons on the right of the inputs list that perform manipulations of the selected policy variable lists, which might be useful in the process of constructing your inputs. You can select a contiguous range of input lists for

manipulation by clicking and dragging and you can select a non-contiguous range by clicking with Ctrl pressed. The **Duplicate** function might be useful if you would like to make second copies of selected would-be forecasts with slightly different input values. The **Merge** function will allow you to combine all of the inputs of many would-be forecasts into a single forecast. Inversely, the **Split** function breaks up the inputs list of each selected would-be forecast into many forecasts, each containing a single policy variable from the original list. By using these tools, it should be easier than ever to rapidly create large numbers of forecasts with your required policy variable inputs.

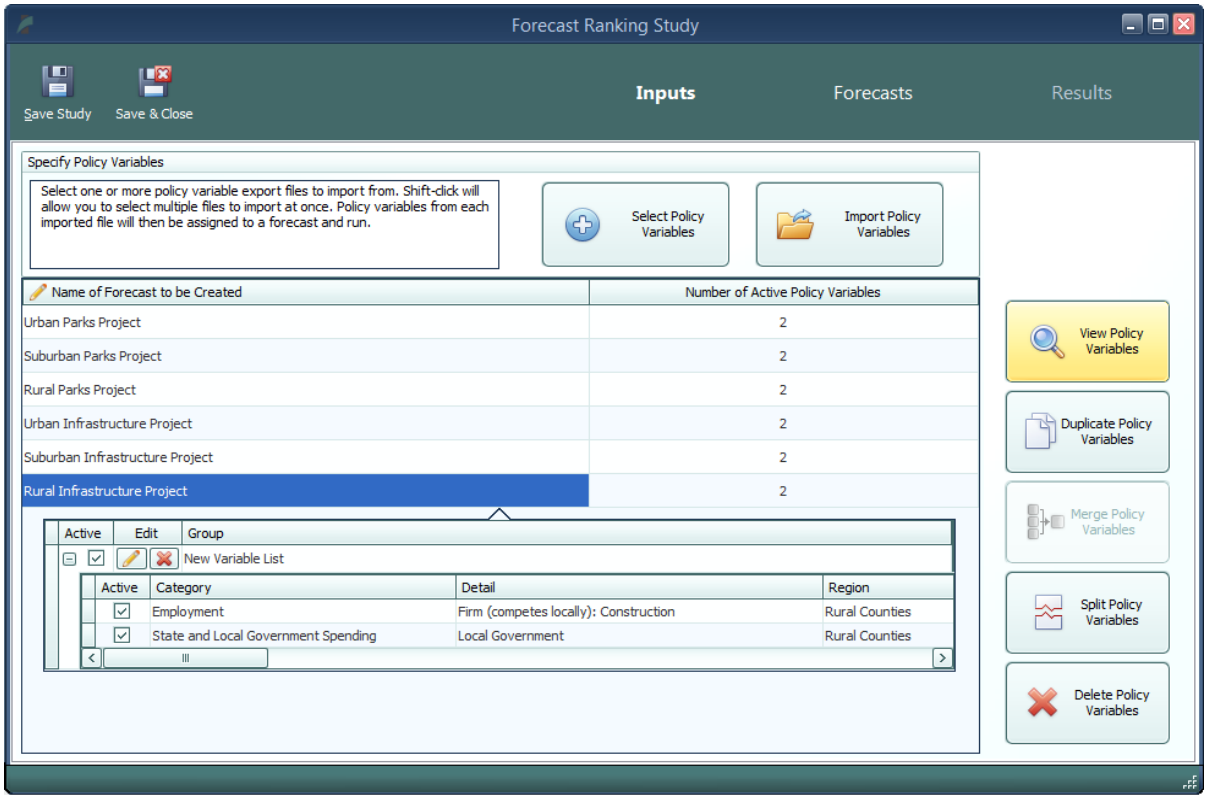


Figure 9: Forecast Ranking - Inputs

Forecasts

As mentioned above, the forecasts section of the study editor is largely the same for each study type. However, because forecast ranking studies have no particular requirements for what inputs belong in its forecasts, there is one special feature accessible only for this study type which allows you to instantly include additional, already-created forecasts in the study's results. Clicking the **Include Additional Forecasts** button will open a list of forecasts that have a matching baseline regional control and are therefore available to include. With this feature, you can view forecast ranking results without specifying any inputs or running the study if you'd prefer to create forecasts individually using the normal forecast window.

Results

Once the forecast ranking study has finished running all of its forecasts, you will be able to access the results section of the editor, as seen in **Figure 10**. The centerpiece of this results interface is the table of scores that displays scores by forecast for each of the currently active economic and attribute scores. The table also contains overall economic scores and overall attribute scores as well as final scores that determine the forecast rankings. On the left of the score table are several sets of controls that determine what is shown on the scoring table. The top group, labelled Forecast Scoring, allows you to create new economic and attribute scores, manage existing scores, and select which scores should be included in the current study's rankings. To learn more about the score editors that handle the creation of new economic and attribute scores, see the appropriate section further down. The Score Aggregation group determines whether scores are combined together using a simple summation or instead using a weighted average of normalized scores. If you elect to use the weighted averaging method, then weights for each active score will need to be entered using the **Edit Score Weights** button. The last group contains a useful option which switches the score grid to display forecast values rather than forecast scores. To see more information about how a score was calculated, you can hover over its selected cell to see an explanation of the score calculation. If you want to see extra detail about the result values that were used to calculate an economic score, press F1 with a cell selected or right click and choose **View Detailed Result** Values to pop open a results display containing the relevant economic results.

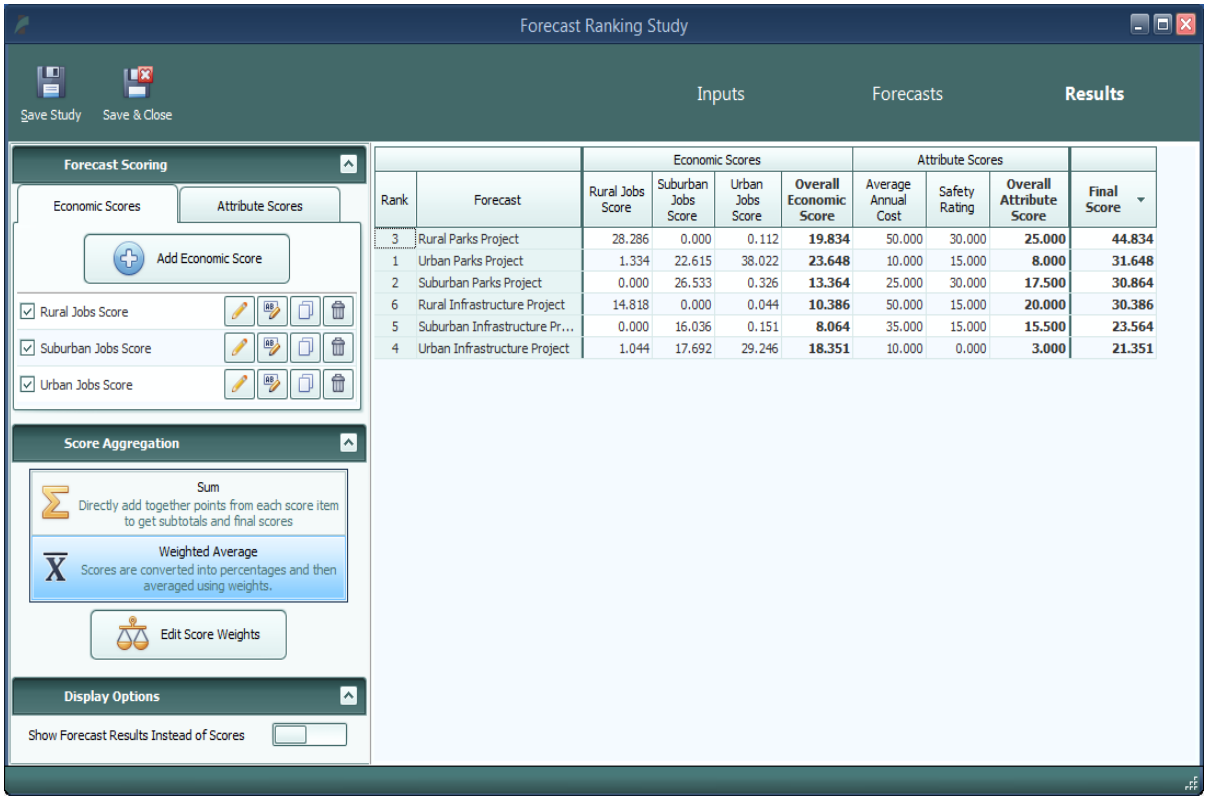


Figure 10: Forecast Ranking - Results

Economic Scores

In a forecast ranking study, economic scores are scores that are based on results from the REMI model. When you create a new economic score, you are able to choose what results the score should be based on and flexibly decide how those results should be translated into a score. The editor for creating an economic score, shown in **Figure 11**, is set up as a step-by-step guide through the process of customizing your score. As you make decisions about how the score should work, further options will be presented until the score is fully specified. Economic scores can be based on individual or aggregated regions and details, they can take into account customizable year ranges, and they can award points to forecasts by ranking, in proportion to result values, or by setting up result value ranges that correspond to scores. Regardless of how you set up your score, the final step of the guide will display a summary chart illustrating the relationship you have created between result values and awarded points.

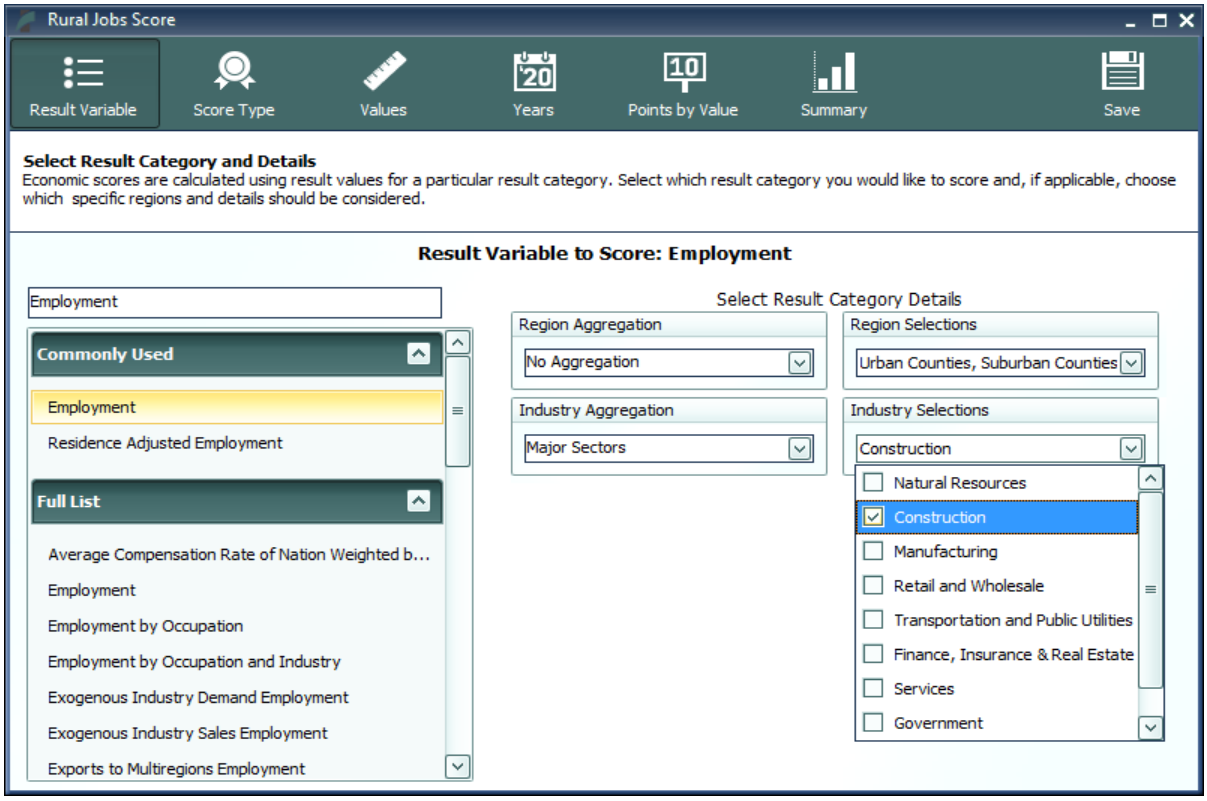


Figure 11: Economic Score

Attribute Scores

Unlike economic scores, attribute scores are not based on model results. Instead, the intention behind attribute scores is to allow you to incorporate extra data into your forecast rankings that is not part of the REMI model. Attribute scores can flexibly score both categorical and numeric data types and they share a similar guided editor to the economic score editor, depicted in **Figure 12**. Categorical data, an example of which might be safety ratings for construction projects, is specified by creating a number of categories that represent all possible values of the attribute and then assigning points to each value. With numerical data, such as a project cost, scores can be determined with the same set of options available to economic scores: by ranking, in proportion to

values, or by setting up value ranges that correspond to scores. Numerical scores also allow you to choose from a predefined list of unit labels that may apply to your attribute and also to add a custom unit label. The attribute score editor will show you a summary chart illustrating the relationship between your attribute's possible values and the points that would be awarded to a forecast with that value. The last step involved with editing an attribute score is to assign values for that attribute to study forecasts, so that the attribute can be incorporated into the forecast ranking study results.

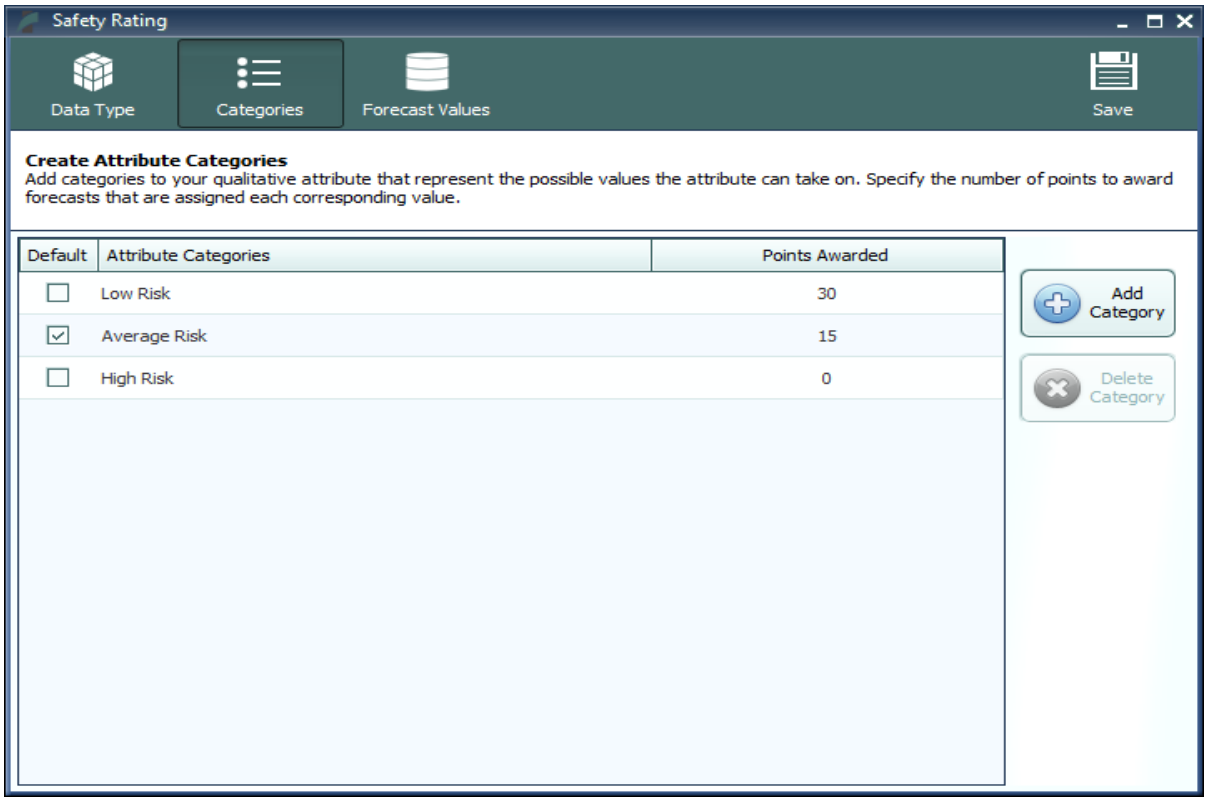


Figure 12: Attribute Score

Multiplier Study

The multiplier study automates the significant amount of work involved with properly calculating employment and output multipliers using the REMI model. Since each multiplier (representing a combination of industry and region) needs to be run as a single policy variable input to a separate forecast, calculating multipliers for multiple regions and industries was previously a time-consuming project. Our goal with this study type is to allow those who like to calculate multipliers to be able to do so quickly and easily.

Inputs

The first section of the multiplier study editor is the inputs list, as displayed in **Figure 13**. This study type has just one list of policy variable inputs that will be used to generate forecasts for the study. Each policy variable in the list must be one of a few specific types of policy variable that

can be used to calculate multipliers and must be associated with only one region and one industry. Inputs matching this description can be selected manually or imported from XML export files using the buttons at the top right. When the study is run, forecasts will be created using each individual policy variable in the inputs, since they each correspond to a multiplier that can be calculated. There are options at the top of the inputs section of the editor that allow you to decide whether multipliers should be calculated for just employment, just output, or both. Additionally, there are controls for selecting which of the three varieties of multipliers: **Type I**, **Type II**, and **Dynamic** should be calculated. Note that each multiplier type that is selected will require extra forecasts to be created, since each type is calculated using a different baseline control. More information about what these three types of multipliers represent and how they are calculated can be found in the "Calculating Multipliers with the REMI Model" documentation and also within the multiplier study inputs window by clicking the **About REMI Multipliers** button.

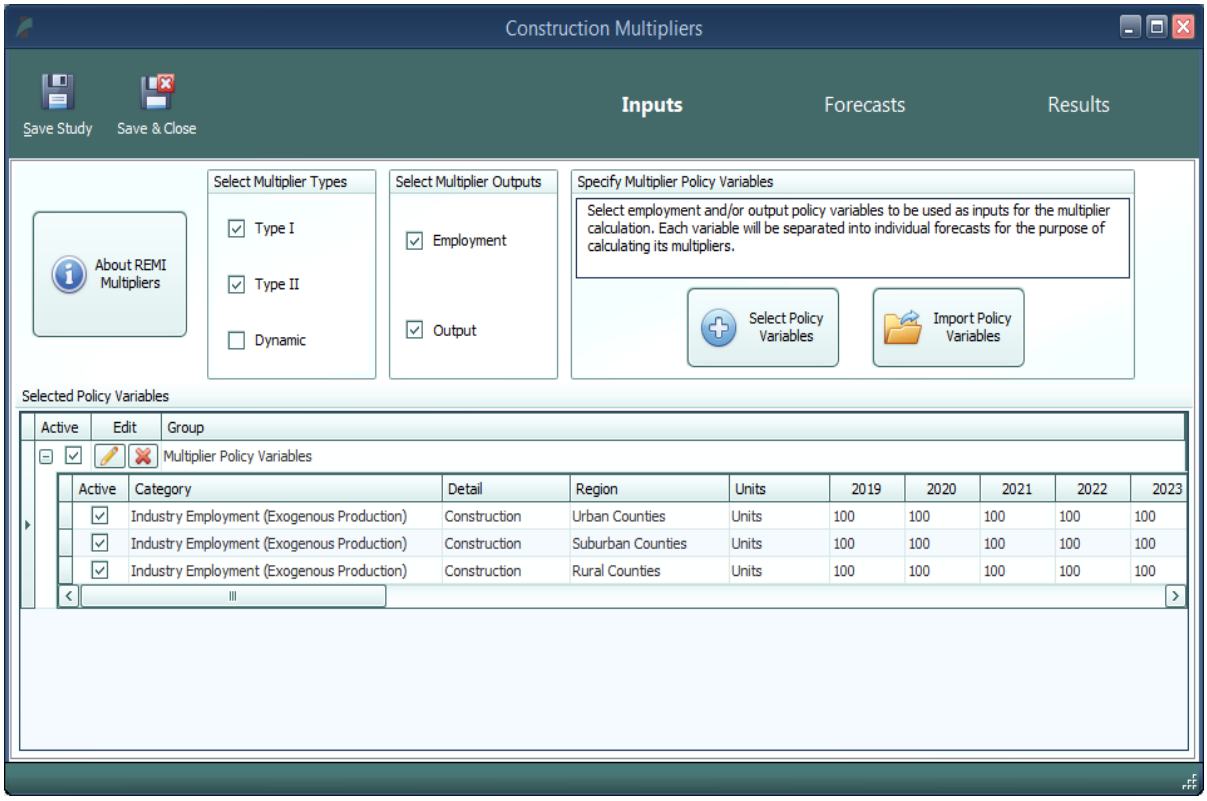
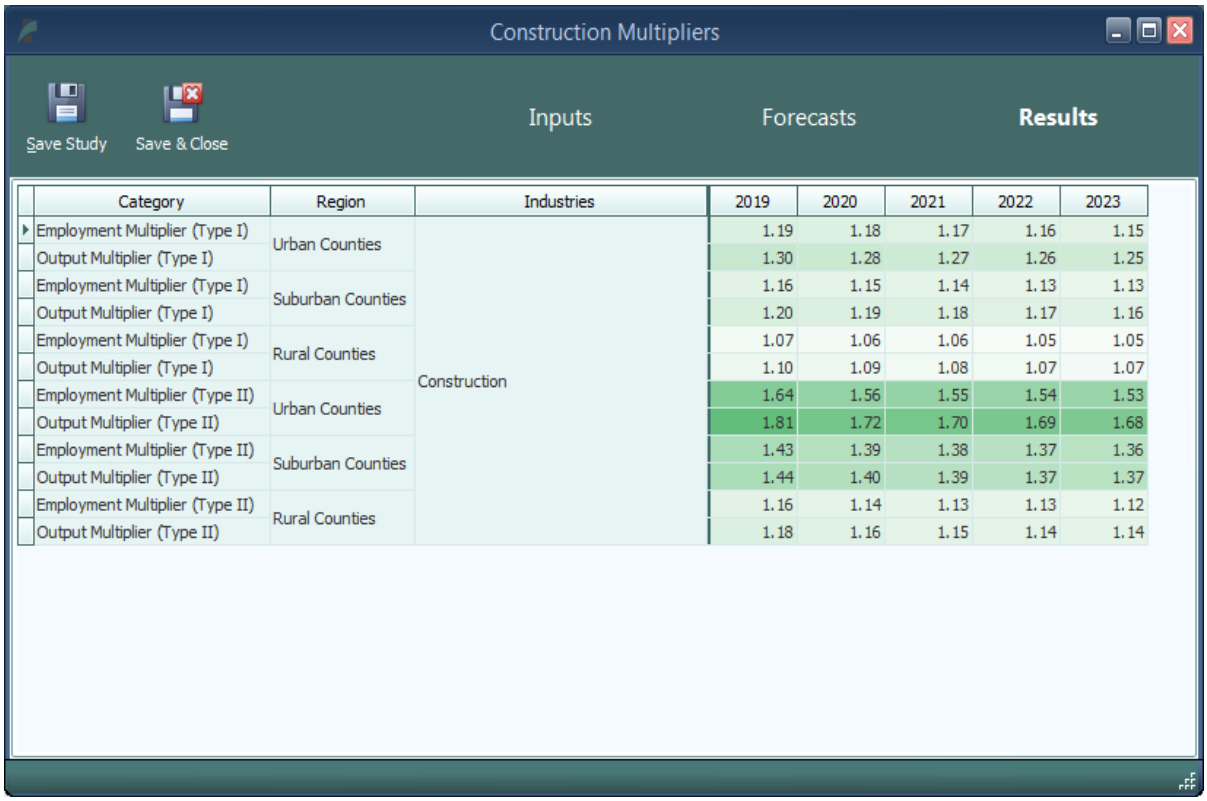


Figure 13: Multiplier Inputs

Results

The results section of the multiplier study is very straightforward, it is simply a table of multiplier values corresponding to the inputs and options that were specified for the study. See **Figure 14** for an example of what this results table might look like, with multipliers listed by type (e.g. Type I Employment Multiplier), region, industry, and year. There is conditional formatting applied to the results to help with visualizing magnitudes for large sets of multipliers.



Category	Region	Industries	2019	2020	2021	2022	2023
Employment Multiplier (Type I)	Urban Counties	Construction	1.19	1.18	1.17	1.16	1.15
Output Multiplier (Type I)			1.30	1.28	1.27	1.26	1.25
Employment Multiplier (Type I)	Suburban Counties		1.16	1.15	1.14	1.13	1.13
Output Multiplier (Type I)			1.20	1.19	1.18	1.17	1.16
Employment Multiplier (Type I)	Rural Counties		1.07	1.06	1.06	1.05	1.05
Output Multiplier (Type I)			1.10	1.09	1.08	1.07	1.07
Employment Multiplier (Type II)	Urban Counties		1.64	1.56	1.55	1.54	1.53
Output Multiplier (Type II)			1.81	1.72	1.70	1.69	1.68
Employment Multiplier (Type II)	Suburban Counties		1.43	1.39	1.38	1.37	1.36
Output Multiplier (Type II)			1.44	1.40	1.39	1.37	1.37
Employment Multiplier (Type II)	Rural Counties		1.16	1.14	1.13	1.13	1.12
Output Multiplier (Type II)			1.18	1.16	1.15	1.14	1.14

Figure 14: Multiplier Results

Tools & Settings

The Tools & Settings section of the main window contains, as the name suggests, several tools and settings that will useful for customizing PI+ and performing advanced tasks.

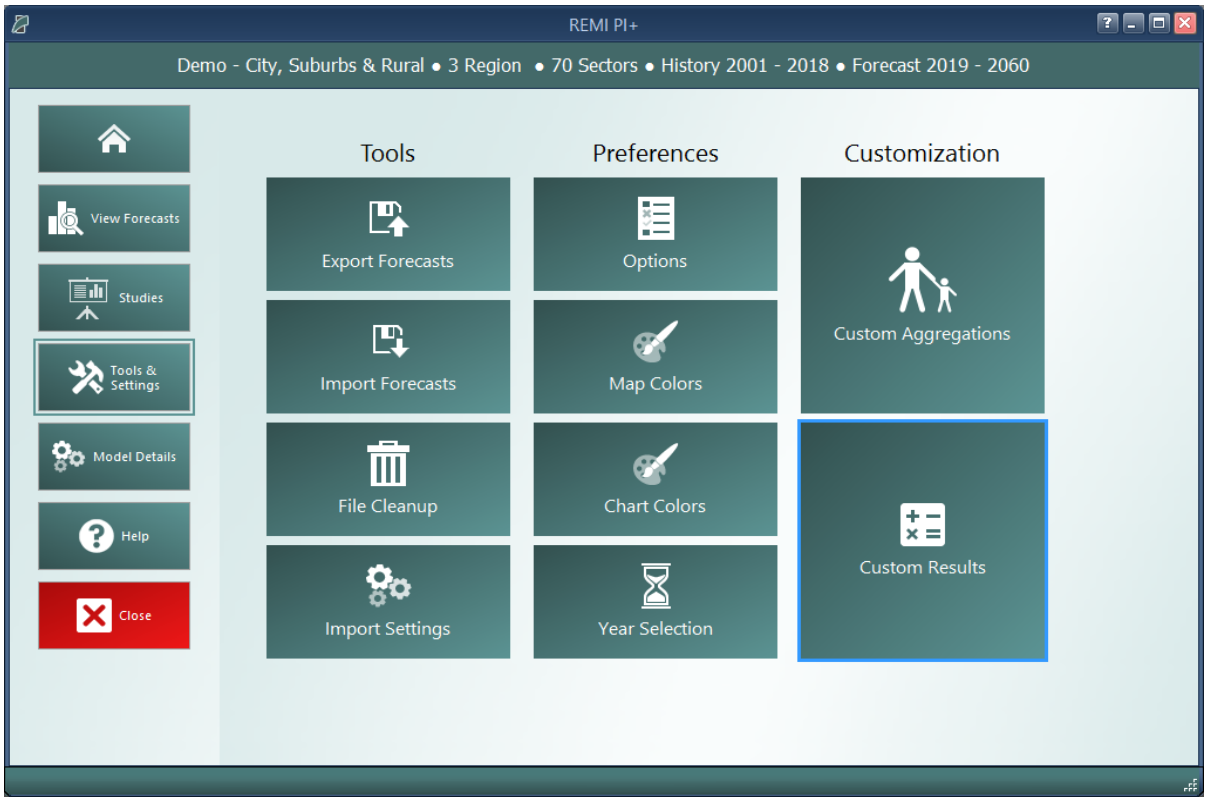


Figure 15: Tools & Settings

Exporting and Importing Forecasts

Perhaps most important among the various tools and settings available on the Tools & Settings screen are the forecast export and import features. Due to our new system of automatically managing forecast files, it is no longer possible to simply pass along a ".RWB" workbook file to other users or to REMI for support because a given installation of PI+ will not know about forecasts in files that it did not create itself. The solution to this is our new export and import features. The corresponding tiles are located under the **Tools** heading. The export feature will allow you to select any forecasts you want to share and package them up in a single file that can be imported by another user with the same PI+ model. Exported forecasts will be contained within a new ".FEX" file format. When selecting forecasts for export, be aware that any parent control forecasts are required to be exported as well and will be automatically checked off.

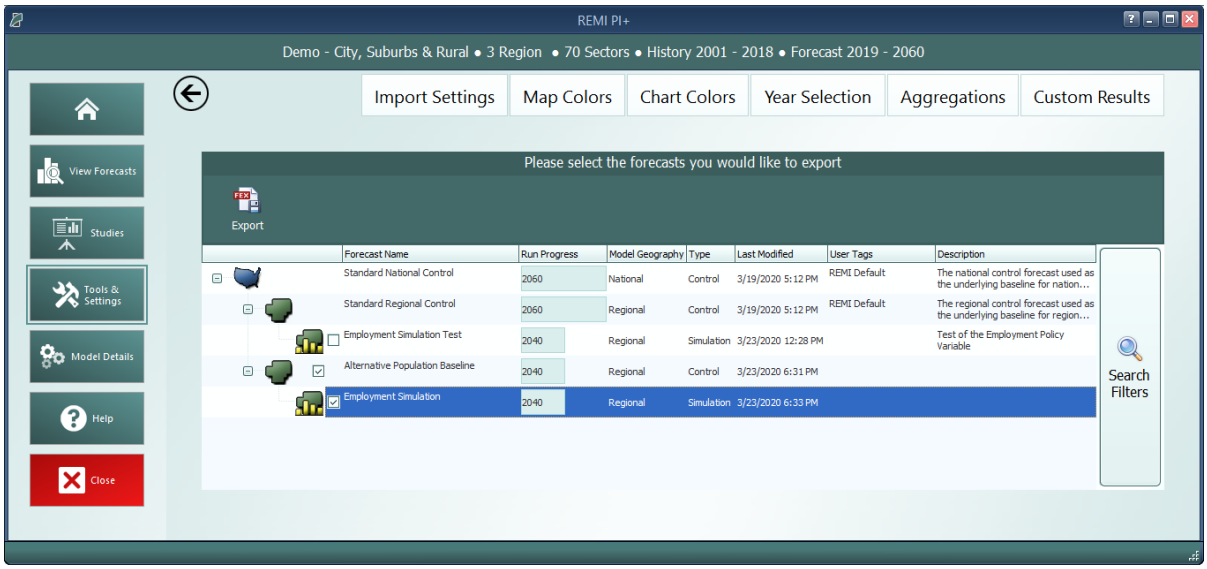


Figure 16: Forecast Export

File Cleanup

Another file management feature is the forecast backup file. Each time a forecast is saved, a backup file is created as well so that there is something to fall back on in case the file is corrupted or lost when it is next used. If you end up with too many backup files in the Workbooks sub-directory of your model folder or if you find that you would like to attempt to access a backup, you can use the File Cleanup feature. The File Cleanup dialog will determine how many forecast files exist that are unknown to PI+ as either backups, exports that have yet to be imported, or any other forecast files and allow you to deal with them by either deleting or importing them.

Options

The options menu consists of several minor settings. You can change the PI+ color scheme, select an alternative tile navigation design, decide whether exported files should automatically open, allow for PI+ to use the Internet to retrieve **OpenStreetMaps** data, supply a sound file for use as an indicator alert that PI+ has finished running a forecast, and select from several alternative industry labelling forms that include NAICS codes.

Map Colors

The map colors interface allows for selecting what colors the map should use when it displays results. To select your preferred color option, choose it from the gallery and click the **Save as Default** button. Custom colors ranges can be created by using the **Add New** button. Three-color ranges are offered for ease of viewing both positive and negative results on the same map while two-color ranges work better for black-and-white printing.

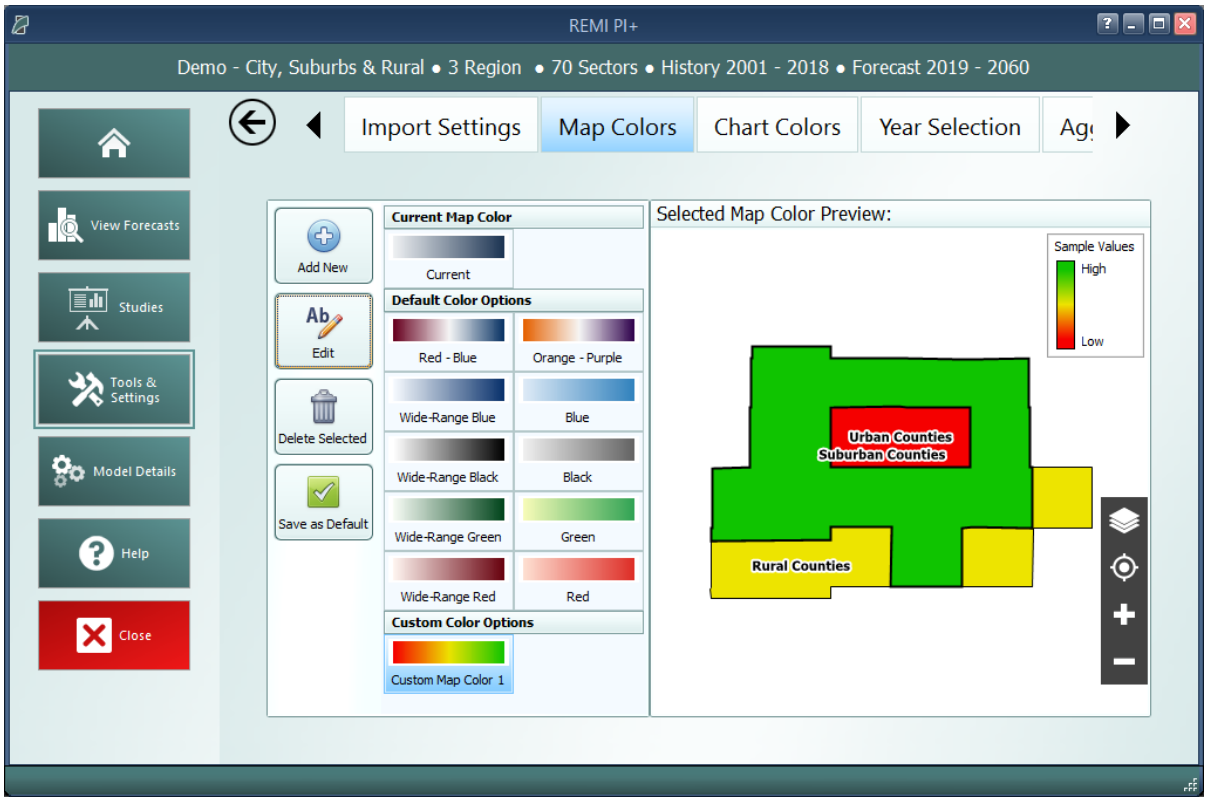


Figure 17: Map Colors

Chart Colors

Similar to map colors, the Chart Colors Selection screen allows for selecting the default palette to be used by the charts on the results. It also includes a tool for creating custom color palettes. Colors can be selected to add to a palette using a color selector tool or by entering RGB or HEX codes.

Year Selection

The Year Selection screen is used to build lists of years for use on the results. Saved year lists that you create can later be applied to result visualizations such that only the years included in the list are shown. This feature is useful if you are only interested in viewing certain years of results and would prefer to have a saved list rather than filtering the years shown by visualizations manually.

Import Manager

Use the Import Manager to import settings and preferences from other REMI models installed on your computer. You can either select from a list of installed models or import from a **REMI Settings File** (.rsf). If you choose to import from a REMI Settings File you will need to then click the **Select File to Import** button and choose the .rsf file to import. Once a file has been selected the remaining fields in this section will be filled out so you can see how the model the file came from compares to your current model.

Once a model has been selected, use the viewer on the bottom of the window to see what user settings from that model are available for import. If a tab is disabled, that means that there are no user settings from that model available for import. Certain settings may require additional settings to be imported to work properly, such as importing a favorite result table with custom result variables. The favorite result will not display the custom result if it is not also imported.

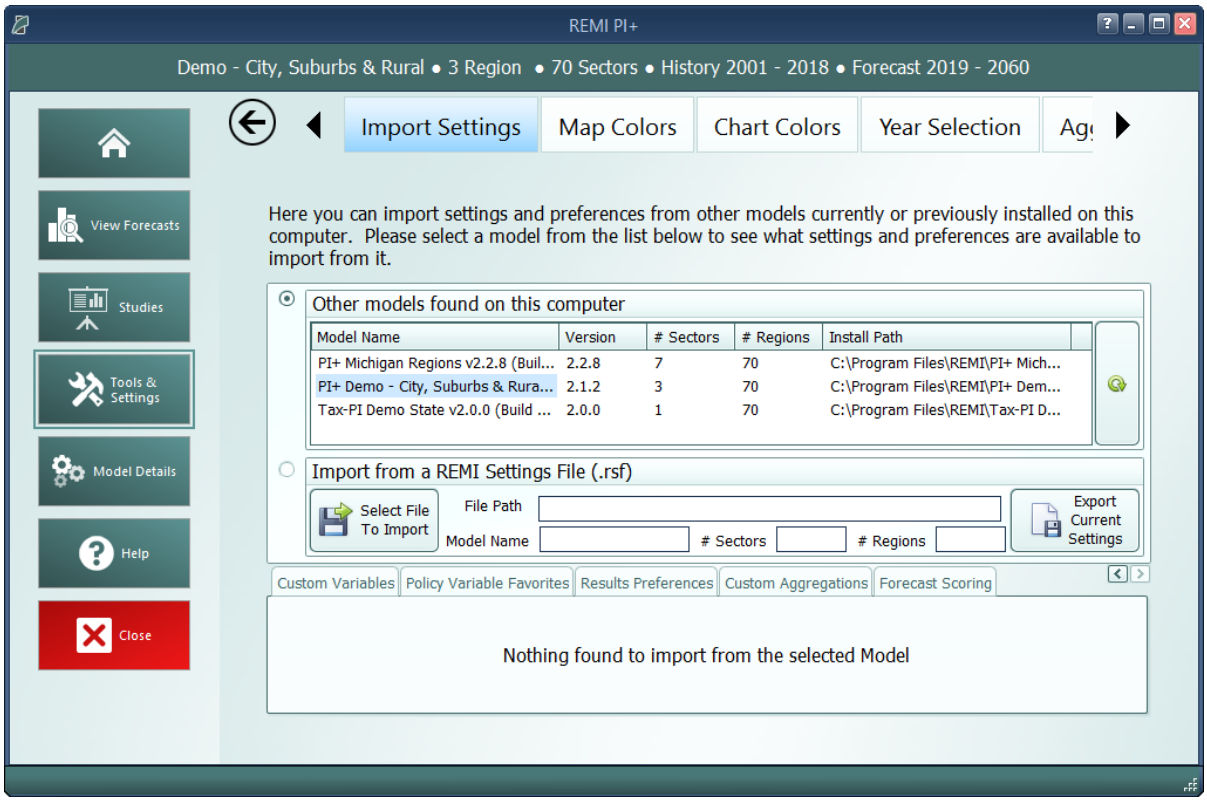


Figure 18: Import Manager

To export the current model settings click the **Export Current Settings** button under the **Import from a REMI Settings File (.rsf)**. This file can then be shared with other users and assistants or be used transfer settings between computers.

Aggregation Manager

Aggregations are groupings of details including regions, industries, commodities, occupations, and ages. They have been thoroughly integrated into the model with respect to both policy variable creation and the results. Aggregations save time when you are interested in only certain details or when you would like to define your own customized structuring of all the details. The **Aggregation Manager** allows you to create aggregations for each of the five supported detail types. Aggregations that you import from other models using the **Import Manager** appear here.

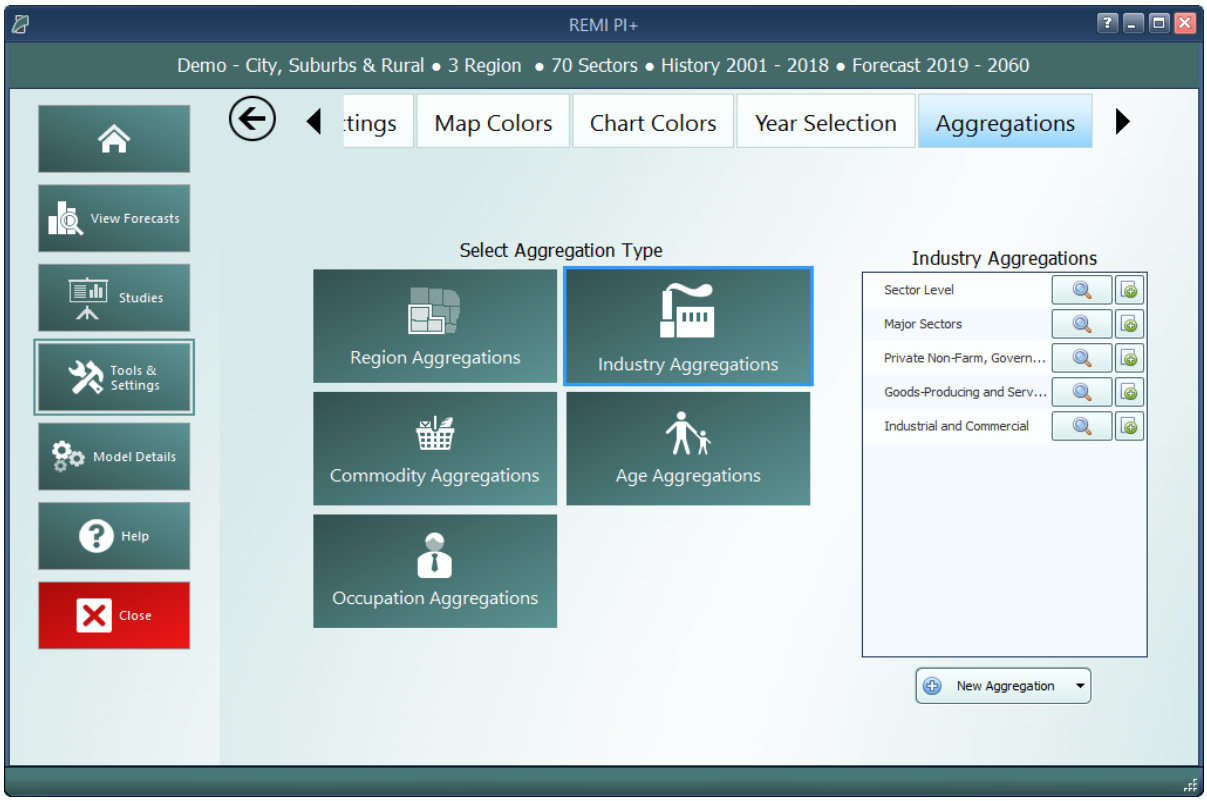


Figure 19: Industry Aggregation Manager

For most of the detail types, you will find some default aggregations built by REMI. You can view these default aggregations to see how they categorize details and also duplicate them if you would like to make a small change. For making a completely new aggregation, click the **New Aggregation** button at the bottom of the aggregation list. Depending on your model and the detail type, you may be prompted to choose what level of detail you would like to use in building the aggregation. For example, a 70-sector model would be able to create industry aggregations using the default 70 sectors or, optionally, using 23 sectors instead.

Creating a custom aggregation will open the Aggregation Editor. The first decision you need to make is whether to make a **Strict** or **Flexible** aggregation. The difference between each option is detailed within the selection gallery. It is also possible to change this later, although when switching from **Flexible** to **Strict** some changes will be made to your aggregation groups to make them valid for a Strict aggregation.

To build an aggregation using the Aggregation Editor, simply create some groups using the **Add Group** button, give them meaningful names, and then drag details from the left-hand list box onto the groups. In long lists of details, it may be useful to use the search box to filter the list. Groups and details can be deleted by selecting them and clicking the **Delete Selection** button, and details can be moved between groups or back to the left-hand list box by dragging. There are additional detail-moving features located in the right-click menu. Using the Aggregation Editor to create a region aggregation includes a map as an additional tool. Regions listed in either list box can be

selected using the map (hold shift while dragging to multi-select on the map) and the map also serves to visually indicate how your regions are being aggregated.

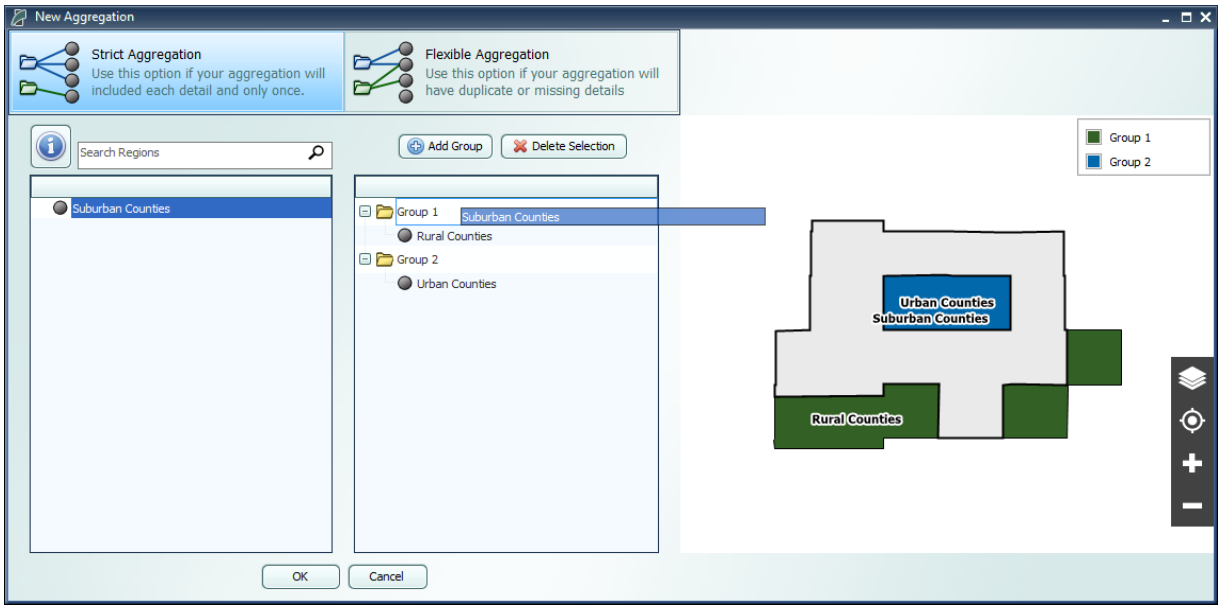


Figure 20: Region Aggregation Editor

Once finished, the aggregation will appear on the Aggregation Manager's list and can be given a name. This saved aggregation will now be available when creating policy variables with the same detail type. Instead of selecting from the regular detail list, you will be able to select from groups you created when building the aggregation. In some cases, where policy variables only allow a subset of the full detail list (such as industry policy variables that exclude farm and government industries), your aggregation will be automatically filtered to remove excluded details and groups containing only excluded details. Similarly, results can also be displayed at the level of your aggregation groups rather than the regular detail list.

Custom Results

Custom results allow users to create new result variables by performing operations on the default results or other custom results. There are three methods to create custom results: Adjust by Constant Factors, Define Equation, and Weighted Spreading. All three types of custom results can be created through the Custom Results Manager shown in **Figure 21**. When you select a method under "Create Custom Result," a Custom Result Builder window appears where you can specify how your result is calculated.

The Custom Results Manager lists your custom results along with their method type, the original result that was adjusted (called the "base variable") and which types of forecasts can display the variable. The manager also has several right-click options, including one to change the name and description of a custom result. The rightmost column of the manager contains buttons to edit and delete custom results.

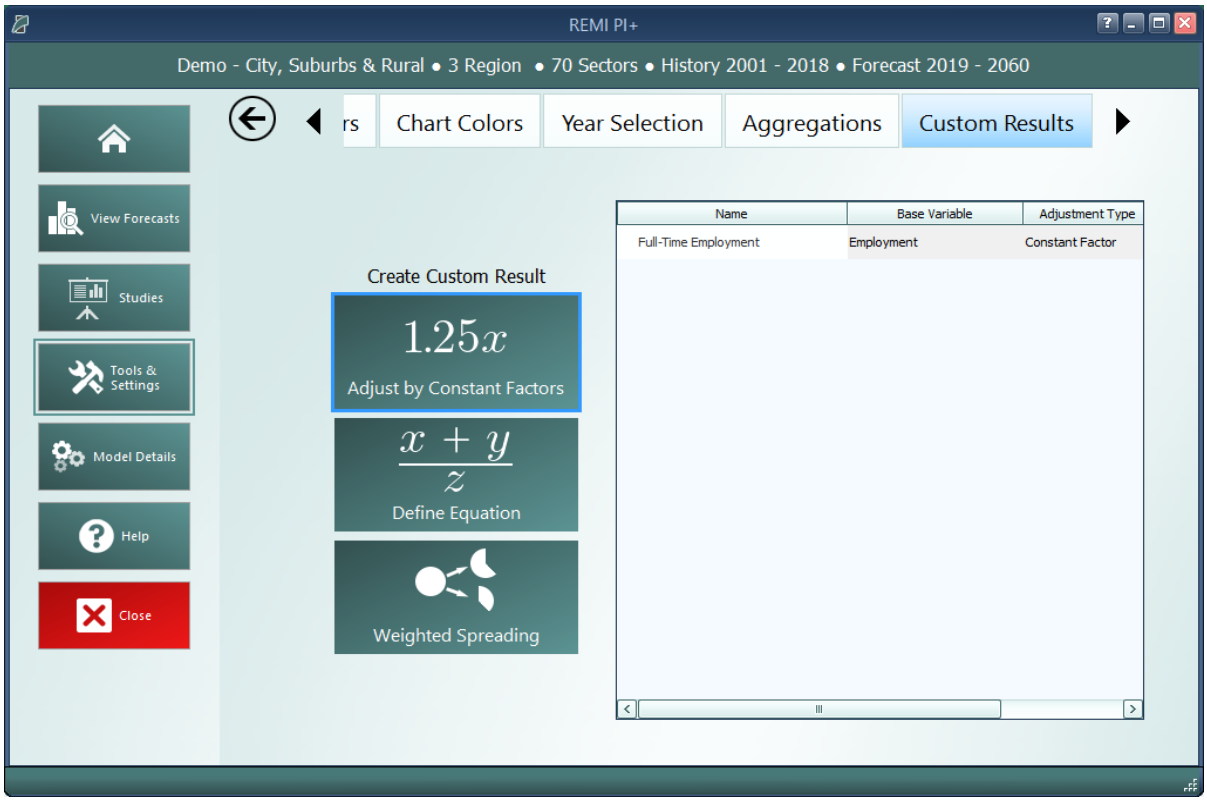


Figure 21: Custom Results Manager

Adjust by Constant Factors

Use this option to create custom results by making an additive or multiplicative adjustment to a result, as shown in the Custom Result Builder in **Figure 22**. Specify the base variable by searching for the result in the Base Variable text box or by selecting from the list, where other custom results that are compatible with this option are listed first. After selecting a base variable, a list of detail dimension will appear. Toggling on/off the individual detail dimensions will modify the shape of the grid for entering constant factor values. Select an adjustment factor to specify if the adjustment will be additive or multiplicative. Optionally, you can specify units for your custom result, otherwise the new custom result will display the same units as their base variable. Important information on custom result units can be found in the **Custom Result Units in Forecasts** section.

In forecast results, constant factors will act on the base variable after the base has been converted to the units specified in the forecast. For additive factors, this means that if a GDP-based custom result of 1 billion dollars has an additive constant factor of 2, the custom result will be displayed as 3 billion if the results are displayed in billions of dollars, and as 1,002 million if the results are displayed in millions of dollars.)

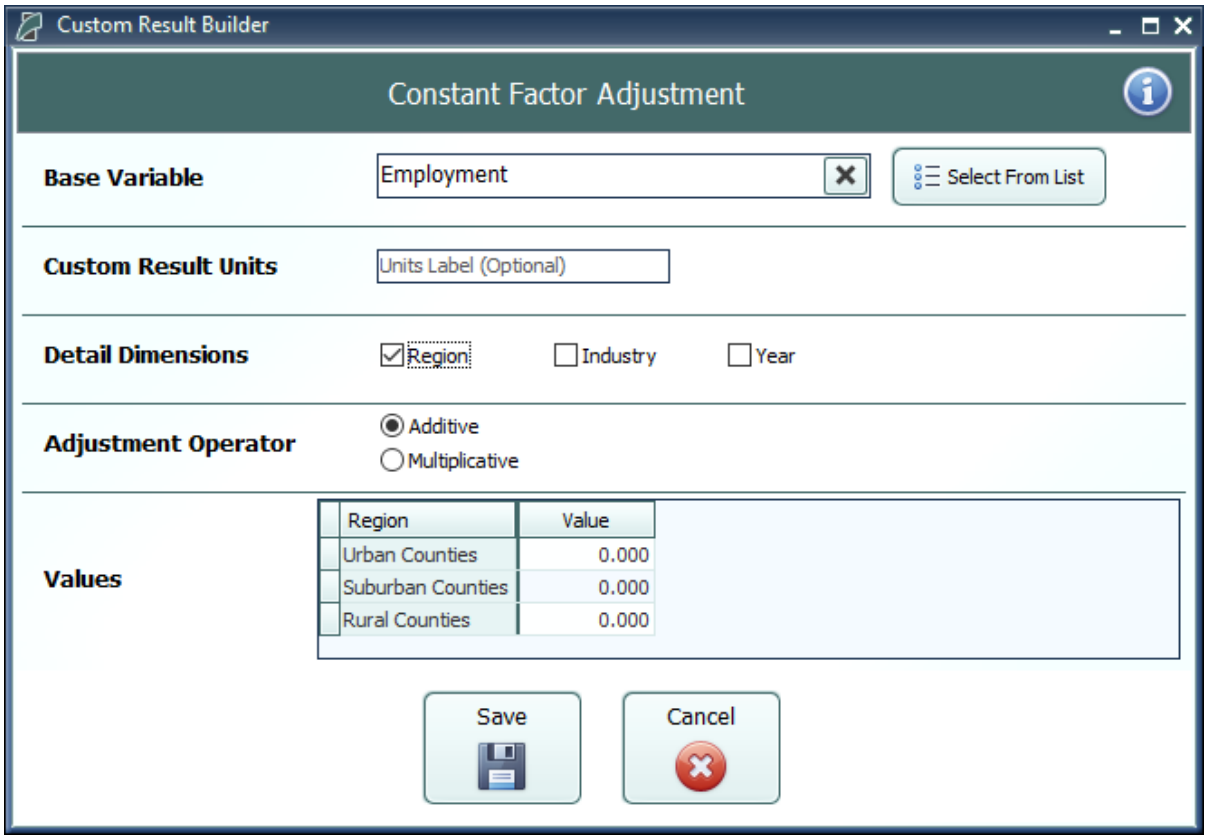


Figure 22: Creating a Constant Factor Custom Result

You can add your custom result to your model by clicking **Save**, at which point the Custom Result Builder will suggest a name and description for your custom result that you can edit as shown in **Figure 23**.

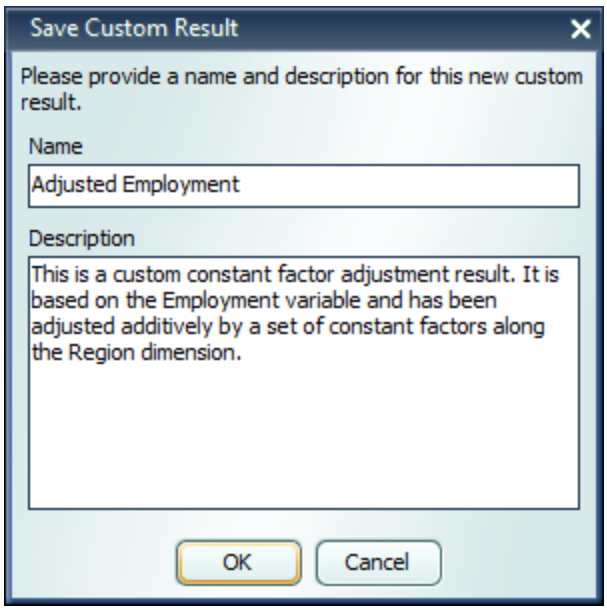


Figure 23: Naming and Describing a Custom Result

Define Equation

Use this option to define custom results by an equation where a base variable acts on another variable, which is called the "interacting variable." In simple cases, you can combine two result variables using a mathematical operator. To produce more complex results, you can create custom results that reference other custom results by selecting them as base and/or interacting variables. An example of this is given in the **Example Custom Results** document.

As shown in **Figure 24**, first select a base variable that will be the first term in the equation by searching for the result in the Base Variable text box or by selecting from the list, where other custom results that are compatible with this option will be listed first. You can then select an interacting variable that is compatible with the base. The units of the interacting variable are automatically selected based on those of the base variable, and can also be changed in some cases.

Depending on the base and interacting variables you chose, you might be able to select from addition, subtraction, multiplication, or division operators. The equation previewer will display the equation that defines the new custom result. Based on the variables and type of interaction, a unit for the new custom result will be suggested that you can edit.

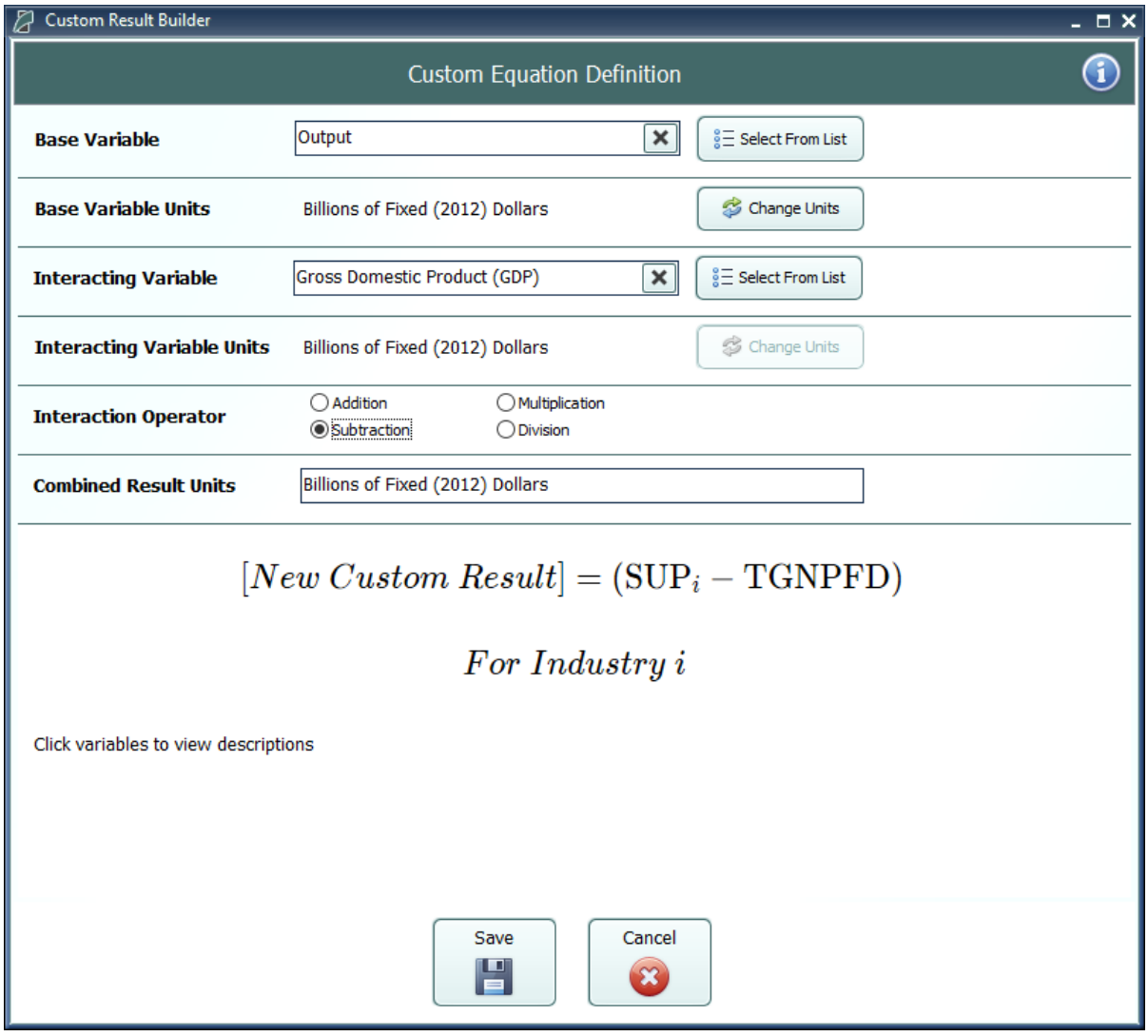


Figure 24: Creating a Custom Equation Result

Similar to constant factor custom results, you can click the **Save** button to save, name, and write a description for this custom result.

Weighted Spreading

Use this option to create custom results where you divide a base variable into subcategories with specific weights. As shown in **Figure 25**, specify the base variable by searching for the result in the Base Variable text box or by selecting from the list, where other custom results that are compatible with this option will be listed first. Select a detail dimension to spread and check the **Year** box if you want to enter different spreading weights for each year. You can choose whether to create the same subcategories under detail by toggling **Synchronize Subcategories** on or off. Click on subcategory names to edit them. You can specify your spreading values as a percentage in the bottom chart of the Custom Result Builder, or as a proportion in the grid of user-created subcategories that will appear when you click **Open In Grid**, as shown in **Figure 26**. In the grid, you

can also paste values and use the calculator feature. If you are using synchronized subcategories, you can specify a Dimension Label for your subcategories that will appear as a header in forecast tables.

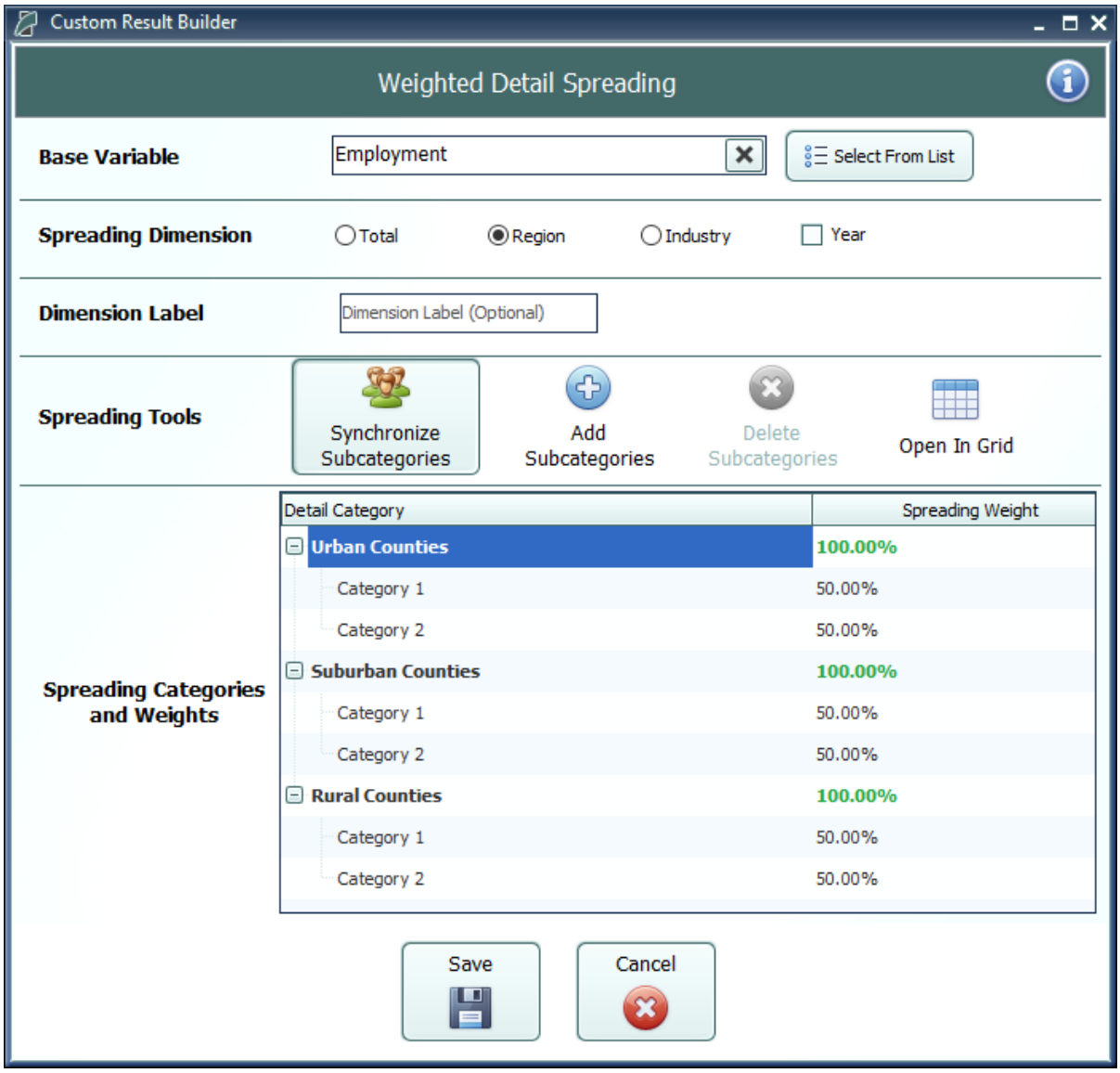


Figure 25: Creating a Weighted Spreading Custom Result

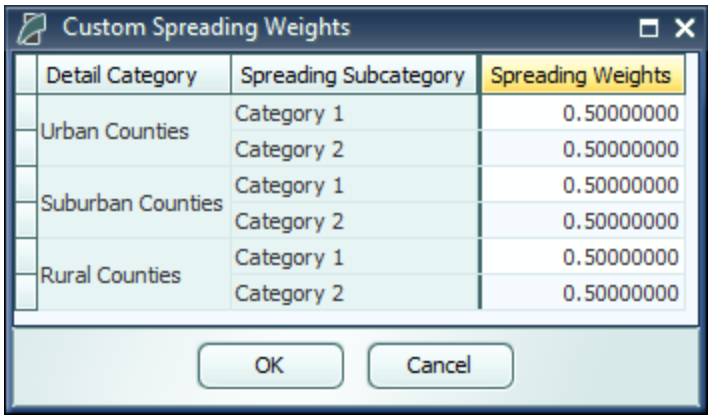


Figure 26: Input Grid

The total spreading weights for each set of subcategories is displayed in a heading. You can, if desired, instantly change a subcategory value so that the total adds up to 100% by right clicking on that value and selecting **Balance Total**.

Similar to constant factor custom results, you can click the **Save** button to save, name, and write a description for this custom result.

Viewing Custom Results in Forecasts

You can view custom results in a compatible forecast by adding them to a Favorite. When selecting results to be shown in a Favorite, click on the **Custom Results** category to see the custom results available as shown in **Figure 27**.

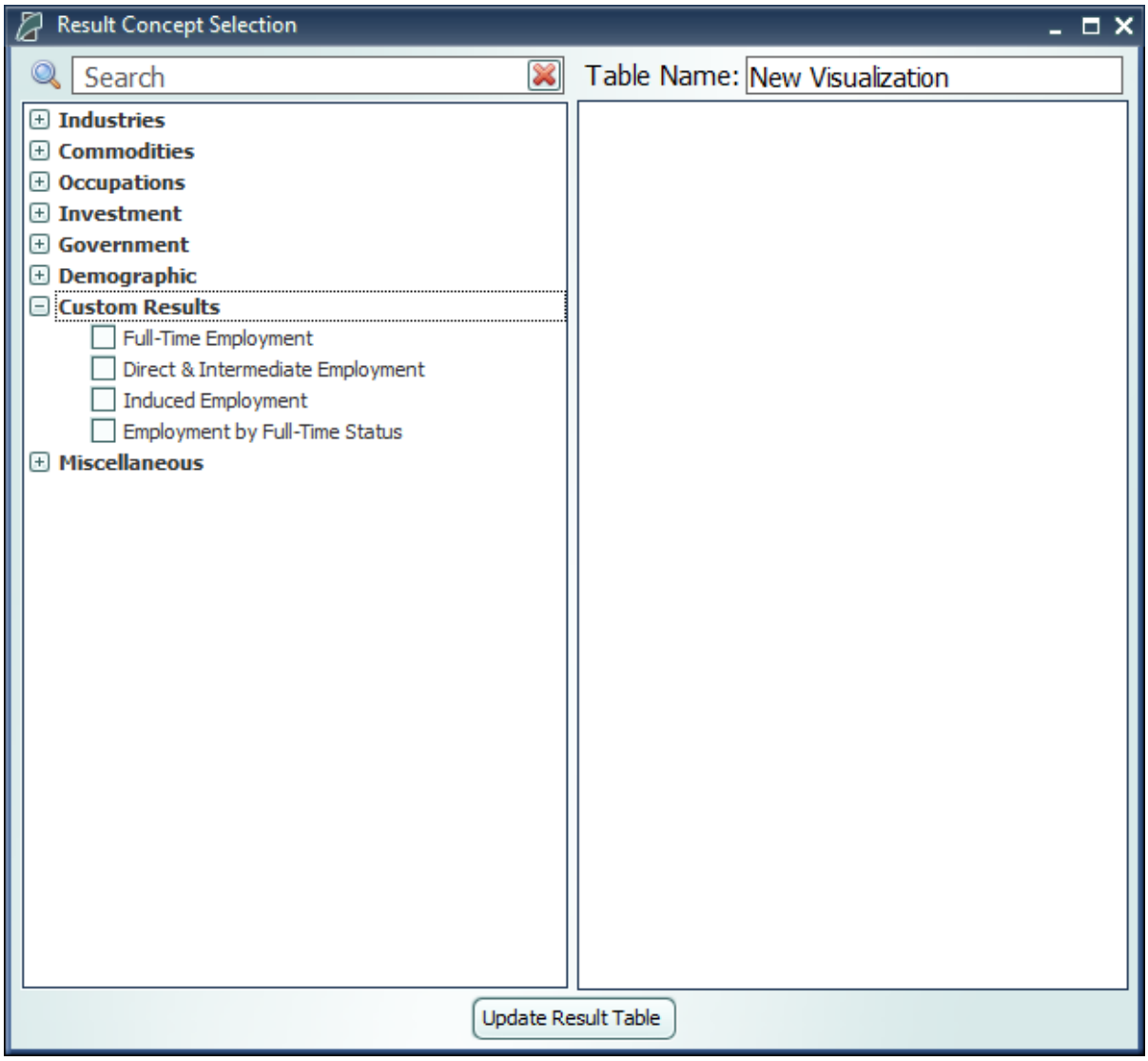


Figure 27: Adding Custom Results to a Favorite

While you can display both constant factor and custom equation results with other results, you can only display weighted spreading results in a visualization alone.

Custom Result Units in Forecasts

Numbers in constant factor results are given in the same units as their base variable. If you choose to use a custom unit label, the label will not change to reflect the units the model actually gives the results in. For example, as shown in **Figure 28**, if, in a forecast that displays jobs in thousands, you display a constant factor result with an Employment base variable and units that you have named "Number of People," the model will give the custom result in thousands, but the units will be labeled "Number of People." As shown in **Figure 29**, you will have to change the forecast's display units or rename the units label for the results and units label to match. Constant factor results without a custom units label will display with the same label as their base variable, which will change to match the units in which results are given.

Category	Units	2018
Adjusted Employment	Number of People	1.840
Employment	Thousands (Jobs)	1.840

Figure 28: Constant Factor Result Displayed with Jobs Given in Thousands

Category	Units	2018
Adjusted Employment	Number of People	1840
Employment	Individuals (Jobs)	1840

Figure 29: Constant Factor Result Displayed with Jobs in Given in Individuals

As shown in **Figure 30** and **Figure 31**, neither the units labels nor the units in which custom equation results are given will change to match settings in the forecast. For example, a custom equation where Output in billions of fixed 2012 dollars is divided by Employment in thousands will give results in billions divided by thousands with the units label "Billions of Fixed (2012) Dollars per Thousands (Jobs)." If you change the forecast settings to display currency in millions, neither the numbers nor the units label in the custom equation result will change.

Category	Units	2018
Output per Employee	Billions of Fixed (2012) Dollars per Thousands (Jobs)	0.045
Output	Billions of Current Dollars	0.084

Figure 30: Custom Equation Result with Currency Units Set to "Billions of Current Dollars"

Category	Units	2018
Output per Employee	Billions of Fixed (2012) Dollars per Thousands (Jobs)	0.045
Output	Millions of Current Dollars	84.404

Figure 31: Custom Equation Result with Currency Units Set to "Millions of Current Dollars"

Model Details

The fourth section of the PI+ Home Window is the Model Details screen. This area contains a variety of detailed data as well as other information like lists of all possible variables, your model region layout, industry sectors, occupations, and commodities.

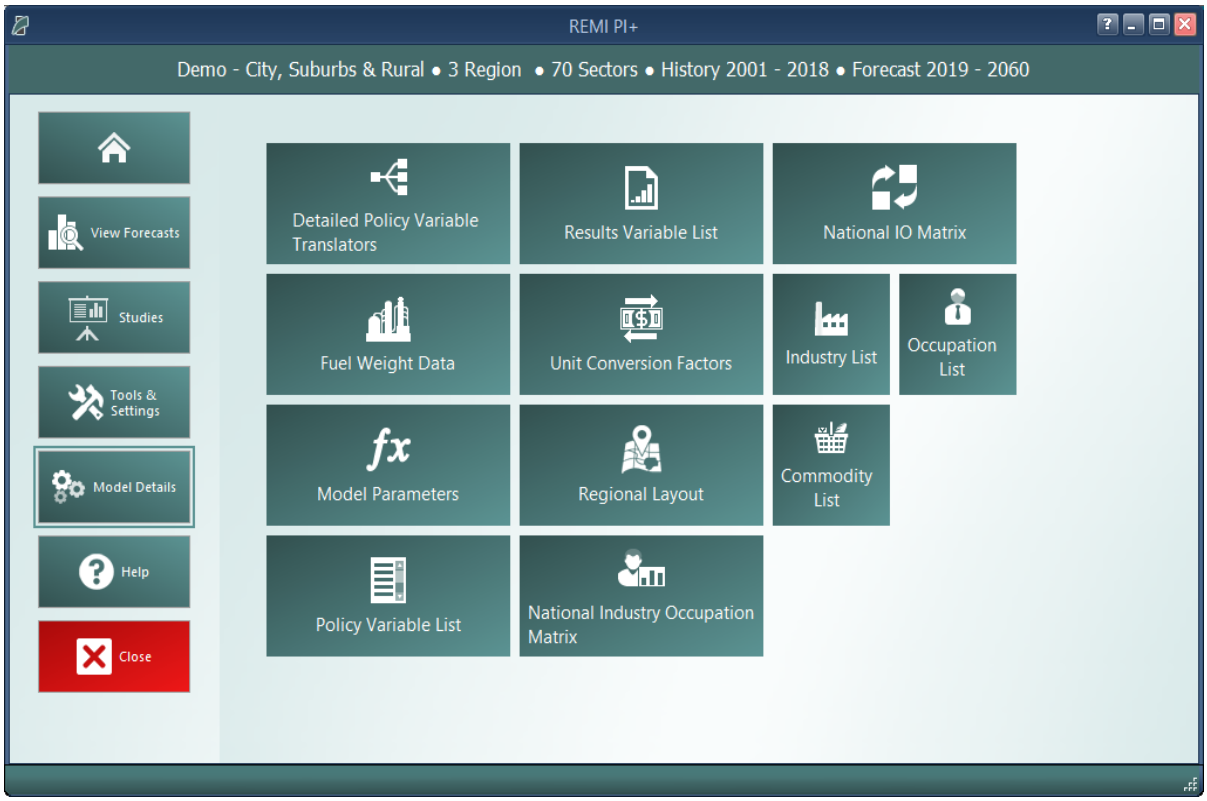


Figure 32: Model Details

Model Parameters

The Model Parameters window displays the values of all parameter constants used in REMI's equations for your specific model. The window is arranged so that each model equation has its own tab containing all relevant parameters. Descriptions are provided to explain the significance of each parameter in its equation.

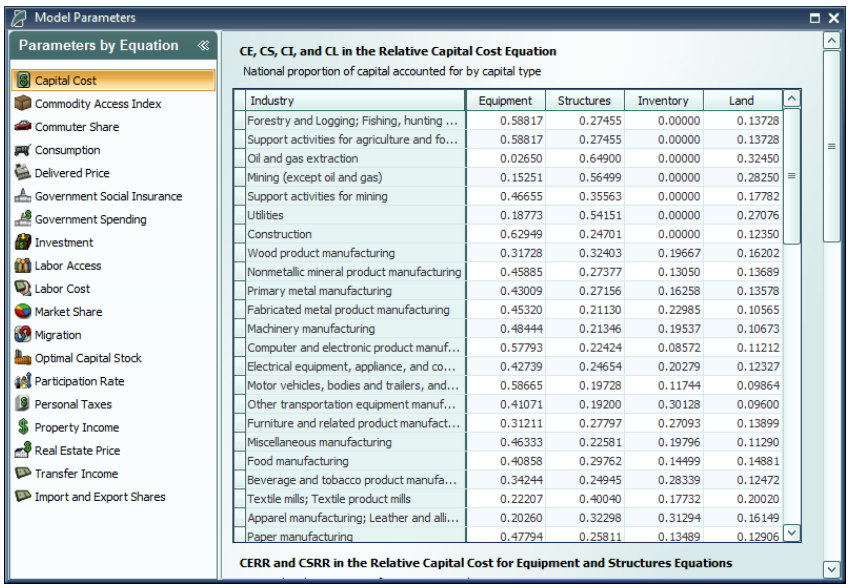


Figure 33: Model Parameters

Help Center

The final section of the home window is the Help center. Here you will find several useful sources of information that can help answer questions about the PI+ software or the underlying REMI model.

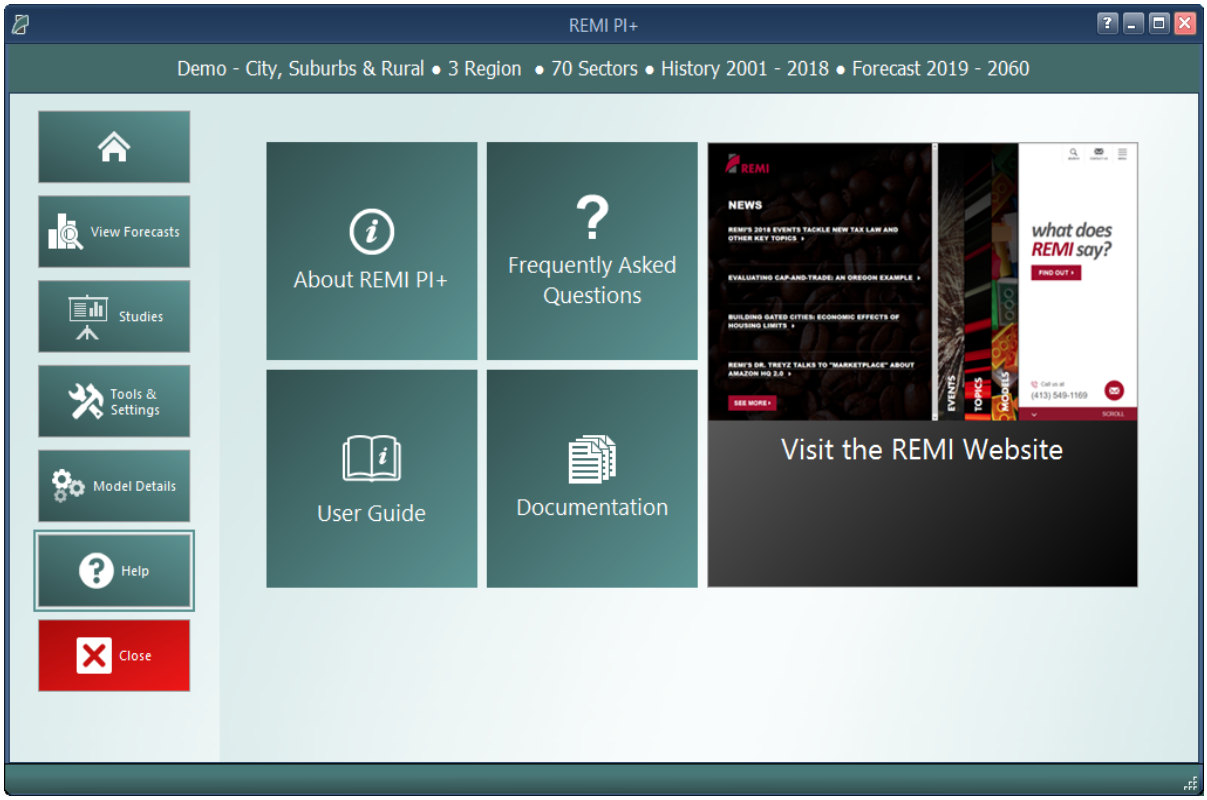


Figure 34: Help Center

Software Information

The **About** window displays information about your installation of PI+. It contains version, model, and build ID numbers as well as information that could be useful for a REMI support situation such as information about applied patches and some statistics pertaining to your computer's memory usage.

Frequently Asked Questions

The FAQ window contains answers to common questions about using PI+. Questions and answers are grouped by topic and provide insight into important REMI model concepts, detail some best-practices for policy variable usage, explain the options available when running a forecast, and give tips for troubleshooting errors.

Documentation

The documentation viewer is a built-in PDF viewer that provides easy access to all documentation files that are shipped with your model. Documentation is organized into different sections for version change documents, equations and data, examples of use, etc. From the documentation viewer, you can print as well as easily open our Documentation folder if you'd like to copy or share our documentation files. Specific documentation pieces that are worth noting are the **Major Changes** file, which briefly outlines a history of major changes between PI+ versions, and the **Model Overview** file which provides an in-depth description of data, software, and methodology changes made for the current version. The rest of our documentation focuses on REMI's model equations, data sources, and estimation procedures.

III. Overview of Forecast Windows

The process of creating a forecast takes place within a Forecast Window. The three main aspects of working with a forecast: specifying policy variables, running the forecast, and viewing the results, each take place on separate screens of the Forecast Window and are accessed using the navigation links along the window's header panel. At any time, your forecast and its contents such as policy variables and customized result visualizations can be saved using the **Save Forecast** button which is always located at the upper left of the screen on the header panel. Forecast windows are now separate entities from the main application window and thus multiple forecasts can now be open simultaneously, with each accessible via a button on the Windows taskbar.

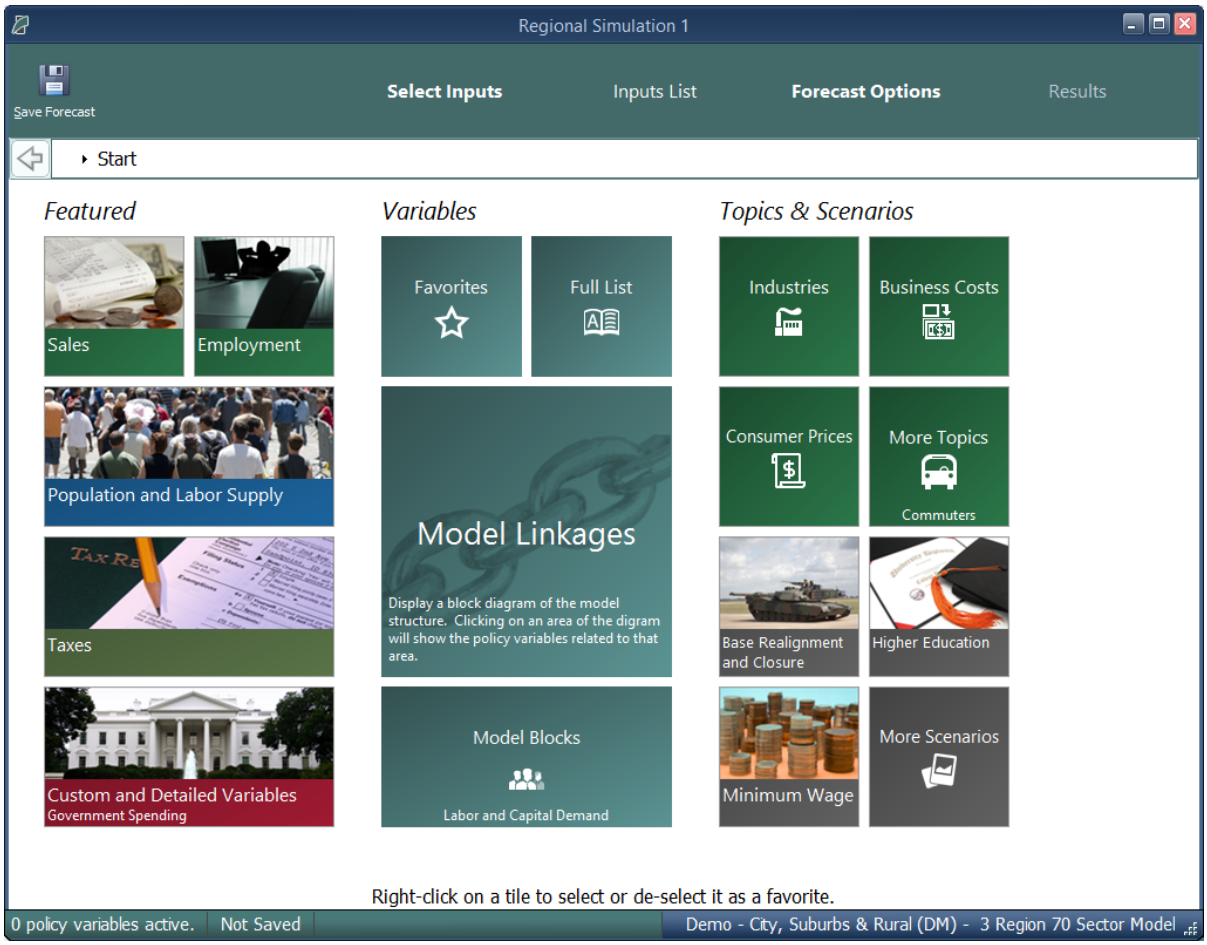


Figure 35: Forecast Window

Select Inputs

The first screen that will be visible when creating a new forecast is Select Inputs (shown in **Figure 35**). This tile-based interface is the jumping off point for choosing what policy variables to add to the forecast. Each tile represents some number of policy variables which will be opened in the Policy Variable Selector, whether it is a single variable like in the case of the Employment tile

or a group of related policy variables like with the Business Costs or various Scenario tiles. At the forefront of the input selection screen, the Featured section highlights variables and topics that are likely to be used most often. Alternatively, the Model Linkages and Model Blocks tiles offer ways of accessing policy variables by area of the REMI model structure where they fit in. If you'd prefer to see all variables that are available for your forecast, the Full List tile will open all variables in the Policy Variable Selector.

If there are certain policy variables that you are likely to frequently use together and they are not already grouped by one of REMI's scenarios, you might consider using the Custom Scenario editor to build your own. This editor, found under the **More Scenarios** tile by clicking **Custom Scenarios**, allows for creating multiple groups of policy variables where each variable can also have its list of details filtered down to remove ones that won't be useful. The custom scenario can be given a name, description, and saved using the controls on the editor. Saved custom scenarios are given their own tiles in the **Custom Scenarios** section of the Select Inputs screen.

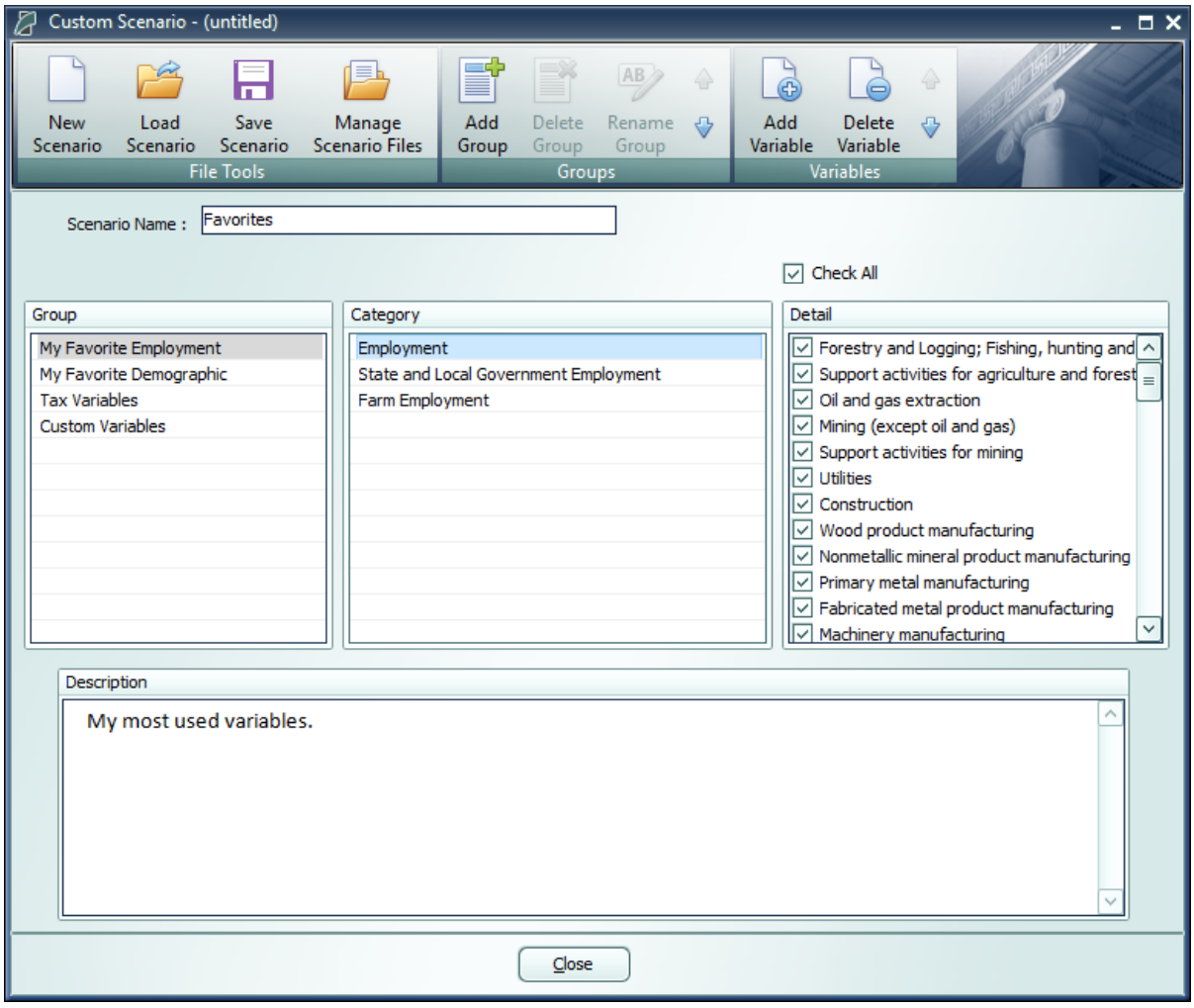


Figure 36: Custom Scenario Editor

In order to make your most-used policy variables and custom scenarios even more accessible, you can make use of the Favorites section. Right-clicking any tile will save it to your Favorites (indicated with a star), where they can then be dragged into any customized order.

Policy Variable Selector

Clicking on a tile that represents some number of policy variables will open up the Policy Variable Selector window. This window is split into three tabs (**Variables**, **Details**, and **Edit Values**) that each represent a step in the process of defining exactly how your policy variables will enter into the model. At any time, you can name your policy variables using the editor at the top of the window. You can also click the **Scenario Info** button to see a description of the scenario you have open.

The first tab on the Policy Variable Selector contains the variable list. This screen is where an individual policy variable is selected for editing. The contents of the variable list are determined by what group of variables was previously chosen. Only one variable can be selected for editing at a time, but once you finish creating a variable, you can always go back to the variable list tab to start working with another. In cases where you accessed the Policy Variable Selector using a tile that represents just a single variable, this section will be skipped since there is no selection to be made. If the number of available variables is large, it may be helpful to use the search field for filtering the list down by variable name or description.

Clicking a variable in the list will display information about it and its options. In some cases, a diagram may be available that depicts how the selected policy variable interacts with other variables and how it fits into the REMI model. Once you have decided what variable to choose, clicking the **Select** arrow button on the window's header panel will move the variable to the Details tab to begin editing.

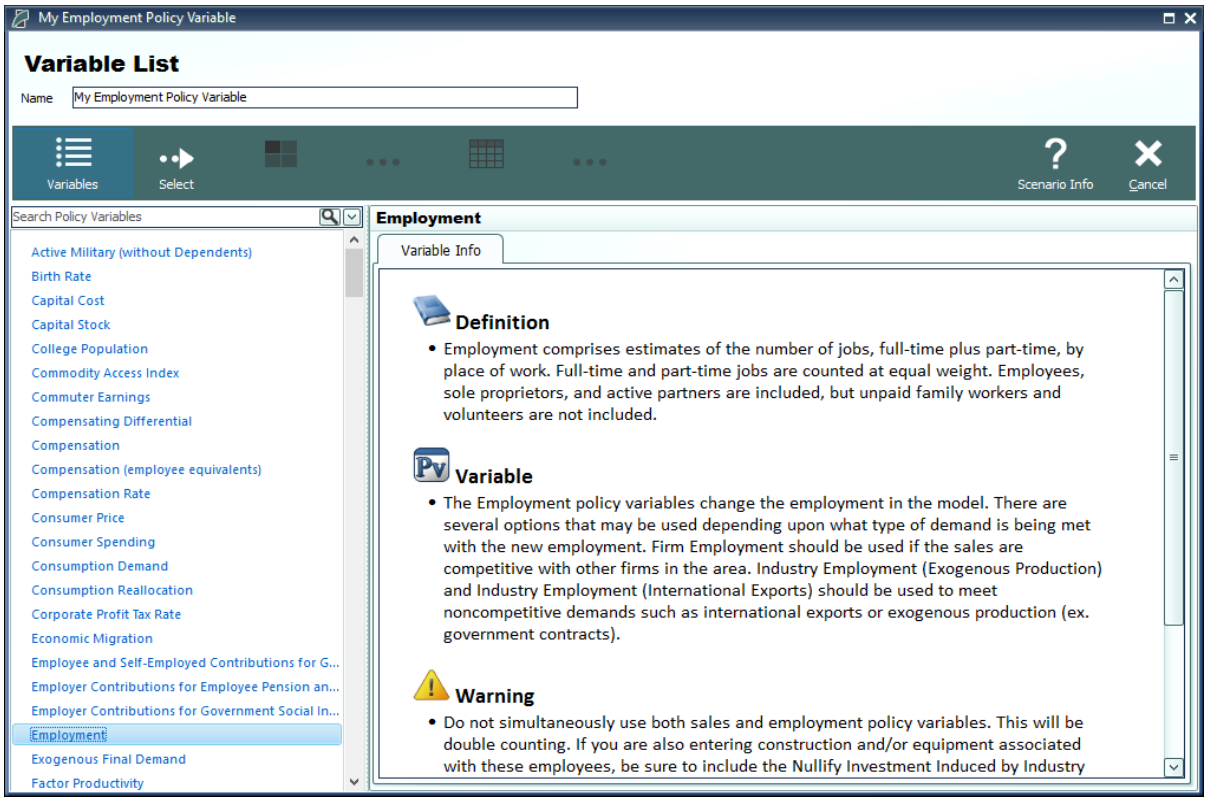


Figure 37: Policy Variable Selector – Variable List Tab

The Details tab is where you specify what the exact form of the policy variable should be. Different variables have different sets of details that must be filled out before the variable can be added to your forecast. Each type of detail information that must be specified will be represented by a tile on the left-hand side of the screen. Clicking one of these tiles will allow you to fill out some information describing your policy variable and can be done in any order. Most policy variables will require you to at least specify the regions it should affect and the unit type of the values. In the specific case of the Employment policy variable, shown below in **Figure 38**, option and industry details are also required. Options only exist on some policy variables, they allow for choosing exactly how the variable should interact with other parts of the model. Selecting industry details for the Employment variable depicted below controls what industries will be impacted by the policy variable's changes to employment levels.

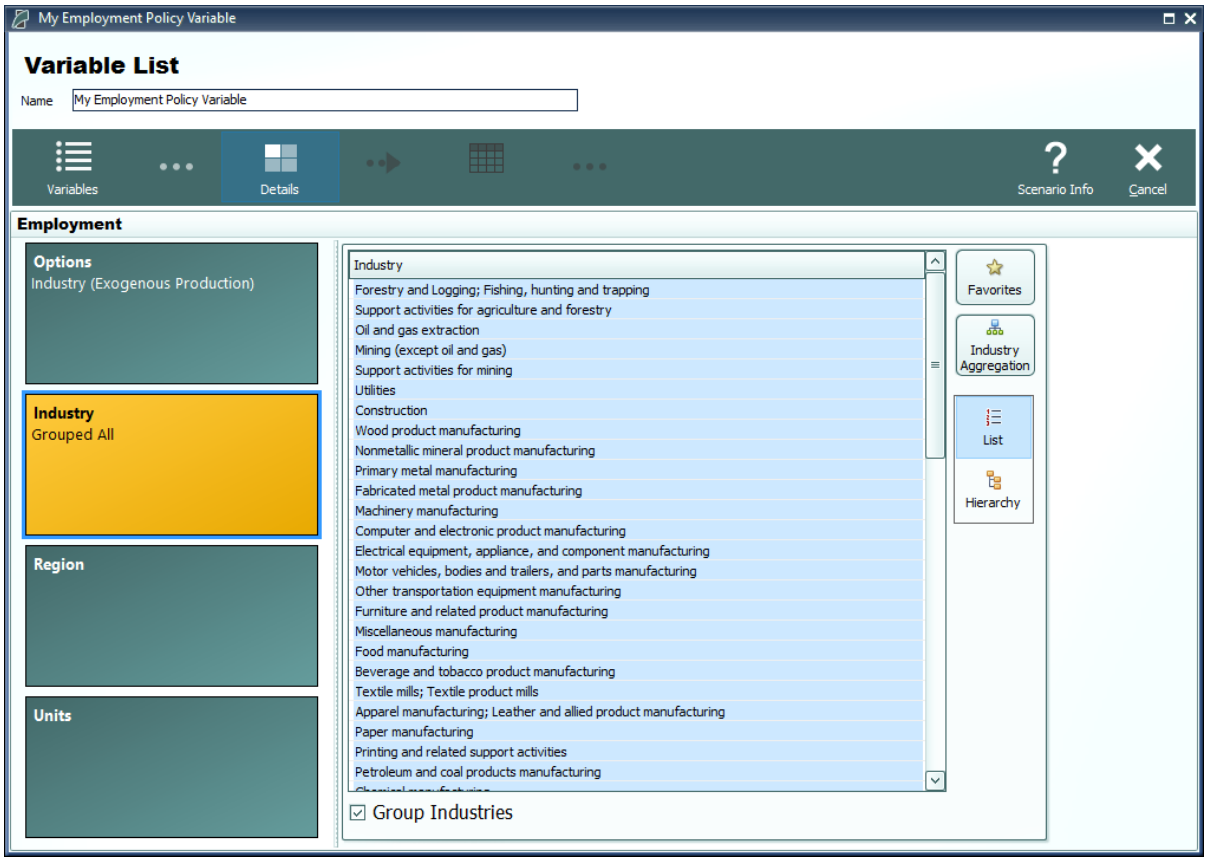


Figure 38: Policy Variable Selector – Details Tab (In Progress)

There are several ways to select specific details from the various types of detail lists, which include regions, industries, commodities, occupations, and ages. The first way is to select them from the simple flat list view. Hold down the Ctrl key to select multiple details one at a time or Shift to select a range of details all at once. If you would like to apply the same policy change to multiple details, it is helpful to check the **Group Industries** or equivalent checkbox below the detail list. This will put all of the details into a single variable rather than creating separate variables for each selected detail.

Another way of selecting details is to use the hierarchical view. Simply click the **Hierarchy** button to the right of the detail list to see a hierarchical tree structure with checkboxes as the selection mechanism. This view is useful for selecting multiple related details all at once. For example, you could check the **Manufacturing** tree item to capture all manufacturing sub-industries. The final way to select details is to click the **Aggregation** button and select a custom or pre-defined aggregation, discussed in the **Aggregation Manager** section. Selecting an aggregation will repopulate the flat and hierarchical detail lists with the aggregated detail groups contained within the chosen aggregation. Similar to the detail grouping checkboxes, creating a variable with an aggregated detail will cause the inputted year values to be spread among the individual regions, industries, commodities, occupations, or ages as it enters the model.

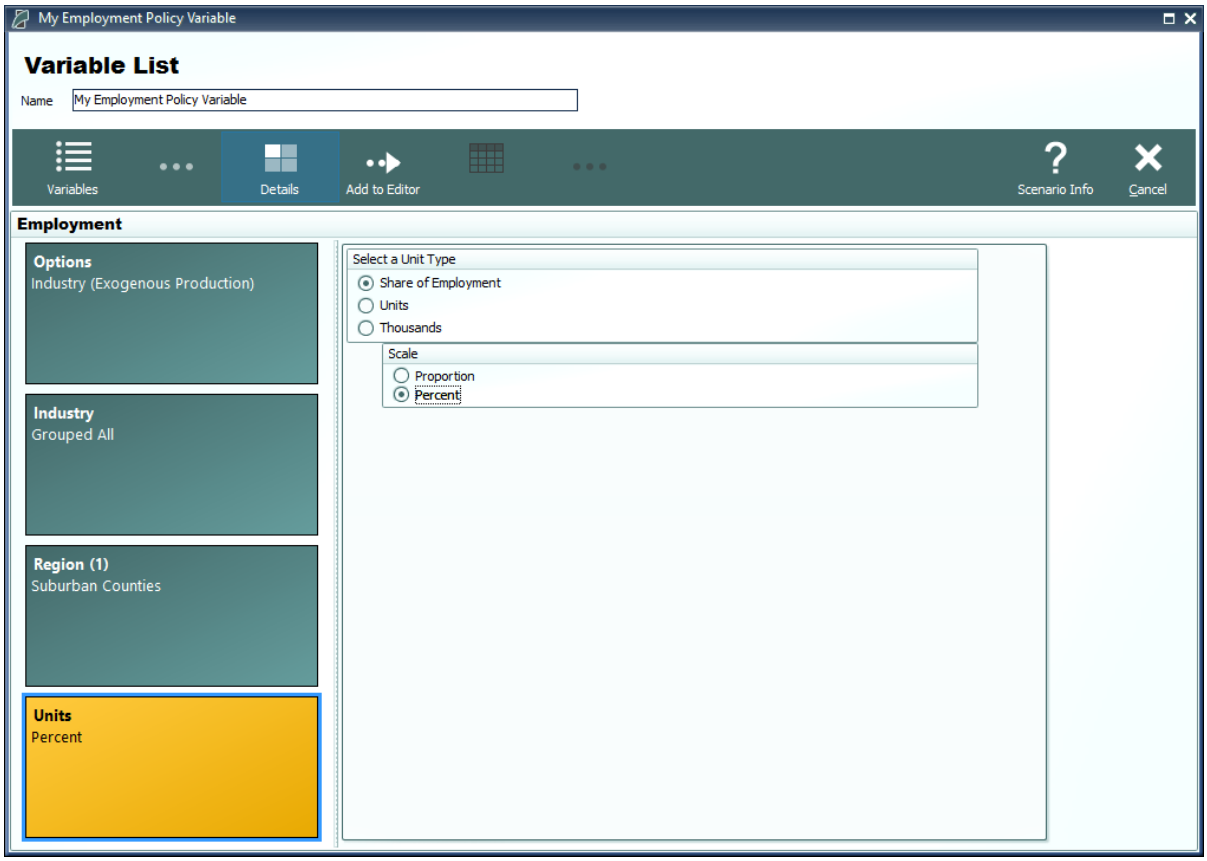


Figure 39: Policy Variable Selector – Details Tab (Completed)

Once the unit type and the rest of the options on the policy variable have been specified, you will be able to click the **Add to Editor** button to move the variable into the value editing spreadsheet. The number of created policy variables will be displayed as a badge on the **Edit Values** button that becomes enabled once at least one variable has been added. One policy variable will be created and added to the spreadsheet for each combination of details specified on the Details tab. If you chose to check any of the grouping check boxes or chose to use aggregations, then all of those grouped details will be combined into one variable, which is depicted below for the industry dimension.

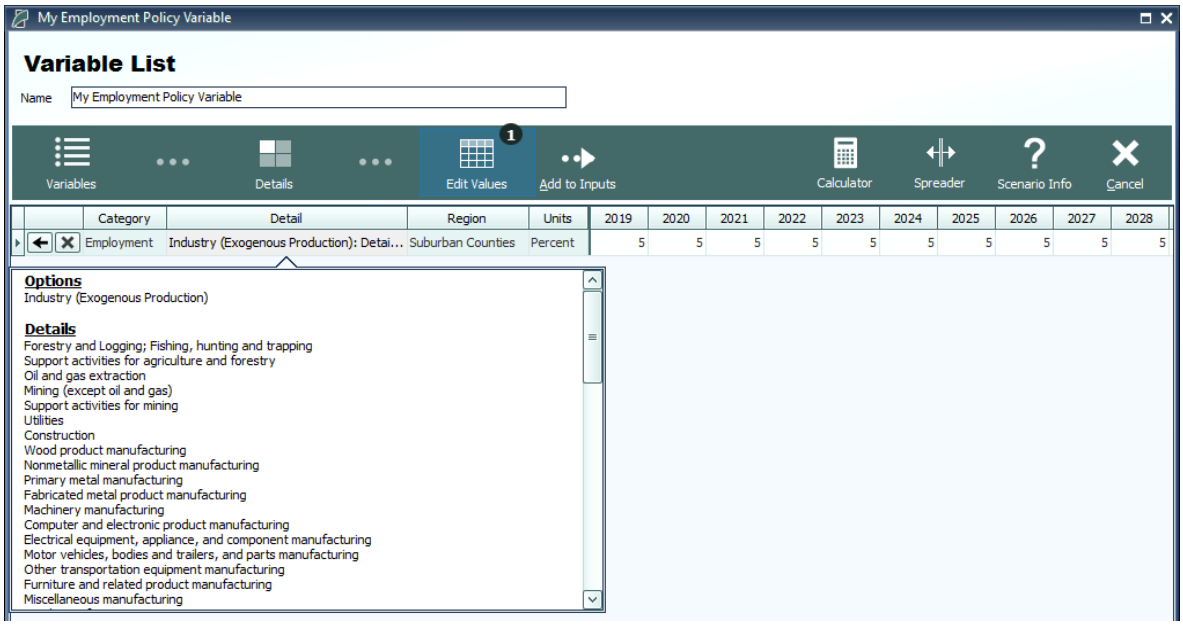


Figure 40: Policy Variable Selector – Value Editor

The editor will allow you to input values for each policy variable in each year. You can change the region and units by clicking on those cells in the spreadsheet, which contain combo-box editors. The Calculator and Spreader tools located on the top right of the navigation panel are useful for inputting more complicated series of values. If you need to change more options on your variable, you can click the **Redefine Details** button marked with a left-facing arrow. Variables can be deleted using the adjacent button that is marked with an "X". Once finished, add your variables to the forecast's Inputs List screen by clicking the final arrow button, **Add to Inputs**. Submitted variables will appear on the Inputs List together in a group with the name specified on the Policy Variable Selector.

Custom Variables

There are a handful of special policy variables available only to regional simulations that are known as custom variables. These variables are much more customizable than regular policy variables because they allow for modifications to be made to the input-output (IO) table data that dictates how the variable will affect different parts of the economy within the model. There are custom variables for Industry Output/Sales, Government Spending, Investment Spending, Consumer Spending, Imports, Exports, and Tourism Spending. These variables can be found under the **Custom and Detailed Variables** tile in the Featured section of the Select Inputs screen and also can be added to a custom scenario. Custom variables can be created, edited, and deleted from the Policy Variable Selector's Details tab once a particular type of custom variable has been selected. Creating a new custom variable opens the Custom Variable Editor, which looks slightly different and has various options depending on which type of custom variable is being created.

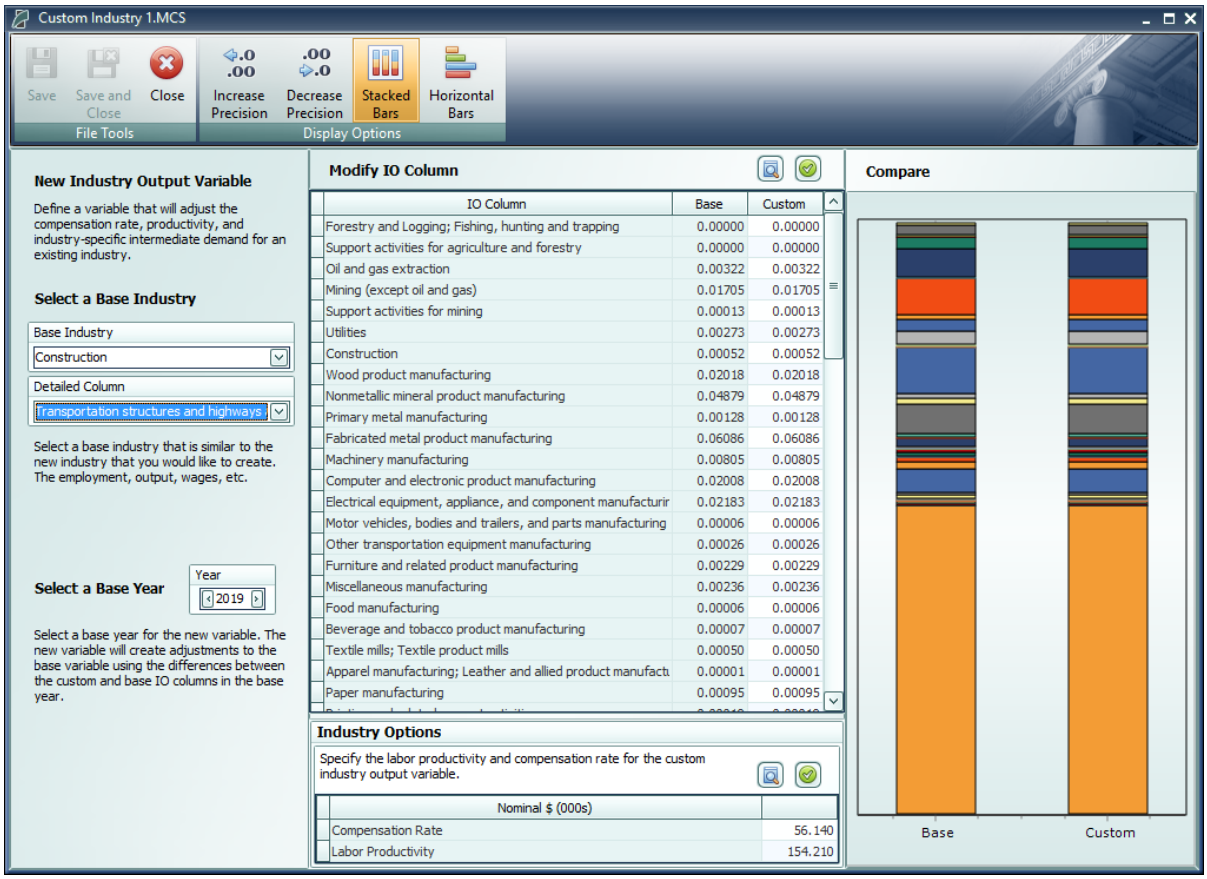


Figure 41: Custom Variable Editor – Industry Output/Sales

On the left-hand panel of the Custom Variable Editor are variable-specific options and instructions. These options typically involve specifying information about what base data you would like to associate with the custom variable such as the base year, base industry, commodity or government spending category, and so on. The base IO column data resulting from your choices is what you are able to subsequently modify using the central IO Column editor in order to finish specifying the custom variable. Additional customizations are available for certain types of custom variables, such as the options for adjusting compensation rate and labor productivity of custom industries, as shown in **Figure 41**.

To aid in constructing your custom IO column, the chart on the right-hand side of the screen, which can be toggled between stacked-bar and horizontal-bar views, helps visualize the differences between the base and custom IO columns. Additionally, using the button marked with a magnifying glass in the IO column editing area, IO column reference data for each forecast year can be viewed as a table or chart and can be auto-filled into the custom column editor. The Custom Industry Output/Sales variable editor also has reference information for national and regional compensation rates and labor productivity. The right-click menu of the custom column editor has an **Apply Remainder** option (except when editing Industry Output/Sales, for which Value Added captures the remainder), which can prove useful as the IO column needs to total to one. If there are issues with any of your custom values, the button usually displaying a green checkmark

in the corresponding section of the editor will change and instead warn you of the problems with what you have entered.

Once you have finished your custom variable, simply save it and subsequently use it as you would a normal policy variable. Saved custom variables appear in the Details tab of the Policy Variable Selector once you have selected that same category of custom variable. Be aware that custom variable files should not be transferred between versions of PI+ because each new release includes an updated IO table. This means that the values you attached to the custom variable will vary from the base data not only in the way that you intended them to, but also due to our updates affecting the base IO table.

Model Assumptions

In addition to directly entering policy variables, a forecast can also be changed from its baseline by another type of input: customized model assumptions. Model assumptions can only be added to control forecasts. There are five categories of model assumptions, some of which are applicable only to regional controls and some only to national controls. All five categories of model assumptions are handled by the Forecast Updates window shown in **Figure 42**. This window shows all of the available assumption types that can be modified for the current forecast. Each assumption type has at least one default assumption, called either the Baseline or REMI Standard assumption. Some types of assumptions have other pre-defined choices available. **Figure 42** shows two such alternative Macroeconomic Update assumptions, representing higher and lower GDP growth scenarios compared to the baseline forecast. The tools menu along the top of the window has buttons for opening each assumption to view its data, copying an assumption for customization, and creating a brand-new assumption to start from scratch. You can also rename and delete assumptions and import assumption files from past versions. To select a non-baseline assumption, whether it is a REMI alternative or custom-made, just click the checkmark button on the assumption's card. Some types of assumptions will feature a visualization consisting of a chart and table that depict how the selected assumption affects the relevant concept.

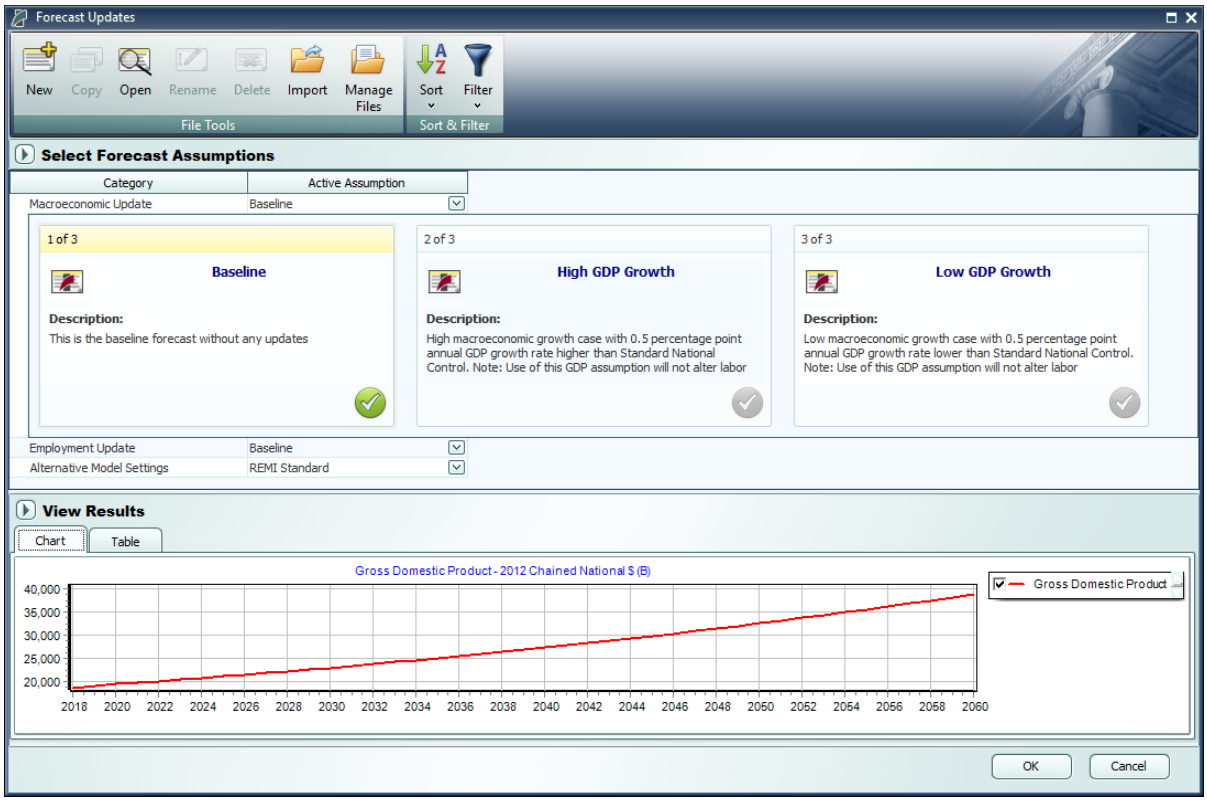


Figure 42: Forecast Updates Manager

Employment Update

Employment updates are accessible for national and regional control forecasts and allow for calibration of a forecast to alternative by-industry employment data.

Creating an employment update is a multi-step process. You will first be presented with an **Overview** to guide you on how an Employment Update works and how to use it. Moving on to **Options** you can enter employment values at different industry and region aggregation levels and in different units. If you make changes to the options after entering values you may lose some of the changes you made.

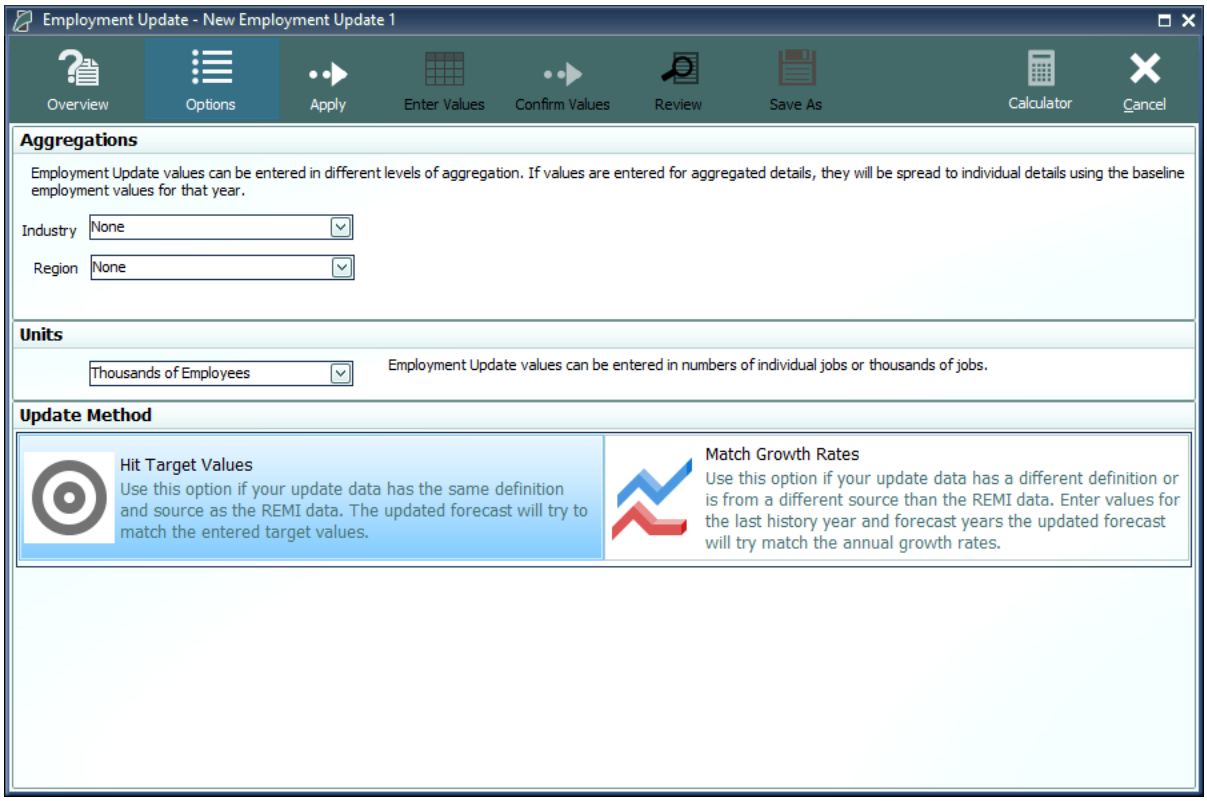
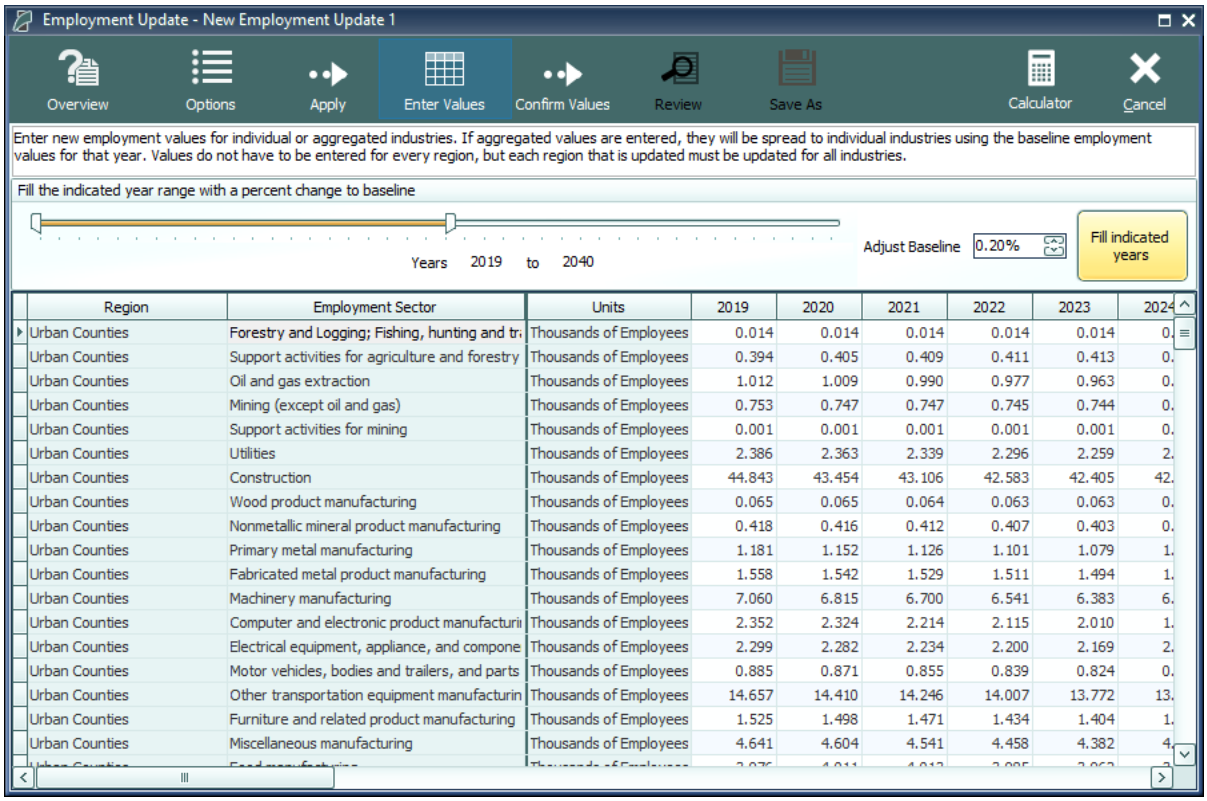


Figure 43: Employment Update - Options

Once you have made any necessary changes to the options click **Apply** to begin entering the updated values. Data must be entered for every industry, but not every region. To fill in new employment values based on the default employment values use the tools at the top of the window.



Region	Employment Sector	Units	2019	2020	2021	2022	2023	2024
Urban Counties	Forestry and Logging; Fishing, hunting and tr	Thousands of Employees	0.014	0.014	0.014	0.014	0.014	0.
Urban Counties	Support activities for agriculture and forestry	Thousands of Employees	0.394	0.405	0.409	0.411	0.413	0.
Urban Counties	Oil and gas extraction	Thousands of Employees	1.012	1.009	0.990	0.977	0.963	0.
Urban Counties	Mining (except oil and gas)	Thousands of Employees	0.753	0.747	0.747	0.745	0.744	0.
Urban Counties	Support activities for mining	Thousands of Employees	0.001	0.001	0.001	0.001	0.001	0.
Urban Counties	Utilities	Thousands of Employees	2.386	2.363	2.339	2.296	2.259	2.
Urban Counties	Construction	Thousands of Employees	44.843	43.454	43.106	42.583	42.405	42.
Urban Counties	Wood product manufacturing	Thousands of Employees	0.065	0.065	0.064	0.063	0.063	0.
Urban Counties	Nonmetallic mineral product manufacturing	Thousands of Employees	0.418	0.416	0.412	0.407	0.403	0.
Urban Counties	Primary metal manufacturing	Thousands of Employees	1.181	1.152	1.126	1.101	1.079	1.
Urban Counties	Fabricated metal product manufacturing	Thousands of Employees	1.558	1.542	1.529	1.511	1.494	1.
Urban Counties	Machinery manufacturing	Thousands of Employees	7.060	6.815	6.700	6.541	6.383	6.
Urban Counties	Computer and electronic product manufacturi	Thousands of Employees	2.352	2.324	2.214	2.115	2.010	1.
Urban Counties	Electrical equipment, appliance, and compone	Thousands of Employees	2.299	2.282	2.234	2.200	2.169	2.
Urban Counties	Motor vehicles, bodies and trailers, and parts	Thousands of Employees	0.885	0.871	0.855	0.839	0.824	0.
Urban Counties	Other transportation equipment manufacturin	Thousands of Employees	14.657	14.410	14.246	14.007	13.772	13.
Urban Counties	Furniture and related product manufacturing	Thousands of Employees	1.525	1.498	1.471	1.434	1.404	1.
Urban Counties	Miscellaneous manufacturing	Thousands of Employees	4.641	4.604	4.541	4.458	4.382	4.

Figure 44: Employment Update - Enter Values

Once you are done entering new employment values, click the **Confirm Values** button. This will bring you to the **Review** section. From here you can review the changes broken out to the most detailed levels and compare it against the baseline employment. You can also enter a description of your customized employment update in the text field at the bottom of the window.

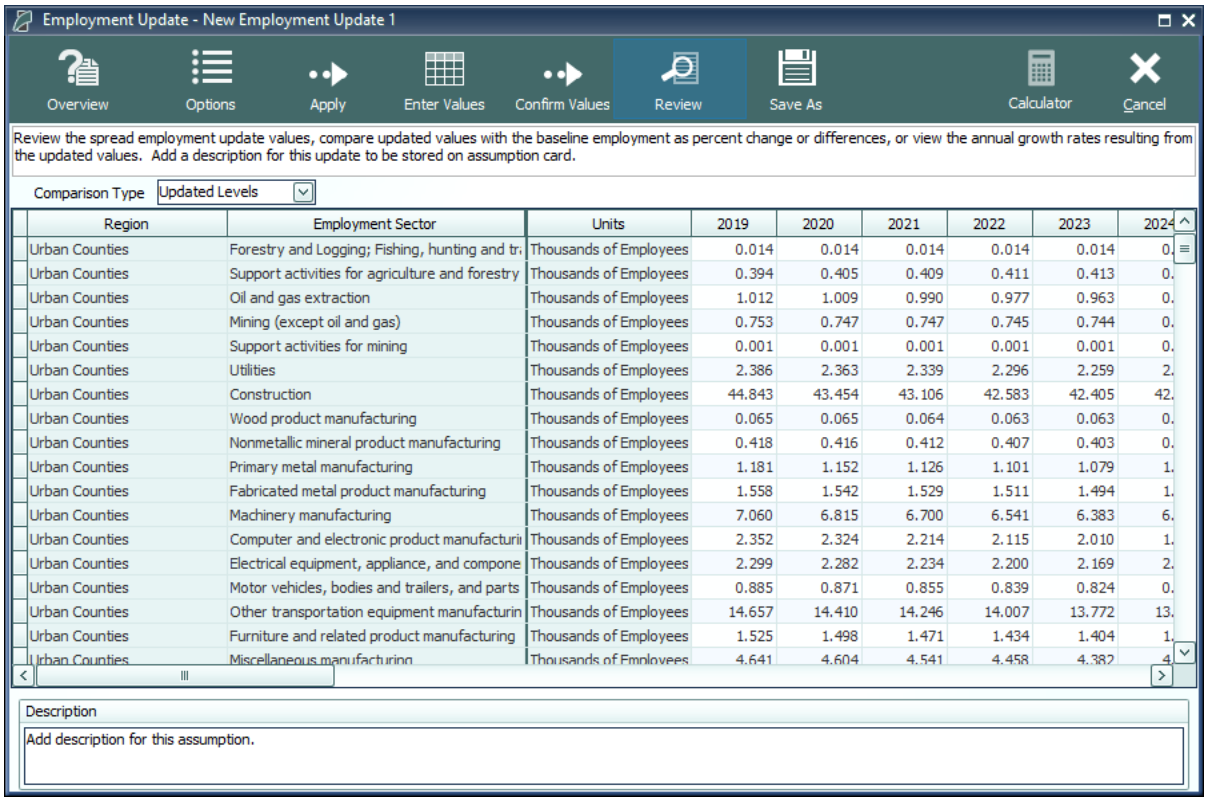


Figure 45: Employment Update - Review

When you are done reviewing click the **Save As** button to save your new Employment update.

Population Update

Population updates are available only for regional controls. This type of assumption can be used to adjust regional population levels. The overall process is the same as an employment update but with different options. Alternate population values can be entered by race and by gender, or for all races and both genders together. Different age aggregations, unit types, and region aggregations are also available.

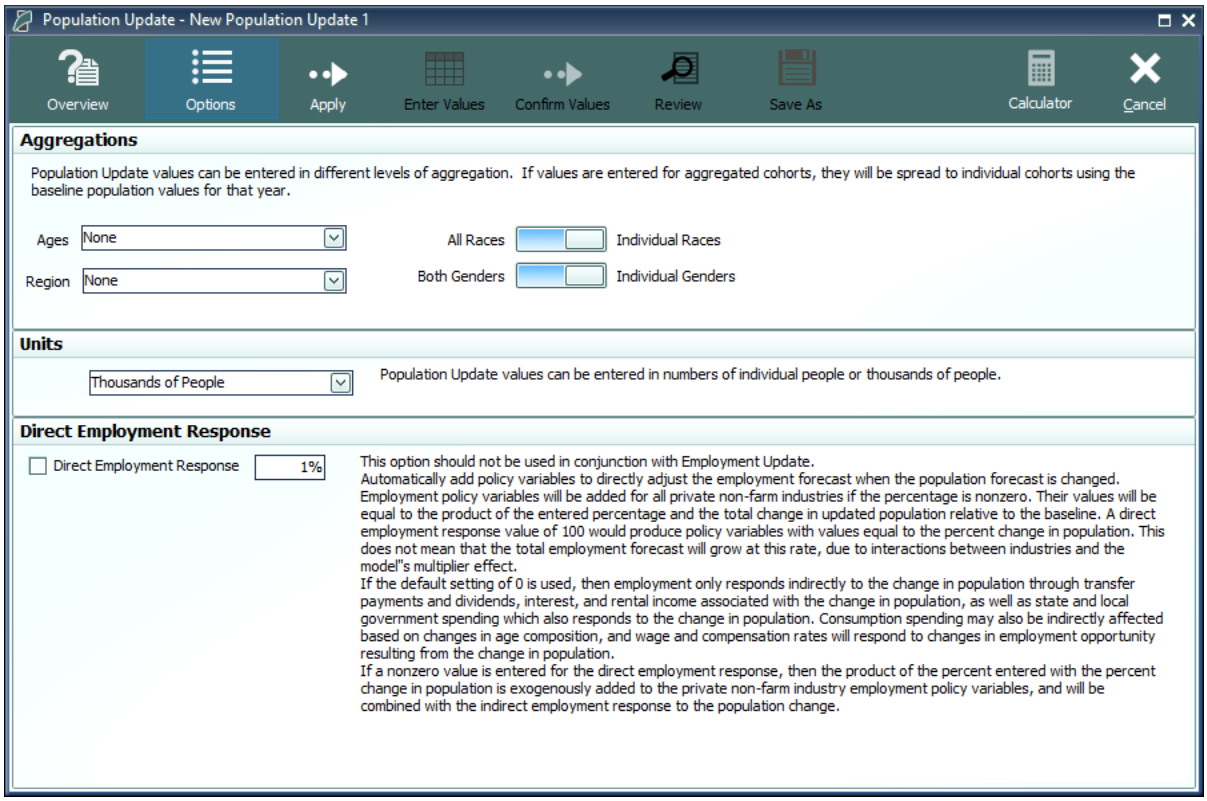


Figure 46: Population Update - Options

Macroeconomic Update

The Macroeconomic Values Update allows you to calibrate a national forecast to alternative macroeconomic data by component. The overall process is the same as an employment update but with different options. You can enter values based on final demand, personal income, or a combination of final demand and personal income. Changing the level of the GDP type in the combobox allows you to specify the level of final demand detail you wish to enter. You can also toggle on several optional inputs to enter a different inflation assumption, change the national unemployment rate assumption, or change the average labor productivity growth rate.

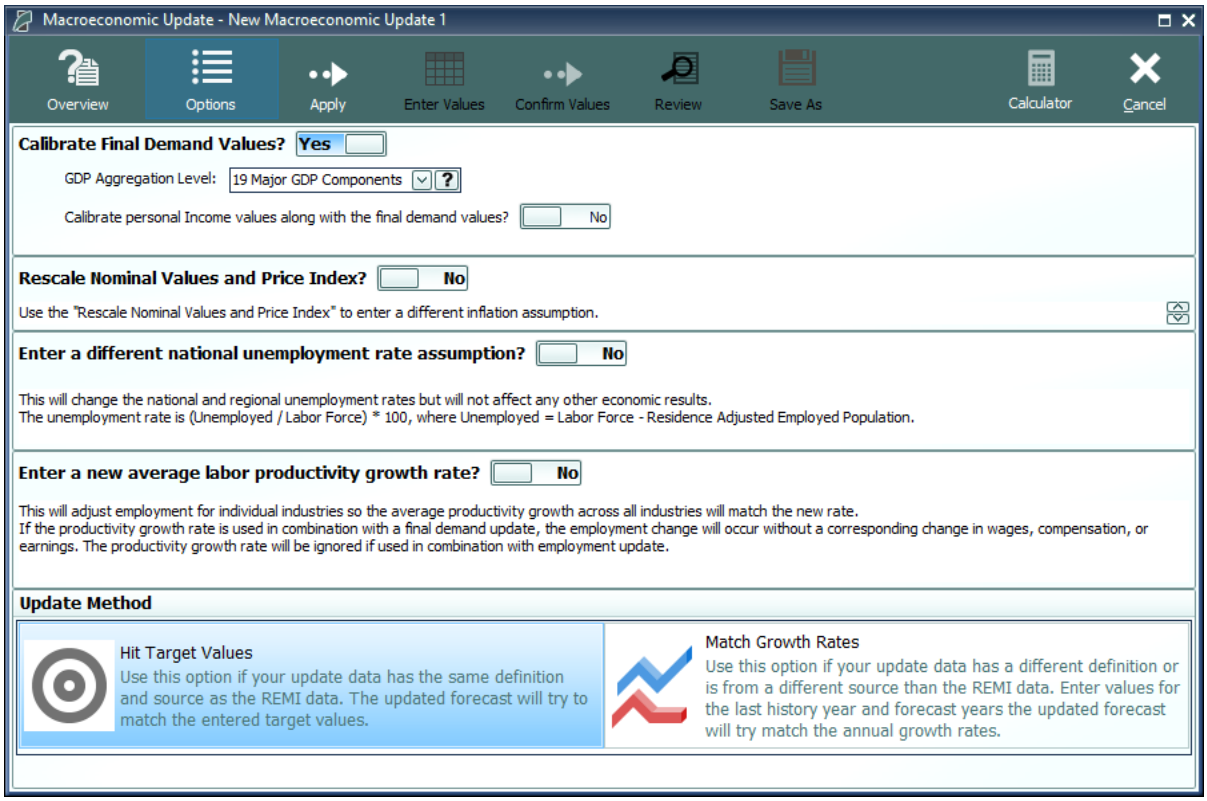


Figure 47: Macroeconomic Update - Options

National Demographic Assumptions

National Demographic assumptions allow for modifying various demographic aspects of a national forecast. Alternate values can be entered for birth rates, survival rates, international migration, and participation rates. These custom national demographic values must be entered by gender, race, and individual age group. A description of a national demographic assumption can be added using the text field on the top left of the form.

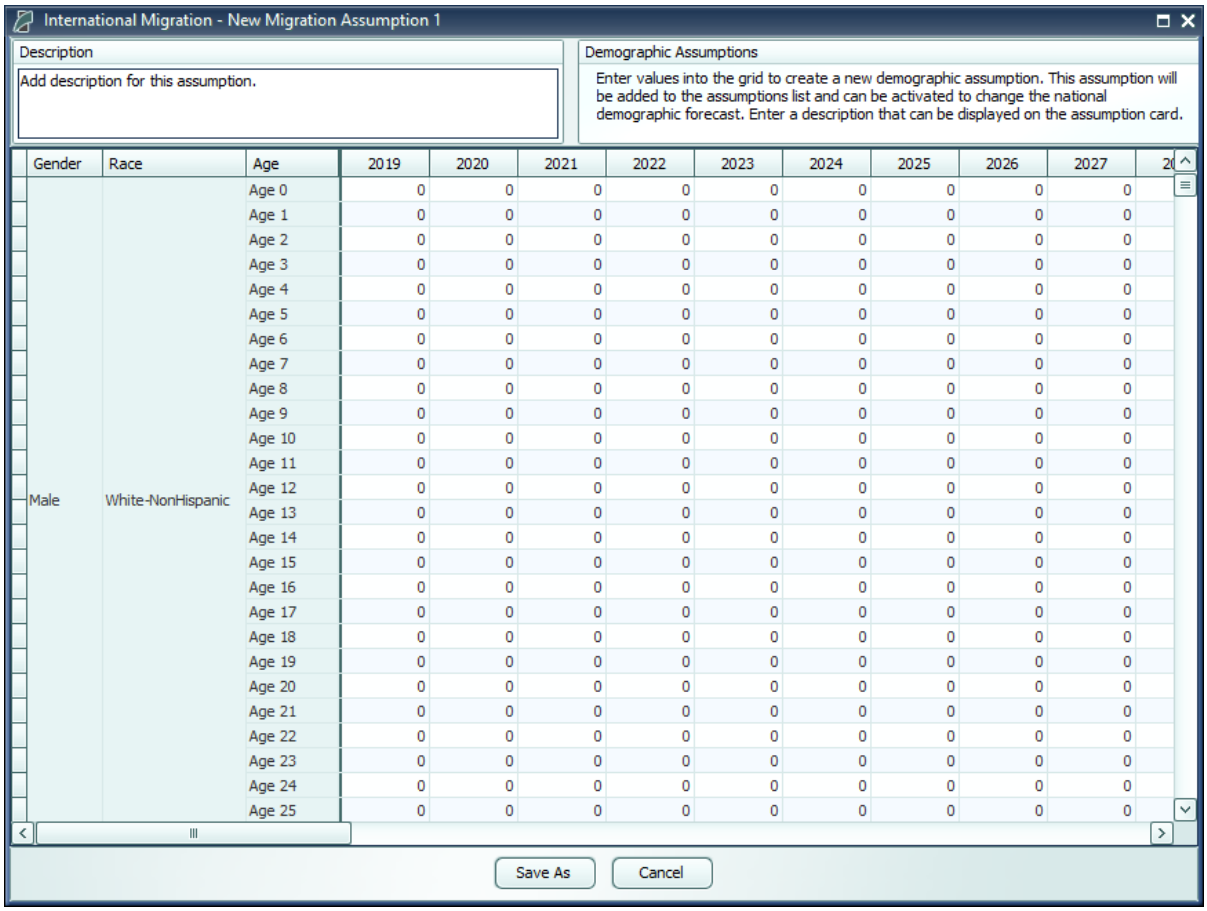


Figure 48: National Demographic Assumption

Alternative Model Settings

Different pieces of the REMI model's structure are linked together in certain ways as our best means of approximating of how the real economy generally works. In some cases, you may find that the model would better match a particular real-world scenario if some of these connections behaved differently or were removed altogether. Using the Alternative Model Settings, you can do just that by changing certain settings that control various interacting parts of the model. Depending if you are creating a national or regional control, there are different settings that are available. Certain pre-defined alternative sets of settings exist that REMI has found to be useful in the past. When making your own custom alternate model settings, simply toggle any of the on-off switches to enable or disable that particular model response. A few settings are actually parameters to model equations that can be modified. Each of these has an alternative set of values that can be viewed and selected for substitution. The default housing price and land price coefficients can also be substituted for custom values. Any setting that has been changed from the REMI default value will be highlighted for easy differentiation. Information buttons containing setting descriptions are present next to every setting.

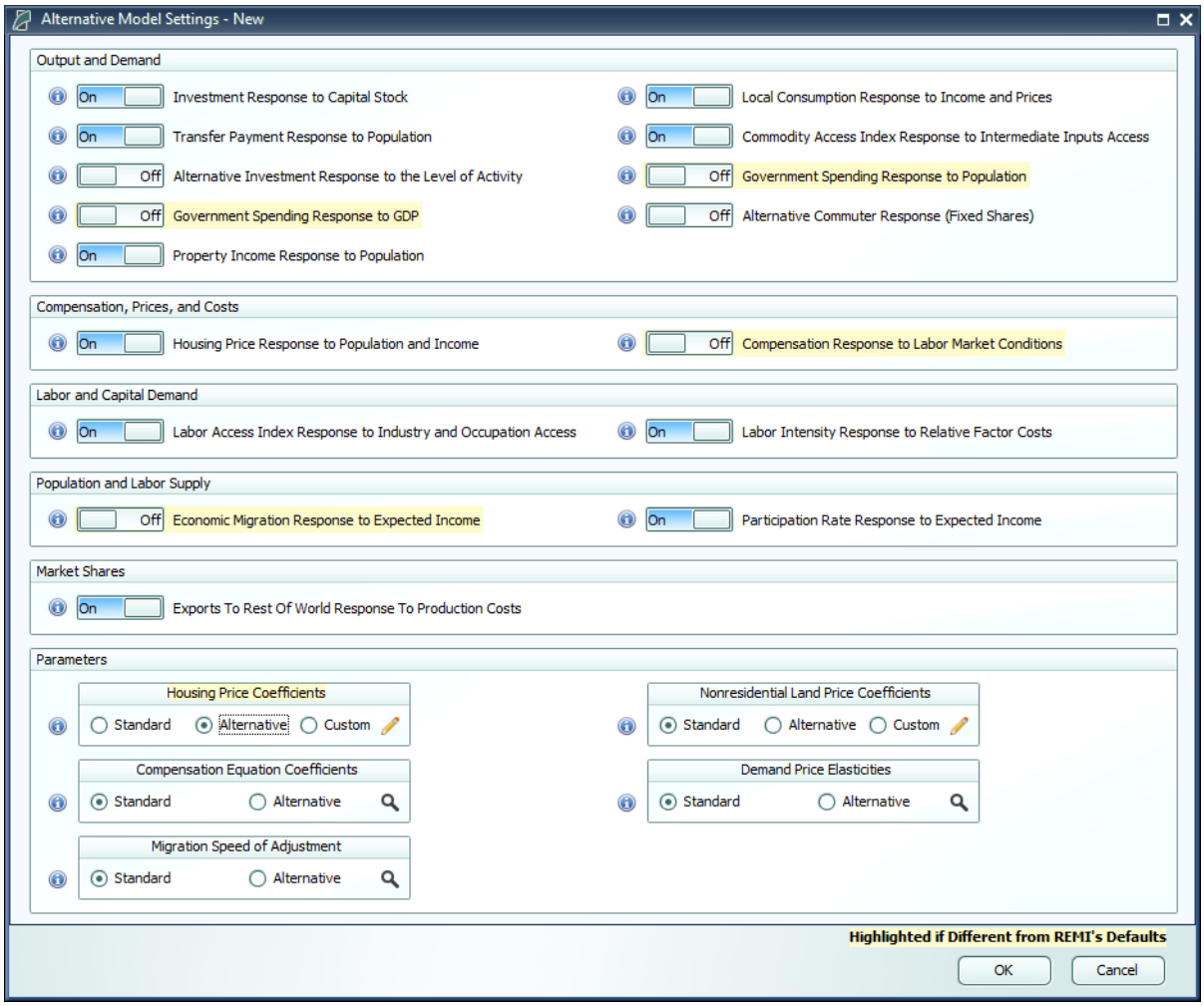


Figure 49: Alternative Model Settings

Inputs List

The Inputs List is a screen that displays the policy variable groups and contained policy variables that will be included as inputs to the model as it runs. Expand any group to see the variables inside. Unchecking a check box in the **Active** column of the list will exclude the corresponding variable or variable group from the forecast run. Another feature of the Inputs List is the ability to inspect the converted versions of a given policy variable. While there are many different ways to specify any particular policy variable, only one format can actually be used by the model, so conversion is necessary. Clicking on the magnifying glass icon on a policy variable in the Inputs List will open this converted variable window. The **Tools** button stationed on the header of the Inputs List provides some useful functionality for selecting, merging, and deleting groups of policy variables from the list. Finally, any model assumptions that have been added to the forecast will also be displayed on this screen alongside a button for quickly editing them.

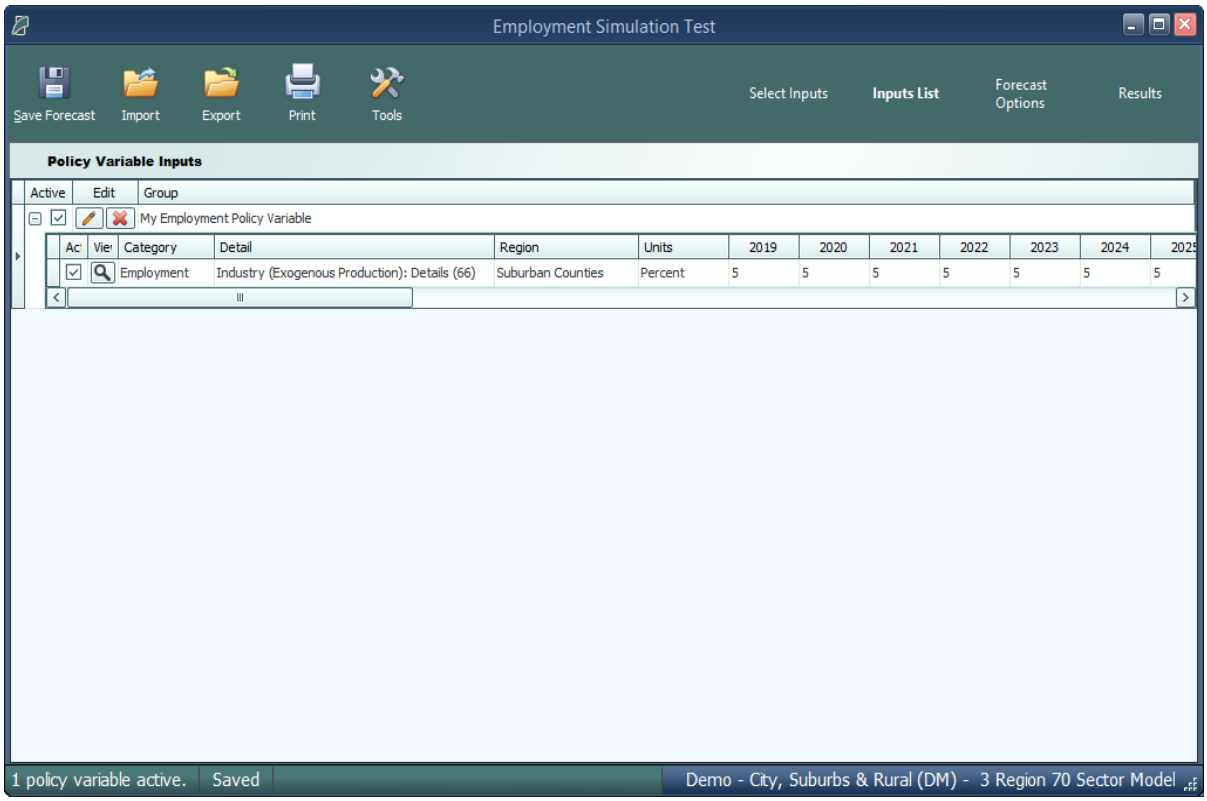


Figure 50: Inputs List

The policy variable import and export buttons are also located on the inputs list. Clicking the **Export** button will open the Export Center, which provides functionality for selecting which of the existing policy variables should exported. Likewise, clicking the **Import** button launches a file selection dialog, which, once completed, opens the Import Center. The Import Center offers similar selection functionality to the Export Center, but also has additional options for merging, duplicating, and clearing values from variables found in the export file.

Policy Variable Export and Import Centers

The Export and Import Centers are similar windows that provide a method for deciding which user inputs contained in the present forecast should be exported to a file or imported from a file, respectively. Simply check or uncheck checkboxes in the **Include** column to include or exclude variables.

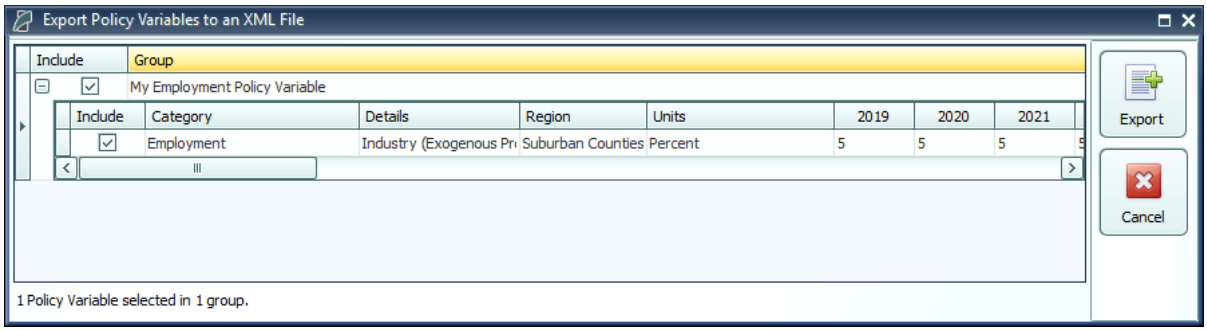


Figure 51: Export Center

Our current policy variable export files use the flexible XML format to store the wide variety of options that can be associated with all of our different types of policy variables. Unfortunately, XML files are not easily manipulated by hand or by third-party software. As such, when working with large numbers of variables for repeated forecast runs, we recommend creating one or more templates using the PV Selector and the policy variable group merging tool and exporting them. A template would then be a large policy variable group containing all of your required variables in the correct order and with the desired options to match the format of your values. Each use of a template then just becomes a task of opening the variable group in the PV Selector and pasting in values, rather than attempting to replicate the complex structure of the policy variables in our export files, which would be highly error-prone.

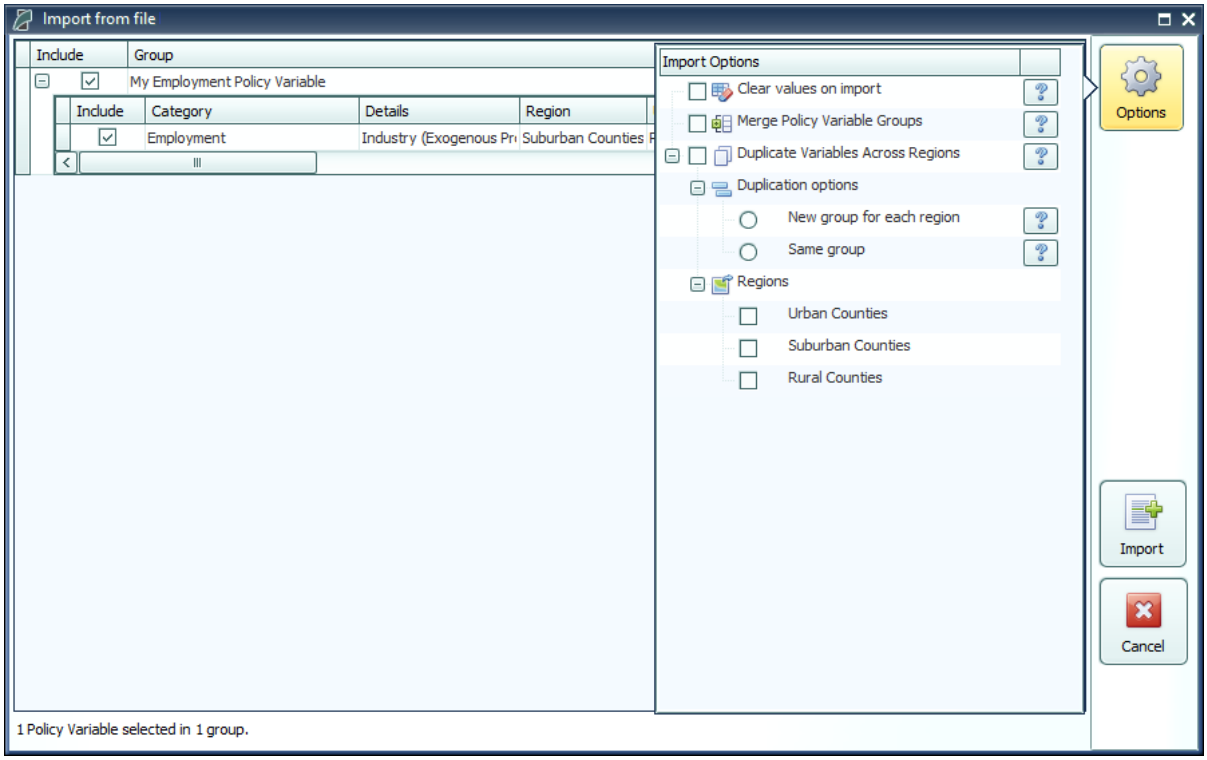


Figure 52: Import Center

Importing with the Import Center follows roughly the same process as exporting, but with more options. There are options for merging policy variable groups, clearing the values out of the variables, and duplicating variables across all or some of your model regions. In addition to the most straightforward form of importing: from an exported XML policy variable file, you can also import policy variables from a REMI workbook file. Use caution when importing from older versions, as your old variables may not perfectly map to new variables.

Forecast Options

Running a forecast takes place on the Forecast Options screen. Once you have finalized your policy variable inputs, you should make some final decisions about how the forecast should run. Depending on the type of forecast, some different options will be available including closure options and iteration settings. Regardless of the forecast, there will be frequently asked questions and answers about the available run options right on this screen. The **Run Years** selector shows what years the forecast will run for. Not all forecast years up to 2060 will be available in all cases. If your forecast has a parent baseline control, only the years for which that control has run will be available. Once you have chosen your options, settings, and run years, simply click the **Run Forecast** button and the model will begin calculating results, as indicated by the pop-up run progress window.

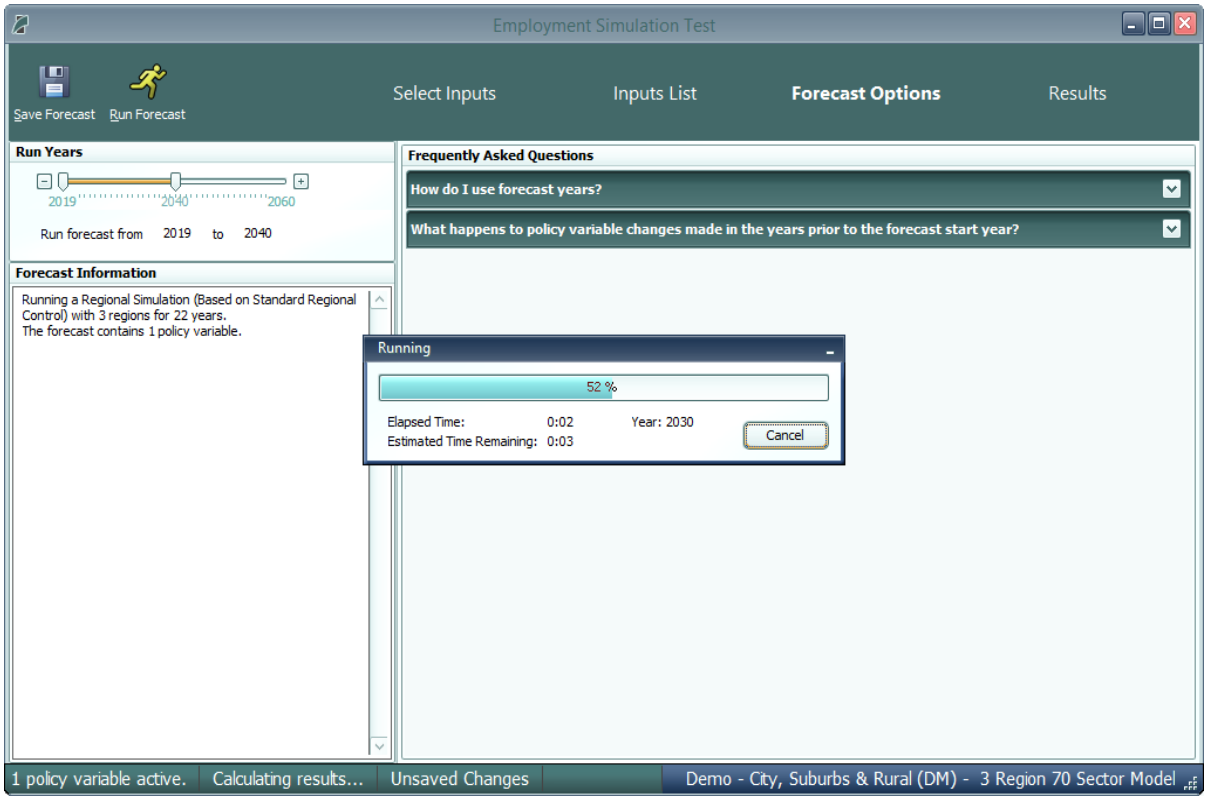


Figure 53: Forecast Options

Results

The Results section of PI+ contains all of the results of the forecast run that were produced by the REMI model. Result data are displayed in tables, maps, and a wide variety of chart-types. The main navigation bar, on the left side of the window, provides a means for accessing all of the different categories of result visualizations that have been created by REMI. These groupings put results together by concept and help to break up the huge amount of data into more manageable sections.

There are five layouts that are used for arranging visualizations among the different categorized sections of the Results screen. The first, which is visible in **Figure 54**, is the gallery layout mode. In gallery mode, one visualization takes up the majority of the space on the screen and the remaining visualizations belonging to the same group are previewed on a scrolling list of tiles on the right-hand side of the screen. This tile list can be dragged with the mouse, scrolled by mouse wheel, and scrolled by hovering your mouse near the top or bottom visualization and clicking on the arrow buttons that appear. Clicking on any preview tile will slide that visualization into the central, focused view.

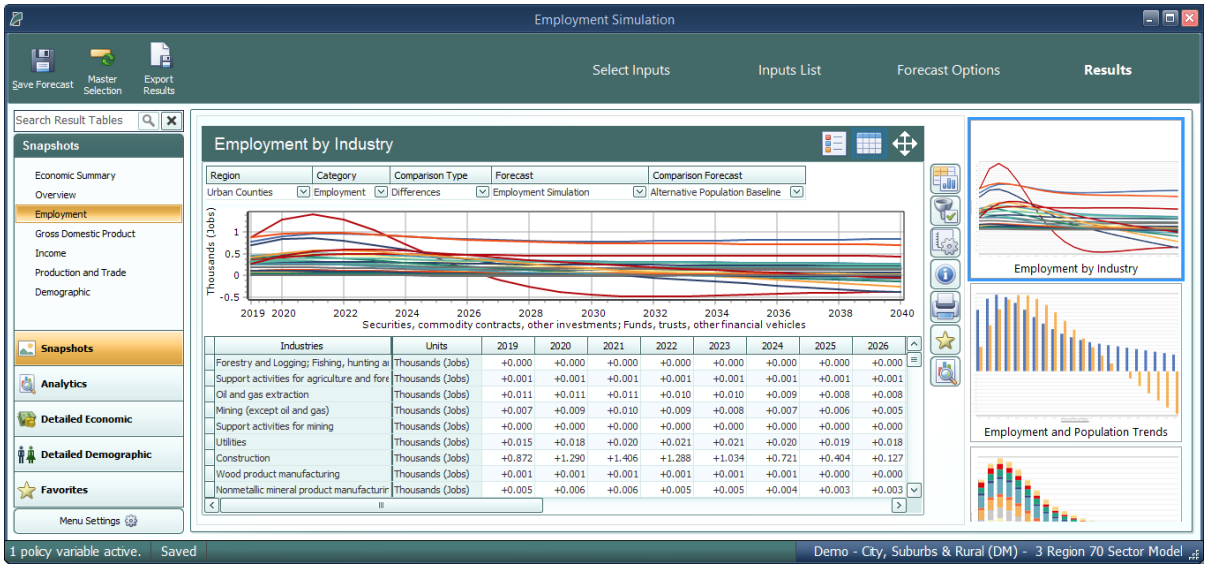


Figure 54: Results – Gallery Mode

The next four visualization layout types each look quite different, but all function in very similar ways.

The Model Linkages view, shown in **Figure 55**, consists of an interactive diagram that depicts the various links that interconnect different parts of the economy in the REMI model. Any of the outer or inner blocks of the diagram, when clicked, will bring forward a group of related results tables.

Other result categories use tile and list layout modes. These two organizational modes simply contain a list of concepts, hierarchically structured in the case of list mode, where each concept has its

own tile or list item that links to the corresponding result table. Examples of these two modes are displayed in **Figure 56** and **Figure 57**.

Model Linkages, tile mode, and list mode share similar functionality once you have selected a concept for viewing of its results. Depicted in **Figure 58**, you can see that the selected result table is shown by itself as part of a tabbed view. The tab bar along the top of the visualization area allows for quickly switching to view any of the other tables included in the same model block, tile group, or list section. The tab bar can be scrolled left and right using the respective on-screen arrow buttons. To go back to the starting view, use the back button on the top left. There is also a row mode which can show multiple rows of visualizations with multiple visualizations on each row.

The fifth and final layout used on the results screen is row mode that is used on the customizable Favorites section of the results. As shown in **Figure 59**, tables and visualizations appear to the right of their group name and description. To enlarge a visualization for further viewing, click the button with four direction arrows on the top right corner of any visualization. You can shrink the visualization to return to the rest of the rows view by clicking the top right button again.

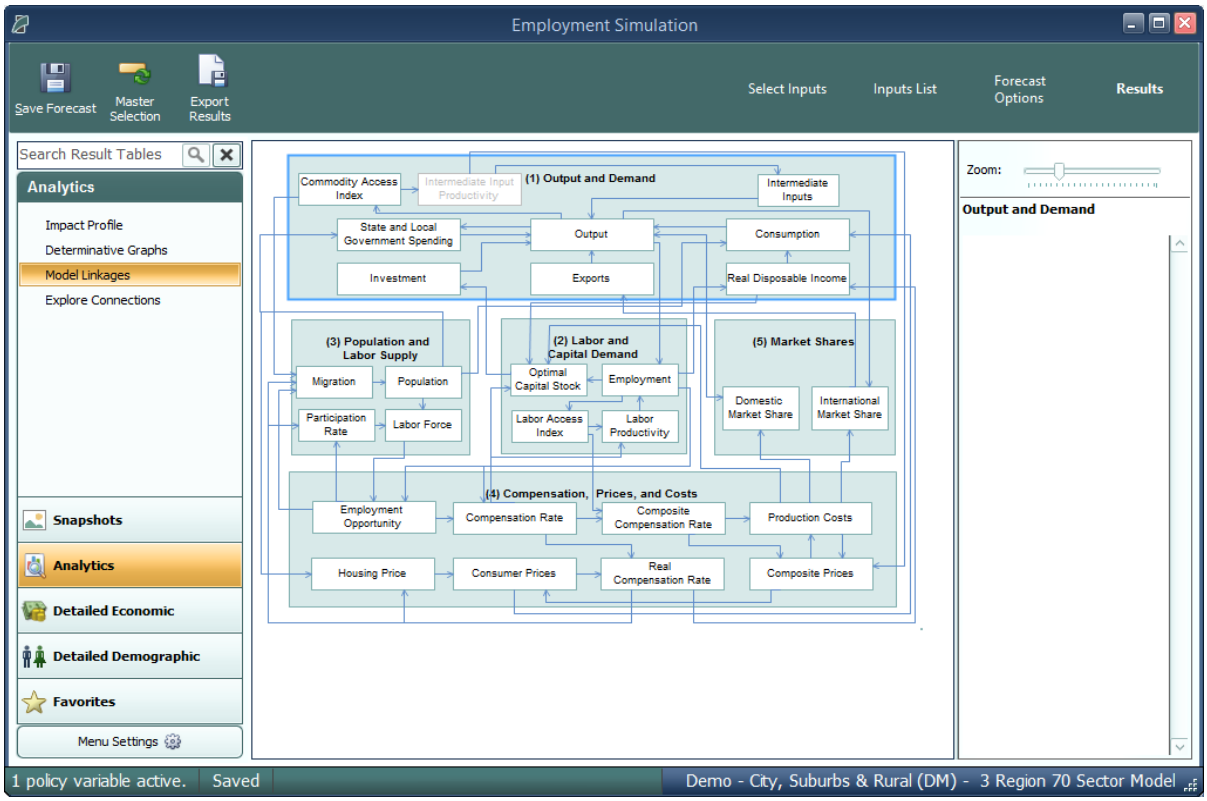


Figure 55: Results – Model Linkages

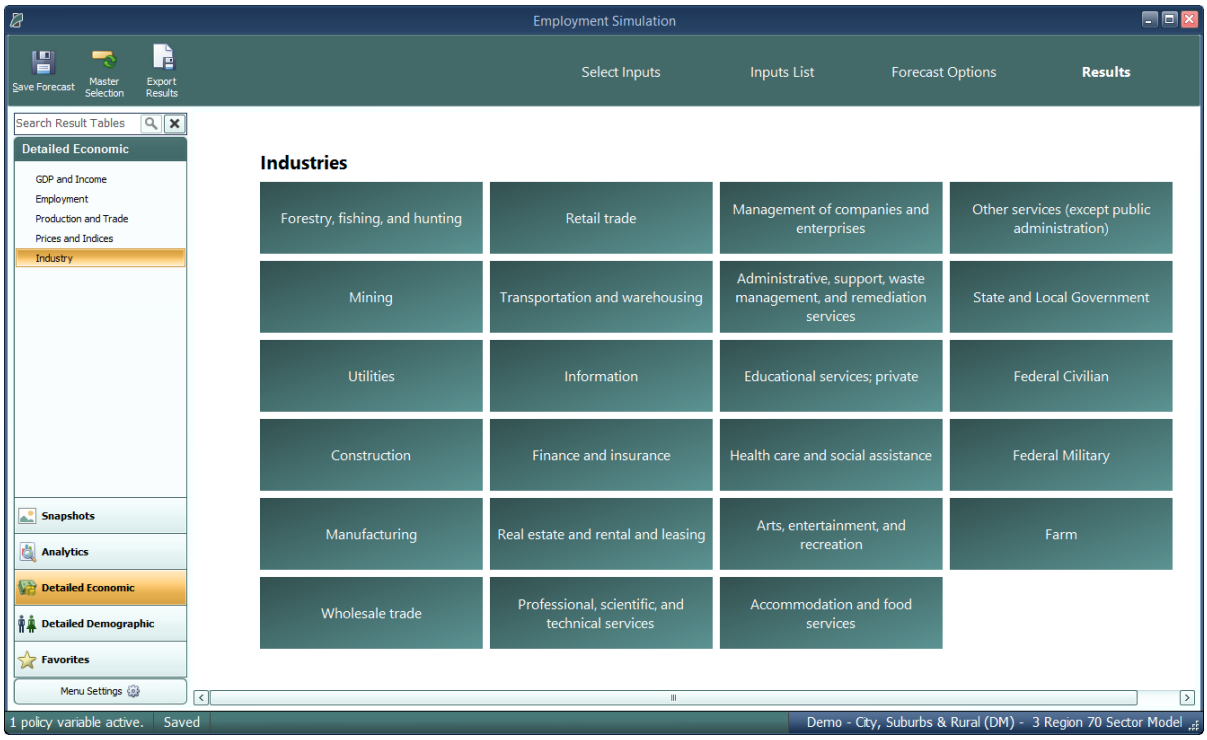


Figure 56: Results – Tile Mode

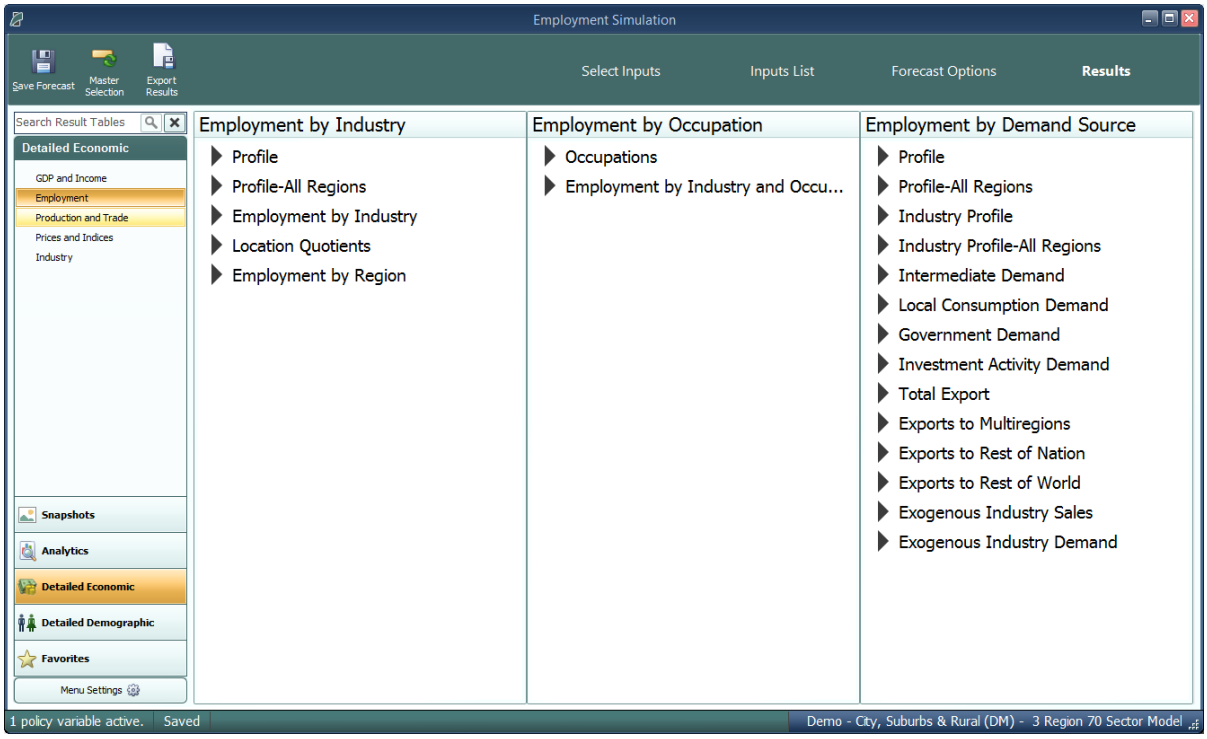


Figure 57: Results – List Mode

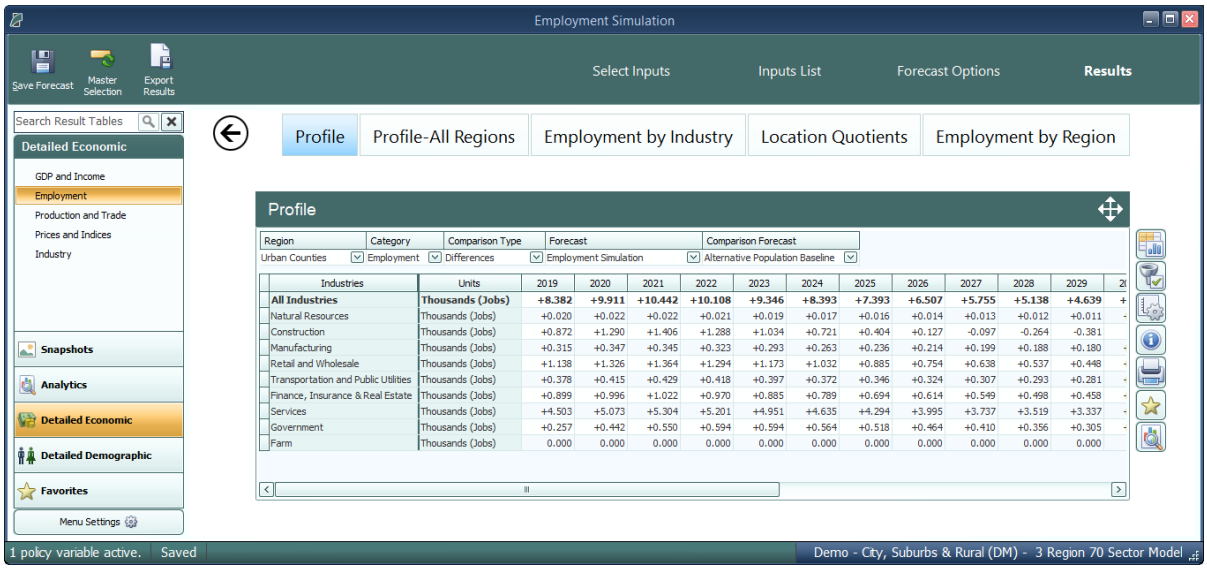


Figure 58: Results – Tabbed View

Figure 59: Results – Rows View

Results Preferences

You can change what types of options are visible in the main navigation bar by clicking **Menu Settings** at the bottom of the bar, as shown in **Figure 60**. Using the dropdown menus, each group of options can be specified to appear in all forecasts, no forecasts, control forecasts, or simulations. The **Default** setting will revert an option to the forecasts it appears in when you first begin using

the model (e.g., Profiles and Snapshots will only be visible in controls and simulations, respectively.)

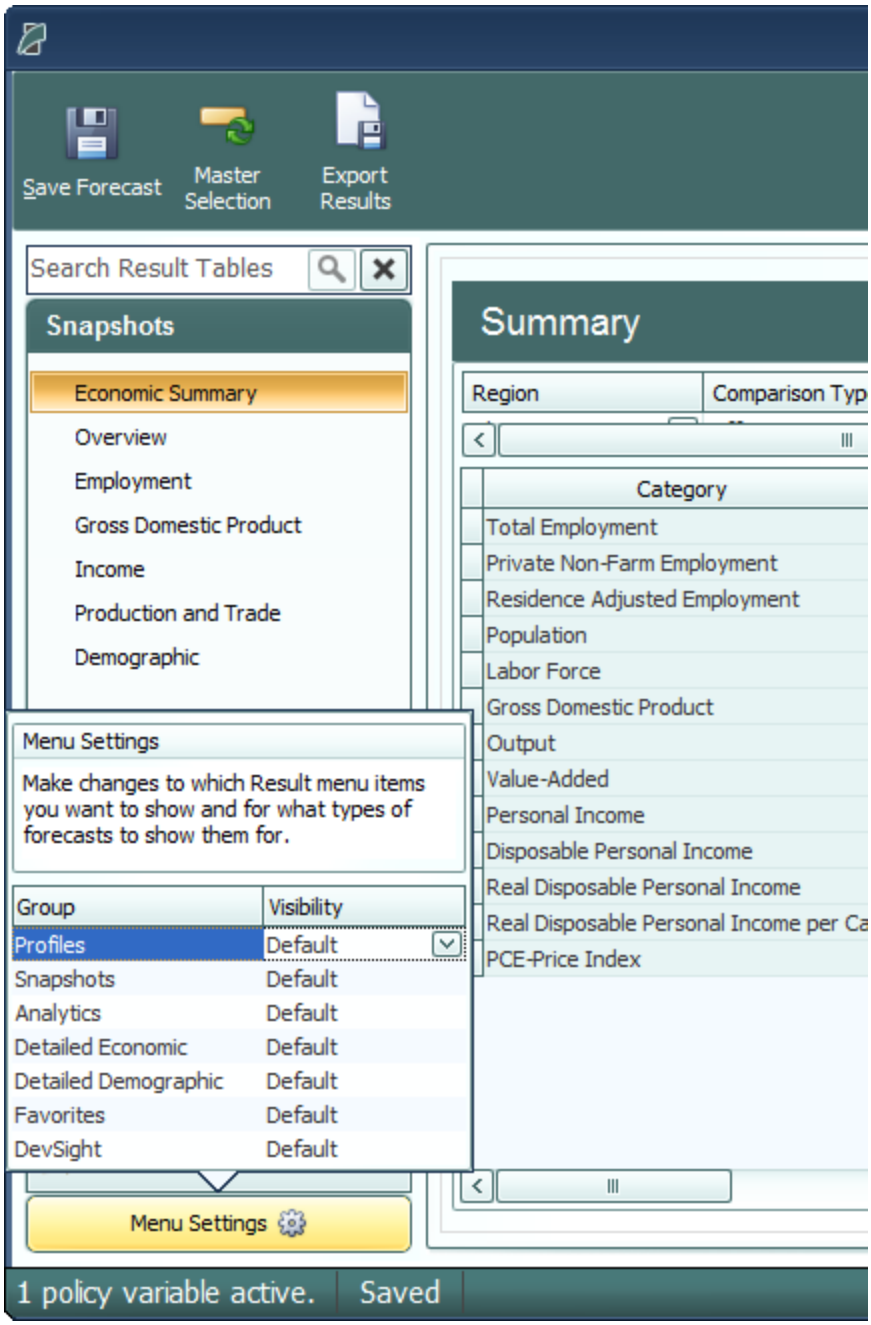


Figure 60: Menu Settings

Favorites

The Favorites section is intended to allow users to build their own preferred tables, charts, and maps and arrange them however they would like. Favorites are saved and can be viewed for every forecast that you run. To add a new favorite group, select the **Favorites** group on the main

navigation bar and click on the **Add a New Favorite** button. After prompt to name the new favorite group, a table creation tool will launch.

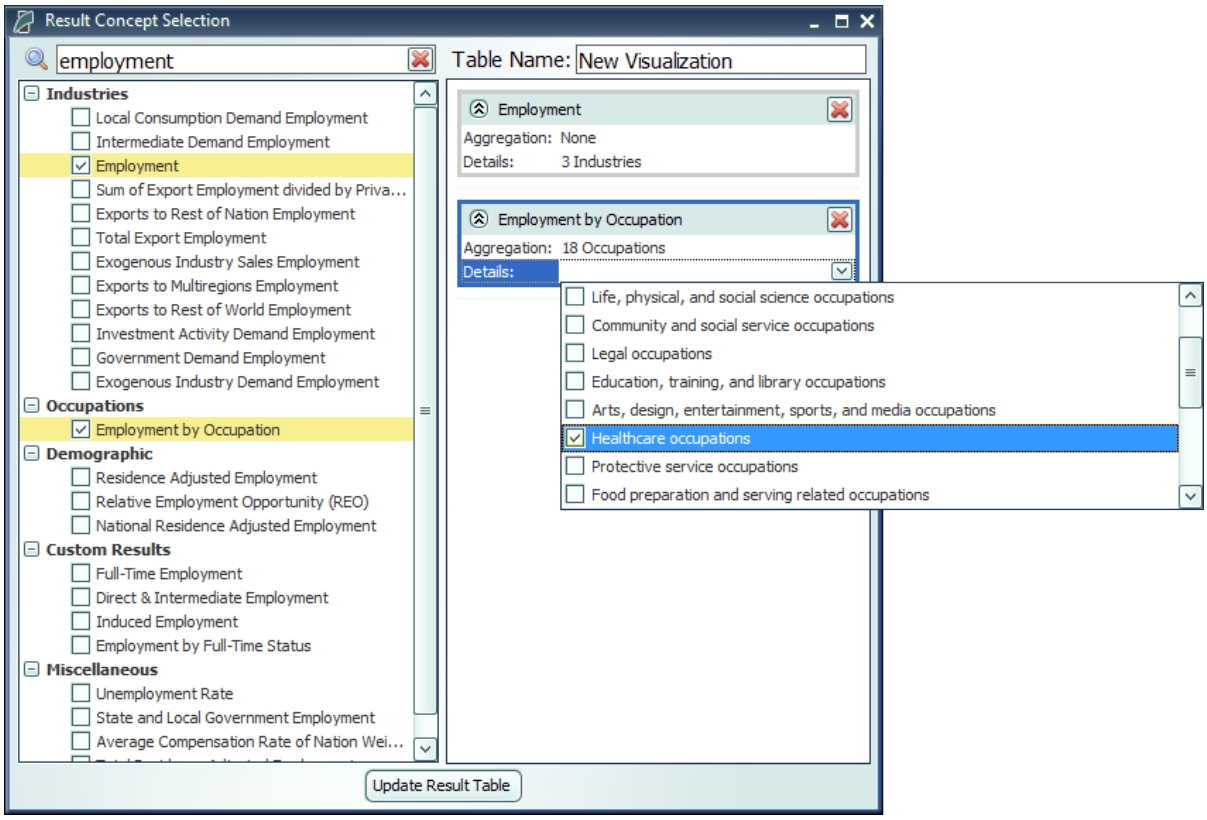


Figure 61: Result Table Creator

The table creator features a full list of every result concept available to the current type of forecast, sorted by detail category. Use the search bar to filter down the long list. Selected concepts will be displayed in the list on the right for ease of keeping track of what has been selected, removing any no-longer-wanted concepts, and lastly, for specifying further information about selected concepts in certain situations. More information will be required when multiple concepts are chosen to be added to a table and they do not all have the same detail category, for example if one variable has industry details and another has age, race, and gender details. In this case, the resulting visualization will need to display values for each concept and a fixed individual detail, like Employment – Construction rather than general Employment with a combo-box filter for switching the industry. Each selected detail can come from an aggregation, if desired, and ultimately will be added to the finished table as separate line item.

After a new favorite group is created, it will appear in the Favorites section of the main navigation bar. When the favorites group is selected, two buttons will appear next to it, one to delete the group and one to open the **Favorites Editor**. The Favorites Editor can be used to customize the favorites group. It can be used to add, remove, or reorder visualizations and change the layout style. Visualizations can also be arranged in groups which will have a different effect depending on the layout type. In gallery mode, each group will appear on a separate tab, in row mode each

group will appear in a separate row, in list mode each group will appear in a different column, and in tile mode each group will form a separate tile group.

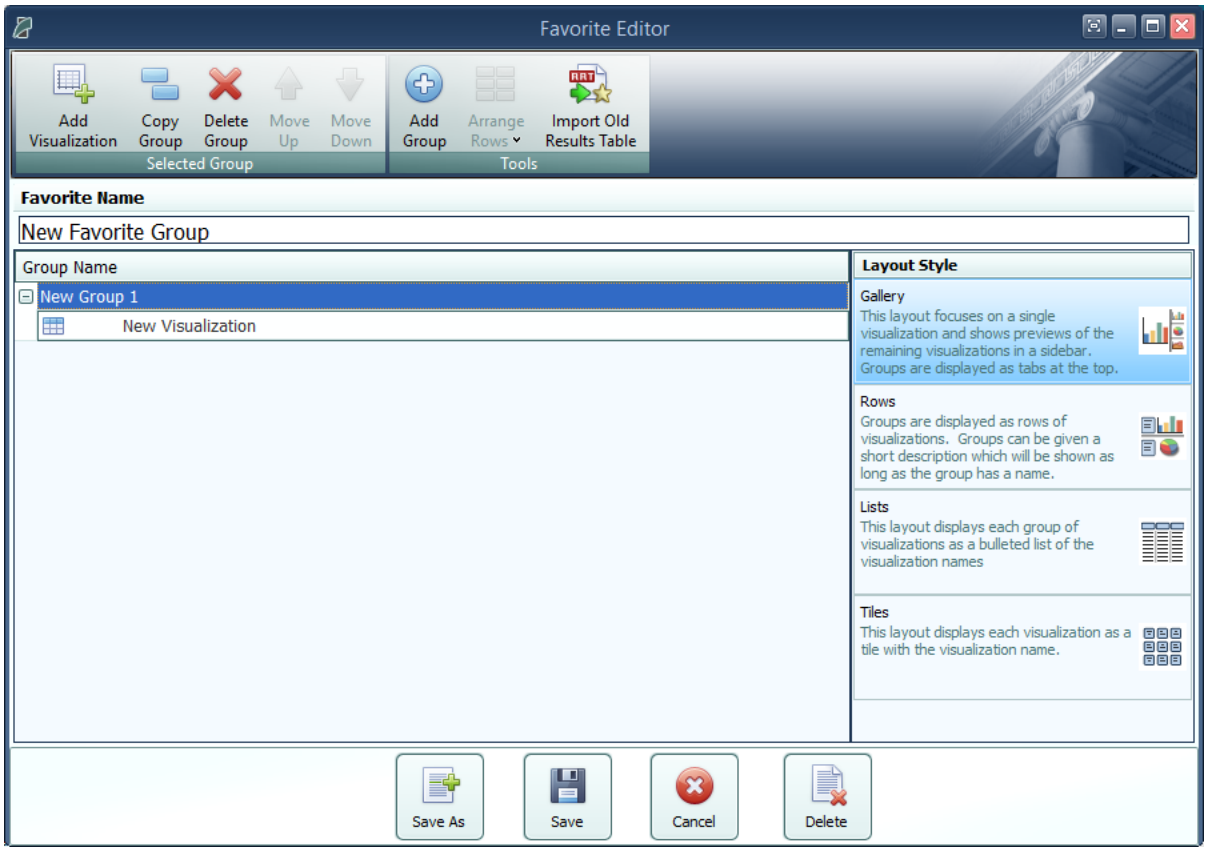


Figure 62: Favorites Editor

Favorite visualizations have a button on their title header panel that will let you re-open the table creator to adjust their contained data. There are several more options for Favorites that are described in the section below in the context of the many options available for interacting with visualizations.

Interacting with Visualizations

As you navigate the results and click around on visualizations, you will notice that a group of six buttons consistently appears to the right of the most recently selected data visualization. These buttons provide important ways of interacting with the selected visualization. The first three buttons each open pop-up menus that respectively allow for changing the chart-type, modifying the included data, and updating the visualization's settings. The fourth button opens a pop-up text field containing a description of the result concepts currently included in the visualization and the fifth adds a copy of the selected visualization to the Favorites. The last button will open the visualization in the **Explore Connections** tool.

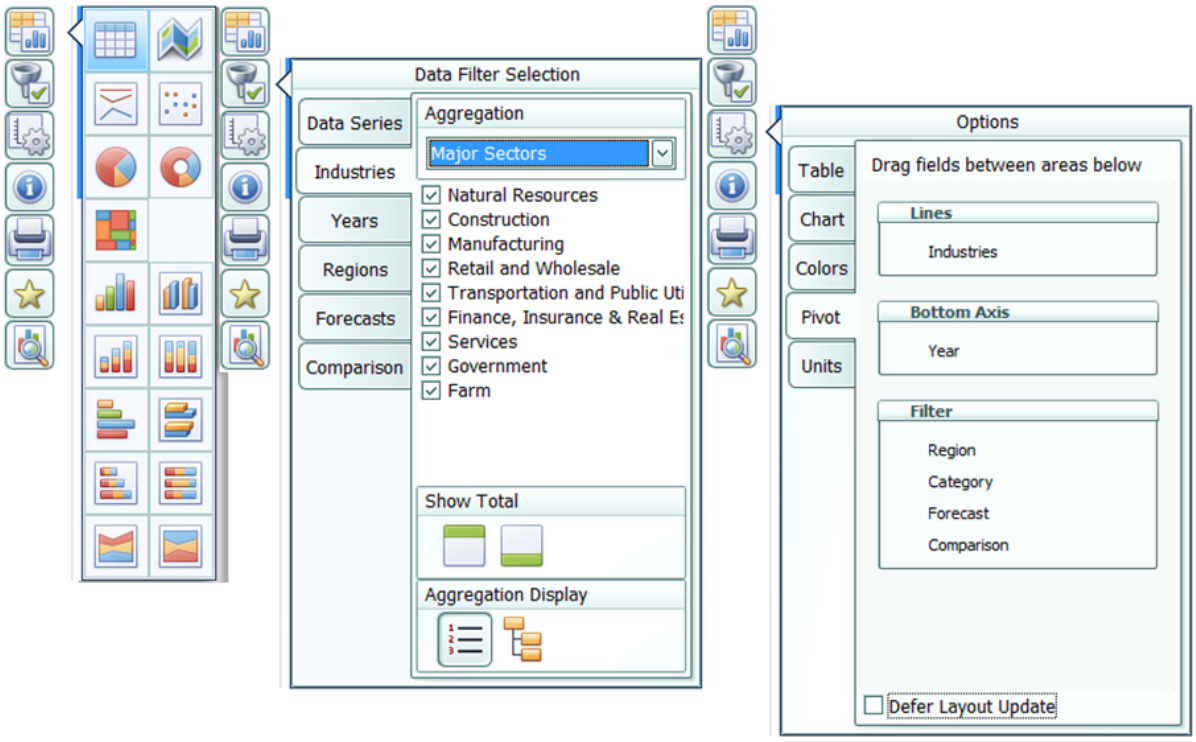


Figure 63: Data Visualization Interaction Buttons and Menus

The chart-type menu lets you switch a visualization between showing a table, map, or fifteen different types of charts. Once you have selected a chart-type option, another menu will open that lets you choose between each of the different ways your data could fit into the new type of chart, with visual previews of each of the available configurations.

If you want to change what data is being shown on a visualization, look in the data selection menu accessed using the second button from the top with the filter icon. This menu has several tabs that each focus on a separate aspect of the data included in the visualization. In the data series tab, you can toggle whether any of the included data series are visible in the chart, remove them altogether, and add new data series using the result table creator. On the other tabs, which vary depending on what details are associated with the data series being displayed, you can change what details are being shown. You can choose to hide or show each region, year, comparison forecast, comparison method, and other detail. There are also options for changing the aggregation level of the displayed details, adding totals, and introducing hierarchy to the layout of the result table in order to see values for multiple aggregation levels at the same time. It is also possible to access the filtering options by right-clicking on a column header in the grid, this will pop up the filter options specific for the field that column represents.

The options menu, shown furthest to the right in **Figure 63**, has a few more options for modifying the current visualization. For certain chart-types you can choose to enable sorting, pick alternate color schemes, and change the decimal precision of listed values. You can also change the displayed units and use the pivoting tool to restructure the chart entirely by dragging different

dimensions of the result data into the different pivot-able destinations afforded by the chart-type. For example, in the pivot menu shown above, industries are currently being displayed down the rows of a table, years along the columns, and the remaining detail types in the filter combo-boxes. This can be altered in any way by dragging these data dimensions between the different groups, although putting too many dimensions onto the rows or columns of a table or either of the two axes on a chart might cause the visualization to take a very long time to finish updating. It is also possible to pivot from the grid directly by left-clicking on a column header or filter combo-box and dragging it to the column or filter position you want it in.

There are several other ways of interacting with and modifying visualizations outside of the main visualization buttons. Master selection, which is located at the top of the window on the header panel, should be turned on when you would like to make changes to all visualizations at once such as changing the focused region or selecting the visible years. Another useful feature is the full-screen button. This button can be found on the top right corner of any visualization's title area and will toggle full-screen mode for that visualization. When viewing charts or maps, a **Show Table** button appears next to the full screen button that will show a table of values that correspond to the displayed chart or map.

Searching for Result Tables

Toward the top left corner of the results screen is a search bar where you can search for names of tables and visualizations in your forecast. The results search is intended to be used to search for entire tables and visualizations rather than individual result variables.

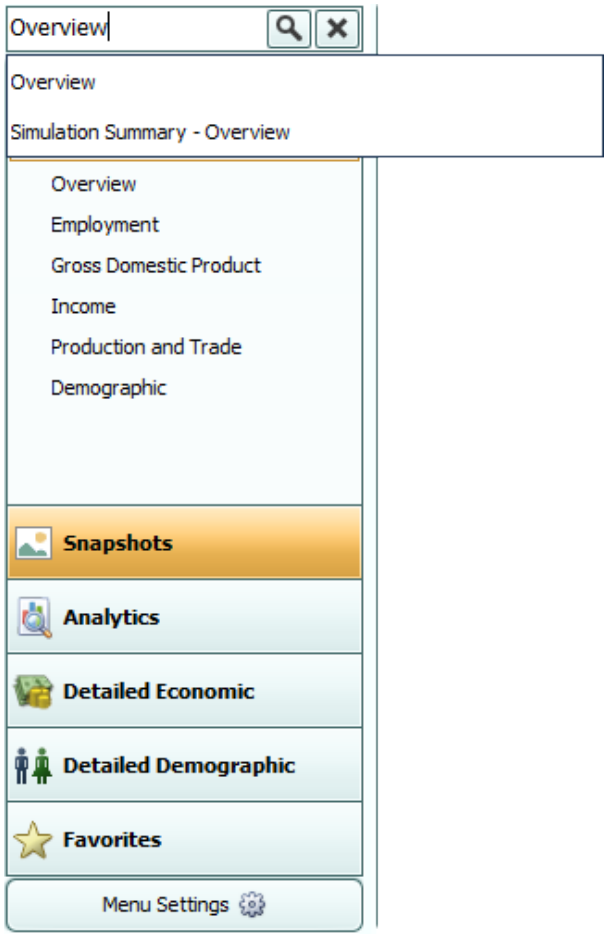


Figure 64: Results Search

Conditional Formatting

You can use conditional formatting to visually categorize results in tables. You can find conditional formatting in any forecast by clicking the **Options** button to the right of any table and viewing the **Table** tab. You will be able to choose color scales, data bars, or icons to automatically categorize your results into low, mid-range, and high categories. You can also click on **Top/Bottom Rules** to choose to highlight the top or bottom ten results in your table, all results that are above or below average, or all results that are in the top or bottom tenth percentile of the table. Tables will automatically clear themselves of all conditional formatting when you navigate away from them.

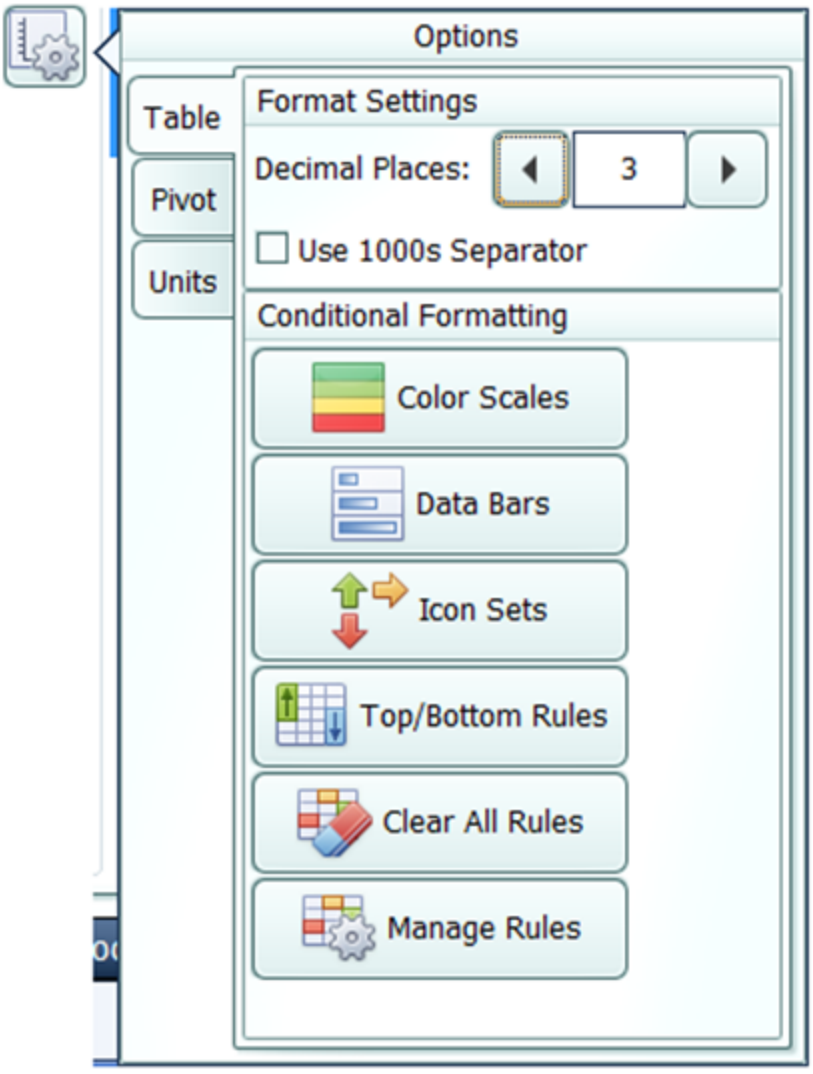


Figure 65: Conditional Formatting

Impact Ranking Tool

The impact ranking tool is a feature of forecast charts that can show where in the economy a policy will have the greatest or least impacts. To view charts that show the impact ranking tool by default, go to the Analytics panel in the forecast results and select the Impact Profile option. Over the top of the chart, click on the **Ranked** tab as shown in **Figure 66**. As shown in **Figure 67**, the tool will appear as a menu where you can select how many ranked items to show and what year of impacts to reference. For other charts, the tool can be made visible by clicking the **Options** button, navigating to the **Chart** tab, and selecting the order in which impacts should be displayed as shown in **Figure 68**. Impacts are ordered by magnitude (e.g., an impact of -5 jobs will be considered greater than an impact of 2 jobs.) Impact ranking is not available for certain chart types.

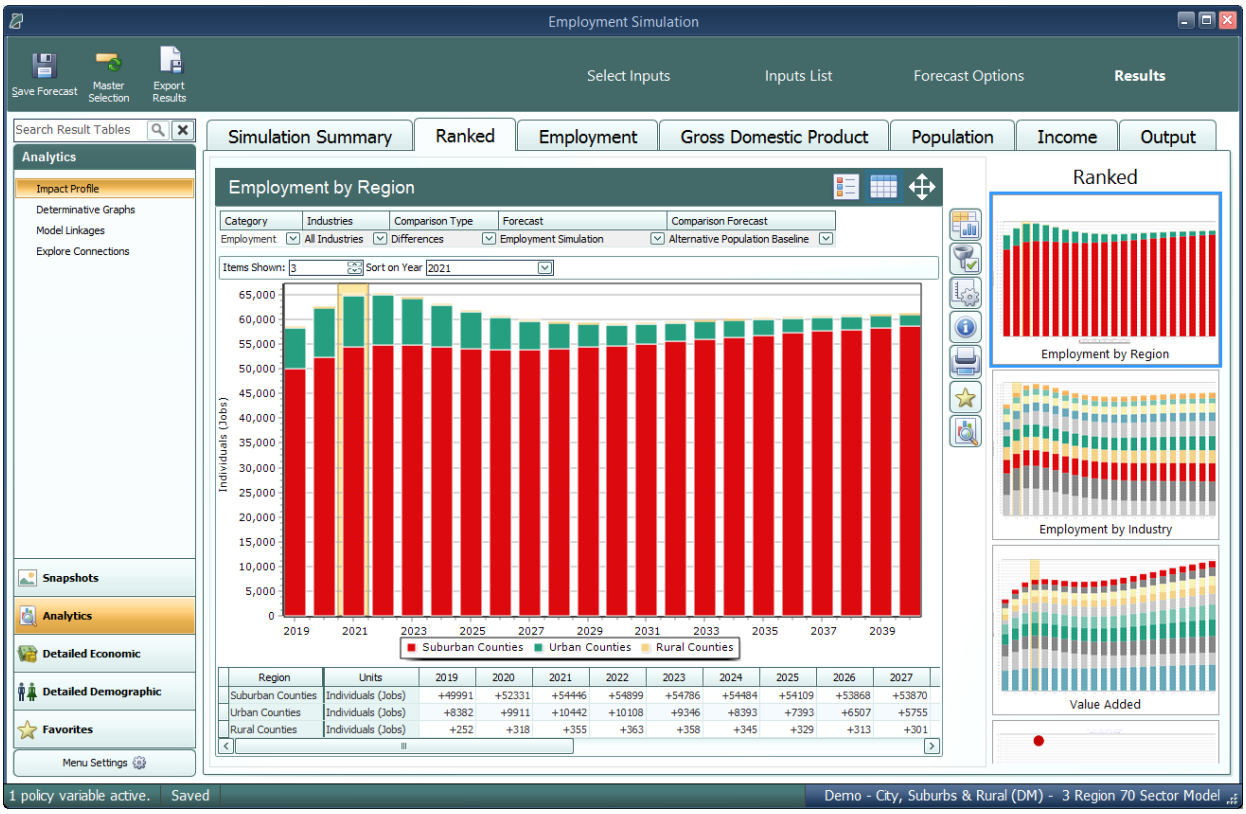


Figure 66: Ranked Visualizations

Figure 67: Impact Ranking Tool

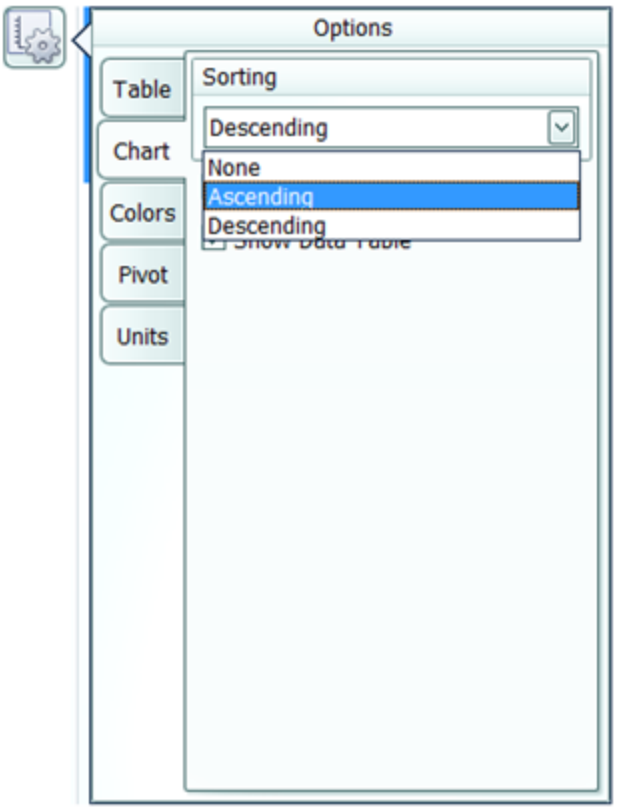


Figure 68: Making the Impact Ranking Menu Visible

Connections Explorer

The Connections Explorer is designed to allow you to go through the REMI model step-by-step to see the effects of individual policy variables. It will show you a policy variable or result that you have selected along with the other variables in the model that are connected to it. The Connections Explorer can be accessed in the Results section of regional forecasts by going to the Analytics panel and selecting **Explore Connections** as shown in **Figure 69** or by clicking the **View in Explorer** button to the right of any result visualization as shown in **Figure 70**.

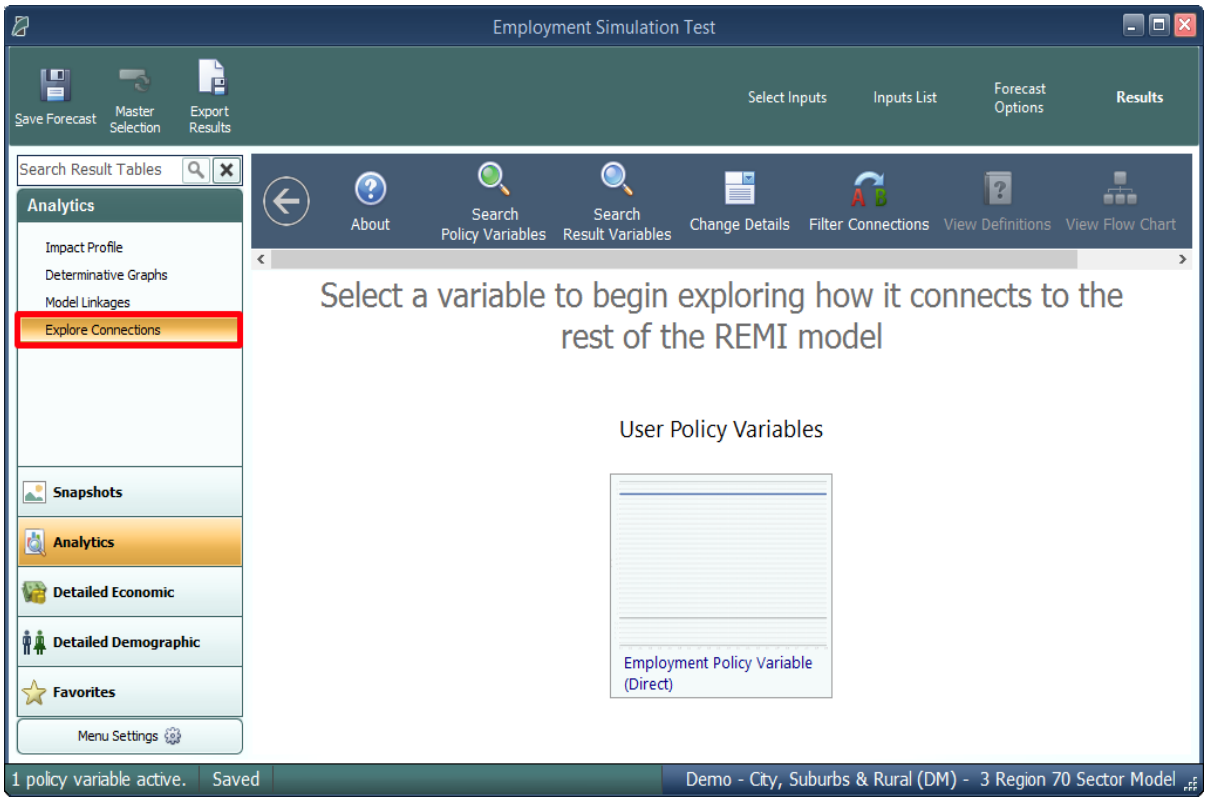


Figure 69: Opening the Connections Explorer

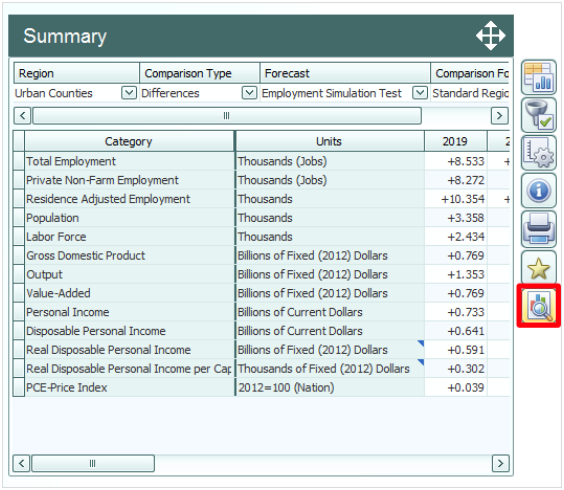


Figure 70: View in Explorer

As shown on **Figure 71**, the Connections Explorer contains graphs of policy and result variables over the forecast period. Clicking on the graph of a variable you are interested in will enlarge it. Once your variable is enlarged, the feature also displays a **Determinants** column that lists any variables that directly affect your variable and a **Dependents** column that lists any variables that your variable directly affects. To make changes to the details that are displayed for each variable, you can make changes to the dropdown menus just above the visualization. You can also make

changes to the details displayed and the detail aggregations used by clicking the **Change Details** button on the top bar.

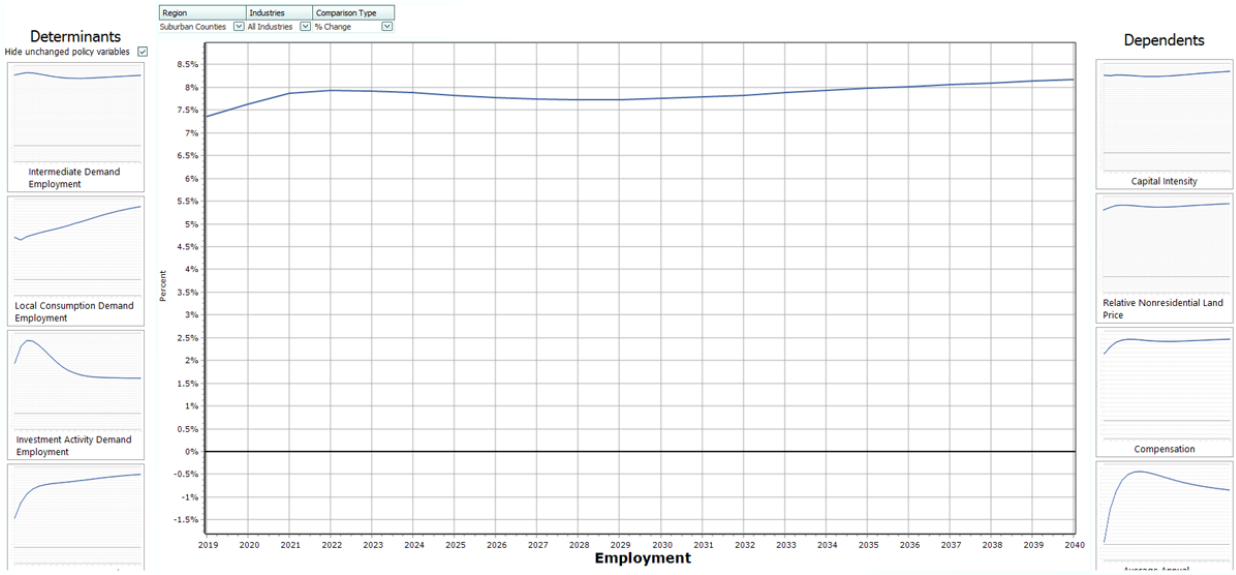


Figure 71: Viewing a Variable in the Connections Explorer

To search for a specific policy variable, click the **Search Policy Variables** button on the top bar as shown in **Figure 72**. You will be able to search for available policy variables with the search bar or choose from the list. The policy variables that are active in your simulation are listed first. Similarly, to search for a specific result variable, click the **Search Result Variables** button next to Search Policy Variables. You will be able to search from available result variables with the search bar or choose from the list.

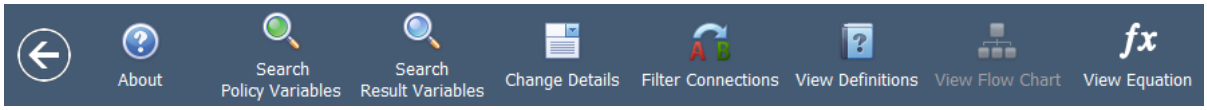


Figure 72: Top Bar of the Connections Explorer

To see how REMI defines variables, click the **View Definitions** button on the top bar. This will show you the definition of the variable you are currently viewing along with the definitions of any determinant or dependent variables being shown.

Equation Viewer

To see model equations that involve your variable, click on the **View Equation** button on the top bar as shown in **Figure 73** to open the Equation Viewer. Your variable that you are currently viewing will be shown in red. You can click on any variable in the equations to view its name, definition, and in some cases a **View Variable** button that will show you the graph of that variable along with its determinants and dependents.

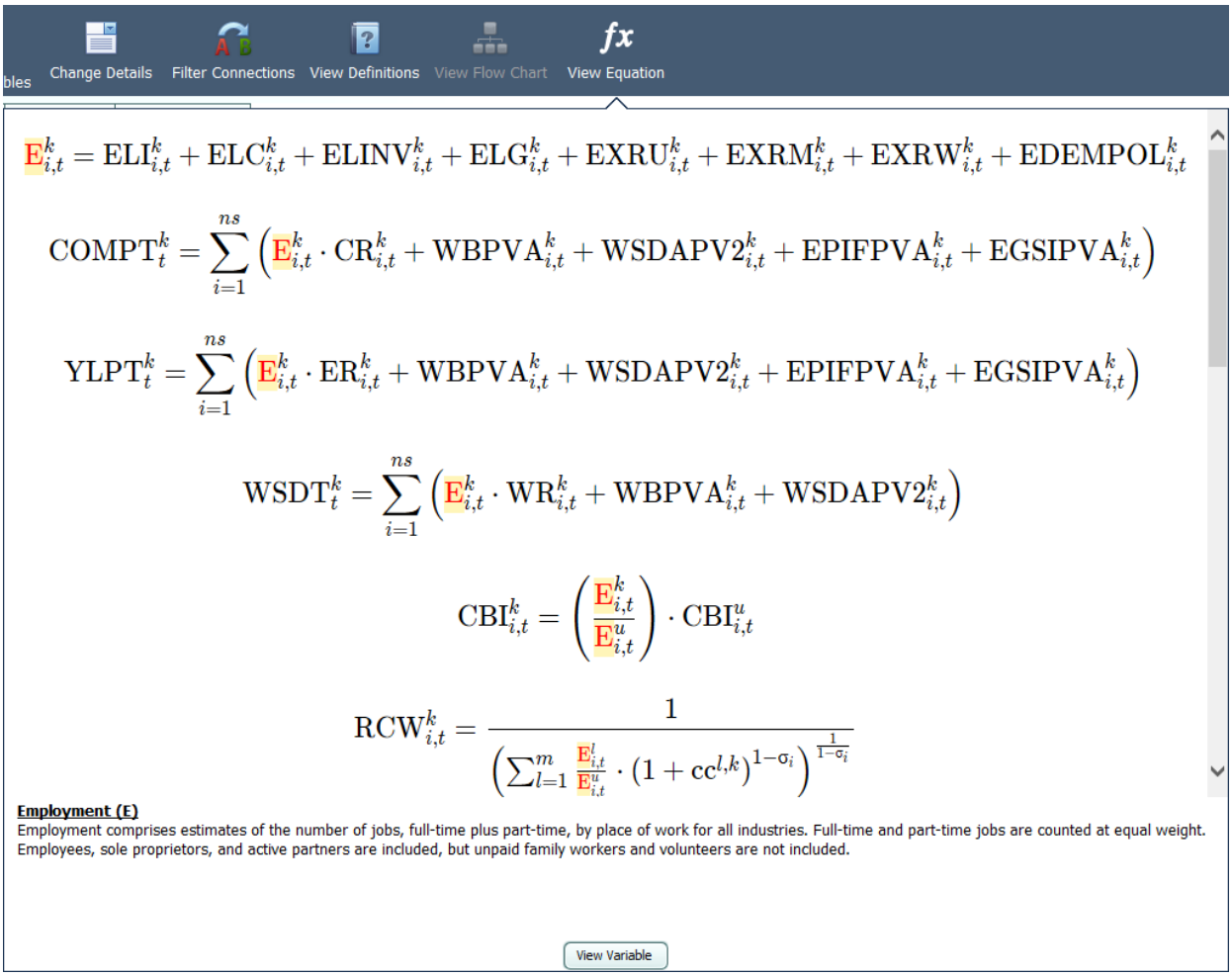


Figure 73: Equation Viewer

Stepping Through the Model

To view one of your variable's determinants or dependents, click on that variable in the relevant column. The visualization of that variable will be enlarged, and the Determinants and Dependents columns will be replaced with your new variable's determinants and dependents. To return to your old variable, simply search through the relevant column, where it will be outlined in blue. By clicking on determinants and dependents, you can "step through" the model and the interactions between variables.

Connections Explorer Filter

To automatically map out relationships between any two variables, click on the **Filter Connections** button on the top bar to access the Connections Filter, which is a search feature for linkages between specific variables. Type the starting and ending variables for the paths you want to map out. The Connections Filter will show a connections map which will represent up to 12 of the most direct paths between the two variables. Paths that are more than 20 variables long will not be shown. To view the entire map at once, press the **Zoom Out** button in the top left corner of

the map. To begin tracing through the paths between your starting and ending variables, click one of the **Apply Filter** buttons below the connections map as shown in Figure 66. You will then be shown your starting variable, and will be able to step through either all the paths that were shown on the connections map or the single selected path, with all other variable relationships filtered out. When you are done with the Connections Filter or would like to see all possible determinants and dependents for your variable and not just the ones found on the connections map, bring up the Connections Filter again and click the **Remove Filter** button.

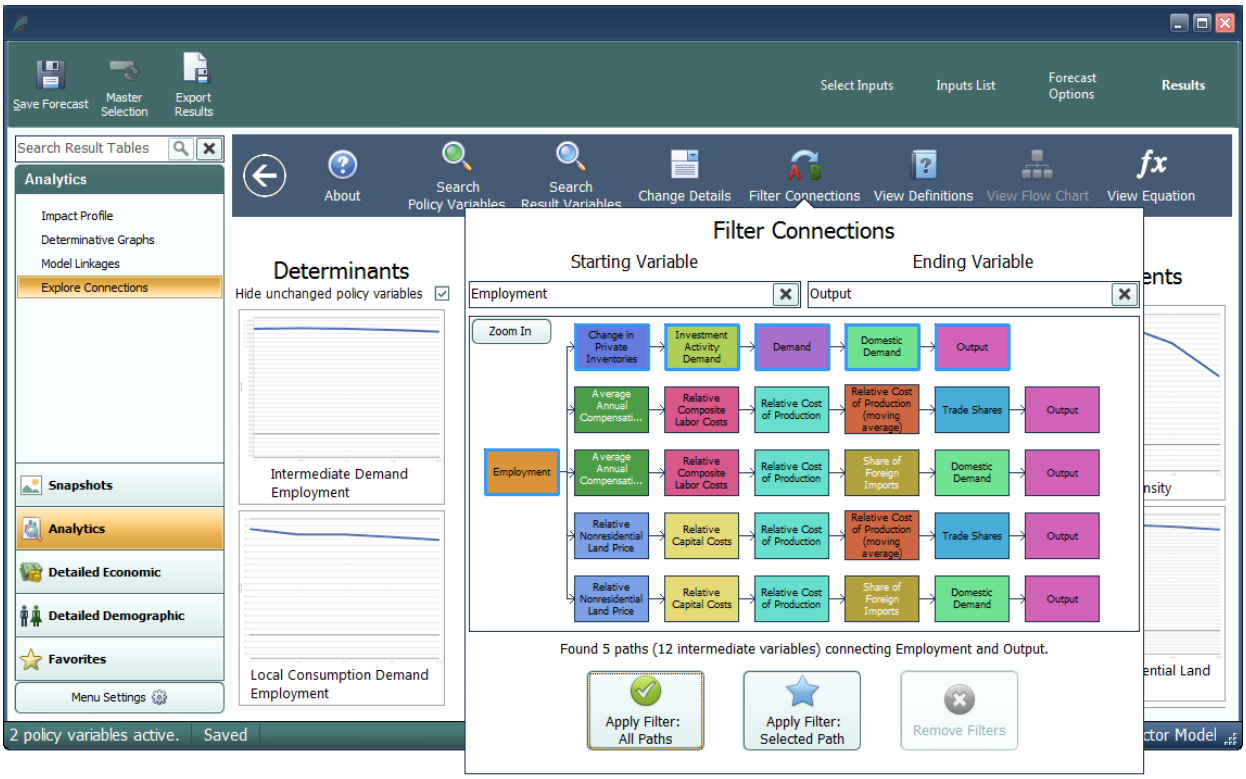


Figure 74: Connections Filter

Purpose of the Connections Explorer

The Connections Explorer shows you connections between policy variables and results, but in simulations with multiple policy variables active, it cannot isolate the effects of each policy variable. Exploring the effects of multiple policy variables at once will make the cause and effect relationships between policy variables and results become unclear and confusing, since there is no way of seeing which effect was caused by each policy variable. Because of this, we recommend using the Connections Explorer on simulations with a single policy variable active. The policy variable should be applied to only 1 region, 1 industry, 1 commodity, etc. A specific example of how the Connections Explorer can be used to solve issues in a policy analysis is given in the documentation.

Exporting Results

In order to export forecast results from PI+, you will need to locate the **Export Results** button on the navigation header bar, between the save and options buttons. This button launches the **Data Export Center**, which is the home for all result exporting. The interface of the export center has options for deciding what content should be exported, as well as the export file format, and some additional settings. When exporting multiple visualizations to an Excel Workbook, visualizations are each placed on a separate spreadsheet tab.

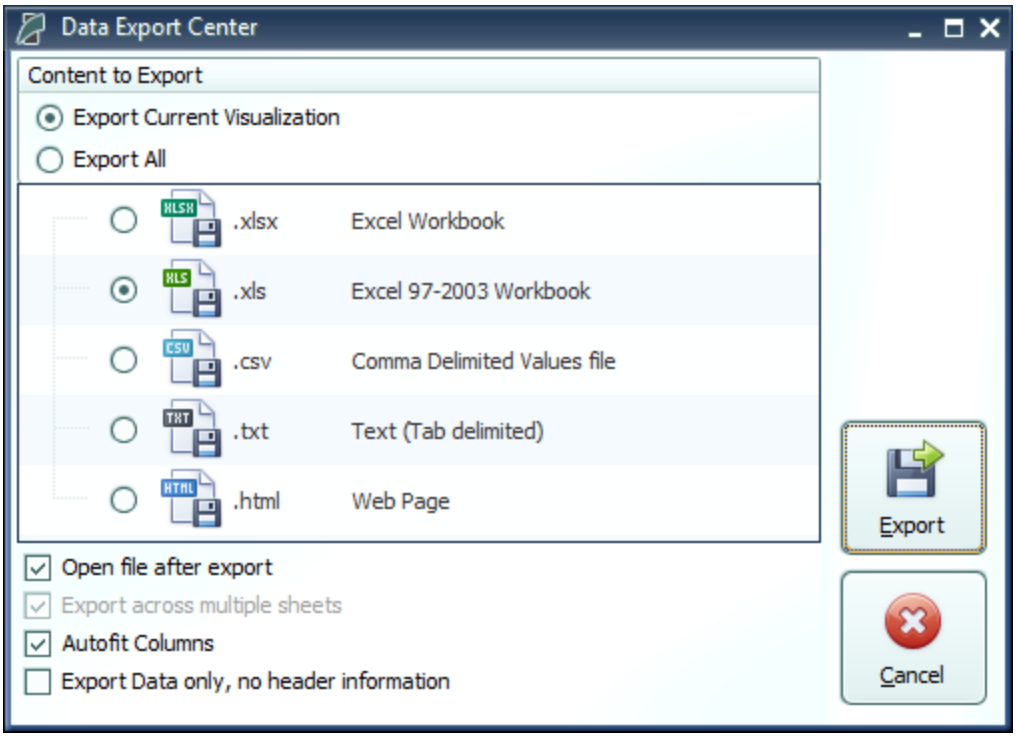


Figure 75: Result Export