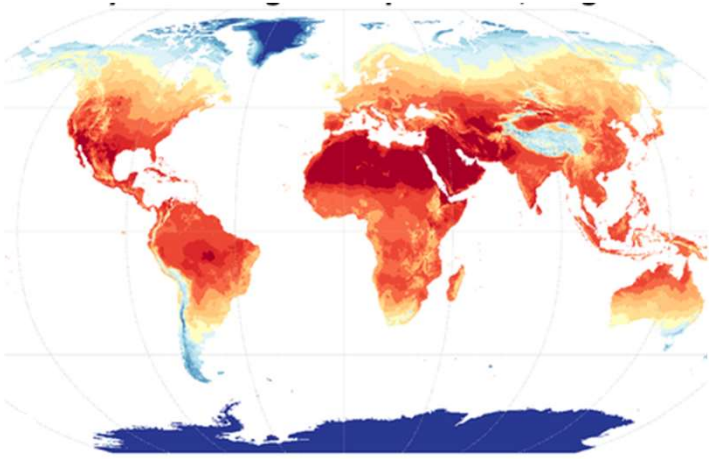
Augment Economic Contribution Analysis with a Semantic Model

Add Reasoning to I-O with Theory-Directed Semantic Decomposition



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Abstract

Studies describing the economic contribution of agriculture and forestry industries are common. Even though studies usually draw information from a common source (I-O), they can vary widely regarding the precise meaning of "economic contribution" or simply "contribution". Study-to-study comparisons are difficult because the *meaning* of contribution varies. This paper describes a method called "Theory-Directed Semantic Decomposition" (TDSD) that extends the common practice of structural decomposition applied to I-O and SAMs by including steps to identify characteristics that correspond to an extant economic theory such as economic base theory. This way, TDSD adds an explicit bridge between I-O data about contribution and theory-based knowledge about contribution. The augmented model, with added semantic layers of knowledge about contribution, can be investigated using multi-dimensional, semantic reasoning, and natural language querying tools. TDSD will benefit several use cases involving contribution analysis including learning/research, monitoring/reporting, and providing web-based analytical services.

Motivation

- Discussions and explanations of Economic Contribution studies are often conflated with I-O accounting, I-O models, impact analysis, economic growth modeling …

- Why not have a model that only describes contribution?

TDSD and Regional Contribution Analysis

- Apply *Theory-Directed Semantic Decomposition* (TDSD) to Multi-Regional Social Accounts to build a Contribution Knowledge Network model

- TDSD is a replicable protocol for Economic Contribution Analysis, standardizing the "meaning" or semantics of contribution analysis

- TDSD uses information structured by Economic Base Theory to categorize/explain Contribution using Social Accounts data
  - The way production relates to internal vs external markets (Direct vs Support)
  - Exploits the relationship (accounting identity) of output and VA
  - Definitive about contribution … to whom, of what, where, how

- The TDSD-derived contribution database can be "re-packaged" as a *Contribution Knowledge Network Model* that returns explanation patterns of contribution when queried

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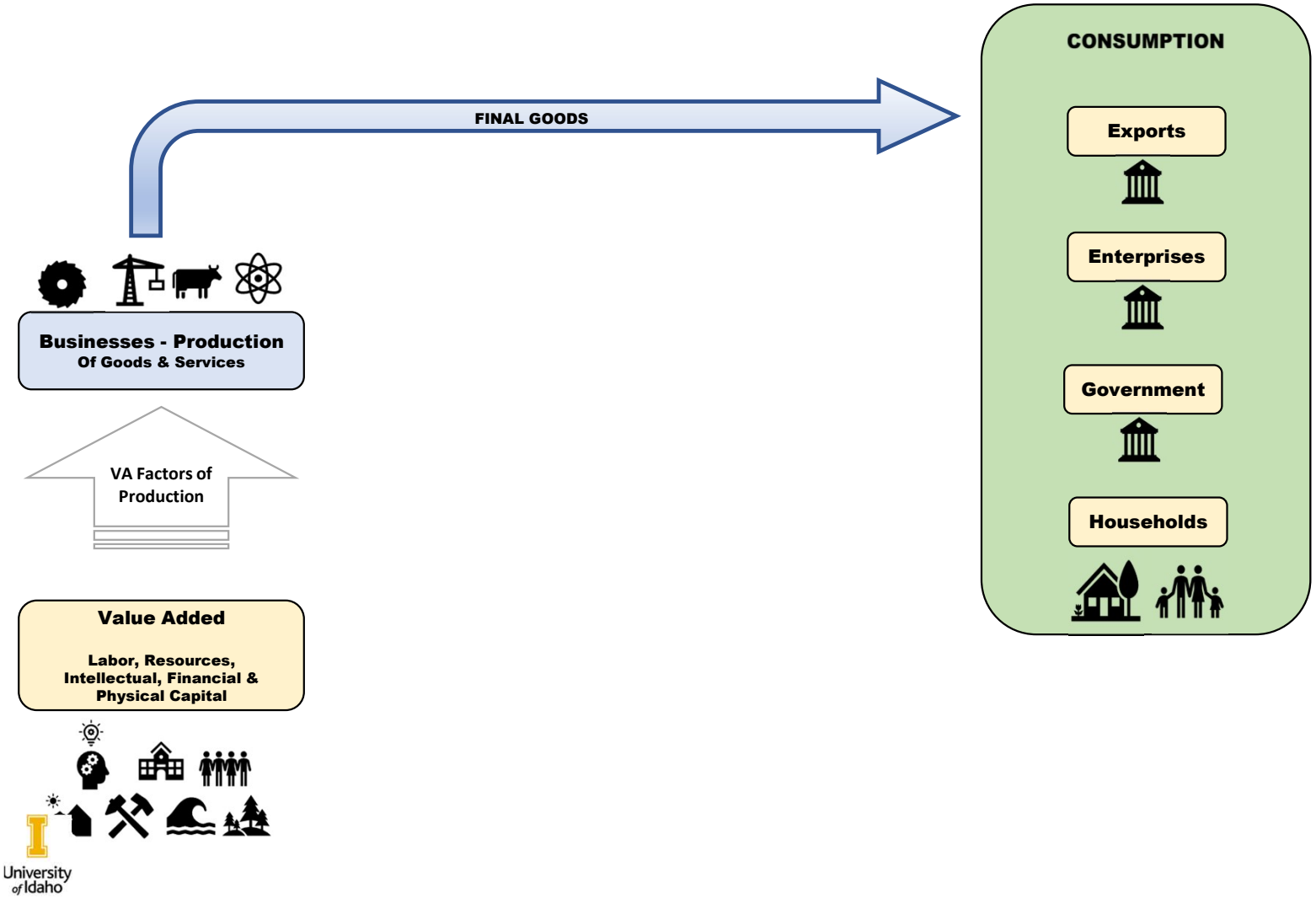
TDSD Regional Contribution Analysis

- Contribution analysis uses information from Social Accounts along with relationships derived from Economic Base Theory to depict how a region's industries use the region's endowment of primary inputs (VA factors) to make final products which are sold to consumers.

- In short, contribution analysis is about connecting the incomes earned by owners of factors to final products delivered to consumers.

Simplified Accounting Framework



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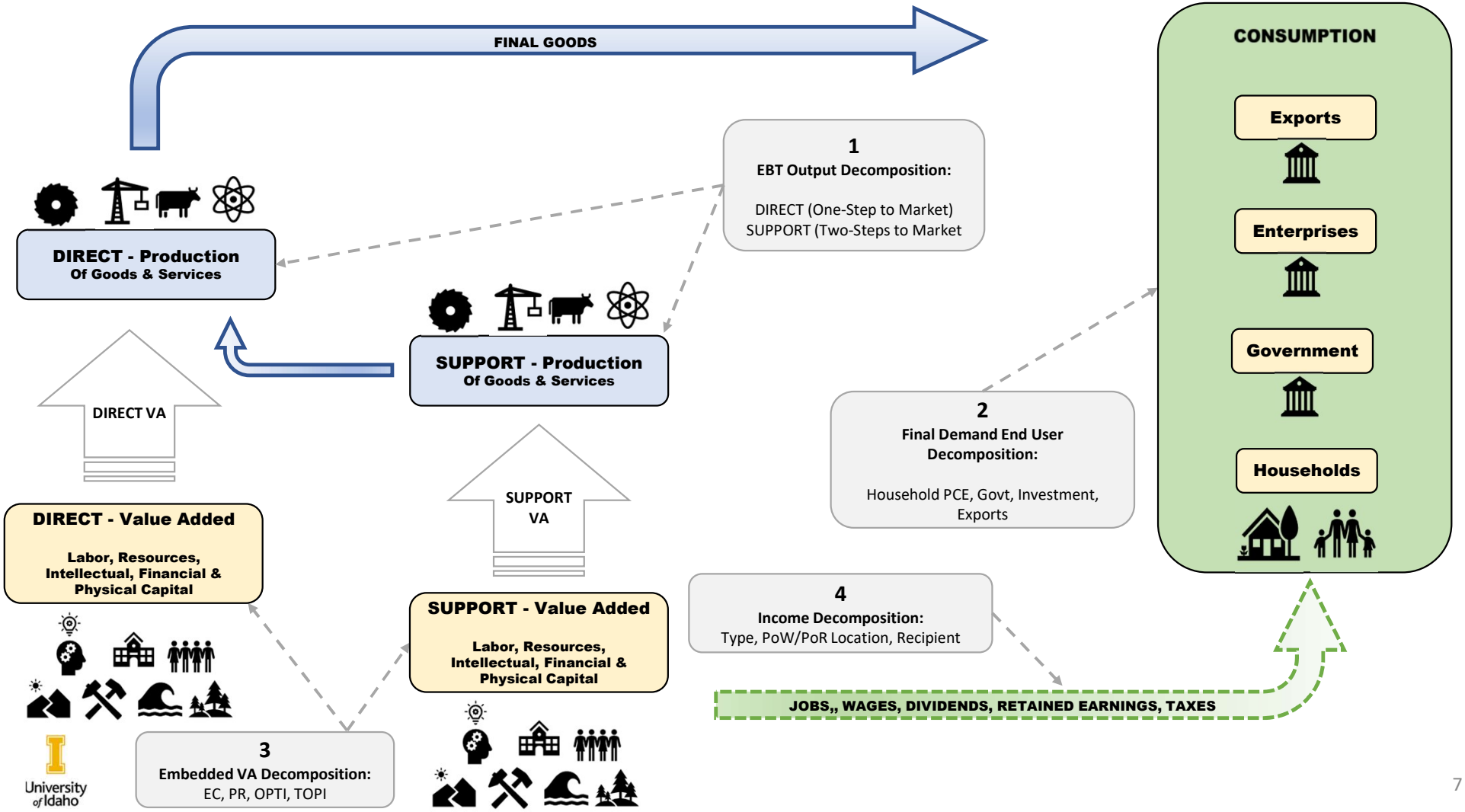
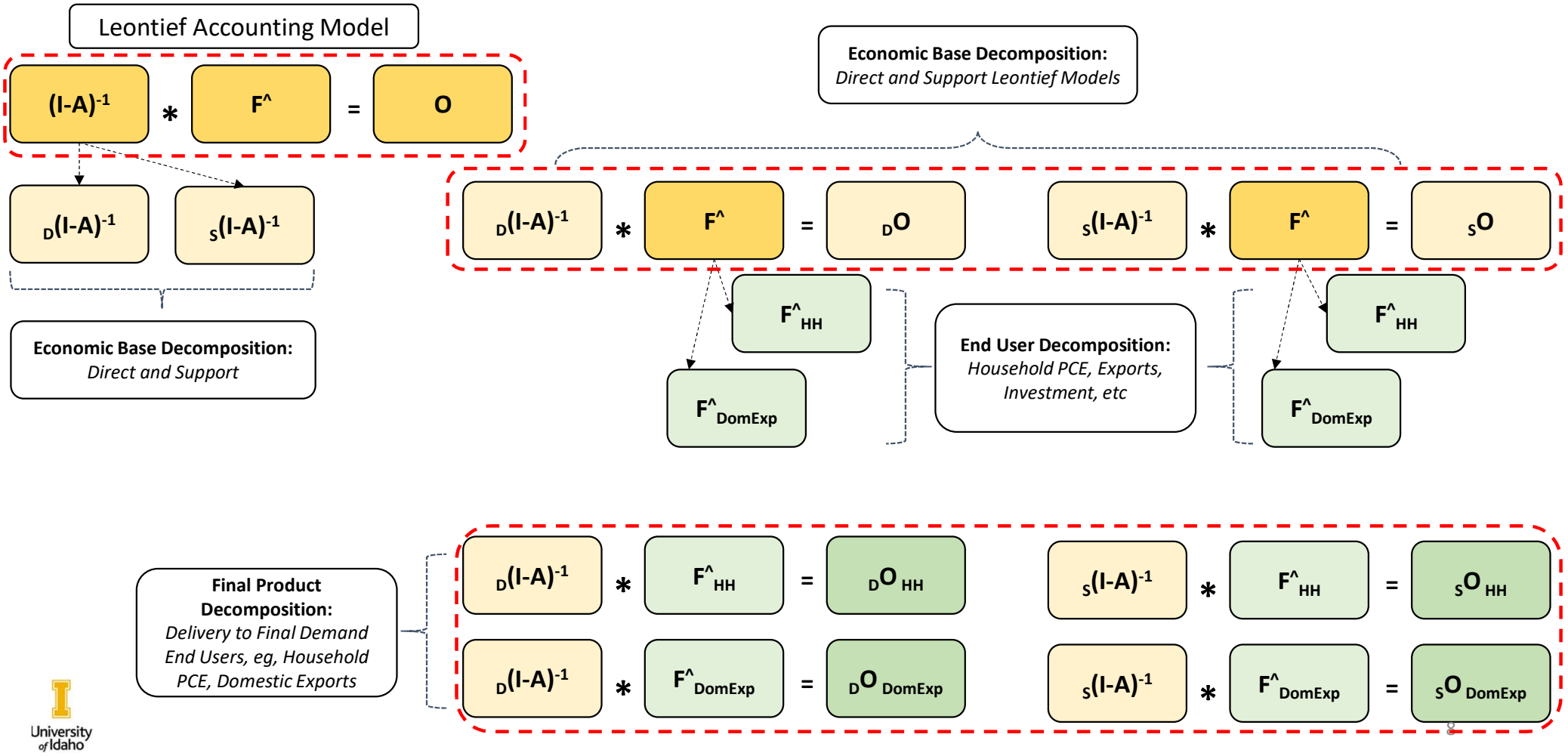
Theory-Directed Semantic Decomposition



Decomposition of Final Product Output



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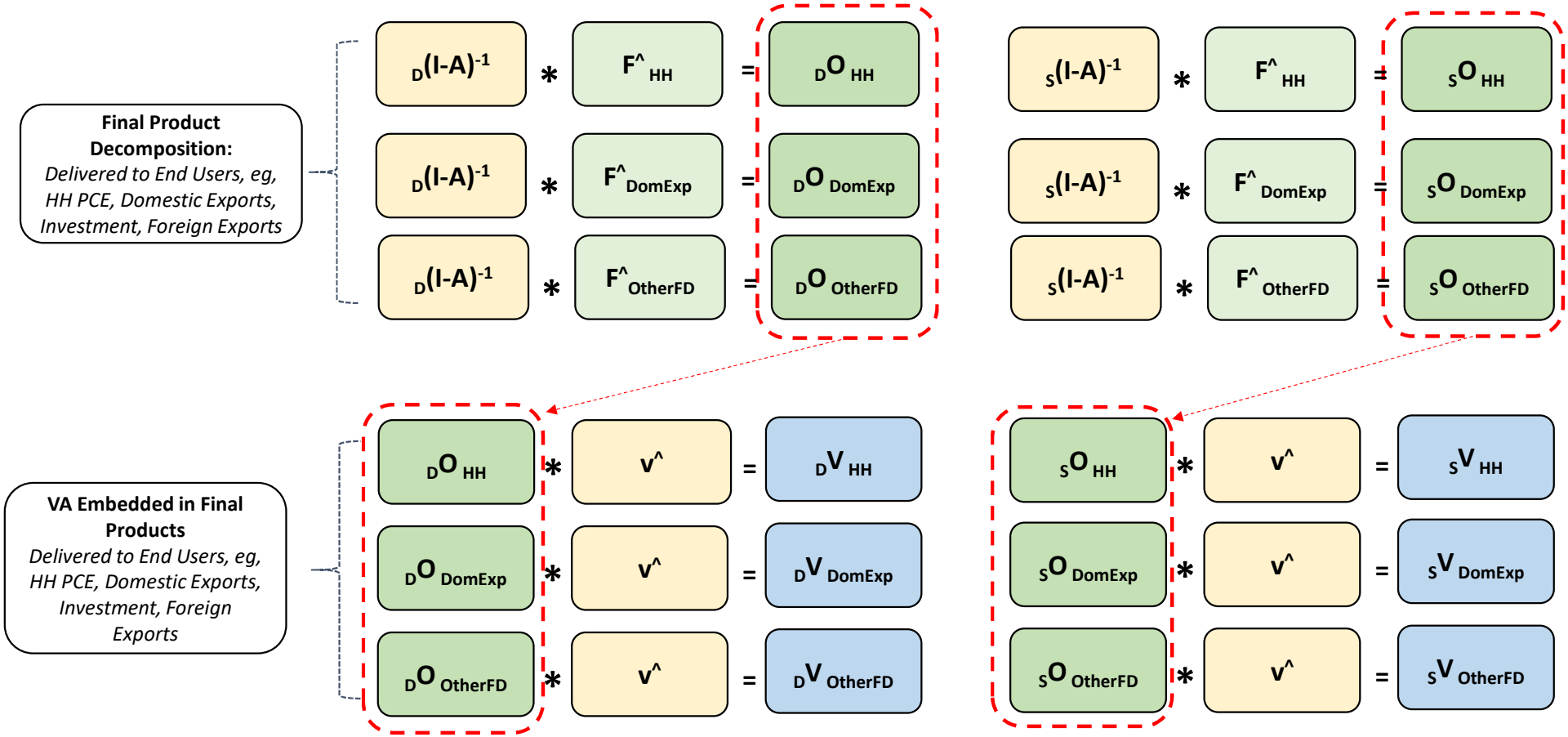
Decomposition of VA



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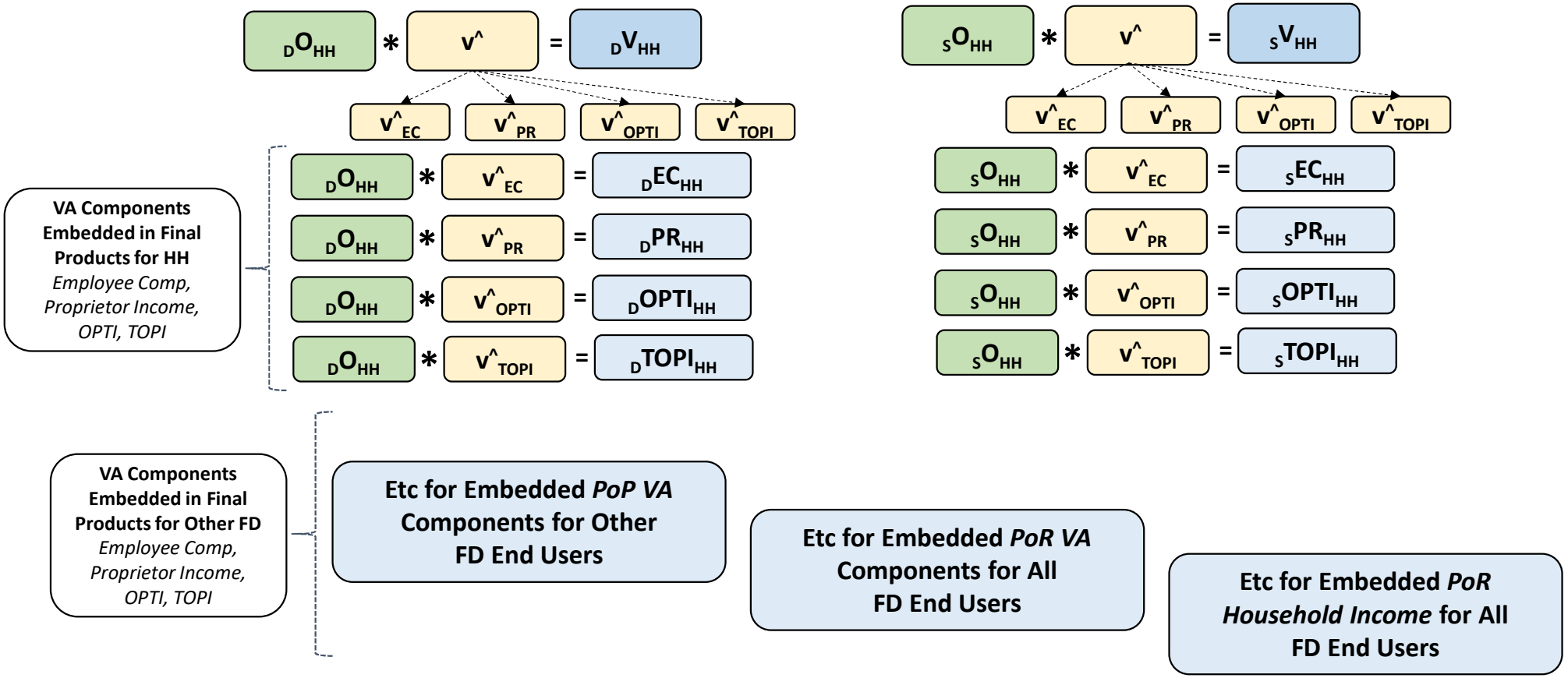
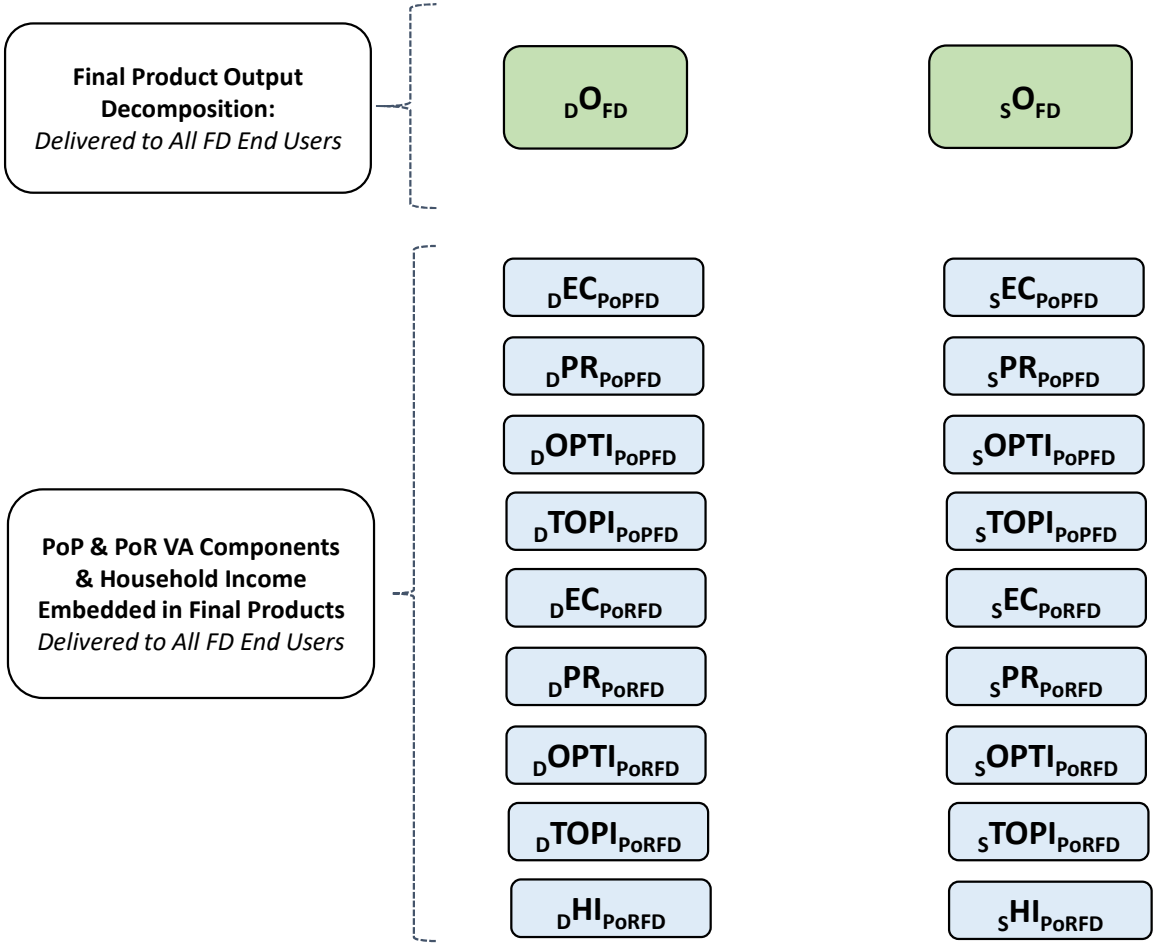
Contribution Database of VA (PoP & PoR) and Household Income (PoR)



Decomposed Contribution Database



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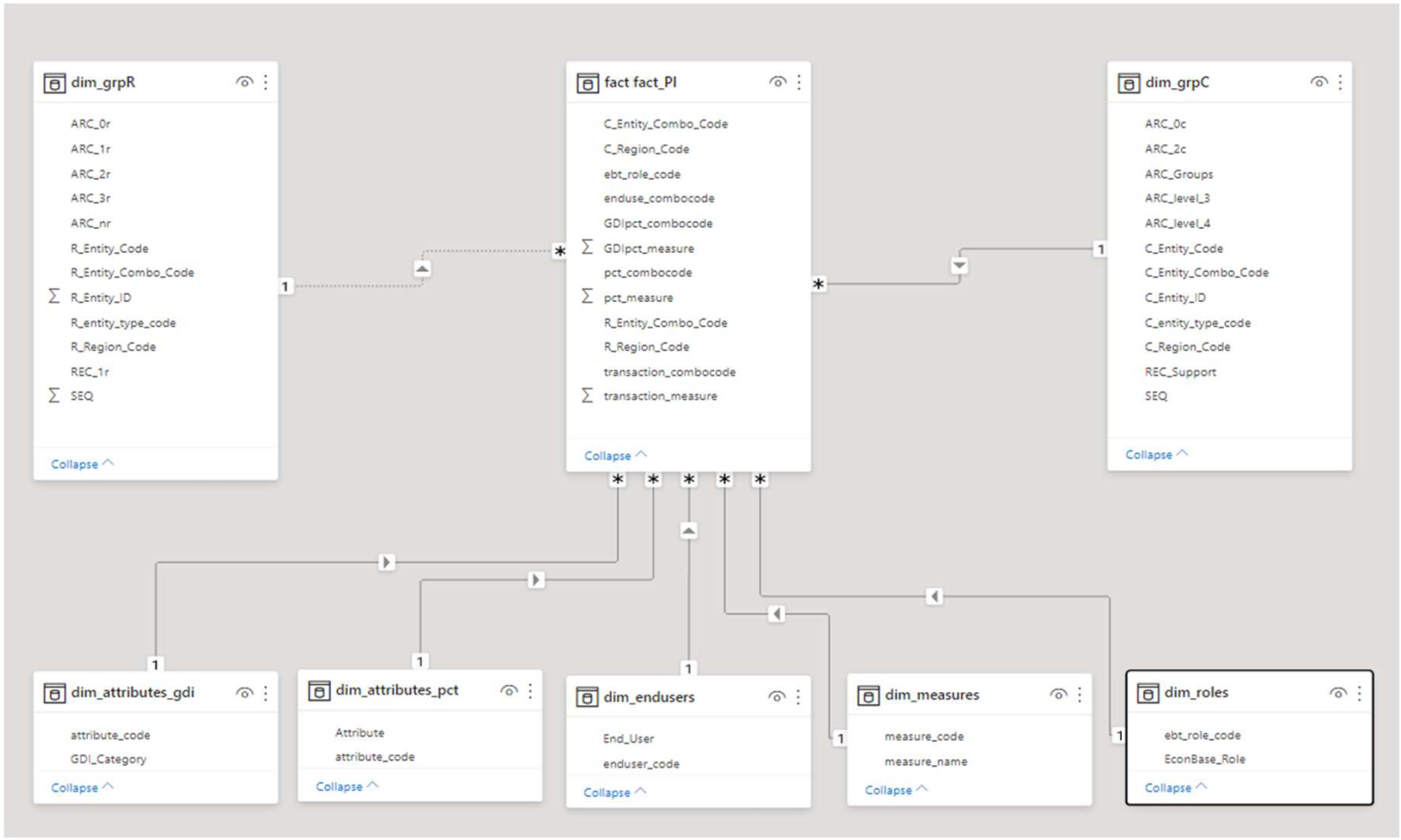
Multi-Dimensional Data Model



Contribution Analysis with Contribution Data Model

- Decompose the SAM accounts to build a Contribution Data Model that explicitly relates the delivery of each final product to each:
  - Job (*Place of Production & Place of Residence*),
  - VA component (*Place of Production & Place of Residence*) transaction,
  - Household Income (*Place of Residence*) transaction, and
  - Output transaction to final products

- Use aggregation and decomposition queries producers contribute to the regional economy.

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Querying a Decomposed Contribution Database

Jobs (PoP) by Resource Group

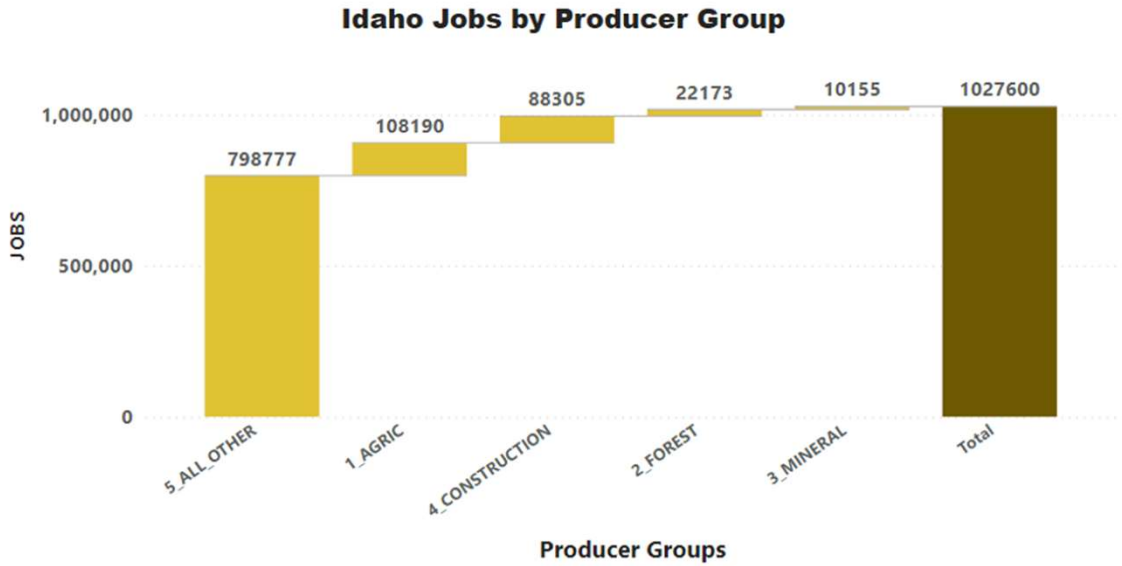
EconBase_Role	1_AGRIC	2_FOREST	3_MINERAL	4_CONSTRUCTION	5_ALL_OTHER	Total
01_DIRECT	50,792	13,375	4,438	66,291	575,193	**710,088**
02_SUPPORT	57,398	8,798	5,718	22,014	223,585	**317,512**
Total	**108,190**	**22,173**	**10,155**	**88,305**	**798,777**	**1,027,600**

Measure Selector

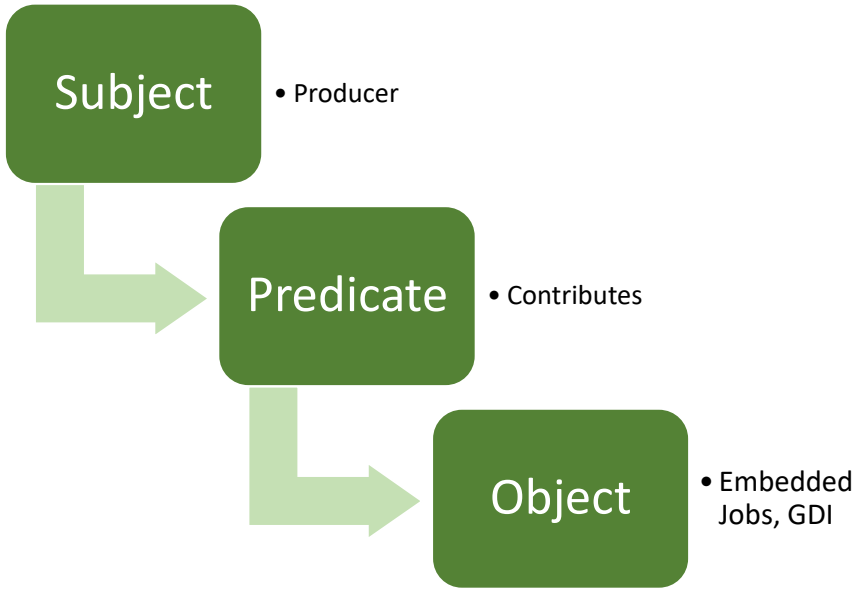
28_DIMP | 33_OUTPUT | **34_JOBS_PoP**

Resource Group Selector

1_AGRIC | **2_FOREST** | **3_MINERAL**



Database to Knowledgebase: Semantic Triples



Semantic Triple

Semantic queries work on *linked triples*. This enables the query to process the relationships *between* information and *infer* the answers from the *network of knowledge* e.g., using *backward chaining*.

A **controlled vocabulary** organizes semantic knowledge about *contribution analysis* for subsequent retrieval, mandating the use of *predefined terms* consistent with *Economic Base Theory*.

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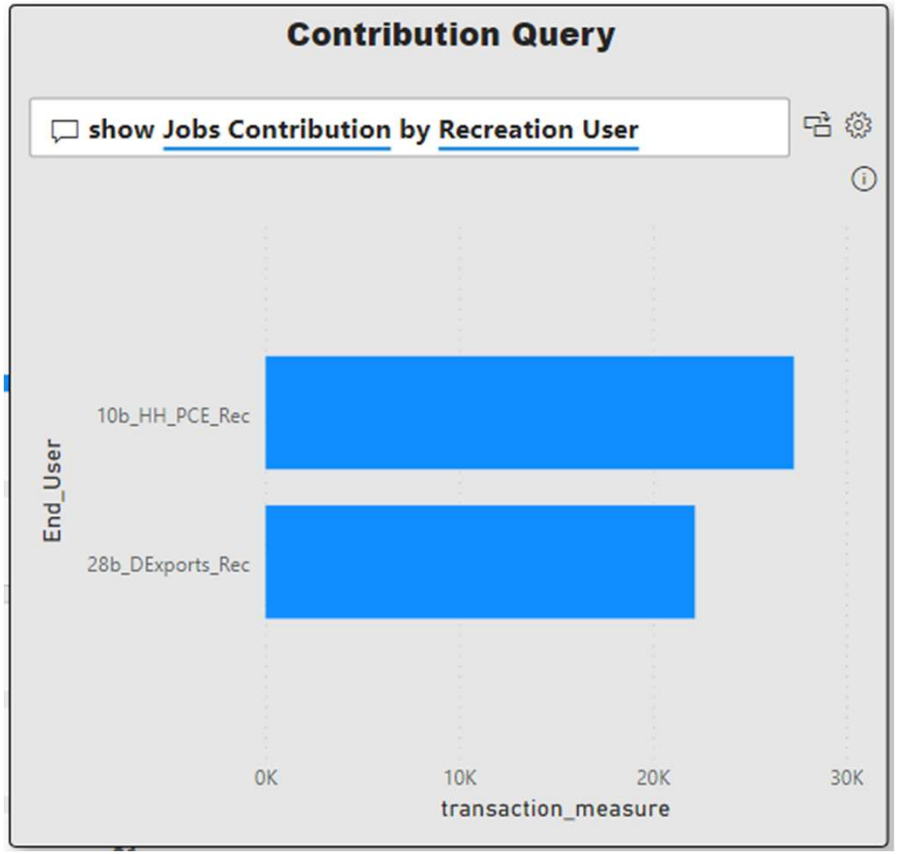
Contribution Analysis with a Knowledge Network Model

- Reframe the Data Model as a Knowledge Network using *semantic triples* to encode how each transaction relates to a measure of Contribution

- Formulate ***Semantic Queries*** using a ***Controlled Vocabulary*** and ***Backward Chaining*** to navigate the Contribution Knowledge Network.

Semantic Query Using Controlled Vocabulary



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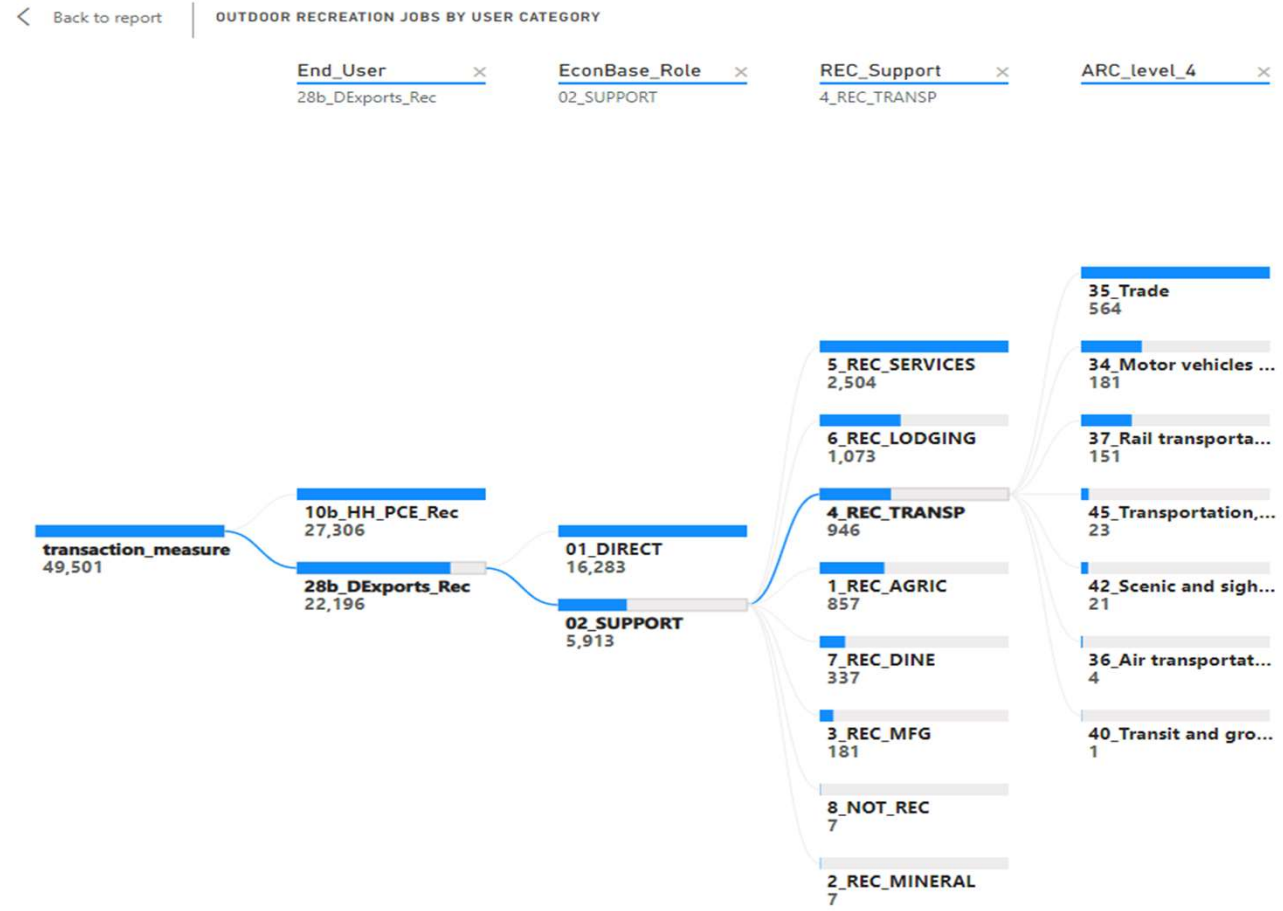
Explanation Pattern: Chain of Contribution of Jobs by Producers Serving Outdoor Recreation Market



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Augmented Contribution Analysis with a Knowledge Network Model

- Knowledge Network instantiates a semantic model of Contribution Analysis
- *Semantic Queries* using *Controlled Vocabulary* **constrains** questions about Contribution Analysis to the set of information about Contribution only – repeatable and comparable Contribution Analysis
- Both summary and pattern knowledge about Contribution
- Both Regional and Multi-Regional Contribution Analysis: VA of Region A embedded in final products of Region B (e.g., TiVA)
- Distinguishes Contribution Analysis from Impact Analysis

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Thanks!





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% Jobs (PoP) by Resource Group

EconBase_Role	1_AGRIC	2_FOREST	3_MINERAL	Total
01_DIRECT	4.9	1.3	0.4	6.7
02_SUPPORT	5.6	0.9	0.6	7.0
Total	10.5	2.2	1.0	13.7

Measure Selector

28_DIMP | 33_OUTPUT | 34_JOBS_PoP

Resource Group Selector

1_AGRIC | 2_FOREST | 3_MINERAL

Percent of All Idaho Jobs by Resource Group