International trade in agricultural products at the U.S. State level

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Abstract: We develop a structural model that leverages both input-output accounts and economic geography to estimate State-level imports and exports of agricultural products. We then create and employ a method to allocate farm revenue across observed exports and imports across State-level absorption. The model accounts for economic geography under a gravity theory; for example, the more proximate farm output is to observed export nodes, the greater is the export share. Our method generates more realistic estimates of the link between farms, agricultural products, domestic absorption of these goods, and international trade. To illustrate this, we provide descriptive reports that indicate differences in our estimates relative to other methods. We focus our discussion on State-level wheat exports. Wheat is a good example to illustrate the gravity model, because wheat grown in the Palouse region (Idaho, Oregon, and Washington) is proximate to the major ports servicing Asia and the Pacific. The gravity model thus indicates a higher export share for these States and lower export shares for centrally located wheat-producing States, like Kansas. This study thus provides a new and important consideration for assessing a State's participation in U.S. agricultural trade.

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1. Introduction

An individual U.S. State's exposure to international markets is often a topic of social commentary and economic analysis. Informed analysis seems to require an estimate of a State's exports and imports. Unfortunately, published measures of State-level trade often fall short of accurately reflecting trade exposure. U.S. Customs tracks international trade at specific Ports of Entry (exit) rather than the ultimate destination of imports or source of export shipments. In the official State-trade statistics from the U.S. Department of Commerce's Bureau of the Census (Census Bureau), too much trade exposure is reported for States with major seaports or border crossings, and nearly zero exposure for interior States producing major export commodities like wheat and soybeans. A simple alternative employed by the U.S. Department of Agriculture, Economic Research Service (USDA, ERS) (2023b) is to ascribe a share of total U.S. exports of a particular product to each State based on that State's share of total production of that product. While transparent, this method fails to account for trade costs over economic geography and the co-location embedded in input-output relationships.

In this paper, we develop and apply a new method for estimating State-level international trade in agricultural products that incorporates geographic trade frictions. The method is based on a fundamental proposition from trade theory, which posits equal absorption shares of regionally differentiated goods in the absence of trade frictions. Adopting this assumption allows us to calibrate a commodity-specific, Armington demand system to input-output accounts that establish supply and demand vectors for each State and Port. We then utilize the structure with trade frictions included to establish the benchmark flows of goods from the point of production to domestic uses and port-level exports. Similarly, we distribute Port-level imports to their use in specific States. While our primary focus is on international trade, the method yields a bilateral interstate trade matrix for each commodity.

Our work complements recent advances in open-source calculations of State input-output accounts by the Wisconsin National Data Consortium (WiNDC).[1] The WiNDC project focuses on publicly available data sources and a series of routines that generate micro-consistent subnational accounts. Previously available subnational accounts were both expensive and proprietary, which made them less ideal for research.[2] The academic based WiNDC project has many advantages including its accessibility, transparency, and extensibility to alternative research questions.

Representing bilateral interstate and State-level international trade in the WiNDC accounts remains a challenge. A lack of reliable data on interstate trade favors a

[1] See https://windc.wisc.edu/.

[2] The IMPLAN (https://implan.com/) State accounts are an example of a closed-source commercial alternative.

pooled national market formulation, which ultimately limits the structural options for researchers. At first glance, the Census Bureau's Commodity Flow Survey (CFS) might be considered the best source for bilateral State trade, but these data suffer from a fundamental problem: the CFS tracks shipments of goods, not the goods themselves. For example, a rail shipment of a bushel of wheat from an elevator in Minnesota to a Mississippi River terminal plus the barge shipment of that bushel to an export facility in the Port of New Orleans escalates the quantity (and value) of the actual wheat shipped. This problem of double counting in the CFS data is noted by Anderson and van Wincoop (2003) who correct the CFS interstate trade flows by assuming they are exaggerated by a factor of 2.08. Our proposed method for generating bilateral interstate trade imposes consistency between State-level production and aggregate absorption and export demand.

The State-level *international* trade data in the core WiNDC accounts are also a known weakness. The WiNDC trade data come from the Census Bureau's reports of imports and exports by State, but these reports are actually measured by Port of Entry.[3] The ports from which agricultural exports exit the United States, however, are not necessarily located in the States where those products are produced. For example, almost all wheat exports that depart the United States from ports in Louisiana are grown outside that State, which accounted for just 0.08 percent of U.S. wheat production in 2022 (U.S. Department of Agriculture, National Agricultural Statistics Service, 2024). In fact, the large volume of Louisiana's grain exports (as reported by the Census Bureau and thus inferred in the WiNDC accounts) is only explained by the purchase of grains grown outside Louisiana by firms with access to export facilities in that State.

On the supply side, the excess supply of wheat in a State like Kansas does not leave for other countries via the State's sole Port of Entry in Wichita but instead travels by truck, rail, and/or ship to various Ports of Entry, including shipping ports in the Gulf and Pacific Northwest and rail crossings into Mexico in the El Paso and Laredo Customs Districts. Looking at the Census Bureau's Port-level data, Louisiana exports a significant quantity of wheat, but Kansas, a key wheat producer, does not. A better representation would attribute international exports (and imports) of agricultural products to the State of production (and absorption).

Faced with the Census Bureau's problematic State Trade Data, USDA, ERS generates an alternative measure of State agricultural exports based on cash receipts. For these estimates, the products that make up U.S. agricultural exports are grouped to match the 24 product groups in U.S. farm sales estimates. For each of these product groups, exports are allocated by State in approximate proportion to the State's share of national cash receipts for that product group. Thus, Kansas, with 18.5 percent ($2.2 billion) of U.S. cash receipts for wheat in 2021, is

[3] The Census Bureau disseminates export and import statistics by Port of Entry at the HS-6 level (U.S. Department of Commerce, Bureau of the Census, 2023).

estimated to have accounted for 18.5 percent ($1.3 billion) of U.S. wheat exports that year (U.S. Department of Agriculture, Economic Research Service, 2023a,b). In contrast, the Census Bureau's State Trade Data indicate Kansas's wheat exports (HS-6 100199) accounted for about 6.9 percent ($500 million) of the national total in 2021 (U.S. Department of Commerce, Bureau of the Census, 2023).

Neither of these two estimates is based on a comprehensive assessment of the use of Kansas's wheat production, along the lines of USDA's PSD (Production, Supply, and Distribution) Online Database (U.S. Department of Agriculture, Foreign Agricultural Service, 2023). Some rough estimates are commonly circulated by the industry and the media, however. For instance, the Kansas Wheat Commission (2024) places the share of the State's wheat crop that is exported at "roughly half," while an educational flyer from the Salina Journal (2024) indicates that "Two-thirds of the wheat grown in Kansas is exported to other countries." Similar estimates are available for other States. An educational booklet from Farm and Ranch Guide (2017) states that "about half" of North Dakota's crop is exported; the Washington Department of Agriculture (2025) indicates that "up to 90 percent" of that State's crop is exported; Ernst (2016) reports that "about 80 percent" of Montana's crop is exported; the Idaho State Department of Agriculture, as cited by Ellis (2024), indicates that half of that State's crop is exported; Charles Vogel of the Minnesota Wheat Growers, as cited by Radelat (2022), said that "Normally, on average, about 30% of Minnesota's wheat is exported"; and the Oklahoma Wheat Commission (2024) posts on its webpage that "Exports account for 55% to 65% of the demand for our Hard Red Winter wheat."

Our purpose is to inform the key question of how much of a State's production of specific agricultural goods are exported and how much is disbursed to each of the 50 States (and the District of Columbia). We use a structural gravity model following the theory of Anderson and van Wincoop (2003). A presentation of the full theory and its development is given by Yotov et al. (2016). There are two specific features of this theory that we leverage in developing our estimates of interstate agricultural trade and the flows of agricultural products between ports and States. First is the assumption of identical and homothetic preferences. This provides an anchor point for calibration, where in the absence of trade frictions expenditure shares on regionally differentiated goods are the same across regions. The second assumption is that trade costs are of the iceberg type. That is, they are paid in units of the good being shipped. This allows us to establish trade at normalized prices at both the frictionless anchor and the benchmark equilibrium.

The remainder of the paper is organized as follows: In the next section, we provide additional discussion of the literature directly related to our goal of developing State trade accounts. In Section 3 we consider the frictionless anchor point suggested in gravity theory. In Section 4 we present our model and method in the context of the structural model. In Section 5 we itemize the data sources. Results are presented in Section 6 with a comparison to other methods and including sensitivity analysis. Concluding remarks are offered in section 7.

2. Literature

Our development of State-international and interstate trade flows builds on earlier work. Any attempt to model State-level impacts of policy faces the challenge of reconciling State income, production, and consumption with the State's external transactions. In many ways, a State's dependence and interactions beyond its borders are even more important than a given country's international transactions. This is because of the close ties any State has with other States in terms of facilitating the overall supply chain (including moving goods to and from ports). There are significant barriers to international trade that limit economic integration that do not exist among U.S. States. We highlight some of the State-level modeling efforts and how these authors addressed interstate and State-international trade. Our contribution relative to this literature is to document the theoretic justification of a gravity structure and to provide a set of foundational estimates for agricultural goods that can be incorporated into the core open-source WiNDC accounts, which facilitate general equilibrium modeling of state economies.

Within the regional economics literature, focused on price-invariant input-output calculations, paired trade flows between a given State and an external agent were not a priority. In modeling a region (State) as a price-insensitive open economy, a simple measure of the proportion of demand for a product that is purchased from local producers is sufficient to perform the input-output calculations. These proportions became known as *regional purchase coefficients* or RPCs. Construction of RPC accounts incorporating a theory of transport costs is documented in the work of Stevens et al. (1983). This improves upon the contemporaneous IMPLAN work (Alward and Palmer, 1981), which simply took regional purchases as the proportion of total regional supply to demand.

The early RPC literature advanced to more elaborate empirical models. Alward and Despotakis (1988), as cited by Thorvaldson, Olson, and Alward (2011), utilized a log-log regression to estimate RPCs. Lindall, Olson, and Alward (2006) develop a method of estimating RPCs under a gravity theory constrained by the IMPLAN accounts. With the gravity model estimated, the IMPLAN accounts can be developed into multi-region accounts with reconciled bilateral trade flows. Lindall, Olson, and Alward (2006) estimate their gravity model iteratively at the U.S. County level under the adding-up constraints to generate a distance elasticity consistent with observed CFS flows. As mentioned above, there is reason to expect the CFS data to be significantly biased in terms of exaggerating interstate trade. More recent advances in the development of the IMPLAN RPCs and a comparison to the gravity-based implied RPCs is provided by Thorvaldson, Olson, and Alward (2011).

As a part of the USAGE modeling project, the gravity techniques developed by Horridge (2011) for Australia are applied to develop fitted interstate U.S. trade flows for the USAGE-TERM model and accounts. The USAGE-TERM model is a dynamic, computable general equilibrium (CGE), State-level model of the U.S. economy developed at the Center of Policy Studies (CoPS), Victoria University, Melbourne. Documentation of the USAGE-TERM model and accounts can be found in Wittwer (2017), with updates in Wittwer (2024).

The goal and gravity techniques used in this paper are similar to those in Lindall, Olson, and Alward (2006) and Horridge (2011). It is, however, useful to point out a few differences. First, our analysis builds out a theoretic foundation for the constrained gravity demand system under a more flexible, nested constant-elasticity-of-substitution (CES) structure. We also systematically incorporate the 2017 Port-level U.S. import and export data. This allows us to consider each Port as a supply and demand node in the interstate trade network. Finally, all of our data and code, including the constraining WiNDC State-level accounts, are open-source. This means that they can be easily modified and developed for specific research questions as they arise.

3. Gravity Theory and the Frictionless Anchor

We start by considering a structural gravity model under regionally differentiated goods as presented by Anderson and van Wincoop (2003) and Yotov et al. (2016). We generally adopt the notation of Yotov et al. (2016) with the exception that we index goods using $i \in I$ and regions (States) using $s \in S$ or $r \in S$. We proceed in this section by suppressing the index on the good, which is consistent with the one-sector, general equilibrium treatment of Anderson and van Wincoop (2003). The structure remains intact for each individual good under *separability* as demonstrated by Larch and Yotov (2016, Appendix B).[4] Another simplification in the Anderson and van Wincoop (2003) theory as presented is the suppression of intermediate inputs to production. The extension to accommodate measured intermediates requires us to consider regional supply of a good to be measured as gross output (not value added) and expenditures on the good to include intermediates as well as final demand—absorption.

A fundamental assumption of the Anderson and van Wincoop (2003) structure is an identical and linearly homogeneous *Armington* aggregation of the regionally differentiated goods.[5] This aggregate is then available for absorption in terms of intermediate inputs in production and final demand. Let us denote supply of this *Armington* aggregate (or composite) in region s as A_s. Assuming a CES aggregator,

[4] Separability such that each good abides by the fundamental one-sector Anderson and van Wincoop (2003) gravity system requires additional assumptions. The assumptions made by Larch and Yotov (2016, Appendix B) are shown to be sufficient.

[5] The seminal analysis that viewed international trade data as being comprised of regionally differentiated goods comes from Armington (1969).

we have an analog to equation (1-1) of Yotov et al. (2016, p13):

$$A_s = \left[\sum_r \alpha_r^{\frac{1-\sigma}{\sigma}} c_{rs}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}. \tag{1}$$

This technology is better represented in its dual form as the *minimized* unit-cost function, which embeds optimal sourcing of each regional variety. Let p_r indicate the factory-gate price, and let t_{rs} be the trade cost index associated with shipping from r to s. With no trade costs, the t_{rs} would be one. We also assume symmetry in trade costs, $t_{rs} = t_{sr}$. An agent in region s will minimize expenditures ($\sum_r p_r t_{rs} c_{rs}$) by choosing consumption levels (the c_{rs}) conditional on a level of A_s. The technology is linear homogeneous, so expenditures (costs) are linear in A_s allowing us to choose any scale of A_s. Minimizing costs at one unit ($A_s = 1$), the unit-cost or, equivalently, the unit-expenditure function is

$$P_s = \left[\sum_r (\alpha_r p_r t_{rs})^{1-\sigma} \right]^{\frac{1}{1-\sigma}}. \tag{2}$$

P_s can be interpreted as an ideal price index or equivalently the marginal cost of a unit of the composite A_s. The corresponding level of expenditures is

$$E_s = P_s A_s. \tag{3}$$

The remainder of the equilibrium is somewhat mechanical. The nominal value of supply, denoted Y_r, is given by the product price and the fixed supply quantity

$$Y_r = p_r q_r. \tag{4}$$

Demand is derived by applying the envelope theorem to the expenditure functions and then summing across the potential destinations. Market clearance is thus given by

$$q_r = \sum_s A_s \frac{\partial P_s(\boldsymbol{p})}{\partial p_r}. \tag{5}$$

It is important to note the operation of so-called *iceberg* transport costs in terms of the market clearance condition. From the perspective of the exporter in r, the quantity shipped equals $t_{rs} c_{rs}$ at a price of p_r. From the perspective of the importer in region s, the quantity that arrives for consumption is c_{rs} at a price of $t_{rs} p_r$.[6]

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[6] Conditional demand at the destination is

$$c_{rs} = A_s \frac{\partial P_s(\boldsymbol{p})}{\partial (p_r t_{rs})},$$

but at the source it is

$$t_{rs} c_{rs} = t_{rs} A_s \frac{\partial P_s(\boldsymbol{p})}{\partial (p_r t_{rs})} = A_s \frac{\partial P_s(\boldsymbol{p})}{\partial p_r}.$$

In the context of the one-sector, Anderson and van Wincoop (2003) environment, equations (2)–(5) represent a Walrasian general equilibrium (see Balistreri and Hillberry, 2008). In the general equilibrium, the quantity supplied q_r is a fixed endowment quantity, and expenditures are income ($E_r \equiv Y_r$). With n regions, there are $4n$ equilibrium conditions and $4n$ variables interpreted as follows: Y_r is nominal income; A_r is an index on welfare; P_r the true-cost-of-living index, and p_r is the endowment price at its origin. We have a Walrasian equilibrium so a unique solution requires a price normalization.

The focus in the structural gravity literature is nominal bilateral trade. To be concrete, under our CES assumption, we can pull out a bilateral trade term from the right-hand side of the market clearance condition (5). In nominal terms, this is

$$x_{rs} = p_r A_s \frac{\partial P_s(\boldsymbol{p})}{\partial p_r}. \tag{6}$$

Taking the derivative and converting this to uncompensated demand (using $Y_s = E_s = P_s A_s$ from equation (3) we have

$$x_{rs} = Y_s \left(\frac{\alpha_r p_r t_{rs}}{P_s} \right)^{1-\sigma}. \tag{7}$$

Using equations (4) and (5) nominal market clearance can be represented as

$$Y_r = \sum_s Y_s \left(\frac{\alpha_r p_r t_{rs}}{P_s} \right)^{1-\sigma}. \tag{8}$$

Dividing through by total nominal supply $Y^w \equiv \sum_r Y_r$ and factoring out the price-weighted source region preference we have

$$\frac{Y_r}{Y^w} = (\alpha_r p_r)^{1-\sigma} \sum_s \frac{Y_s}{Y^w} \left(\frac{t_{rs}}{P_s} \right)^{1-\sigma}, \tag{9}$$

To simplify the exposition define the following source-region index as in Anderson and van Wincoop (2003):

$$\Pi_r \equiv \left[\sum_s \frac{Y_s}{Y^w} \left(\frac{t_{rs}}{P_s} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \tag{10}$$

so equation (9) is given as

$$\frac{Y_r}{Y^w} = (\alpha_r p_r)^{1-\sigma} \Pi^{1-\sigma}. \tag{11}$$

Using this equation to substitute the price-weighted preference parameters out of equation (7) give us the fundamental structural gravity equation (Anderson and van Wincoop, 2003):

$$x_{rs} = \frac{Y_r Y_s}{Y^w} \left(\frac{t_{rs}}{\Pi_r P_s} \right)^{1-\sigma}. \tag{12}$$

The structural gravity system used to analyze bilateral trade would include the gravity equation (12), as well as the indexes specified in equations (2) and (10). Anderson and van Wincoop (2003) discuss these indexes in terms of inward multilateral resistance (P_r) and outward multilateral resistance (Π_r). The product of the inward and outward indexes reflect the fact that, in addition to the specific bilateral trade cost on the link in question, the trade flow on that link is affected by the exporter's relative access to all markets and the importer's relative access to all markets.

For our purpose in this paper, a key lesson from the structural gravity system is the fact that in the absence of trade frictions, each region will consume its global expenditure share of goods from any source region. If we impose $t_{rs} = 1 \ \forall rs$ so all regions face the same price vector and therefore the same price index $P_s = P^w \ \forall s$. Furthermore, with no trade frictions, equation (10) indicates that the Π_r are also invariant across regions ($\Pi_r = \Pi^w \ \forall r$). Nominal trade in the absence of frictions is thus

$$x_{rs} = \frac{Y_r Y_s}{Y^w} \Gamma, \tag{13}$$

where $\Gamma \equiv (\Pi^w P^w)^{\sigma-1}$. The only way that equation (13) satisfies market clearance is if $\Gamma = 1$ when there are no trade frictions:

$$\sum_s x_{rs} = Y_r \frac{\sum_s Y_s}{Y^w} = Y_r.$$

To conclude our discussion of the frictionless anchor for calibration, define $\theta_s = Y_s / Y^w$ such that nominal trade flows under no trade frictions equals the nominal supply weighted by the expenditure share

$$x_{rs} = \theta_s Y_r; \tag{14}$$

or equivalently expenditures at the destination weighted by the supply share

$$x_{rs} = \theta_r Y_s. \tag{15}$$

Calibration of a theory-consistent model to the *frictionless* equilibrium only requires measures of nominal supply in r and nominal absorption in r. With the model calibrated to the implied bilateral trade at the frictionless anchor we can use a well specified gravity system, like equations (2)–(5), to estimate bilateral trade flows conditional on any set of bilateral trade costs. While conceptually the same, in a model with States trading with other States and with Ports (which facilitate trade with the rest of the world), the structure must be extended beyond the simple Anderson and van Wincoop (2003) model. We develop these extensions in the next section.

4. Structural Model

In this section, we develop a structural gravity model in the spirit of the canonical theory presented above. We use this structure to attribute a State's measured production of an agricultural product, like wheat (WHT), to Customs-District-level exports or absorption by one of the 49 regions in the United States (the lower 48 States plus the District of Columbia).[7] Similarly, the model simultaneously allocates District-level imports to each region. To set up the model, let us index commodities by $i \in I$. As a first pass, we focus on the 11 aggregate agricultural goods in the 43 sector GTAP-WiNDC accounts:

C_B	Sugar cane, sugar beet
CTL	Bovine cattle, sheep, goats and horses
GRO	Cereal grains nec
OAP	Animal products nec
OCR	Crops nec
OSD	Oil seeds
PDR	Paddy rice
PFB	Plant-based fibers
V_F	Vegetables, fruit, nuts
WHT	Wheat, and
WOL	Wool, silk-worm cocoons.

As a rule, we will assume that there is a well-defined mapping from the farm cash-receipts commodity i and an aggregation of the (six-digit) trade and demand data in the GTAP classification, so that i refers to both. The 49 regions are indexed by $s \in S$ or $r \in S = \{\text{AL, AZ, AR}, \ldots, \text{WY}\}$. In addition, we observe imports and exports by Customs District. We index the 41 Customs Districts in the contiguous United States by $k \in K$ as listed:

[7] Our current analysis only considers the contiguous United States. This allows us to roughly approximate intra-national trade costs with a simple distance measure. As discussed, we think a more refined model of the transportation network by mode and measured rates is more appropriate, but our methodological goal is served better by transparently relating outcomes to proximity. Adding Alaska and Hawaii to the analysis would seem to require the transportation-network extension, or at a minimum special treatment of these noncontiguous States.

AL_MOBI	Mobile, AL	ND_PEMB	Pembina, ND
AZ_NOGA	Nogales, AZ	NJ_NEWK	Newark, NJ
CA_LOSA	Los Angeles, CA	NY_BUFF	Buffalo, NY
CA_SAND	San Diego, CA	NY_JAMA	Jamaica, NY
CA_SANF	San Francisco, CA	NY_NEWY	New York City, NY
DC_WASH	Washington, DC	NY_OGDE	Ogdensburg, NY
FL_MIAM	Miami, FL	OH_CLEV	Cleveland, OH
FL_TAMP	Tampa, FL	OR_COLU	Columbia-Snake, OR
GA_SAVA	Savannah, GA	PA_PHIL	Philadelphia, PA
IL_CHIC	Chicago, IL	RI_PROV	Providence, RI
LA_NEWO	New Orleans, LA	SC_CHAR	Charleston, SC
MA_BOST	Boston, MA	TX_DALL	Dallas-Fort Worth, TX
MD_BALT	Baltimore, MD	TX_ELPA	El Paso, TX
ME_PORT	Portland, ME	TX_HOUS	Houston-Galveston, TX
MI_DETR	Detroit, MI	TX_LARE	Laredo, TX
MN_DULU	Duluth, MN	TX_PRTA	Port Arthur, TX
MN_MINN	Minneapolis, MN	VA_NORF	Norfolk, VA
MO_STLO	St. Louis, MO	VT_STAL	St. Albans, VT
MT_GREA	Great Falls, MT	WA_SEAT	Seattle, WA
NC_CHAR	Charlotte, NC	WI_MILW	Milwaukee, WI
NC_WILM	Wilmington, NC		

The goal of our exercise is to estimate the following flows of goods between States and Customs Districts:

$\hat{X}_{irs}$ The bilateral flow of commodity i from state r absorbed in state s,
$\hat{E}_{irk}$ Exports of commodity i from State r through Customs District k; and
$\hat{M}_{ikr}$ Imports of commodity i at Customs District k absorbed in State r.

The challenge is that we have limited data. In the GTAP-WiNDC State-level input-output accounts, we observe the value of absorption of good i in each State, denoted here as the product of the price index and composite good: $P_{is}A_{is}$. Total absorption is consistent with the State-level use of good i in intermediates and final demand. We also observe cash receipts from supply in State r as $p^y_{ir}Y_{ir}$, where Y_{ir} is the output quantity and p^y_{ir} is the factory gate price. We also observe the value of imports and exports of good i at Customs District k as M_{ik} and E_{ik}. These observations of the totals discipline the estimated flows through the following accounting identities:

$$P_{is}A_{is} \equiv \sum_r \hat{X}_{irs} + \sum_k \hat{M}_{iks}. \tag{16}$$

In words, the value of observed absorption of good i for intermediate use or final demand in region s ($P_{is}A_{is}$) is the same as the value of demand of i by region s from all States r (including $r = s$) and the value of imports of i demanded by s from Customs Districts k. Next, we have an identity that indicates market clearance for output from region r. The value of output of i from r ($p^y_{ir} Y_{ir}$) is exhausted on shipments to other States and Customs Districts of export.

$$p^y_{ir} Y_{ir} \equiv \sum_s \hat{X}_{irs} + \sum_k \hat{E}_{irk}. \tag{17}$$

For international trade, we equate the value of total imports of good i at Customs District k with its estimated disbursement to States r

$$M_{ik} \equiv \sum_r \hat{M}_{ikr}; \tag{18}$$

and the total value of exports at Customs District k must equal the value of shipments to that Customs District from across the States r

$$E_{ik} \equiv \sum_r \hat{E}_{irk}. \tag{19}$$

These linear relationships establish consistency of the solution estimates, but we need a structural model to translate the observed data, on the left-hand side of (16)–(19), into the estimated component flows.

Like the relatively simple model in Section 3, we build the structural model around the unit-cost function for *Armington* aggregation. As an empirical tool, however, we specify a more complex nested CES structure. The components of Armington absorption, A_{is}, include good i produced in that State, good i produced in other States $r \neq s \in S$, and good i imported via Customs Districts $k \in K$. Let us denote the relevant prices p^y_{ir} as the factory-gate price of good i in any state r, and p^m_{ik} as the price of import i landed (import-duty paid) at Customs District k. The unit-cost of A_{is} is given by

$$\begin{aligned} P_{is} = \Bigg[& \left(\theta_s (t_{ss} p^y_{is})^{1-\sigma_{ln}} + \left[\sum_{r \neq s} \theta_r (t_{rs} p^y_{ir})^{1-\sigma_{nn}} \right]^{\frac{1-\sigma_{ln}}{1-\sigma_{nn}}} \right)^{\frac{1-\sigma_{dm}}{1-\sigma_{ln}}} \\ & + \left(\sum_k \theta_{ik} (t_{ks} p^m_{ik})^{1-\sigma_{mm}})^{\frac{1-\sigma_{dm}}{1-\sigma_{mm}}} \right)^{\left(\frac{1-\sigma_{dm}}{1-\sigma_{mm}}\right)} \Bigg]^{\frac{1}{(1-\sigma_{dm})}} . \end{aligned} \tag{20}$$

In the first line of (20) we have a CES aggregation of the local State good with the national aggregate of other U.S. State goods at an elasticity of substitution σ_{ln}. The national aggregate of other U.S. State goods has a CES across goods of σ_{nn}. In the second line, we have the CES aggregation of imports from different Customs Districts, where the elasticity of substitution is σ_{mm}. This nesting structure gives us considerable flexiblity in terms of different substitution opportunities among the various components and facilitates our ability to perform sensitivity analysis. Note, however, that if $\sigma = \sigma_{ln} = \sigma_{nn} = \sigma_{mm}$, the nesting collapses and we revert to the simple price index suggested in equation (2) elaborated with Customs Districts as additional sources and destinations.

In (20), we replaced the parameters α_r in the earlier theory with standard good-specific CES weights θ_{ir} and θ_{ik}. While there is a simple conversion back to the implied α, the θ are more convenient in the context of calibrating to the frictionless flows. To illustrate, let us choose supply-quantity units at the frictionless equilibrium such that all source prices are one ($p_{ir} = p_{kr} = 1$). Then if we normalize such that $\sum_r \theta_{ir} + \sum_k \theta_{ik} = 1$ we can see that the value of the price index must also be one without trade friction ($P_s = 1 \;\; \forall s$). Furthermore it is relatively easy to see that, despite our elaborate nesting, bilateral nominal demand is given by

$$x_{irs} = \theta_{ir} P_{is} A_{is} \;\text{ and} \tag{21}$$

$$x_{iks} = \theta_{kr} P_{is} A_{is}; \tag{22}$$

where

$$\theta_{ir} \equiv \frac{Y_{ir}}{\sum_s Y_{is}} \left[\frac{\sum_s Y_{is} - \sum_{k'} E_{ik}}{\sum_s Y_{is} + \sum_k M_{ik} - \sum_{k'} E_{ik}} \right], \text{and}$$

$$\theta_{ik} \equiv \frac{M_{ik}}{\sum_k M_{ik}} \left[\frac{\sum_k M_{ik}}{\sum_s Y_{is} + \sum_k M_{ik} - \sum_{k'} E_{ik}} \right].$$

While the first term in each of these fractions is simply the share of production by State and imports by Customs District, they need to be corrected by the other terms. The second term in the first definition is the share of total U.S. non-exported output to total U.S. absorption. The second term in the second definition is the share of total imports in U.S. absorption. With these weights, we have, as indicated before, $\sum_r \theta_{ir} + \sum_k \theta_{ik} = 1$. The key is that these are now indicated by the observable data indicating uniform consumption of the regionally differentiated goods in the absence of friction.

We still need to develop the State-level export demand system which ships to Customs Districts that portion of output that is not absorbed in the United States. Let us again use the notion of Armington aggregation to specify the District-specific unit cost, P^x_{ik} of exporting some good i from Customs District k:

$$P^x_{ik} = \left(\sum_r \theta^x_{ir} (t_{rk} p^y_{ir})^{1-\sigma_x} \right)^{\frac{1}{1-\sigma_x}}, \tag{23}$$

where the $\theta^x_{ir} = \frac{Y_{ir}}{\sum_s Y_{is}}$ are simply the production shares. Again, with no frictions and all prices at one, the nominal export demand at a Customs District is just the State production share times the level of District exports:

$$e_{irk} = \theta^x_{ir} E_{ik} \tag{24}$$

Away from the frictionless equilibrium, we have to hold the θ parameters fixed and calculate estimated bilateral interstate trade, State imports, and State exports. These can be calculated at an equilibrium based on the nominal demand functions implied by the unit expenditure function (20):

$$\hat{X}_{irs} = p^y_{ir} P_{is} A_{is} \frac{\partial P_{is}(\boldsymbol{p})}{p^y_{ir}}, \text{ and}, \tag{25}$$

$$\hat{M}_{iks} = p^m_{ik} P_{is} A_{is} \frac{\partial P_{is}(\boldsymbol{p})}{p^m_{ik}}, \text{ and}, \tag{26}$$

Conditional on trade costs, these two equations provide the disposition of imports and bilateral trade. On the export demand side, we make a similar calculation based on the unit cost of exporting from a given Customs District. State-level exports using the demand functions derived from (23) are

$$\hat{E}_{isk} = p^y_{is} E_{ik} \frac{\partial P^x_{ik}(\boldsymbol{p})}{\partial p^y_{is}}. \tag{27}$$

We can close the system by using these demand function and the data identities to specify the market clearance conditions. We maintain the observed total values as given by the right-hand sides of equations (16)–(19) in both the equilibrium with frictions and in the frictionless anchor. In this regard, we are adopting the *conditional general equilibrium* environment suggested by Yotov et al. (2016, p75).

With the system well specified and calibrated to the frictionless anchor, we can find our estimated trade flows by inserting trade costs. For our methodological demonstration, we make the simple assumption that distance is the only friction. The standard coefficient estimated in empirical gravity applications is the elasticity of trade with respect to trade costs. We assume three values of this parameter $\varepsilon = \{-0.8, -1, -1.2\}$, with our central results relying on the central value. The distance elasticity (the elasticity of trade costs with respect to distance) is a transform of the assumed elasticity based on the relevant elasticity of substitution. With distance d the trade costs are calculated as follows:

$$t_{ss} = d_{ss}^{\frac{\varepsilon}{(1-\sigma_{ln})}}, \;\; t_{rs} = d_{rs}^{\frac{\varepsilon}{(1-\sigma_{nn})}}, \;\; t_{rk} = d_{rk}^{\frac{\varepsilon}{(1-\sigma_{x})}}, \;\text{ and }\; t_{ks} = d_{rk}^{\frac{\varepsilon}{(1-\sigma_{mm})}}. \tag{28}$$

Our estimates are conditional on this simplistic representation of trade costs, and we do not defend it beyond its transparency. Our research agenda includes an attempt to measure product-specific trade costs based on mode of transport and actual transportation rates.

5. Data

The primary data structure we work within is the GTAP-WiNDC framework of social accounts that include input-output acccounts, incomes and expenditures, and international trade flows. GTAP-WiNDC is an extension of the core WiNDC accounts as documented at the link https://windc.wisc.edu/buildstream/. WiNDC builds a set of consistent multisector subnational accounts using publically available data that include national input-output accounts and regional income and expenditures data from the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) as well as Census Bureau data on international trade and government expenditures.

In the GTAP-WiNDC extension, the WiNDC accounts are reconciled with the global GTAP (version 11) accounts, which treat the United States as a single region. The GTAP-WiNDC accounts, in contrast, include U.S. States as distinct regions within the global GTAP accounts. A key weakness of the GTAP accounts is the relatively course aggregation of all goods and services into 65 sectors. These are further aggregated in the GTAP-WiNDC accounts to 43 sectors including the 11 agricultural sectors enumerated above. The advantage of the GTAP accounts is their global consistency, which facilitates global general equilibrium analysis of policy. The base year for our GTAP-WiNDC data structure is 2017, corresponding to the latest GTAP release. Except as noted in this section, we give deference to the GTAP accounts, as partitioned into the State accounts using WiNDC, in determining supply and absorption.[8] In addition, the empirically informed Armington elasticities in GTAP are adopted in our gravity analysis.

The first instance of augmenting the accounts concerns State-level agricultural output. We utilize the USDA, ERS, data product "Cash Receipts by State" to allocate national output of the agricultural products to individual States (https://data.ers.usda.gov/reports.aspx?ID=17843). This provides us with good estimates of State gross output, which is superior to the value-added allocation internal to the WiNDC accounts. The use of the USDA Cash Receipts has been integrated into the GTAP-WiNDC extended build stream.

The international trade data by Customs District are sourced from the Census Bureau. These data are extracted using the Census Application Programming Interface (API) and merged into GAMS Data eXchange (GDX) format for use in the gravity model.[9] The imports and exports by commodity are used to compute each Customs District's share in national imports and exports by commodity. These shares are then applied to the GTAP-WiNDC totals for international trade to provide a consistent set of District-level accounts. The primary purpose of this exercise is to establish a State's exposure to international markets, but we note that the District-level data include the destination country for exports and the source country for imports. We carry this information into the GTAP-WiNDC data structure, which potentially allows us to assign a State's exports and imports to specific trade partners.

For perspective on agricultural trade at the Customs District level, the Census Bureau's export data are reported in Table 1 and the import data are reported

[8] As an extension of this project we are currently working on a version of the WiNDC accounts that does not rely on the GTAP accounts, but rather applies the gravity model to the fully disaggregated BEA detailed accounts (402 goods and services).

[9] The GAMS programs that directly extract these data from the Census web pages are available upon request (email: edward.balistreri@unl.edu).

Table 1. Port-district exports of agricultural goods ($M)

Port	C_B	CTL	GRO	OAP	OCR	OSD	PDR	PFB	V_F	WHT	WOL
AL_MOBI		53	0	0	2	249		67	1		
AZ_NOGA		8	7	6	27	5	1	4	530	16	
CA_LOSA	0	0	185	1,157	791	1,094	0	3,033	3,018	13	17
CA_SAND		4	61	9	47	10		2	402	2	
CA_SANF	0	1	32	188	211	103	10	109	5,876	1	1
DC_WASH		5	0	8	1	0		0	0		
FL_MIAM	0	79	12	199	143	16	0	5	209	1	0
FL_TAMP		0	21	2	17	3		1	29		
GA_SAVA		1	7	124	37	79		1,121	242	0	0
IL_CHIC		293	5	77	31	36		2	11	4	0
LA_NEWO		7	5,415	72	21	13,061	365	21	34	945	0
MA_BOST		0	0	85	1	0			0		
MD_BALT		0	7	1	5	16		0	5	0	
ME_PORT		1	5	3	7	1		0	68	0	
MI_DETR	3	21	237	157	158	182	5	1	2,910	5	0
MN_DULU			4	10	2	60		5	0	0	0
MN_MINN		0	3	2	0	10			4	156	
MO_STLO				0					0		
MT_GREA	3	95	18	9	28	52		0	1,016	6	
NC_CHAR		0		4	1	12			25		
ND_PEMB	0	12	93	87	24	201		0	254	2	
NY_BUFF	0	29	20	54	118	116	0	0	620	0	0
NY_NEWY		0	55	83	59	134		1	81	0	0
NY_OGDE		28	5	63	93	9	0	1	552	0	0
OH_CLEV		84	18	3	18	163		1	10		0
OR_COLU		5	1,486	0	3	3,180		0	12	3,400	
PA_PHIL		32	0	14	29	3		1	10	0	0
SC_CHAR		0	2	28	24	55		127	46	0	1
TX_DALL		2	0	56	2	0		0	3		0
TX_ELPA		56	224	7	17	16	1	0	169	119	
TX_HOUS	0	3	936	39	17	266	1	1,136	443	1,286	4
TX_LARE		50	1,630	318	30	1,086	56	421	233	391	0
TX_PRTA			142							112	
VA_NORF		0	73	31	28	1,025		80	126	10	0
VT_STAL		0	0	4	4	1		0	2		
WA_SEAT	3	35	887	453	1,276	2,125	0	1	2,412	36	0
WI_MILW			22		0	35					
Total	8	905	11,614	3,352	3,272	23,404	441	6,142	19,352	6,505	25

Table 2. Port-District imports of agricultural goods ($M)

Port	C_B	CTL	GRO	OAP	OCR	OSD	PDR	PFB	V_F	WHT	WOL
AL_MOBI					1				340		
AZ_NOGA		200	3	3	5	5		1	3,292		
CA_LOSA	0		21	279	711	37	0	15	2,558	1	0
CA_SAND	0	41	1	13	74	7		0	2,508	3	
CA_SANF	0	1	74	47	1,343	122		18	933	1	0
DC_WASH		0		7	73				6		
FL_MIAM	0	271	72	33	1,660	49	0	1	1,668	5	0
FL_TAMP			5	7	419	0		0	297	0	0
GA_SAVA			8	57	287	13		13	148	0	0
IL_CHIC	0	143	7	63	222	1		0	63		
LA_NEWO	0	0	28	3	918	100		1	98		1
MA_BOST		0		12	27	1		0	43		1
MD_BALT			54	12	965	183		0	26	5	
ME_PORT		6	3	4	33	0		0	111	0	
MI_DETR		44	55	225	113	45		0	1,030	54	
MN_DULU			148	0	5	19		0	5	110	
MN_MINN		17	0	1	2	3		0	6	5	
MO_STLO					0						
MT_GREA		545	24	65	56	35		0	90	121	0
NC_CHAR			45	0	7	2		0	0		
ND_PEMB		216	162	296	56	379		0	177	313	
NY_BUFF		70	63	52	256	15		0	315	45	0
NY_NEWY			9	30	505	10		1	184	1	
NY_OGDE		68	31	23	75	24		0	203	16	1
OH_CLEV		1	31	9	11	0		3	14	39	0
OR_COLU	0		0	0	3	0			2		
PA_PHIL			109	296	1,292	16		0	4,125		0
SC_CHAR	0		0	22	662	4		3	20		4
TX_DALL			1	3	28	2			6		2
TX_ELPA		397	12	1	16				625		
TX_HOUS	0	0	28	167	561	10		6	631		0
TX_LARE	0	124	2	82	71	10		1	6,903		0
VA_NORF			16	118	1,301	34		7	691		
VT_STAL		8	36	8	17	8		0	27	0	
WA_SEAT		47	25	77	811	57		11	684	2	
Total	1	2,200	1,075	2,012	12,587	1,193	0	83	27,832	721	10

in Table 2. These tables provide context for the expected shifts in the location of export sourcing and absorption of imports by State. To give an example, consider the locations of wheat exports by Customs District. The majority (51.1% in 2021) of U.S. wheat exports exit the country via the Columbia-Snake Customs District (named after the Columbia and Snake Rivers), primarily through the Ports of Portland, Oregon, Kalama, Washington, and Longview, Washington. Wheat production is concentrated in the Great Plains (especially North Dakota, Kansas, Montana, Minnesota, and Oklahoma) and the Palouse region (southeastern Washington, north-central Idaho, and northeastern Oregon). Relative to production-based export estimates, the gravity model is expected to reveal more export exposure for wheat growers in Washington, Idaho, and Oregon given their proximity to the Columbia-Snake Customs District.

The final data component necessary for the gravity model is a measure of trade costs. In this application, we use a transparent model of economic geography that relies only on physical distance. Extending the model to include a more complete representation of transportation networks, including modes and measured costs, is appropriate and advised. Our initial estimates, however, simply use distance. The distances are calculated as follows. Each U.S. County and Customs District is assigned a latitude and longitude. A State's location is determined by the GDP-weighted average of the location of its Counties. We then make a calculation of the *great-circle* distance between each State and between any State and Customs District.[10]

6. Results

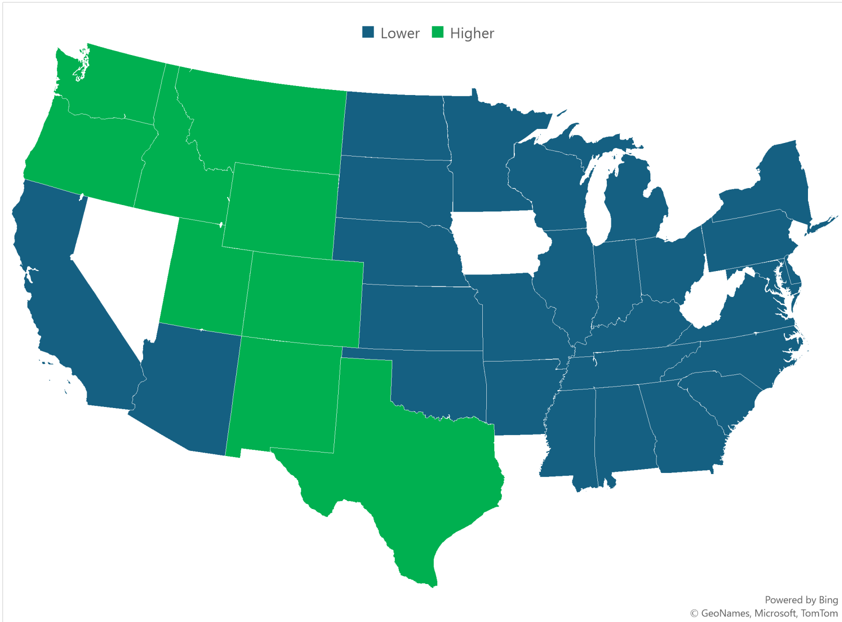
We apply the proposed gravity structure to estimate State-level imports and exports of the 11 agricultural sectors. The full set of *export* results are presented in Appendix A, and the full set of *import* results are presented in Appendix B. In this section, we discuss select results for wheat. We consider only movements of wheat in grain form and not of flour or other wheat-based products. Also, we lack the data needed to distinguish among different classes of wheat, which tend to be grown in different parts of the country (Sowell, 2025), nor do we have data on interstate movements of wheat to final destinations within the United States or on the mixing of wheat grown in different States.

6.1 State-level wheat exports

One of the clearest examples of the gravity model's operation is the case of wheat (WHT). In Table A.10, we see that much of U.S. wheat production is concentrated in the Great Plains, with that area's top three wheat-producing States (North Dakota, Kansas, and Montana) accounting for 40.3% of production in 2021.

[10] Again, the GAMS programs used to generate the distances are available upon request (email: edward.balistreri@unl.edu).

Figure 1. Gravity exports of wheat relative to production sharing



Production in the Palouse is also sizable, with Washington, Idaho, and Oregon accounting for 16.8% of production. Looking at Table 1, we see that over half of U.S. wheat exports depart the country from the Columbia-Snake Customs District and another 20% from the Houston Customs District. The gravity model thus significantly increases wheat exports from Washington, Idaho, Oregon, and Texas. Relative to the share-based approach used by USDA, ERS (2023b), Washington's exports increase by 86.3%, and Idaho's exports increase by 28.8%. Montana, which is also relatively close to the Columbia-Snake Customs District, shows a 25% increase. In contrast, estimated exports from Kansas and North Dakota fall by 14.9% and 2.7%, respectively. To illustrate the shifting of exports to States around the Columbia-Snake and Houston Customs Districts, Figure 1 shows which States are estimated to have higher or lower exports relative to exports based on the share-based approach.

How do the gravity-based estimates of State export shares for wheat compare with the rough estimates in circulation? For States near export ports in the Columbia-Snake and Seattle Customs Districts, such as Washington, Montana, Idaho, and Oregon, the gravity-based estimates of wheat exports are much larger than the corresponding share-based estimates (Table 3). As a result, the gravity-based estimates of State export shares for these States are much higher than the generic, share-based estimate of 42.1%. However, the gravity-based estimates for Washington and Montana still fall appreciably shy of the rough estimates for those States. In contrast, for Kansas and North Dakota, the gravity-based approach generates smaller estimates than the share-based approach, thereby moving farther away from the rough estimates for those States. For example, for Kansas, the gravity-based export share is 35.8%, compared with a share-based export share of 42.1% and the Kansas Wheat Commission's rough estimate of "about half."

The milling of wheat in the State where it is grown reduces the quantity of that State's wheat production that can be exported. A comparison of the quantity of wheat milled with the quantity of wheat harvested by State (or groups of States), Table 4 reveals that neither the share-based nor the gravity-based export estimates are so large that they would contradict the available State-level milling data. For example, in 2021, North Dakota milled about 21.8% of its wheat production, while Kansas milled about 18.9%. Interestingly, there are some States where more wheat is milled than is grown. In California, for example, the quantity of wheat milled in 2021 was more than 9 times the size of that State's wheat crop in 2020. [11]

A more accurate measure of trade costs that varies by product, mode of transportation, and access to the transportation network would greatly improve the estimated exports and imports of agricultural products by State. While the task of assembling such a measure is well beyond the scope of this study, it is useful to consider how they might affect our trade estimates. Kansas is distant from the major Ports of Entry from which wheat departs the United States, but it is well connected by rail to border crossings in the Laredo and El Paso areas and to seaports in the Houston Customs District. Similarly, although Minnesota is far from the Atlantic and Pacific Oceans and the Gulf of Mexico, the State includes the Duluth Customs District adjoining Lake Superior and many terminals along the Mississippi River. We can consider the overall sensitivity of our estimates to the rate at which trade costs escalate over geography. This gives us some indication of how a more elaborate model of transportation affects estimated State-level international trade.

6.2 Sensitivity

The gravity-based estimates are inherently sensitive to the implied distance elasticity. As indicated in the assignments of trade costs, equation (28), the distance elasticity ($\partial t_{ij}/\partial d_{ij}$) depends on our assumed elasticity of trade with respect to trade costs, ϵ, as it interacts with the elasticity of substitution. Higher values of ϵ indicate higher distance elasticities and a greater escalation of trade costs as goods move over distance. That is, a higher assumed ϵ indicates a higher distance-related freight cost. To explore this sensitivity, we vary the parameter ϵ over its range: low -0.8, central -1.0, and high -1.2. The results are presented in Table 5 for the ten largest producing states. We see some clear and intuitive impacts of

[11] The milling data in Table 4 were used only to evaluate the gravity-based estimates and not to calculate demand as part of our modeling approach. In our estimates, demand was derived from the WiNDC State Input-Output Accounts. Although more recent milling data were available at the time of writing, we used milling data for 2021 to compare them with trade data for that year.

Table 3. Share-based and gravity-based estimates of wheat exports for 2021

State	Output	Share-based export estimate	Gravity-based export estimate	Gravity-based export share	Selected rough estimates	Source of Rough Estimates
	Dollars (millions)			*Percent*	*Quote (%)*	
US total	15,453.6	6,505.5	6,505.5	100.0		
North Dakota	2,633.9	1,108.8	1,078.4	40.9	"About half"	Farm and Ranch Guide (2017)
Kansas	2,215.5	932.6	793.7	35.8	"About half"	Kansas Wheat Commission (2025)
Washington	1,396.6	587.9	1,095.2	78.4	"Up to 90 percent"	Washington Dept. of Agriculture (2025)
Montana	1,385.2	583.1	729.2	52.6	"About 80 percent"	Ernst (2016)
Idaho	746.1	314.1	404.6	54.2	"Half"	Ellis (2024)
Minnesota	737.5	310.5	247.3	33.5	"About 30 percent"	Radelat (2022)
Oklahoma	720.6	303.3	275.6	38.2	"55% to 65% of the demand for our Hard Red Winter Wheat"	Oklahoma Wheat Commission (2024)
All other States	5,618.2	2,365.2	1,881.5	33.5		

Note: Exports accounted for 42.1% of US farm income from wheat in 2021.

Sources: Authors' modeling estimates using farm income data from USDA, ERS (2023a) and export data from U.S. Department of Commerce, Bureau of Census (2023). Rough estimates were drawn from the cited sources: Ellis (2024); Ernst (2016); Farm and Ranch Guide (2017); Kansas Wheat Commission (2024); Oklahoma Wheat Commission (2024); Radelat (2022); and Washington Department of Agriculture (2025).

Table 4. Wheat harvest in 2020 and wheat milled for flour in 2021

State(s)	Harvest 2020	Milled 2021	Ratio (Milled to Harvest)
	Millions of bushels		*Percent*
California	7.1	65.1	915.9
Colorado and Oklahoma	142.5	30.5	21.4
Colorado	40.5	-	-
Oklahoma	102.0	-	-
Florida, Georgia, and South Carolina	9.5	36.0	377.9
Florida	-	-	-
Georgia	4.7	-	-
South Carolina	4.8	-	-
Idaho, Montana, Oregon, Utah, and Washington	558.0	64.9	11.6
Idaho	111.5	-	-
Montana	228.7	-	-
Oregon	46.4	-	-
Utah	5.2	-	-
Washington	166.2	-	-
Illinois, Indiana, and Wisconsin	61.5	99.3	161.4
Illinois	35.4	-	-
Indiana	17.5	-	-
Wisconsin	8.6	-	-
Iowa and Nebraska	34.0	33.8	99.5
Iowa	-	-	-
Nebraska	34.0	-	-
Kansas	281.3	61.6	21.9
Kentucky and Tennessee	35.0	34.9	99.6
Kentucky	21.4	-	-
Tennessee	13.6	-	-
Maryland and Virginia	18.8	25.8	137.8
Maryland	11.0	-	-
Virginia	7.8	-	-
Michigan	33.8	22.7	67.2
Minnesota	72.1	45.0	62.5
Missouri	22.3	49.5	221.9
New Jersey and New York	8.5	55.1	650.8
New Jersey	1.2	-	-
New York	7.3	-	-
North Carolina	21.0	31.6	150.3
North Dakota	312.6	58.7	18.8
Ohio	34.8	54.2	155.9
Pennsylvania	12.8	45.7	357.9
Texas	60.0	53.2	88.6
Other States	94.3	45.8	48.6
United States	1,819.7	913.4	50.2

Table 5. Sensitivity of gravity-based wheat exports

		Exports Low Elasticity ($M)	Exports Central Elasticity ($M)	Exports High Elasticity ($M)	Proportion of Central Low	Central	High
State	code	(1)	(2)	(3)	(4)	(5)	(6)
North Dakota	ND	1,069.3	1,078.4	1,125.4	0.99	1.00	1.04
Kansas	KS	806.5	793.7	810.8	1.02	1.00	1.02
Washington	WA	1,025.2	1,095.2	1,121.0	0.94	1.00	1.02
Montana	MT	698.7	729.2	782.6	0.96	1.00	1.07
Idaho	ID	392.5	404.6	424.0	0.97	1.00	1.05
Minnesota	MN	255.0	247.3	245.5	1.03	1.00	0.99
Oklahoma	OK	278.2	275.6	284.6	1.01	1.00	1.03
South Dakota	SD	220.7	218.5	226.7	1.01	1.00	1.04
Colorado	CO	230.6	232.7	234.6	0.99	1.00	1.01
Oregon	OR	364.1	390.2	406.6	0.93	1.00	1.04
Texas	TX	193.3	201.3	167.3	0.96	1.00	0.83
Nebraska	NE	134.7	131.8	134.8	1.02	1.00	1.02

different distance elasticities, but there are a number of States with non-monotonic responses. The northwestern States of Washington, Idaho, and Oregon have the expected pattern with higher distance elasticities indicating higher exports. On average, exports from States distant from the Columbia-Snake Customs District (like Minnesota) become more costly, so States more proximate to the export node export more. Minnesota being more remote (relative to the export nodes) exports less the higher is the distance elasticity. These results are intuitive despite the complexity of the constrained system.

For a State like Kansas, however, we see that exports are slightly higher in both the low and high elasticity cases. This highlights the role of multilateral resistance as identified by Anderson and van Wincoop (2003). There are three distinct effects for a State within the constrained system. First, a higher distance elasticity has the direct effect of increasing the cost of getting product to any Customs District. Second, there is inward multilateral resistance reflecting the increased cost of meeting demand for the product within the State itself from any external source. And finally, there is outward multilateral resistance reflecting the increased cost that a given Customs District faces to meet export demand relative to the State's product. These complex interactions have an overall ambiguous effect within the constrained system that must satisfy the accounting identities. This explains the less intuitive and non-monotonic responses to the elasticity changes.

7. Conclusion

This analysis contributes to the literature on constrained-gravity methods for estimating interstate trade within the United States and State-level international trade. Focusing only on agricultural products, we formulate a structural gravity model that leverages the frictionless calibration point to estimate a State's exposure to international imports and exports. The estimates are consistent with the GTAP-WiNDC data structure and are available for use in either nonlinear general-equilibrium modeling exercises or input-output calculations. The system produces the State-level international trade statistics reported, as well as a complete State-by-State matrix of bilateral interstate trade flows.

We demonstrate the system by using it to explore how transportation costs affect the State-level exports of 11 agricultural product groups. In this analysis, transportation costs depend only on the distance between the State where a product is produced and the Port of Entry from which that product exits the United States. As such, this simplistic representation does not account for the extensive network of trucking, rail, and shipping services within the United States. Clearly, this is an area for future extensions and improvements to the system.

In general, the gravity-based approach attributes higher levels of exports of a given agricultural product to States producing that product which are located near Ports of Entry from which the product exits the country. Compared with the share-based approach used by USDA, ERS, the gravity-based approach estimates higher levels of wheat exports from wheat-producing States in the Palouse region, which is proximate to ports in the Columbia-Snake Customs District. However, the gravity-based estimates of Kansas's wheat exports fall well below the Kansas Wheat Commission's understanding of this trade, given the extensive rail network linking the State's elevators to various export ports. Given these differences and our recognition of the opportunities to upgrade the system's representation of U.S. transportation networks, we are interested in meaningful validation exercises that compare and refine our results relative to the sparse data on State-level trade.

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Appendix A. Exports

Table A.1. State production and estimated exports of Sugar cane, Sugar Beet (c_b)

State	code	Output ($M) (1)	Output Share (2)	Share Based Exports ($M) (3)	Gravity Exports ($M) (4)	Gravity Based Export Share (5)	Percentage Change in State Exports (6)
Florida	FL	799.9	29.3%	2.451	1.509	18.0%	-38.4%
Minnesota	MN	457.6	16.8%	1.402	1.460	17.4%	4.1%
Louisiana	LA	326.7	12.0%	1.001	0.666	8.0%	-33.4%
Idaho	ID	309.6	11.3%	0.949	1.687	20.2%	77.8%
North Dakota	ND	261.2	9.6%	0.801	1.262	15.1%	57.7%
Michigan	MI	153.2	5.6%	0.470	0.446	5.3%	-4.9%
California	CA	65.7	2.4%	0.201	0.162	1.9%	-19.8%
Vermont	VT	62.3	2.3%	0.191	0.076	0.9%	-60.3%
Montana	MT	58.6	2.1%	0.180	0.439	5.2%	144.4%
Nebraska	NE	37.8	1.4%	0.116	0.117	1.4%	0.6%
New York	NY	34.3	1.3%	0.105	0.028	0.3%	-73.4%
Wyoming	WY	30.8	1.1%	0.094	0.145	1.7%	53.6%
Maine	ME	28.7	1.1%	0.088	0.038	0.5%	-57.1%
Colorado	CO	26.4	1.0%	0.081	0.098	1.2%	20.4%
Texas	TX	23.4	0.9%	0.072	0.058	0.7%	-18.6%
Oregon	OR	19.4	0.7%	0.059	0.098	1.2%	64.7%
New Hampshire	NH	8.5	0.3%	0.026	0.007	0.1%	-73.7%
Wisconsin	WI	6.9	0.3%	0.021	0.017	0.2%	-19.0%
Pennsylvania	PA	6.4	0.2%	0.019	0.007	0.1%	-64.8%
Massachusetts	MA	4.7	0.2%	0.015	0.004	0.0%	-72.6%
Washington	WA	4.6	0.2%	0.014	0.037	0.4%	162.6%
Ohio	OH	3.4	0.1%	0.010	0.007	0.1%	-31.4%
Total	USA	2,730.3	100.0%	8.367	8.367	100.0%	0.0%

Table A.2. State production and estimated exports of Bovine cattle, sheep, goats and horses (ctl)

State	code	Output ($M) (1)	Output Share (2)	Share Based Exports ($M) (3)	Gravity Exports ($M) (4)	Gravity Based Export Share (5)	Percentage Change in State Exports (6)
Nebraska	NE	9,149.4	14.2%	128.6	128.9	14.2%	0.3%
Texas	TX	8,957.9	13.9%	125.9	137.5	15.2%	9.2%
Kansas	KS	7,322.8	11.4%	102.9	100.7	11.1%	-2.2%
Iowa	IA	3,835.5	6.0%	53.9	58.6	6.5%	8.7%
Oklahoma	OK	3,421.3	5.3%	48.1	45.1	5.0%	-6.2%
Colorado	CO	3,233.0	5.0%	45.4	46.9	5.2%	3.1%
California	CA	2,951.6	4.6%	41.5	28.8	3.2%	-30.6%
South Dakota	SD	2,551.3	4.0%	35.9	38.6	4.3%	7.6%
Minnesota	MN	1,901.4	3.0%	26.7	28.8	3.2%	7.9%
Missouri	MO	1,837.3	2.9%	25.8	26.3	2.9%	1.8%
Wisconsin	WI	1,827.0	2.8%	25.7	34.0	3.8%	32.4%
Idaho	ID	1,639.4	2.5%	23.0	22.4	2.5%	-3.0%
Montana	MT	1,439.0	2.2%	20.2	26.9	3.0%	33.0%
North Dakota	ND	1,001.6	1.6%	14.1	17.0	1.9%	20.7%
Wyoming	WY	910.7	1.4%	12.8	13.9	1.5%	8.4%
Oregon	OR	877.1	1.4%	12.3	8.9	1.0%	-27.9%
Washington	WA	843.5	1.3%	11.9	10.0	1.1%	-15.9%
Arizona	AZ	842.6	1.3%	11.8	9.7	1.1%	-18.5%
New Mexico	NM	834.6	1.3%	11.7	13.3	1.5%	13.3%
Kentucky	KY	781.7	1.2%	11.0	8.7	1.0%	-20.5%
Illinois	IL	760.4	1.2%	10.7	22.0	2.4%	106.2%
Florida	FL	657.5	1.0%	9.2	8.1	0.9%	-12.7%
Pennsylvania	PA	646.2	1.0%	9.1	4.4	0.5%	-52.1%
Ohio	OH	594.0	0.9%	8.3	7.5	0.8%	-10.1%
Michigan	MI	564.3	0.9%	7.9	8.7	1.0%	10.1%
Tennessee	TN	546.9	0.8%	7.7	5.8	0.6%	-24.8%
Utah	UT	516.2	0.8%	7.3	6.4	0.7%	-11.7%
Arkansas	AR	492.6	0.8%	6.9	6.4	0.7%	-7.3%
Alabama	AL	490.1	0.8%	6.9	4.9	0.5%	-28.4%
Virginia	VA	468.6	0.7%	6.6	2.9	0.3%	-56.7%
Indiana	IN	374.3	0.6%	5.3	5.7	0.6%	9.1%
Georgia	GA	372.7	0.6%	5.2	3.2	0.4%	-39.4%
New York	NY	350.9	0.5%	4.9	1.7	0.2%	-65.2%
Nevada	NV	312.6	0.5%	4.4	2.6	0.3%	-40.7%
North Carolina	NC	308.7	0.5%	4.3	2.1	0.2%	-52.4%
Louisiana	LA	213.9	0.3%	3.0	2.8	0.3%	-6.4%
Mississippi	MS	195.9	0.3%	2.8	2.4	0.3%	-12.7%
West Virginia	WV	189.51	0.3%	2.66	1.62	0.2%	-39.2%
South Carolina	SC	127.16	0.2%	1.79	0.85	0.1%	-52.6%
Vermont	VT	63.52	0.1%	0.89	0.39	0.0%	-55.8%
Total	USA	64,404.53	100.0%	905.24	905.24	100.0%	0.0%

Table A.3. State production and estimated exports of Cereal grains nec (gro)

State	code	Output ($M) (1)	Output Share (2)	Share Based Exports ($M) (3)	Gravity Exports ($M) (4)	Gravity Based Export Share (5)	Percentage Change in State Exports (6)
Iowa	IA	9,933.2	16.3%	1,888.3	1,920.2	16.5%	1.7%
Illinois	IL	9,187.3	15.0%	1,746.5	1,498.2	12.9%	-14.2%
Nebraska	NE	6,309.6	10.3%	1,199.5	1,309.5	11.3%	9.2%
Minnesota	MN	5,644.6	9.2%	1,073.0	1,087.8	9.4%	1.4%
Indiana	IN	4,258.4	7.0%	809.5	647.7	5.6%	-20.0%
Kansas	KS	3,164.3	5.2%	601.5	706.4	6.1%	17.4%
South Dakota	SD	2,927.7	4.8%	556.6	607.6	5.2%	9.2%
Missouri	MO	2,255.0	3.7%	428.7	483.9	4.2%	12.9%
Ohio	OH	2,222.9	3.6%	422.6	296.2	2.6%	-29.9%
North Dakota	ND	1,896.8	3.1%	360.6	406.7	3.5%	12.8%
Texas	TX	1,844.2	3.0%	350.6	641.4	5.5%	83.0%
Wisconsin	WI	1,758.4	2.9%	334.3	297.6	2.6%	-11.0%
Michigan	MI	1,287.5	2.1%	244.8	191.3	1.6%	-21.8%
Kentucky	KY	984.9	1.6%	187.2	151.6	1.3%	-19.0%
Colorado	CO	782.0	1.3%	148.7	156.7	1.3%	5.4%
North Carolina	NC	681.8	1.1%	129.6	77.1	0.7%	-40.5%
Pennsylvania	PA	589.0	1.0%	112.0	45.3	0.4%	-59.5%
Arkansas	AR	534.1	0.9%	101.5	140.0	1.2%	37.9%
Mississippi	MS	525.8	0.9%	100.0	173.1	1.5%	73.1%
Tennessee	TN	497.9	0.8%	94.7	92.2	0.8%	-2.6%
Louisiana	LA	445.2	0.7%	84.6	210.1	1.8%	148.2%
Idaho	ID	438.1	0.7%	83.3	72.5	0.6%	-13.0%
New York	NY	372.6	0.6%	70.8	22.1	0.2%	-68.8%
Maryland	MD	308.5	0.5%	58.6	19.5	0.2%	-66.8%
Georgia	GA	278.3	0.5%	52.9	46.5	0.4%	-12.2%
Montana	MT	256.4	0.4%	48.7	48.3	0.4%	-0.9%
Oklahoma	OK	249.8	0.4%	47.5	60.7	0.5%	27.9%
Virginia	VA	237.8	0.4%	45.2	20.9	0.2%	-53.8%
South Carolina	SC	223.4	0.4%	42.5	25.8	0.2%	-39.3%
California	CA	211.3	0.3%	40.2	19.8	0.2%	-50.6%
Washington	WA	196.1	0.3%	37.3	42.4	0.4%	13.7%
Alabama	AL	194.7	0.3%	37.0	43.7	0.4%	18.1%
Delaware	DE	148.0	0.2%	28.1	8.5	0.1%	-69.8%
Arizona	AZ	85.1	0.1%	16.2	11.6	0.1%	-28.6%
Oregon	OR	81.7	0.1%	15.5	15.9	0.1%	2.4%
Wyoming	WY	79.8	0.1%	15.2	15.0	0.1%	-0.9%
Total	USA	61,092.3	100.0%	11,613.8	11,613.8	100.0%	0.0%

Table A.4. State production and estimated exports of Animal products nec (oap)

State	code	Output ($M) (1)	Output Share (2)	Share Based Exports ($M) (3)	Gravity Exports ($M) (4)	Gravity Based Export Share (5)	Percentage Change in State Exports (6)
Iowa	IA	7,798.6	11.5%	385.7	405.2	12.1%	5.1%
North Carolina	NC	7,129.2	10.5%	352.6	272.1	8.1%	-22.8%
Georgia	GA	5,043.4	7.4%	249.4	222.6	6.6%	-10.8%
Arkansas	AR	4,283.6	6.3%	211.9	243.4	7.3%	14.9%
Minnesota	MN	3,640.3	5.4%	180.0	204.6	6.1%	13.7%
Alabama	AL	3,591.9	5.3%	177.7	174.1	5.2%	-2.0%
Texas	TX	3,302.7	4.9%	163.4	264.6	7.9%	62.0%
Mississippi	MS	2,870.6	4.2%	142.0	161.5	4.8%	13.7%
Indiana	IN	2,545.1	3.8%	125.9	104.6	3.1%	-16.9%
Kentucky	KY	2,334.5	3.4%	115.5	97.5	2.9%	-15.5%
Missouri	MO	2,243.3	3.3%	111.0	119.1	3.6%	7.3%
California	CA	2,208.9	3.3%	109.3	151.3	4.5%	38.5%
Oklahoma	OK	1,802.3	2.7%	89.1	107.7	3.2%	20.8%
Ohio	OH	1,793.6	2.6%	88.7	76.1	2.3%	-14.2%
Pennsylvania	PA	1,689.9	2.5%	83.6	48.4	1.4%	-42.1%
Virginia	VA	1,510.0	2.2%	74.7	47.2	1.4%	-36.8%
Illinois	IL	1,400.4	2.1%	69.3	60.8	1.8%	-12.2%
Maryland	MD	1,155.4	1.7%	57.1	26.9	0.8%	-52.9%
South Carolina	SC	1,098.7	1.6%	54.3	41.1	1.2%	-24.5%
Delaware	DE	1,066.9	1.6%	52.8	22.9	0.7%	-56.5%
Nebraska	NE	918.7	1.4%	45.4	53.3	1.6%	17.3%
Louisiana	LA	851.0	1.3%	42.1	53.9	1.6%	28.1%
Michigan	MI	804.7	1.2%	39.8	39.4	1.2%	-0.9%
South Dakota	SD	803.4	1.2%	39.7	50.0	1.5%	26.0%
Tennessee	TN	684.8	1.0%	33.9	31.8	0.9%	-6.0%
Florida	FL	630.8	0.9%	31.2	39.5	1.2%	26.6%
Kansas	KS	569.3	0.8%	28.2	33.1	1.0%	17.6%
Washington	WA	546.1	0.8%	27.0	26.7	0.8%	-1.3%
Wisconsin	WI	527.5	0.8%	26.1	24.8	0.7%	-5.1%
Utah	UT	467.7	0.7%	23.1	28.0	0.8%	21.2%
Colorado	CO	432.9	0.6%	21.4	28.0	0.8%	30.6%
West Virginia	WV	341.7	0.5%	16.9	12.2	0.4%	-27.8%
New York	NY	269.2	0.4%	13.3	6.2	0.2%	-53.5%
Oregon	OR	249.6	0.4%	12.3	11.5	0.3%	-6.7%
Wyoming	WY	172.9	0.3%	8.6	11.0	0.3%	28.4%
North Dakota	ND	165.5	0.2%	8.2	11.6	0.3%	42.1%
Idaho	ID	162.5	0.2%	8.0	9.8	0.3%	21.6%
Montana	MT	156.55	0.2%	7.74	10.12	0.3%	30.7%
Maine	ME	147.66	0.2%	7.30	4.33	0.1%	-40.7%
Arizona	AZ	102.78	0.2%	5.08	6.34	0.2%	24.7%
New Jersey	NJ	93.84	0.1%	4.64	1.65	0.0%	-64.6%
Connecticut	CT	82.29	0.1%	4.07	1.46	0.0%	-64.2%
New Mexico	NM	76.75	0.1%	3.80	5.36	0.2%	41.2%
Total	USA	67,767.16	100.0%	3,351.79	3,351.79	100.0%	0.0%

Table A.5. State production and estimated exports of Crops nec (ocr)

State	code	Output ($M) (1)	Output Share (2)	Share Based Exports ($M) (3)	Gravity Exports ($M) (4)	Gravity Based Export Share (5)	Percentage Change in State Exports (6)
California	CA	2,651.8	20.0%	653.4	1,074.6	32.8%	64.5%
Florida	FL	1,060.9	8.0%	261.4	180.6	5.5%	-30.9%
Oregon	OR	781.1	5.9%	192.5	344.9	10.5%	79.2%
Texas	TX	684.4	5.2%	168.6	128.6	3.9%	-23.7%
Washington	WA	621.7	4.7%	153.2	373.9	11.4%	144.1%
Pennsylvania	PA	593.8	4.5%	146.3	65.6	2.0%	-55.2%
North Carolina	NC	560.4	4.2%	138.1	64.6	2.0%	-53.2%
Michigan	MI	356.1	2.7%	87.7	53.9	1.6%	-38.6%
Colorado	CO	323.0	2.4%	79.6	77.4	2.4%	-2.7%
New York	NY	319.5	2.4%	78.7	30.0	0.9%	-61.8%
Idaho	ID	313.9	2.4%	77.3	116.7	3.6%	50.9%
Kentucky	KY	298.1	2.2%	73.5	34.7	1.1%	-52.8%
Arizona	AZ	266.2	2.0%	65.6	77.5	2.4%	18.1%
Ohio	OH	263.1	2.0%	64.8	35.1	1.1%	-45.8%
New Jersey	NJ	258.0	1.9%	63.6	18.7	0.6%	-70.6%
Virginia	VA	238.8	1.8%	58.8	25.4	0.8%	-56.8%
Tennessee	TN	227.2	1.7%	56.0	28.2	0.9%	-49.6%
Georgia	GA	220.5	1.7%	54.3	26.0	0.8%	-52.1%
Illinois	IL	218.8	1.6%	53.9	25.6	0.8%	-52.5%
Wisconsin	WI	216.6	1.6%	53.4	27.7	0.8%	-48.0%
Minnesota	MN	176.7	1.3%	43.5	28.0	0.9%	-35.8%
Connecticut	CT	166.2	1.3%	41.0	12.6	0.4%	-69.2%
Montana	MT	161.1	1.2%	39.7	56.4	1.7%	42.0%
Utah	UT	154.6	1.2%	38.1	46.7	1.4%	22.7%
Alabama	AL	151.7	1.1%	37.4	18.6	0.6%	-50.3%
Indiana	IN	150.1	1.1%	37.0	17.1	0.5%	-53.7%
South Carolina	SC	142.9	1.1%	35.2	15.2	0.5%	-56.9%
Maryland	MD	140.6	1.1%	34.6	11.5	0.4%	-66.7%
Missouri	MO	140.3	1.1%	34.6	19.5	0.6%	-43.5%
Nebraska	NE	129.2	1.0%	31.8	21.0	0.6%	-34.0%
Kansas	KS	126.2	1.0%	31.1	19.6	0.6%	-37.0%
Iowa	IA	126.1	0.9%	31.1	17.4	0.5%	-43.9%
Oklahoma	OK	122.8	0.9%	30.3	19.0	0.6%	-37.1%
New Mexico	NM	121.4	0.9%	29.9	30.7	0.9%	2.6%
Massachusetts	MA	98.9	0.7%	24.4	8.8	0.3%	-63.9%
Wyoming	WY	85.1	0.6%	21.0	23.0	0.7%	9.7%
Louisiana	LA	72.4	0.5%	17.8	11.0	0.3%	-38.5%
South Dakota	SD	71.46	0.5%	17.61	13.29	0.4%	-24.5%
Maine	ME	71.08	0.5%	17.51	8.99	0.3%	-48.7%
Nevada	NV	66.28	0.5%	16.33	19.70	0.6%	20.6%
Arkansas	AR	57.28	0.4%	14.11	8.19	0.3%	-42.0%
North Dakota	ND	51.44	0.4%	12.67	12.21	0.4%	-3.7%
Mississippi	MS	51.05	0.4%	12.58	7.03	0.2%	-44.1%
New Hampshire	NH	47.44	0.4%	11.69	3.81	0.1%	-67.4%
Vermont	VT	44.07	0.3%	10.86	5.44	0.2%	-49.9%
West Virginia	WV	37.06	0.3%	9.13	4.30	0.1%	-52.9%
Delaware	DE	21.95	0.2%	5.41	1.76	0.1%	-67.5%
Rhode Island	RI	19.05	0.1%	4.70	1.19	0.0%	-74.7%
Total	USA	13,278.52	100.0%	3,271.84	3,271.84	100.0%	0.0%

Table A.6. State production and estimated exports of Oil Seeds (osd)

State	code	Output ($M) (1)	Output Share (2)	Share Based Exports ($M) (3)	Gravity Exports ($M) (4)	Gravity Based Export Share (5)	Percentage Change in State Exports (6)
Illinois	IL	6,655.6	13.2%	3,089.1	2,761.8	11.8%	-10.6%
Iowa	IA	5,849.8	11.6%	2,715.1	2,748.0	11.7%	1.2%
Minnesota	MN	3,981.9	7.9%	1,848.1	1,872.9	8.0%	1.3%
Indiana	IN	3,559.2	7.1%	1,651.9	1,411.0	6.0%	-14.6%
North Dakota	ND	3,250.3	6.4%	1,508.6	1,652.2	7.1%	9.5%
Nebraska	NE	3,167.3	6.3%	1,470.1	1,562.7	6.7%	6.3%
Missouri	MO	3,041.2	6.0%	1,411.5	1,544.0	6.6%	9.4%
Ohio	OH	2,890.1	5.7%	1,341.4	1,054.5	4.5%	-21.4%
South Dakota	SD	2,778.2	5.5%	1,289.4	1,373.0	5.9%	6.5%
Arkansas	AR	1,835.3	3.6%	851.8	1,065.7	4.6%	25.1%
Kansas	KS	1,828.0	3.6%	848.4	944.5	4.0%	11.3%
Mississippi	MS	1,357.0	2.7%	629.8	938.4	4.0%	49.0%
Michigan	MI	1,168.2	2.3%	542.2	452.5	1.9%	-16.5%
Wisconsin	WI	1,155.7	2.3%	536.4	492.9	2.1%	-8.1%
Kentucky	KY	1,127.3	2.2%	523.2	457.5	2.0%	-12.6%
North Carolina	NC	1,009.8	2.0%	468.7	337.1	1.4%	-28.1%
Georgia	GA	950.7	1.9%	441.2	421.1	1.8%	-4.6%
Tennessee	TN	861.7	1.7%	400.0	404.9	1.7%	1.2%
Louisiana	LA	832.8	1.7%	386.6	680.5	2.9%	76.0%
Texas	TX	439.0	0.9%	203.8	281.4	1.2%	38.1%
Pennsylvania	PA	368.9	0.7%	171.2	87.5	0.4%	-48.9%
Alabama	AL	363.3	0.7%	168.6	197.6	0.8%	17.2%
Virginia	VA	314.8	0.6%	146.1	86.1	0.4%	-41.1%
Florida	FL	314.1	0.6%	145.8	167.0	0.7%	14.5%
Oklahoma	OK	271.7	0.5%	126.1	146.6	0.6%	16.2%
Maryland	MD	269.1	0.5%	124.9	53.3	0.2%	-57.3%
South Carolina	SC	261.1	0.5%	121.2	86.0	0.4%	-29.1%
New York	NY	189.5	0.4%	88.0	36.2	0.2%	-58.9%
California	CA	98.3	0.2%	45.6	25.5	0.1%	-44.2%
Delaware	DE	89.5	0.2%	41.6	16.4	0.1%	-60.5%
Montana	MT	78.6	0.2%	36.5	34.8	0.1%	-4.5%
New Jersey	NJ	67.4	0.1%	31.3	10.3	0.0%	-66.9%
Total	USA	50,425.2	100.0%	23,404.0	23,404.0	100.0%	0.0%

Table A.7. State production and estimated exports of Paddy rice (pdr)

State	code	Output ($M) (1)	Output Share (2)	Share Based Exports ($M) (3)	Gravity Exports ($M) (4)	Gravity Based Export Share (5)	Percentage Change in State Exports (6)
Arkansas	AR	975.4	37.0%	163.2	140.6	31.9%	-13.8%
California	CA	855.4	32.5%	143.1	79.7	18.1%	-44.3%
Louisiana	LA	336.6	12.8%	56.3	140.9	32.0%	150.1%
Texas	TX	164.7	6.3%	27.6	31.2	7.1%	13.1%
Missouri	MO	158.7	6.0%	26.6	13.7	3.1%	-48.4%
Mississippi	MS	142.5	5.4%	23.8	34.6	7.9%	45.2%
Total	USA	2,633.3	100.0%	440.7	440.7	100.0%	0.0%

Table A.8. State production and estimated exports of Plant-based fibers (pfb)

State	code	Output ($M) (1)	Output Share (2)	Share Based Exports ($M) (3)	Gravity Exports ($M) (4)	Gravity Based Export Share (5)	Percentage Change in State Exports (6)
Texas	TX	7,206.2	45.6%	2,799.6	3,376.8	55.0%	20.6%
Georgia	GA	1,719.7	10.9%	668.1	455.8	7.4%	-31.8%
California	CA	1,169.4	7.4%	454.3	531.0	8.6%	16.9%
Mississippi	MS	996.1	6.3%	387.0	339.4	5.5%	-12.3%
Arkansas	AR	701.0	4.4%	272.3	232.8	3.8%	-14.5%
Oklahoma	OK	641.6	4.1%	249.2	229.3	3.7%	-8.0%
Alabama	AL	540.7	3.4%	210.0	156.7	2.6%	-25.4%
Tennessee	TN	526.4	3.3%	204.5	131.9	2.1%	-35.5%
Missouri	MO	485.6	3.1%	188.7	128.3	2.1%	-32.0%
Arizona	AZ	416.9	2.6%	162.0	176.1	2.9%	8.7%
North Carolina	NC	399.7	2.5%	155.3	75.3	1.2%	-51.5%
Louisiana	LA	296.5	1.9%	115.2	119.0	1.9%	3.3%
South Carolina	SC	248.4	1.6%	96.5	57.5	0.9%	-40.4%
Florida	FL	167.4	1.1%	65.1	51.3	0.8%	-21.1%
Virginia	VA	106.8	0.7%	41.5	12.2	0.2%	-70.6%
New Mexico	NM	96.3	0.6%	37.4	40.4	0.7%	8.0%
Kansas	KS	92.0	0.6%	35.7	28.5	0.5%	-20.2%
Total	USA	15,810.8	100.0%	6,142.4	6,142.4	100.0%	0.0%

Table A.9. State production and estimated exports of Vegetables, fruit, nuts (v_f)

State	code	Output ($M) (1)	Output Share (2)	Share Based Exports ($M) (3)	Gravity Exports ($M) (4)	Gravity Based Export Share (5)	Percentage Change in State Exports (6)
California	CA	42,850.5	62.1%	12,022.3	14,831.1	76.6%	23.4%
Washington	WA	6,707.3	9.7%	1,881.8	1,937.9	10.0%	3.0%
Florida	FL	3,945.1	5.7%	1,106.8	304.0	1.6%	-72.5%
Arizona	AZ	2,302.9	3.3%	646.1	515.0	2.7%	-20.3%
Oregon	OR	1,514.4	2.2%	424.9	394.5	2.0%	-7.1%
Idaho	ID	1,326.0	1.9%	372.0	332.5	1.7%	-10.6%
Michigan	MI	1,276.5	1.9%	358.1	175.2	0.9%	-51.1%
Georgia	GA	954.7	1.4%	267.8	60.8	0.3%	-77.3%
New York	NY	916.2	1.3%	257.1	38.1	0.2%	-85.2%
Texas	TX	801.8	1.2%	225.0	92.4	0.5%	-58.9%
Wisconsin	WI	777.2	1.1%	218.0	73.9	0.4%	-66.1%
North Dakota	ND	772.1	1.1%	216.6	126.3	0.7%	-41.7%
North Carolina	NC	755.9	1.1%	212.1	45.9	0.2%	-78.4%
Minnesota	MN	474.5	0.7%	133.1	54.0	0.3%	-59.5%
New Mexico	NM	447.4	0.6%	125.5	76.4	0.4%	-39.1%
New Jersey	NJ	446.1	0.6%	125.2	14.5	0.1%	-88.4%
Montana	MT	305.6	0.4%	85.7	73.6	0.4%	-14.2%
Pennsylvania	PA	303.6	0.4%	85.2	17.0	0.1%	-80.0%
Colorado	CO	302.1	0.4%	84.8	48.9	0.3%	-42.3%
Maine	ME	251.2	0.4%	70.5	15.6	0.1%	-77.8%
Nebraska	NE	248.5	0.4%	69.7	28.2	0.1%	-59.5%
Ohio	OH	188.3	0.3%	52.8	18.7	0.1%	-64.6%
Virginia	VA	174.3	0.3%	48.9	9.3	0.0%	-81.1%
Illinois	IL	150.9	0.2%	42.3	12.8	0.1%	-69.7%
Indiana	IN	140.1	0.2%	39.3	11.7	0.1%	-70.2%
Mississippi	MS	134.8	0.2%	37.8	10.8	0.1%	-71.3%
Massachusetts	MA	99.4	0.1%	27.9	3.8	0.0%	-86.3%
South Carolina	SC	97.1	0.1%	27.2	5.6	0.0%	-79.5%
Tennessee	TN	82.6	0.1%	23.2	6.2	0.0%	-73.1%
Louisiana	LA	81.9	0.1%	23.0	7.3	0.0%	-68.2%
Maryland	MD	73.0	0.1%	20.5	2.9	0.0%	-86.1%
Missouri	MO	72.9	0.1%	20.5	6.8	0.0%	-66.7%
Total	USA	68,974.9	100.0%	19,351.8	19,351.8	100.0%	0.0%

Table A.10. State production and estimated exports of Wheat (wht)

State	code	Output ($M) (1)	Output Share (2)	Share Based Exports ($M) (3)	Gravity Exports ($M) (4)	Gravity Based Export Share (5)	Percentage Change in State Exports (6)
North Dakota	ND	2,633.9	17.0%	1,108.8	1,078.4	16.6%	-2.7%
Kansas	KS	2,215.5	14.3%	932.6	793.7	12.2%	-14.9%
Washington	WA	1,396.6	9.0%	587.9	1,095.2	16.8%	86.3%
Montana	MT	1,385.2	9.0%	583.1	729.2	11.2%	25.0%
Idaho	ID	746.1	4.8%	314.1	404.6	6.2%	28.8%
Minnesota	MN	737.5	4.8%	310.5	247.3	3.8%	-20.4%
Oklahoma	OK	720.6	4.7%	303.3	275.6	4.2%	-9.1%
South Dakota	SD	585.4	3.8%	246.4	218.5	3.4%	-11.3%
Colorado	CO	541.5	3.5%	227.9	232.7	3.6%	2.1%
Oregon	OR	459.3	3.0%	193.4	390.2	6.0%	101.8%
Texas	TX	385.5	2.5%	162.3	201.3	3.1%	24.0%
Nebraska	NE	373.5	2.4%	157.2	131.8	2.0%	-16.2%
Ohio	OH	369.9	2.4%	155.7	59.2	0.9%	-62.0%
Illinois	IL	327.7	2.1%	137.9	66.7	1.0%	-51.7%
Missouri	MO	303.0	2.0%	127.6	90.3	1.4%	-29.2%
Michigan	MI	292.9	1.9%	123.3	51.6	0.8%	-58.2%
Kentucky	KY	228.5	1.5%	96.2	42.5	0.7%	-55.8%
California	CA	224.4	1.5%	94.5	80.8	1.2%	-14.5%
North Carolina	NC	176.9	1.1%	74.5	24.7	0.4%	-66.8%
Indiana	IN	174.6	1.1%	73.5	31.6	0.5%	-57.0%
Tennessee	TN	166.4	1.1%	70.1	37.5	0.6%	-46.5%
Arizona	AZ	141.4	0.9%	59.5	50.3	0.8%	-15.4%
Wisconsin	WI	114.4	0.7%	48.1	25.6	0.4%	-46.9%
Maryland	MD	112.7	0.7%	47.4	8.8	0.1%	-81.4%
Pennsylvania	PA	102.6	0.7%	43.2	9.6	0.1%	-77.8%
Virginia	VA	81.7	0.5%	34.4	8.9	0.1%	-74.2%
New York	NY	78.8	0.5%	33.2	5.4	0.1%	-83.7%
Alabama	AL	73.8	0.5%	31.1	18.5	0.3%	-40.3%
Arkansas	AR	65.3	0.4%	27.5	23.2	0.4%	-15.6%
Utah	UT	59.8	0.4%	25.2	25.9	0.4%	2.8%
Georgia	GA	37.8	0.2%	15.9	7.3	0.1%	-54.1%
Delaware	DE	36.1	0.2%	15.2	2.5	0.0%	-83.4%
New Mexico	NM	32.8	0.2%	13.8	14.5	0.2%	5.4%
South Carolina	SC	27.8	0.2%	11.7	4.0	0.1%	-65.8%
Wyoming	WY	24.0	0.2%	10.1	10.9	0.2%	7.5%
Mississippi	MS	19.6	0.1%	8.3	6.8	0.1%	-17.4%
Total	USA	15,453.6	100.0%	6,505.5	6,505.5	100.0%	0.0%

Table A.11. State production and estimated exports of Wool, silk-worm cocoons (wol)

State	code	Output ($M) (1)	Output Share (2)	Share Based Exports ($M) (3)	Gravity Exports ($M) (4)	Gravity Based Export Share (5)	Percentage Change in State Exports (6)
Texas	TX	95.5	15.0%	3.763	2.792	11.2%	-25.8%
Wyoming	WY	74.4	11.7%	2.934	2.370	9.5%	-19.2%
California	CA	63.2	10.0%	2.493	7.052	28.2%	182.9%
Utah	UT	62.9	9.9%	2.478	2.746	11.0%	10.8%
Colorado	CO	59.4	9.4%	2.341	1.837	7.3%	-21.5%
Montana	MT	52.4	8.3%	2.067	1.705	6.8%	-17.5%
Idaho	ID	43.0	6.8%	1.695	1.715	6.9%	1.2%
South Dakota	SD	41.7	6.6%	1.645	0.805	3.2%	-51.1%
Oregon	OR	21.9	3.5%	0.865	0.807	3.2%	-6.7%
New Mexico	NM	16.3	2.6%	0.641	0.606	2.4%	-5.4%
Nevada	NV	13.6	2.1%	0.537	0.839	3.4%	56.1%
Arizona	AZ	10.7	1.7%	0.423	0.622	2.5%	47.2%
Washington	WA	8.0	1.3%	0.315	0.281	1.1%	-10.7%
North Dakota	ND	7.4	1.2%	0.293	0.157	0.6%	-46.6%
Minnesota	MN	6.8	1.1%	0.268	0.098	0.4%	-63.7%
Iowa	IA	6.7	1.1%	0.266	0.091	0.4%	-65.7%
Nebraska	NE	5.8	0.9%	0.230	0.108	0.4%	-53.1%
New York	NY	4.3	0.7%	0.169	0.013	0.1%	-92.4%
Kansas	KS	4.2	0.7%	0.164	0.077	0.3%	-52.8%
Ohio	OH	3.7	0.6%	0.147	0.028	0.1%	-80.8%
Wisconsin	WI	3.6	0.6%	0.142	0.036	0.1%	-74.7%
Michigan	MI	3.4	0.5%	0.133	0.028	0.1%	-79.1%
Virginia	VA	3.2	0.5%	0.125	0.016	0.1%	-86.9%
Missouri	MO	3.1	0.5%	0.123	0.044	0.2%	-64.2%
Pennsylvania	PA	3.0	0.5%	0.117	0.014	0.1%	-88.4%
West Virginia	WV	2.4	0.4%	0.095	0.016	0.1%	-83.2%
Illinois	IL	2.2	0.4%	0.088	0.020	0.1%	-77.1%
Indiana	IN	2.2	0.3%	0.087	0.018	0.1%	-78.9%
Maryland	MD	2.0	0.3%	0.079	0.007	0.0%	-91.1%
Oklahoma	OK	1.5	0.2%	0.058	0.030	0.1%	-47.1%
New Jersey	NJ	1.3	0.2%	0.053	0.004	0.0%	-92.9%
Kentucky	KY	1.2	0.2%	0.047	0.010	0.0%	-78.1%
Georgia	GA	1.1	0.2%	0.042	0.008	0.0%	-81.7%
Tennessee	TN	0.8	0.1%	0.033	0.008	0.0%	-75.3%
Massachusetts	MA	0.8	0.1%	0.032	0.002	0.0%	-94.0%
Vermont	VT	0.6	0.1%	0.026	0.003	0.0%	-89.0%
Total	USA	634.5	100.0%	25.015	25.015	100.0%	0.0%

Appendix B. Imports

Table B.1. State absorption and estimated imports of Sugar cane, sugar beet (c_b)

State	code	Absorption ($M) (1)	Absorption Share (2)	Share Based Imports ($M) (3)	Gravity Imports ($M) (4)	Gravity Based Import Share (5)	Percentage Change in State Imports (6)
California	CA	275.4	10.1%	0.130	0.400	31.1%	207.8%
Florida	FL	270.6	9.9%	0.128	0.062	4.8%	-51.3%
Texas	TX	157.0	5.8%	0.074	0.067	5.2%	-9.2%
Minnesota	MN	147.2	5.4%	0.069	0.029	2.3%	-58.2%
New York	NY	117.2	4.3%	0.055	0.062	4.9%	12.9%
North Carolina	NC	114.6	4.2%	0.054	0.038	3.0%	-29.1%
Louisiana	LA	100.2	3.7%	0.047	0.029	2.3%	-38.2%
Illinois	IL	96.9	3.6%	0.046	0.034	2.6%	-25.8%
Virginia	VA	89.5	3.3%	0.042	0.042	3.3%	0.3%
Michigan	MI	86.8	3.2%	0.041	0.031	2.4%	-23.9%
Idaho	ID	82.9	3.0%	0.039	0.036	2.8%	-8.4%
Ohio	OH	82.0	3.0%	0.039	0.027	2.1%	-29.1%
Pennsylvania	PA	81.7	3.0%	0.039	0.042	3.3%	9.0%
Georgia	GA	78.1	2.9%	0.037	0.019	1.5%	-48.0%
North Dakota	ND	68.1	2.5%	0.032	0.017	1.3%	-46.8%
Tennessee	TN	55.0	2.0%	0.026	0.017	1.4%	-33.1%
New Jersey	NJ	52.5	1.9%	0.025	0.023	1.8%	-5.2%
Indiana	IN	52.1	1.9%	0.025	0.018	1.4%	-27.7%
Wisconsin	WI	50.1	1.8%	0.024	0.014	1.1%	-42.6%
Missouri	MO	45.3	1.7%	0.021	0.015	1.2%	-29.9%
Washington	WA	44.5	1.6%	0.021	0.019	1.5%	-7.7%
Massachusetts	MA	43.2	1.6%	0.020	0.017	1.3%	-15.0%
Colorado	CO	40.1	1.5%	0.019	0.016	1.2%	-16.6%
Kentucky	KY	38.5	1.4%	0.018	0.014	1.1%	-22.1%
Iowa	IA	38.5	1.4%	0.018	0.010	0.8%	-46.0%
Maryland	MD	35.5	1.3%	0.017	0.018	1.4%	6.3%
Nebraska	NE	32.6	1.2%	0.015	0.009	0.7%	-42.3%
Oregon	OR	29.4	1.1%	0.014	0.015	1.2%	8.0%
Kansas	KS	27.5	1.0%	0.013	0.009	0.7%	-31.2%
Arizona	AZ	26.9	1.0%	0.013	0.032	2.5%	154.5%
Alabama	AL	23.6	0.9%	0.011	0.006	0.5%	-46.9%
South Carolina	SC	23.2	0.9%	0.011	0.006	0.5%	-46.8%
Arkansas	AR	22.2	0.8%	0.010	0.006	0.5%	-37.9%
Connecticut	CT	20.1	0.7%	0.009	0.009	0.7%	-5.6%
Vermont	VT	18.3	0.7%	0.009	0.008	0.6%	-6.4%
Oklahoma	OK	17.8	0.7%	0.008	0.007	0.6%	-15.2%
Montana	MT	17.8	0.7%	0.008	0.005	0.4%	-38.0%
Utah	UT	16.8	0.6%	0.008	0.006	0.5%	-24.9%
Mississippi	MS	14.8	0.5%	0.007	0.004	0.3%	-49.2%
Maine	ME	13.5	0.5%	0.006	0.007	0.6%	13.3%
Nevada	NV	12.8	0.5%	0.006	0.010	0.8%	63.5%
Wyoming	WY	9.4	0.3%	0.004	0.003	0.2%	-34.5%
South Dakota	SD	9.2	0.3%	0.004	0.002	0.2%	-48.2%
New Mexico	NM	9.0	0.3%	0.004	0.007	0.5%	61.2%
New Hampshire	NH	8.9	0.3%	0.004	0.003	0.2%	-39.9%
District of Columbia	DC	7.4	0.3%	0.003	0.004	0.3%	5.2%
Delaware	DE	7.2	0.3%	0.003	0.004	0.3%	10.3%
West Virginia	WV	6.4	0.2%	0.003	0.003	0.2%	-11.1%
Rhode Island	RI	4.9	0.2%	0.002	0.002	0.2%	-8.1%
Total	USA	2,723.2	100.0%	1.285	1.285	100.0%	0.0%

Table B.2. State absorption and estimated imports of Bovine cattle, sheep, goats and horses (ctl)

State	code	Absorption ($M) (1)	Absorption Share (2)	Share Based Imports ($M) (3)	Gravity Imports ($M) (4)	Gravity Based Import Share (5)	Percentage Change in State Imports (6)
California	CA	6,574.1	10.0%	220.1	250.4	11.4%	13.7%
Texas	TX	4,624.2	7.0%	154.8	105.6	4.8%	-31.8%
North Carolina	NC	4,458.9	6.8%	149.3	208.7	9.5%	39.8%
Virginia	VA	3,326.6	5.1%	111.4	177.7	8.1%	59.5%
Georgia	GA	2,649.1	4.0%	88.7	87.4	4.0%	-1.4%
Illinois	IL	2,580.1	3.9%	86.4	56.3	2.6%	-34.8%
Ohio	OH	2,458.1	3.7%	82.3	73.2	3.3%	-11.0%
Nebraska	NE	2,443.4	3.7%	81.8	41.2	1.9%	-49.7%
New York	NY	2,423.6	3.7%	81.2	159.9	7.3%	97.0%
Kansas	KS	2,220.4	3.4%	74.3	39.0	1.8%	-47.6%
Pennsylvania	PA	2,182.2	3.3%	73.1	118.7	5.4%	62.4%
Wisconsin	WI	2,105.9	3.2%	70.5	44.7	2.0%	-36.6%
Tennessee	TN	2,021.6	3.1%	67.7	47.3	2.2%	-30.1%
Iowa	IA	1,996.3	3.0%	66.8	36.7	1.7%	-45.1%
Missouri	MO	1,705.8	2.6%	57.1	32.7	1.5%	-42.8%
Florida	FL	1,626.9	2.5%	54.5	102.9	4.7%	89.0%
Kentucky	KY	1,579.2	2.4%	52.9	37.5	1.7%	-29.1%
Minnesota	MN	1,444.8	2.2%	48.4	28.9	1.3%	-40.2%
Colorado	CO	1,436.3	2.2%	48.1	29.2	1.3%	-39.2%
Indiana	IN	1,377.8	2.1%	46.1	30.9	1.4%	-33.0%
Michigan	MI	1,277.9	1.9%	42.8	34.4	1.6%	-19.6%
Washington	WA	1,125.9	1.7%	37.7	28.5	1.3%	-24.4%
Oklahoma	OK	1,057.3	1.6%	35.4	19.5	0.9%	-44.9%
New Jersey	NJ	952.9	1.5%	31.9	54.7	2.5%	71.3%
Oregon	OR	888.3	1.4%	29.7	21.3	1.0%	-28.4%
Arkansas	AR	853.6	1.3%	28.6	16.9	0.8%	-40.8%
Idaho	ID	759.2	1.2%	25.4	18.3	0.8%	-28.1%
South Dakota	SD	671.0	1.0%	22.5	13.3	0.6%	-40.6%
Massachusetts	MA	639.2	1.0%	21.4	54.0	2.5%	152.5%
Arizona	AZ	628.3	1.0%	21.0	19.5	0.9%	-7.3%
Alabama	AL	627.6	1.0%	21.0	16.7	0.8%	-20.7%
Maryland	MD	595.2	0.9%	19.9	29.2	1.3%	46.7%
Louisiana	LA	529.1	0.8%	17.7	11.3	0.5%	-36.1%
Utah	UT	491.6	0.7%	16.5	11.2	0.5%	-31.7%
South Carolina	SC	465.0	0.7%	15.6	20.2	0.9%	29.7%
Mississippi	MS	378.7	0.6%	12.7	8.3	0.4%	-34.6%
North Dakota	ND	335.8	0.5%	11.2	8.1	0.4%	-28.0%
New Mexico	NM	334.0	0.5%	11.2	9.1	0.4%	-18.7%
Montana	MT	332.0	0.5%	11.1	9.5	0.4%	-14.9%
Connecticut	CT	307.8	0.5%	10.3	21.6	1.0%	109.5%
Nevada	NV	231.1	0.4%	7.7	5.4	0.2%	-30.1%
Delaware	DE	218.9	0.3%	7.3	12.0	0.5%	63.7%
Wyoming	WY	193.1	0.3%	6.5	4.4	0.2%	-31.6%
Maine	ME	164.5	0.3%	5.5	15.7	0.7%	185.6%
Vermont	VT	144.9	0.2%	4.9	11.5	0.5%	138.0%
New Hampshire	NH	128.4	0.2%	4.3	10.6	0.5%	147.2%
West Virginia	WV	109.0	0.2%	3.6	4.1	0.2%	12.7%
District of Columbia	DC	12.4	0.0%	0.4	0.6	0.0%	41.1%
Rhode Island	RI	11.3	0.0%	0.4	0.9	0.0%	146.5%
Total	USA	65,699.1	100.0%	2,199.8	2,199.8	100.0%	0.0%

Table B.3. State absorption and estimated imports of Cereal grains nec (gro)

State	code	Absorption ($M) (1)	Absorption Share (2)	Share Based Imports ($M) (3)	Gravity Imports ($M) (4)	Gravity Based Import Share (5)	Percentage Change in State Imports (6)
California	CA	5,238.0	10.4%	111.4	277.4	25.8%	149.1%
Texas	TX	3,463.5	6.9%	73.6	61.0	5.7%	-17.2%
North Carolina	NC	3,446.1	6.8%	73.3	66.2	6.2%	-9.7%
Illinois	IL	2,518.2	5.0%	53.5	25.6	2.4%	-52.3%
Virginia	VA	2,316.2	4.6%	49.3	46.9	4.4%	-4.8%
Ohio	OH	2,075.2	4.1%	44.1	27.9	2.6%	-36.7%
Georgia	GA	1,976.3	3.9%	42.0	30.9	2.9%	-26.5%
New York	NY	1,913.4	3.8%	40.7	51.2	4.8%	25.9%
Pennsylvania	PA	1,833.3	3.6%	39.0	36.4	3.4%	-6.7%
Iowa	IA	1,793.4	3.5%	38.1	17.9	1.7%	-53.2%
Wisconsin	WI	1,580.3	3.1%	33.6	18.1	1.7%	-46.1%
Indiana	IN	1,490.0	2.9%	31.7	16.8	1.6%	-47.0%
Tennessee	TN	1,481.3	2.9%	31.5	19.8	1.8%	-37.2%
Nebraska	NE	1,403.3	2.8%	29.8	13.7	1.3%	-54.0%
Missouri	MO	1,281.3	2.5%	27.2	14.1	1.3%	-48.2%
Minnesota	MN	1,260.7	2.5%	26.8	14.1	1.3%	-47.4%
Kansas	KS	1,237.9	2.4%	26.3	13.0	1.2%	-50.5%
Florida	FL	1,172.7	2.3%	24.9	44.8	4.2%	79.8%
Kentucky	KY	1,162.0	2.3%	24.7	14.6	1.4%	-41.1%
Michigan	MI	1,095.8	2.2%	23.3	14.7	1.4%	-37.0%
New Jersey	NJ	914.1	1.8%	19.4	20.6	1.9%	5.8%
Colorado	CO	842.1	1.7%	17.9	10.3	1.0%	-42.5%
Washington	WA	777.0	1.5%	16.5	32.6	3.0%	97.4%
Arkansas	AR	656.1	1.3%	14.0	8.0	0.7%	-42.5%
Massachusetts	MA	573.8	1.1%	12.2	20.9	1.9%	71.6%
Oregon	OR	570.8	1.1%	12.1	24.9	2.3%	104.8%
Louisiana	LA	567.9	1.1%	12.1	9.5	0.9%	-21.6%
Oklahoma	OK	564.6	1.1%	12.0	6.6	0.6%	-45.2%
Alabama	AL	529.1	1.0%	11.3	7.5	0.7%	-33.6%
Maryland	MD	527.9	1.0%	11.2	10.0	0.9%	-11.1%
Idaho	ID	480.0	0.9%	10.2	13.7	1.3%	33.7%
South Dakota	SD	452.8	0.9%	9.6	5.0	0.5%	-47.6%
South Carolina	SC	442.6	0.9%	9.4	8.2	0.8%	-12.8%
Arizona	AZ	406.7	0.8%	8.6	14.4	1.3%	67.1%
Utah	UT	346.6	0.7%	7.4	7.6	0.7%	3.2%
Mississippi	MS	342.3	0.7%	7.3	4.7	0.4%	-35.0%
Connecticut	CT	279.0	0.6%	5.9	7.9	0.7%	33.9%
North Dakota	ND	256.1	0.5%	5.4	3.4	0.3%	-37.1%
New Mexico	NM	202.6	0.4%	4.3	4.0	0.4%	-7.8%
Delaware	DE	188.3	0.4%	4.0	3.9	0.4%	-2.4%
Montana	MT	148.2	0.3%	3.2	3.1	0.3%	-2.3%
Nevada	NV	145.2	0.3%	3.1	5.6	0.5%	80.1%
Maine	ME	127.8	0.3%	2.7	5.4	0.5%	99.8%
West Virginia	WV	115.6	0.2%	2.5	1.7	0.2%	-29.9%
Vermont	VT	105.8	0.2%	2.2	3.5	0.3%	57.4%
New Hampshire	NH	100.4	0.2%	2.1	3.7	0.3%	71.5%
Wyoming	WY	88.2	0.2%	1.9	1.1	0.1%	-38.9%
Rhode Island	RI	55.6	0.1%	1.2	2.0	0.2%	65.7%
District of Columbia	DC	7.5	0.0%	0.2	0.1	0.0%	-24.9%
Total	USA	50,553.5	100.0%	1,075.0	1,075.0	100.0%	0.0%

Table B.4. State absorption and estimated imports of Animal products nec (oap)

State	code	Absorption ($M) (1)	Absorption Share (2)	Share Based Imports ($M) (3)	Gravity Imports ($M) (4)	Gravity Based Import Share (5)	Percentage Change in State Imports (6)
California	CA	7,248.6	10.9%	219.6	591.1	29.4%	169.2%
North Carolina	NC	5,082.6	7.7%	154.0	95.5	4.7%	-38.0%
Texas	TX	3,892.2	5.9%	117.9	79.2	3.9%	-32.8%
Virginia	VA	3,557.7	5.4%	107.8	77.5	3.9%	-28.1%
Georgia	GA	3,169.9	4.8%	96.0	53.0	2.6%	-44.8%
New York	NY	2,965.9	4.5%	89.8	75.0	3.7%	-16.6%
Illinois	IL	2,885.8	4.3%	87.4	55.7	2.8%	-36.2%
Ohio	OH	2,722.0	4.1%	82.5	58.2	2.9%	-29.4%
Pennsylvania	PA	2,484.6	3.7%	75.3	60.2	3.0%	-20.0%
Florida	FL	2,180.8	3.3%	66.1	49.8	2.5%	-24.6%
Tennessee	TN	2,118.1	3.2%	64.2	38.5	1.9%	-40.0%
Iowa	IA	1,837.9	2.8%	55.7	31.6	1.6%	-43.2%
Wisconsin	WI	1,809.1	2.7%	54.8	35.9	1.8%	-34.6%
Kentucky	KY	1,670.9	2.5%	50.6	31.6	1.6%	-37.6%
Missouri	MO	1,653.3	2.5%	50.1	29.7	1.5%	-40.7%
Indiana	IN	1,609.6	2.4%	48.8	31.3	1.6%	-35.8%
Minnesota	MN	1,449.9	2.2%	43.9	26.5	1.3%	-39.6%
Michigan	MI	1,443.7	2.2%	43.7	33.5	1.7%	-23.3%
New Jersey	NJ	1,246.6	1.9%	37.8	31.6	1.6%	-16.4%
Washington	WA	1,207.9	1.8%	36.6	90.7	4.5%	148.0%
Arkansas	AR	1,068.9	1.6%	32.4	18.4	0.9%	-43.1%
Colorado	CO	1,032.0	1.6%	31.3	27.3	1.4%	-12.6%
Kansas	KS	984.3	1.5%	29.8	17.9	0.9%	-40.0%
Massachusetts	MA	898.1	1.4%	27.2	35.0	1.7%	28.5%
Nebraska	NE	882.0	1.3%	26.7	16.0	0.8%	-40.1%
Alabama	AL	877.8	1.3%	26.6	14.9	0.7%	-44.0%
Maryland	MD	850.6	1.3%	25.8	18.5	0.9%	-28.3%
Oregon	OR	844.1	1.3%	25.6	63.3	3.1%	147.6%
Louisiana	LA	651.1	1.0%	19.7	11.9	0.6%	-39.8%
South Carolina	SC	646.9	1.0%	19.6	11.6	0.6%	-41.0%
Arizona	AZ	646.5	1.0%	19.6	38.2	1.9%	95.0%
Oklahoma	OK	633.4	1.0%	19.2	11.3	0.6%	-41.3%
Mississippi	MS	585.6	0.9%	17.7	10.2	0.5%	-42.7%
Utah	UT	489.8	0.7%	14.8	22.0	1.1%	48.3%
Idaho	ID	448.2	0.7%	13.6	27.1	1.3%	99.3%
Connecticut	CT	432.1	0.7%	13.1	12.7	0.6%	-3.3%
Delaware	DE	313.3	0.5%	9.5	7.3	0.4%	-23.6%
Nevada	NV	285.1	0.4%	8.6	18.1	0.9%	109.2%
South Dakota	SD	271.2	0.4%	8.2	5.4	0.3%	-34.4%
Maine	ME	207.9	0.3%	6.3	11.0	0.5%	75.5%
New Mexico	NM	205.4	0.3%	6.2	6.8	0.3%	10.0%
North Dakota	ND	186.5	0.3%	5.6	4.4	0.2%	-21.4%
New Hampshire	NH	175.7	0.3%	5.3	6.9	0.3%	29.2%
Vermont	VT	140.5	0.2%	4.3	5.7	0.3%	32.8%
West Virginia	WV	138.2	0.2%	4.2	2.9	0.1%	-30.2%
Montana	MT	109.7	0.2%	3.3	6.0	0.3%	79.9%
Rhode Island	RI	93.7	0.1%	2.8	3.4	0.2%	20.0%
District of Columbia	DC	71.5	0.1%	2.2	1.4	0.1%	-36.9%
Wyoming	WY	20.1	0.0%	0.6	0.7	0.0%	9.4%
Total	USA	66,427.5	100.0%	2,012.1	2,012.1	100.0%	0.0%

Table B.5. State absorption and estimated imports of Crops nec (ocr)

State	code	Absorption ($M) (1)	Absorption Share (2)	Share Based Imports ($M) (3)	Gravity Imports ($M) (4)	Gravity Based Import Share (5)	Percentage Change in State Imports (6)
California	CA	2,828.0	12.5%	1,575.5	1,433.2	11.4%	-9.0%
Texas	TX	1,557.2	6.9%	867.5	1,020.9	8.1%	17.7%
North Carolina	NC	1,264.2	5.6%	704.3	751.2	6.0%	6.7%
New York	NY	1,167.7	5.2%	650.5	628.7	5.0%	-3.4%
Florida	FL	1,015.9	4.5%	566.0	687.2	5.5%	21.4%
Illinois	IL	969.7	4.3%	540.2	520.6	4.1%	-3.6%
Virginia	VA	953.9	4.2%	531.4	558.2	4.4%	5.0%
Georgia	GA	884.2	3.9%	492.6	473.6	3.8%	-3.8%
Pennsylvania	PA	877.5	3.9%	488.8	522.5	4.2%	6.9%
Ohio	OH	848.8	3.8%	472.9	477.0	3.8%	0.9%
Tennessee	TN	594.8	2.6%	331.4	334.1	2.7%	0.8%
Michigan	MI	559.7	2.5%	311.8	333.4	2.6%	6.9%
New Jersey	NJ	541.5	2.4%	301.7	287.7	2.3%	-4.6%
Wisconsin	WI	541.0	2.4%	301.4	310.5	2.5%	3.0%
Indiana	IN	510.4	2.3%	284.4	267.6	2.1%	-5.9%
Washington	WA	492.2	2.2%	274.2	204.0	1.6%	-25.6%
Missouri	MO	477.3	2.1%	265.9	274.6	2.2%	3.3%
Minnesota	MN	444.7	2.0%	247.7	268.6	2.1%	8.4%
Kentucky	KY	431.0	1.9%	240.1	235.8	1.9%	-1.8%
Massachusetts	MA	421.3	1.9%	234.7	232.6	1.8%	-0.9%
Iowa	IA	399.8	1.8%	222.7	222.2	1.8%	-0.2%
Colorado	CO	387.1	1.7%	215.7	198.8	1.6%	-7.8%
Maryland	MD	351.1	1.6%	195.6	194.3	1.5%	-0.7%
Oregon	OR	325.0	1.4%	181.1	134.9	1.1%	-25.5%
Kansas	KS	306.2	1.4%	170.6	168.2	1.3%	-1.4%
Arizona	AZ	304.8	1.3%	169.8	137.6	1.1%	-19.0%
Nebraska	NE	272.2	1.2%	151.6	150.3	1.2%	-0.9%
South Carolina	SC	258.1	1.1%	143.8	139.8	1.1%	-2.8%
Alabama	AL	255.2	1.1%	142.2	141.9	1.1%	-0.2%
Louisiana	LA	248.9	1.1%	138.7	151.3	1.2%	9.1%
Arkansas	AR	232.7	1.0%	129.6	131.5	1.0%	1.4%
Connecticut	CT	211.6	0.9%	117.9	110.3	0.9%	-6.5%
Oklahoma	OK	202.6	0.9%	112.9	108.8	0.9%	-3.7%
Utah	UT	180.9	0.8%	100.8	82.4	0.7%	-18.3%
Idaho	ID	161.8	0.7%	90.1	73.8	0.6%	-18.1%
Mississippi	MS	152.2	0.7%	84.8	88.5	0.7%	4.4%
Nevada	NV	132.1	0.6%	73.6	58.2	0.5%	-20.9%
New Mexico	NM	102.7	0.5%	57.2	55.5	0.4%	-3.1%
South Dakota	SD	95.7	0.4%	53.3	55.3	0.4%	3.7%
North Dakota	ND	79.7	0.4%	44.4	51.4	0.4%	15.9%
Maine	ME	79.1	0.4%	44.1	56.2	0.4%	27.5%
New Hampshire	NH	78.2	0.3%	43.6	40.2	0.3%	-7.7%
Delaware	DE	77.8	0.3%	43.4	42.9	0.3%	-1.1%
West Virginia	WV	65.6	0.3%	36.6	36.1	0.3%	-1.3%
Montana	MT	61.4	0.3%	34.2	31.7	0.3%	-7.3%
District of Columbia	DC	57.6	0.3%	32.1	30.4	0.2%	-5.3%
Rhode Island	RI	50.5	0.2%	28.2	25.6	0.2%	-9.1%
Vermont	VT	48.5	0.2%	27.0	31.0	0.2%	14.7%
Wyoming	WY	32.9	0.1%	18.3	15.7	0.1%	-14.2%
Total	USA	22,593.2	100.0%	12,586.5	12,586.5	100.0%	0.0%

Table B.6. State absorption and estimated imports of Oil Seeds (osd)

State	code	Absorption ($M) (1)	Absorption Share (2)	Share Based Imports ($M) (3)	Gravity Imports ($M) (4)	Gravity Based Import Share (5)	Percentage Change in State Imports (6)
California	CA	2,829.4	10.0%	119.6	356.1	29.9%	197.7%
North Carolina	NC	2,265.1	8.0%	95.8	65.5	5.5%	-31.6%
Virginia	VA	1,620.0	5.7%	68.5	51.7	4.3%	-24.5%
Illinois	IL	1,541.7	5.5%	65.2	30.6	2.6%	-53.1%
Texas	TX	1,456.5	5.2%	61.6	53.5	4.5%	-13.2%
Georgia	GA	1,309.9	4.6%	55.4	34.9	2.9%	-36.9%
Ohio	OH	1,303.1	4.6%	55.1	31.5	2.6%	-42.8%
New York	NY	1,078.9	3.8%	45.6	46.3	3.9%	1.5%
Pennsylvania	PA	1,009.0	3.6%	42.7	32.0	2.7%	-24.9%
Tennessee	TN	997.6	3.5%	42.2	25.1	2.1%	-40.5%
Iowa	IA	916.4	3.2%	38.7	19.3	1.6%	-50.2%
Wisconsin	WI	863.3	3.1%	36.5	19.4	1.6%	-46.8%
Indiana	IN	840.4	3.0%	35.5	17.9	1.5%	-49.7%
Missouri	MO	817.4	2.9%	34.6	18.1	1.5%	-47.5%
Kentucky	KY	766.3	2.7%	32.4	17.9	1.5%	-44.7%
Minnesota	MN	700.1	2.5%	29.6	16.4	1.4%	-44.5%
Florida	FL	669.9	2.4%	28.3	40.0	3.4%	41.2%
Michigan	MI	599.9	2.1%	25.4	14.6	1.2%	-42.5%
Nebraska	NE	525.0	1.9%	22.2	11.4	1.0%	-48.5%
Kansas	KS	513.8	1.8%	21.7	11.6	1.0%	-46.6%
New Jersey	NJ	470.2	1.7%	19.9	17.2	1.4%	-13.4%
Arkansas	AR	449.3	1.6%	19.0	10.8	0.9%	-43.1%
Washington	WA	438.9	1.6%	18.6	48.8	4.1%	162.9%
Colorado	CO	388.5	1.4%	16.4	10.9	0.9%	-33.6%
Oregon	OR	339.6	1.2%	14.4	40.0	3.4%	178.6%
Massachusetts	MA	299.8	1.1%	12.7	18.3	1.5%	44.7%
Maryland	MD	292.0	1.0%	12.3	10.5	0.9%	-15.1%
Louisiana	LA	290.6	1.0%	12.3	8.4	0.7%	-31.6%
Alabama	AL	275.3	1.0%	11.6	7.3	0.6%	-37.5%
North Dakota	ND	231.1	0.8%	9.8	7.2	0.6%	-26.1%
South Carolina	SC	227.4	0.8%	9.6	6.3	0.5%	-34.4%
Mississippi	MS	226.0	0.8%	9.6	6.0	0.5%	-37.1%
South Dakota	SD	225.4	0.8%	9.5	5.5	0.5%	-41.9%
Oklahoma	OK	211.5	0.7%	8.9	5.2	0.4%	-42.2%
Arizona	AZ	197.2	0.7%	8.3	17.2	1.4%	106.0%
Idaho	ID	191.5	0.7%	8.1	13.5	1.1%	66.9%
Utah	UT	185.9	0.7%	7.9	10.7	0.9%	36.6%
Connecticut	CT	142.7	0.5%	6.0	6.7	0.6%	10.9%
Delaware	DE	110.4	0.4%	4.7	3.7	0.3%	-20.6%
Maine	ME	74.5	0.3%	3.2	5.4	0.5%	71.8%
Nevada	NV	71.8	0.3%	3.0	6.8	0.6%	122.3%
New Mexico	NM	65.8	0.2%	2.8	3.2	0.3%	16.2%
New Hampshire	NH	57.5	0.2%	2.4	3.5	0.3%	44.9%
Vermont	VT	57.2	0.2%	2.4	3.2	0.3%	32.1%
West Virginia	WV	36.7	0.1%	1.6	1.0	0.1%	-36.1%
Montana	MT	32.5	0.1%	1.4	1.5	0.1%	10.7%
District of Columbia	DC	0.5	0.0%	0.0	0.0	0.0%	-24.5%
Rhode Island	RI	0.4	0.0%	0.0	0.0	0.0%	39.0%
Wyoming	WY	0.2	0.0%	0.0	0.0	0.0%	-29.5%
Total	USA	28,214.0	100.0%	1,192.8	1,192.8	100.0%	0.0%

Table B.7. State absorption and estimated imports of Paddy rice (pdr)

State	code	Absorption ($M) (1)	Absorption Share (2)	Share Based Imports ($M) (3)	Gravity Imports ($M) (4)	Gravity Based Import Share (5)	Percentage Change in State Imports (6)
California	CA	309.3	14.1%	0.066	0.061	13.0%	-8.0%
Texas	TX	234.0	10.7%	0.050	0.022	4.6%	-56.6%
Illinois	IL	123.2	5.6%	0.026	0.015	3.2%	-43.3%
North Carolina	NC	114.9	5.2%	0.025	0.028	6.0%	15.3%
Pennsylvania	PA	104.2	4.8%	0.022	0.037	7.9%	67.0%
Ohio	OH	102.1	4.7%	0.022	0.020	4.3%	-7.4%
New York	NY	100.8	4.6%	0.022	0.045	9.5%	106.9%
Indiana	IN	96.3	4.4%	0.021	0.012	2.6%	-41.7%
New Jersey	NJ	83.3	3.8%	0.018	0.036	7.7%	101.7%
Florida	FL	61.3	2.8%	0.013	0.019	4.1%	48.4%
Michigan	MI	58.3	2.7%	0.013	0.013	2.8%	3.4%
Louisiana	LA	56.9	2.6%	0.012	0.004	0.9%	-64.5%
Georgia	GA	55.9	2.5%	0.012	0.007	1.5%	-41.1%
Massachusetts	MA	52.1	2.4%	0.011	0.028	6.0%	154.6%
Virginia	VA	51.4	2.3%	0.011	0.017	3.5%	51.6%
Tennessee	TN	48.3	2.2%	0.010	0.004	0.9%	-60.1%
Missouri	MO	41.8	1.9%	0.009	0.003	0.7%	-63.5%
Maryland	MD	38.8	1.8%	0.008	0.014	2.9%	62.4%
Wisconsin	WI	38.6	1.8%	0.008	0.007	1.4%	-18.2%
South Carolina	SC	35.2	1.6%	0.008	0.007	1.6%	-1.2%
Iowa	IA	33.0	1.5%	0.007	0.004	0.8%	-49.2%
Kentucky	KY	28.5	1.3%	0.006	0.003	0.7%	-48.6%
Minnesota	MN	28.4	1.3%	0.006	0.006	1.2%	-8.0%
Washington	WA	26.8	1.2%	0.006	0.004	0.9%	-24.2%
Alabama	AL	26.0	1.2%	0.006	0.002	0.5%	-60.2%
Connecticut	CT	24.6	1.1%	0.005	0.012	2.5%	127.7%
Kansas	KS	20.1	0.9%	0.004	0.002	0.4%	-58.2%
Colorado	CO	19.8	0.9%	0.004	0.003	0.6%	-35.0%
Arkansas	AR	16.9	0.8%	0.004	0.001	0.2%	-69.8%
Arizona	AZ	15.6	0.7%	0.003	0.002	0.5%	-35.1%
Nebraska	NE	14.4	0.7%	0.003	0.002	0.4%	-45.9%
West Virginia	WV	13.9	0.6%	0.003	0.003	0.7%	9.0%
Utah	UT	13.8	0.6%	0.003	0.002	0.4%	-42.6%
Oklahoma	OK	13.6	0.6%	0.003	0.001	0.2%	-61.0%
Mississippi	MS	13.2	0.6%	0.003	0.001	0.2%	-64.9%
Oregon	OR	12.7	0.6%	0.003	0.001	0.3%	-46.2%
Nevada	NV	10.2	0.5%	0.002	0.001	0.3%	-40.4%
Delaware	DE	6.6	0.3%	0.001	0.003	0.5%	81.1%
Maine	ME	6.2	0.3%	0.001	0.004	0.8%	184.3%
Idaho	ID	6.1	0.3%	0.001	0.001	0.2%	-44.7%
New Hampshire	NH	6.1	0.3%	0.001	0.003	0.7%	155.5%
Rhode Island	RI	5.8	0.3%	0.001	0.003	0.7%	149.1%
New Mexico	NM	5.5	0.3%	0.001	0.001	0.1%	-40.6%
District of Columbia	DC	5.3	0.2%	0.001	0.002	0.4%	58.9%
South Dakota	SD	4.2	0.2%	0.001	0.001	0.2%	-16.1%
Wyoming	WY	3.3	0.1%	0.001	0.001	0.1%	-27.8%
North Dakota	ND	3.2	0.1%	0.001	0.001	0.2%	14.7%
Vermont	VT	2.4	0.1%	0.001	0.001	0.3%	142.5%
Montana	MT	0.1	0.0%	0.000	0.000	0.0%	-15.2%
Total	USA	2,193.1	100.0%	0.470	0.470	100.0%	0.0%

Table B.8. State absorption and estimated imports of Plant-based fibers (pfb)

State	code	Absorption ($M) (1)	Absorption Share (2)	Share Based Imports ($M) (3)	Gravity Imports ($M) (4)	Gravity Based Import Share (5)	Percentage Change in State Imports (6)
California	CA	1,270.9	13.0%	10.850	17.339	20.8%	59.8%
Texas	TX	765.4	7.8%	6.535	2.276	2.7%	-65.2%
New York	NY	635.1	6.5%	5.423	8.054	9.7%	48.5%
Florida	FL	598.0	6.1%	5.106	3.125	3.8%	-38.8%
Georgia	GA	418.0	4.3%	3.569	1.401	1.7%	-60.7%
Illinois	IL	394.4	4.0%	3.367	1.839	2.2%	-45.4%
Pennsylvania	PA	387.2	4.0%	3.306	3.674	4.4%	11.1%
North Carolina	NC	360.9	3.7%	3.081	1.483	1.8%	-51.8%
Ohio	OH	321.9	3.3%	2.748	1.892	2.3%	-31.1%
New Jersey	NJ	295.6	3.0%	2.524	3.484	4.2%	38.0%
Virginia	VA	276.4	2.8%	2.360	1.825	2.2%	-22.7%
Michigan	MI	270.8	2.8%	2.312	2.059	2.5%	-10.9%
Massachusetts	MA	256.5	2.6%	2.190	4.286	5.1%	95.7%
Washington	WA	226.7	2.3%	1.936	6.955	8.4%	259.3%
Indiana	IN	190.9	2.0%	1.630	0.801	1.0%	-50.8%
Maryland	MD	190.5	2.0%	1.626	1.467	1.8%	-9.8%
Tennessee	TN	186.3	1.9%	1.591	0.662	0.8%	-58.4%
Minnesota	MN	179.7	1.8%	1.534	1.372	1.6%	-10.6%
Arizona	AZ	176.4	1.8%	1.506	1.186	1.4%	-21.3%
Colorado	CO	169.7	1.7%	1.449	0.948	1.1%	-34.6%
Missouri	MO	168.7	1.7%	1.441	0.605	0.7%	-58.0%
South Carolina	SC	167.2	1.7%	1.427	0.656	0.8%	-54.1%
Wisconsin	WI	162.6	1.7%	1.388	1.074	1.3%	-22.6%
Alabama	AL	130.0	1.3%	1.110	0.432	0.5%	-61.1%
Connecticut	CT	124.8	1.3%	1.065	1.779	2.1%	67.1%
Louisiana	LA	120.2	1.2%	1.026	0.384	0.5%	-62.6%
Kentucky	KY	114.7	1.2%	0.979	0.445	0.5%	-54.6%
Oregon	OR	111.8	1.1%	0.955	3.013	3.6%	215.6%
Iowa	IA	94.5	1.0%	0.807	0.397	0.5%	-50.8%
Oklahoma	OK	88.6	0.9%	0.756	0.274	0.3%	-63.8%
Kansas	KS	82.7	0.8%	0.706	0.294	0.4%	-58.3%
Nevada	NV	79.0	0.8%	0.674	0.813	1.0%	20.6%
Utah	UT	77.7	0.8%	0.663	0.846	1.0%	27.6%
Mississippi	MS	75.5	0.8%	0.645	0.245	0.3%	-62.0%
Arkansas	AR	72.1	0.7%	0.615	0.229	0.3%	-62.8%
Nebraska	NE	63.2	0.6%	0.540	0.255	0.3%	-52.7%
New Hampshire	NH	49.3	0.5%	0.421	0.845	1.0%	100.5%
New Mexico	NM	49.0	0.5%	0.418	0.203	0.2%	-51.4%
West Virginia	WV	41.0	0.4%	0.350	0.221	0.3%	-37.1%
Idaho	ID	40.9	0.4%	0.349	0.716	0.9%	105.3%
Maine	ME	40.7	0.4%	0.347	0.803	1.0%	131.1%
District of Columbia	DC	38.6	0.4%	0.330	0.271	0.3%	-17.8%
Rhode Island	RI	35.3	0.4%	0.301	0.563	0.7%	87.0%
Delaware	DE	31.5	0.3%	0.269	0.294	0.4%	9.5%
South Dakota	SD	30.1	0.3%	0.257	0.209	0.3%	-18.7%
North Dakota	ND	29.3	0.3%	0.250	0.339	0.4%	35.5%
Montana	MT	27.4	0.3%	0.234	0.464	0.6%	98.4%
Vermont	VT	18.3	0.2%	0.157	0.305	0.4%	94.7%
Wyoming	WY	15.7	0.2%	0.134	0.153	0.2%	13.8%
Total	USA	9,751.6	100.0%	83.254	83.254	100.0%	0.0%

Table B.9. State absorption and estimated imports of Vegetables, fruit, nuts (v_f)

State	code	Absorption ($M) (1)	Absorption Share (2)	Share Based Imports ($M) (3)	Gravity Imports ($M) (4)	Gravity Based Import Share (5)	Percentage Change in State Imports (6)
California	CA	10,450.7	13.5%	3,755.2	1,607.6	5.8%	-57.2%
Texas	TX	5,547.1	7.2%	1,993.2	1,954.1	7.0%	-2.0%
New York	NY	4,704.3	6.1%	1,690.4	2,407.3	8.6%	42.4%
Florida	FL	4,301.6	5.6%	1,545.7	1,791.9	6.4%	15.9%
North Carolina	NC	3,548.6	4.6%	1,275.1	1,605.1	5.8%	25.9%
Illinois	IL	3,215.9	4.2%	1,155.6	1,130.4	4.1%	-2.2%
Pennsylvania	PA	3,059.3	3.9%	1,099.3	1,575.1	5.7%	43.3%
Virginia	VA	2,939.3	3.8%	1,056.2	1,473.1	5.3%	39.5%
Ohio	OH	2,789.6	3.6%	1,002.4	1,186.6	4.3%	18.4%
Georgia	GA	2,724.1	3.5%	978.9	1,061.0	3.8%	8.4%
New Jersey	NJ	2,064.1	2.7%	741.7	977.7	3.5%	31.8%
Michigan	MI	2,051.5	2.6%	737.2	839.3	3.0%	13.8%
Tennessee	TN	1,835.1	2.4%	659.4	742.9	2.7%	12.7%
Washington	WA	1,832.8	2.4%	658.6	254.6	0.9%	-61.3%
Massachusetts	MA	1,684.9	2.2%	605.4	909.4	3.3%	50.2%
Wisconsin	WI	1,627.5	2.1%	584.8	571.5	2.1%	-2.3%
Missouri	MO	1,534.0	2.0%	551.2	538.8	1.9%	-2.3%
Indiana	IN	1,531.5	2.0%	550.3	598.2	2.1%	8.7%
Minnesota	MN	1,440.5	1.9%	517.6	433.4	1.6%	-16.3%
Colorado	CO	1,361.5	1.8%	489.2	302.7	1.1%	-38.1%
Maryland	MD	1,325.8	1.7%	476.4	664.9	2.4%	39.6%
Arizona	AZ	1,280.4	1.7%	460.1	256.9	0.9%	-44.2%
Kentucky	KY	1,261.8	1.6%	453.4	522.1	1.9%	15.2%
Iowa	IA	1,029.2	1.3%	369.8	319.3	1.1%	-13.7%
Oregon	OR	992.1	1.3%	356.5	146.9	0.5%	-58.8%
South Carolina	SC	910.4	1.2%	327.1	360.7	1.3%	10.3%
Alabama	AL	879.2	1.1%	315.9	337.3	1.2%	6.8%
Louisiana	LA	857.4	1.1%	308.1	337.9	1.2%	9.7%
Kansas	KS	826.5	1.1%	297.0	240.2	0.9%	-19.1%
Connecticut	CT	820.7	1.1%	294.9	407.3	1.5%	38.1%
Arkansas	AR	717.5	0.9%	257.8	256.0	0.9%	-0.7%
Oklahoma	OK	704.0	0.9%	253.0	210.2	0.8%	-16.9%
Nebraska	NE	655.6	0.8%	235.6	177.9	0.6%	-24.5%
Utah	UT	598.3	0.8%	215.0	115.1	0.4%	-46.4%
Nevada	NV	567.4	0.7%	203.9	95.7	0.3%	-53.0%
Mississippi	MS	515.0	0.7%	185.0	203.9	0.7%	10.2%
Idaho	ID	435.9	0.6%	156.6	77.7	0.3%	-50.4%
New Mexico	NM	361.9	0.5%	130.0	86.4	0.3%	-33.5%
New Hampshire	NH	317.6	0.4%	114.1	162.5	0.6%	42.4%
Maine	ME	291.8	0.4%	104.9	166.5	0.6%	58.8%
Delaware	DE	270.3	0.3%	97.1	139.4	0.5%	43.6%
West Virginia	WV	270.2	0.3%	97.1	124.7	0.4%	28.5%
South Dakota	SD	223.1	0.3%	80.2	53.9	0.2%	-32.8%
District of Columbia	DC	221.8	0.3%	79.7	103.4	0.4%	29.7%
North Dakota	ND	211.1	0.3%	75.8	53.0	0.2%	-30.1%
Rhode Island	RI	199.8	0.3%	71.8	103.3	0.4%	43.9%
Montana	MT	197.2	0.3%	70.9	37.9	0.1%	-46.6%
Vermont	VT	163.9	0.2%	58.9	88.1	0.3%	49.6%
Wyoming	WY	105.0	0.1%	37.7	22.0	0.1%	-41.7%
Total	USA	77,454.8	100.0%	27,831.7	27,831.7	100.0%	0.0%

Table B.10. State absorption and estimated imports of Wheat (wht)

State	code	Absorption ($M) (1)	Absorption Share (2)	Share Based Imports ($M) (3)	Gravity Imports ($M) (4)	Gravity Based Import Share (5)	Percentage Change in State Imports (6)
California	CA	1,186.5	12.3%	88.5	92.2	12.8%	4.1%
Texas	TX	787.4	8.1%	58.7	42.9	6.0%	-26.9%
North Carolina	NC	569.5	5.9%	42.5	53.7	7.4%	26.3%
Illinois	IL	471.3	4.9%	35.2	23.7	3.3%	-32.5%
New York	NY	450.8	4.7%	33.6	56.4	7.8%	67.8%
Ohio	OH	415.3	4.3%	31.0	24.6	3.4%	-20.5%
Pennsylvania	PA	404.5	4.2%	30.2	40.4	5.6%	33.9%
Virginia	VA	352.3	3.6%	26.3	34.0	4.7%	29.3%
Georgia	GA	326.2	3.4%	24.3	25.1	3.5%	3.0%
Florida	FL	311.8	3.2%	23.3	46.4	6.4%	99.6%
Indiana	IN	308.6	3.2%	23.0	15.5	2.2%	-32.5%
New Jersey	NJ	272.6	2.8%	20.3	28.8	4.0%	41.6%
Tennessee	TN	254.1	2.6%	19.0	14.1	2.0%	-25.6%
Michigan	MI	242.1	2.5%	18.1	13.9	1.9%	-23.3%
Wisconsin	WI	220.7	2.3%	16.5	11.8	1.6%	-28.1%
Missouri	MO	207.8	2.1%	15.5	9.1	1.3%	-41.5%
Washington	WA	179.7	1.9%	13.4	6.4	0.9%	-52.5%
Massachusetts	MA	177.7	1.8%	13.3	28.5	3.9%	114.6%
Kentucky	KY	175.5	1.8%	13.1	8.7	1.2%	-33.2%
Minnesota	MN	174.0	1.8%	13.0	8.9	1.2%	-31.2%
Iowa	IA	170.8	1.8%	12.7	8.2	1.1%	-35.9%
Kansas	KS	169.3	1.8%	12.6	6.6	0.9%	-47.7%
Louisiana	LA	159.8	1.7%	11.9	10.6	1.5%	-11.3%
Maryland	MD	138.6	1.4%	10.3	12.2	1.7%	18.3%
Colorado	CO	135.6	1.4%	10.1	5.7	0.8%	-43.9%
South Carolina	SC	117.5	1.2%	8.8	10.4	1.4%	18.3%
Nebraska	NE	108.1	1.1%	8.1	4.6	0.6%	-42.5%
Alabama	AL	105.8	1.1%	7.9	7.3	1.0%	-7.9%
Oregon	OR	102.5	1.1%	7.6	3.8	0.5%	-50.2%
Arkansas	AR	94.4	1.0%	7.0	4.0	0.6%	-42.8%
Arizona	AZ	91.5	0.9%	6.8	5.9	0.8%	-13.2%
Oklahoma	OK	89.5	0.9%	6.7	3.4	0.5%	-49.1%
Connecticut	CT	85.8	0.9%	6.4	11.4	1.6%	77.9%
North Dakota	ND	81.4	0.8%	6.1	4.2	0.6%	-31.2%
Utah	UT	66.4	0.7%	5.0	2.8	0.4%	-42.6%
Idaho	ID	66.0	0.7%	4.9	2.7	0.4%	-44.7%
Mississippi	MS	58.1	0.6%	4.3	3.5	0.5%	-19.1%
Montana	MT	46.4	0.5%	3.5	2.1	0.3%	-38.4%
South Dakota	SD	41.5	0.4%	3.1	1.9	0.3%	-37.4%
West Virginia	WV	38.9	0.4%	2.9	2.7	0.4%	-8.5%
Nevada	NV	37.5	0.4%	2.8	2.0	0.3%	-29.7%
Delaware	DE	33.5	0.3%	2.5	3.0	0.4%	18.9%
New Mexico	NM	28.6	0.3%	2.1	1.4	0.2%	-36.4%
Maine	ME	28.3	0.3%	2.1	5.0	0.7%	138.6%
New Hampshire	NH	26.9	0.3%	2.0	4.3	0.6%	115.0%
Rhode Island	RI	19.2	0.2%	1.4	3.0	0.4%	108.8%
Vermont	VT	15.9	0.2%	1.2	2.4	0.3%	102.3%
Wyoming	WY	12.1	0.1%	0.9	0.5	0.1%	-39.8%
District of Columbia	DC	11.3	0.1%	0.8	0.5	0.1%	-35.9%
Total	USA	9,669.5	100.0%	721.4	721.4	100.0%	0.0%

Table B.11. State absorption and estimated imports of Wool, silk-worm cocoons (wol)

State	code	Absorption ($M)	Absorption Share	Share Based Imports ($M)	Gravity Imports ($M)	Gravity Based Import Share	Percentage Change in State Imports
		(1)	(2)	(3)	(4)	(5)	(6)
California	CA	76.9	12.4%	1.232	0.247	2.5%	-80.0%
Texas	TX	45.3	7.3%	0.725	0.318	3.2%	-56.1%
New York	NY	41.1	6.6%	0.658	1.146	11.5%	74.1%
Georgia	GA	38.6	6.2%	0.619	0.849	8.6%	37.3%
Florida	FL	37.0	6.0%	0.592	1.141	11.5%	92.6%
North Carolina	NC	27.7	4.5%	0.443	0.798	8.0%	79.9%
Pennsylvania	PA	24.0	3.9%	0.384	0.591	6.0%	53.7%
Illinois	IL	22.5	3.6%	0.360	0.187	1.9%	-48.1%
Ohio	OH	19.2	3.1%	0.307	0.292	2.9%	-4.8%
New Jersey	NJ	18.2	2.9%	0.291	0.489	4.9%	68.0%
Virginia	VA	17.2	2.8%	0.275	0.457	4.6%	65.8%
Michigan	MI	16.5	2.7%	0.265	0.209	2.1%	-21.0%
Massachusetts	MA	16.5	2.7%	0.264	0.579	5.8%	119.4%
South Carolina	SC	14.2	2.3%	0.227	0.461	4.6%	102.9%
Washington	WA	13.8	2.2%	0.221	0.036	0.4%	-83.5%
Tennessee	TN	12.1	2.0%	0.194	0.175	1.8%	-9.7%
Maryland	MD	11.4	1.8%	0.183	0.275	2.8%	50.5%
Arizona	AZ	11.0	1.8%	0.176	0.036	0.4%	-79.7%
Indiana	IN	10.7	1.7%	0.172	0.121	1.2%	-30.0%
Colorado	CO	10.6	1.7%	0.169	0.029	0.3%	-82.5%
Minnesota	MN	10.5	1.7%	0.168	0.042	0.4%	-74.8%
Wisconsin	WI	10.1	1.6%	0.162	0.074	0.7%	-54.6%
Missouri	MO	9.8	1.6%	0.157	0.065	0.7%	-58.9%
Alabama	AL	9.3	1.5%	0.149	0.151	1.5%	1.7%
Connecticut	CT	8.0	1.3%	0.128	0.242	2.4%	90.0%
Kentucky	KY	7.0	1.1%	0.113	0.098	1.0%	-12.5%
Oregon	OR	6.9	1.1%	0.111	0.018	0.2%	-83.4%
Louisiana	LA	6.9	1.1%	0.111	0.068	0.7%	-38.2%
Oklahoma	OK	5.4	0.9%	0.087	0.026	0.3%	-69.7%
Mississippi	MS	5.3	0.9%	0.085	0.063	0.6%	-25.2%
Nevada	NV	5.0	0.8%	0.080	0.015	0.2%	-81.4%
Utah	UT	4.9	0.8%	0.079	0.012	0.1%	-85.3%
Iowa	IA	4.8	0.8%	0.077	0.021	0.2%	-72.3%
Kansas	KS	4.6	0.7%	0.074	0.021	0.2%	-71.9%
Arkansas	AR	4.1	0.7%	0.066	0.029	0.3%	-56.7%
New Hampshire	NH	3.5	0.6%	0.057	0.117	1.2%	106.3%
Nebraska	NE	3.4	0.6%	0.055	0.013	0.1%	-75.5%
New Mexico	NM	3.0	0.5%	0.048	0.011	0.1%	-77.2%
Maine	ME	2.8	0.5%	0.045	0.097	1.0%	116.0%
Idaho	ID	2.6	0.4%	0.042	0.007	0.1%	-83.4%
Rhode Island	RI	2.6	0.4%	0.042	0.087	0.9%	108.7%
West Virginia	WV	2.4	0.4%	0.039	0.048	0.5%	23.6%
District of Columbia	DC	2.4	0.4%	0.038	0.048	0.5%	27.1%
Delaware	DE	2.1	0.3%	0.033	0.054	0.5%	64.1%
Montana	MT	1.9	0.3%	0.030	0.005	0.1%	-82.5%
South Dakota	SD	1.7	0.3%	0.028	0.006	0.1%	-77.6%
North Dakota	ND	1.5	0.2%	0.024	0.005	0.1%	-77.9%
Wyoming	WY	1.3	0.2%	0.020	0.004	0.0%	-82.6%
Vermont	VT	1.2	0.2%	0.018	0.036	0.4%	96.9%
Total	USA	619.4	100.0%	9.920	9.920	100.0%	0.0%