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The rapid growth in GLP-1 use could reshape the U.S. agricultural landscape

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Abstract

The diffusion of glucagon-like peptide-1 receptor agonist medicines (GLP-1s) could reshape food systems through reduced food intake, but its economy-wide consequences remain unclear. We combine Bayesian projections of adoption, discontinuation, and reinitiation of GLP-1s in the United States, Canada, and Mexico with RCT-anchored dietary responses to estimate a recursive-dynamic computable general equilibrium model. By 2030, U.S. active treatment prevalence reaches 15.6% under current eligibility and access conditions and 28.4% under expanded weight-management access, generating food-demand reductions of 3.9–6.4% and 7.1–11.6%, respectively. Markets absorb these shocks through changes to domestic production, imports, exports, and prices rather than through changes to domestic production alone. Broader North American diffusion primarily reshapes bilateral trade, whereas expanded access scales U.S. adjustments. Agricultural land rents fall 2.3–2.4% under current conditions and 4.1–4.2% under expanded access, while wages and capital returns change little. These conditional counterfactuals show how pharmaceutical innovation can reshape food-system outcomes.

Food systems transformation could substantially restructure global agriculture, with health innovations such as glucagon-like peptide-1 receptor agonists (GLP-1s) identified as potential contributors to dietary change[1]. Originally developed for type 2 diabetes and increasingly used for obesity and weight management, link health innovation and food demand[2]. GLP-1 diffusion illustrates how innovations originating outside agriculture can alter food-system outcomes through changes in consumer behavior[3,4]. Randomized controlled trials document clinically relevant weight loss among treated individuals, reductions in ad libitum energy intake, and changes in food preferences[5–9]. Survey, purchasing, and demand studies associate GLP-1 use with changes in food consumption, expenditure, and purchasing behavior[2,10–13]. These responses are heterogeneous across food categories, with larger reductions in some energy-dense foods and distinct adjustments among protein and other food groups[7,10,2,13]. GLP-1 use can therefore affect both the scale and composition of food demand, with lower overall intake reducing aggregate demand and compositional changes reallocating demand across agricultural and food sectors[12,13]. Whether these individual-level responses become consequential at the food-system scale depends on the diffusion of treatment and the prevalence of active use.

The population potentially exposed to these dietary effects is large, while its realized scale depends on treatment eligibility and access conditions[14]. Nearly three billion people globally are overweight or obese, and approximately 40% of U.S. adults are obese[15,16]. In the United States, a substantial share of adults already reports current or previous use of, or interest in, anti-obesity medications, while uptake remains constrained by treatment eligibility, out-of-pocket costs, insurance coverage, product availability, and access to prescribers[11,17]. These constraints shape the treatable population and treatment diffusion.. Diffusion may also broaden geographically as semaglutide patent protection expires in Canada and regulatory access to GLP-1-based obesity

39 treatments expands in Mexico and other markets[18–20]. Treatment eligibility, access, diffusion, and
40 persistence therefore determine the population-scale demand exposure generated by individual
41 dietary responses.

42 Existing GLP-1 evidence is concentrated on clinical efficacy[21,8,22], treatment adoption[23],
43 changes in household food demand and purchases[10,2,12,13], and anticipated supply-chain
44 responses[24]. These studies characterize key components of the individual and household response
45 but do not establish how GLP-1-induced dietary change propagates once adoption alters aggregate
46 food demand and triggers substitution and broader food-market adjustments[25]. System-wide food-
47 system analyses show that changes in food demand propagate through prices, production, trade,
48 land use, resource allocation, and environmental pressures, generating outcomes that cannot be
49 inferred from consumption changes alone[26–28]. Lower household food demand therefore need not
50 translate proportionally into lower domestic production because adjustment can occur through
51 prices, imports, exports, and the reallocation of productive resources[27–29]. The implications of
52 GLP-1-induced demand change for agricultural production, trade, land use, factor returns, and
53 environmental pressures consequently remain largely unexplored.

54 Here we trace how individual-level medical interventions translate to population-scale
55 food-system changes. We combine Bayesian projections of GLP-1 diffusion in the United States,
56 Canada, and Mexico with treatment discontinuation and reinitiation to derive active treatment
57 prevalence, map active use into RCT-anchored, evidence-constrained food-demand pathways, and
58 propagate them through the Global Trade Analysis Project Recursive Dynamic (GTAP-RD) model,
59 a recursive-dynamic computable general equilibrium model, to 2030. We contrast current
60 eligibility and access conditions with expanded weight-management access, and U.S.-only with
61 North America-wide adoption. The framework quantifies deviations from the model's middle-of-

the road baseline[1] in production, prices, trade, land use, factor returns, and environmental pressures. We find that eligibility and access primarily determine shock scale; market adjustment is distributed across production and trade rather than mapping proportionally from household demand; factor-market incidence is concentrated in agricultural land rents; and broader geographic diffusion primarily reshapes trade patterns.

Results

Results trace GLP-1 diffusion and treatment persistence through population food demand to economy-wide adjustment. Bayesian projections of first-time uptake are converted to active treatment prevalence through discontinuation and reinitiation, then combined with evidence-constrained dietary responses to construct country- and food-category-specific demand pathways for GTAP-RD. We compare current eligibility and access conditions with expanded weight-management access under U.S.-only and North America-wide adoption. The main text reports the middle diffusion pathway, with country trajectories in Fig. S1 and Table S1 and low- and high-diffusion results in Figs. S2–S5. Unless otherwise stated, outcomes are 2030 percentage deviations from the corresponding SSP2 baseline; definitions of each outcomes is provided in Table S2.

From GLP-1 diffusion to population food demand

The population exposed to GLP-1-induced dietary change expands substantially over the projection period, particularly under expanded weight-management access (Fig. S1 and Table S1).

[1] In the GTAP-RD (Global Trade Analysis Project–Recursive Dynamic) framework, the "middle-of-the-road" baseline represents the model's reference, or business-as-usual, trajectory, broadly calibrated to the Shared Socioeconomic Pathway 2 (SSP2). SSP2 assumes intermediate trends in population, economic growth, technological change, and other socioeconomic drivers, without major departures toward either more sustainable or more fragmented development pathways. Scenario results are evaluated as deviations from this baseline.

After accounting for treatment discontinuation and reinitiation, current active use in the United States increases from 9.00% of adults in 2026 to 15.58% in 2030 under current eligibility and access conditions, compared with 9.90% to 28.38% under expanded access. Active use remains lower in Canada and Mexico, reaching 4.81% and 2.36%, respectively, by 2030 under current conditions and 6.91% and 3.57% under expanded access. These differences show that treatment eligibility and practical access substantially alter the population exposed to the dietary effects of GLP-1 use, while discontinuation and reinitiation determine how projected first-time adoption translates into active treatment prevalence.

Active treatment prevalence, in turn, determines the scale at which individual dietary responses become population food-demand shocks. The calibrated per-user pathways imply reductions of 25.0–40.8% in daily caloric intake across the nine food categories, with the largest reduction for vegetable oils and fats and smaller reductions for fruits and vegetables and fish and seafood (Table S3). Scaling these responses by active use yields U.S. household food-demand reductions in 2030 ranging from 3.90% to 6.36% under current eligibility and access conditions and from 7.09% to 11.58% under expanded access. The corresponding shocks are smaller in Canada, ranging from 1.20% to 1.96% under current conditions and 1.73% to 2.82% under expanded access, and in Mexico, ranging from 0.59% to 0.96% and from 0.89% to 1.46%, respectively. Thus, the composition of the dietary response is determined by the per-user food-basket pathway, whereas treatment diffusion and persistence determine its population scale. These countries and food-category-specific demand reductions provide the household demand pathways whose economy-wide adjustment is examined below.

Food markets absorb the demand shock through multiple margins

The GLP-1-induced food-demand shock is absorbed across multiple market margins rather than translating proportionally into lower domestic production (Fig. 1). Across the nine food sectors, U.S. production and imports are below baseline in all scenarios, while farmgate-price responses are small and exports generally increase. Production contracts most in sugar and sugar products, beverages and tobacco,[2] processed food, dairy, and meat and meat products. Expanded weight-management access magnifies production and import responses, reflecting greater exposure to GLP-1-induced dietary change. By contrast, extending adoption to Canada and Mexico produces little additional change in U.S. production or farmgate prices. Thus, domestic eligibility and access conditions primarily determine the scale of U.S. adjustment, while the demand contraction is distributed across production, imports, exports, and prices rather than being absorbed by domestic output alone.

Dairy illustrates this adjustment across market margins. Under current eligibility and access, U.S. dairy production is 3.60% below baseline with U.S.-only adoption and 3.62% with North America-wide adoption; under expanded access, the reductions are 6.42% and 6.44%, respectively (Fig. 1). Farmgate prices respond much less, declining by 0.13% under current conditions and 0.24% under expanded access in both geographic scenarios. Imports contract more strongly than domestic production, by 4.60–4.61% under current conditions and 8.17–8.18% under expanded access, whereas exports increase. Dairy exports are 1.04% and 0.76% above baseline under current conditions with U.S.-only and North America-wide adoption, respectively, and 1.90% and 1.46% above baseline under expanded access. Thus, the reduction in domestic demand

[2] In the GTAP database, beverages and tobacco are represented as a single composite commodity. The demand adjustment applied to this sector is calibrated from RCT-anchored changes in caloric intake and related food-demand evidence; we do not separately model changes in smoking or a tobacco-specific behavioral response. Accordingly, results for this composite sector should not be interpreted as evidence of reduced tobacco consumption.

is absorbed not only through lower U.S. production but also through reduced imports and increased exports. The near-identical production and price responses across the two geographic scenarios further indicate that the magnitude of domestic adjustment is driven primarily by U.S. treatment eligibility and access, while geographic diffusion operates more strongly through trade.

Geographic diffusion primarily reshapes trade

Extending GLP-1 adoption to Canada and Mexico primarily changes the geographic distribution of U.S. trade adjustment rather than aggregate U.S. production. In Fig. 1, U.S.-only and North America-wide adoption generate nearly overlapping production and farmgate-price responses across most food sectors, while trade responses differ more clearly. Fig. 2 isolates this effect by comparing North America-wide with U.S.-only adoption. Across most sectors, U.S. export responses to Canada and Mexico are lower when those countries also experience GLP-1-induced demand reductions, while import responses from both countries are generally higher. Changes in trade with the rest of the world are comparatively small. Broader geographic diffusion therefore primarily reallocates trade within North America rather than further contracting U.S. agricultural production.

Dairy again provides a transparent numerical illustration of this bilateral adjustment. Under current eligibility and access conditions, North America-wide adoption lowers the U.S. export response to Canada by 1.28 percentage points and to Mexico by 0.79 percentage points relative to U.S.-only adoption (Fig. 2). Under expanded weight-management access, these differences increase to 1.84 and 1.23 percentage points, respectively. U.S. dairy import responses move in the opposite direction, increasing by 0.17 and 0.20 percentage points from Canada and Mexico under current conditions and by 0.24 and 0.29 percentage points under expanded access. These bilateral responses are consistent with lower Canadian and Mexican food demand reducing their absorption

of U.S. products alongside equilibrium adjustments in relative prices and regional sourcing. Thus, geographic diffusion primarily redistributes trade adjustment across partners, whereas treatment eligibility and access determine the overall scale of U.S. food-system adjustment.

Input adjustments are concentrated in agricultural land

Agricultural land use is below the 2030 baseline across all nine food sectors, with substantially larger reductions under expanded weight-management access than under current eligibility and access conditions (Fig. 3a). Within each access scenario, differences between U.S.-only and North America-wide adoption are small across sectors. This pattern mirrors the domestic production response and indicates that the scale of U.S. agricultural resource adjustment is determined primarily by treatment eligibility and access rather than by the geographic reach of adoption.

The factor-market response is even more concentrated in agricultural land (Fig. 3b). Under current eligibility and access conditions, aggregate U.S. agricultural land rents are 2.31% below baseline with U.S.-only adoption and 2.37% below baseline with North America-wide adoption. Under expanded weight-management access, the corresponding reductions increase to 4.10% and 4.20%. By comparison, real wages are only 0.01% below baseline across all four scenarios, while capital returns are 0.05% below baseline under current conditions and 0.08% below baseline under expanded access. Thus, the factor-market incidence of the GLP-1-induced food-demand shock is concentrated in agricultural land rather than mobile factors. Expanded treatment access amplifies both the reduction in agricultural land use and the decline in land rents, whereas extending adoption to Canada and Mexico adds little to either response.

Production-side environmental pressures

Production-side emissions[3] are below the 2030 baseline across all nine food sectors shown, for both total greenhouse gas (GHG) and CO_2 emissions (Fig. 4). The largest percentage reductions occur in beverages and tobacco, sugar and sugar products, processed food, dairy, and meat and meat products, broadly corresponding to the sectors with the largest production adjustments. Expanded weight-management access consistently produces larger emissions reductions than current eligibility and access conditions, whereas differences between U.S.-only and North America-wide adoption remain small. As with production and land use, the magnitude of the U.S. food-sector emissions response is therefore determined primarily by the scale of domestic treatment access rather than by the geographic reach of GLP-1 adoption.

These reductions in food-sector emissions do not imply an economy-wide environmental gain. Production and resource reallocation generate offsetting responses outside the food sectors shown in Fig. 4. In the U.S.-only scenario, gas-sector CO_2 emissions are approximately 0.45% above baseline under current eligibility and access conditions and 0.82% above baseline under expanded access, while coal and oil show smaller increases. The environmental response therefore reflects redistribution of production-side emissions across sectors as the economy adjusts to lower food demand. Thus, lower emissions in the food sectors examined do not imply a corresponding reduction in aggregate U.S. emissions.

Discussion and policy implications

This study shows how a pharmaceutical innovation can become a population-scale food-system shock. Its aggregate importance depends on a medication access environment shaped by regulatory

[3] These estimates capture production-side and intermediate-input emissions within GTAP-RD and do not include the full life-cycle emissions associated with GLP-1 manufacturing, distribution, and use.

approval, eligibility, reimbursement, insurance coverage, affordability and prescribing access, together with treatment diffusion and persistence[30–32]. Regulatory and reimbursement environments differ across the United States, Canada, and Mexico, illustrating how institutional conditions shape realized access even where treatments are clinically available[33–35]. By linking these conditions to evidence-constrained dietary responses and economy-wide adjustment, our framework identifies a channel through which health and particularly pharmaceutical policy can become an upstream determinant of agricultural demand. Health and food systems are therefore economically interconnected even when governed separately.

Once transmitted to food demand, these shocks are mediated by agricultural markets. The resulting effect does not translate proportionally into lower domestic production because general-equilibrium adjustment distributes it across output, imports, exports, prices and productive resources. In several sectors, imports contract more than production while exports increase, showing that trade absorbs part of the adjustment. This distinction matters because the literature documents substantial changes in food intake, purchases, and demand at the individual or household level after GLP-1 initiation[5,6,2,12]. Such evidence identifies the initial behavioral response but not its ultimate incidence across producers, trading partners, or factor markets. Agricultural projections that extrapolate directly from household consumption changes may therefore mischaracterize the magnitude and location of adjustment.

Treatment access and geographic diffusion govern different dimensions of this adjustment. In this analysis, the general-equilibrium system includes the United States, Canada, Mexico, and an aggregate Rest-of-the-World region, so production and trade adjustments can propagate globally. We focus the discussion on the United States, Canada, and Mexico because GLP-1 adoption is modeled explicitly for these three countries and their bilateral trade flows are separately

identified, allowing us to distinguish domestic U.S. adjustment from the additional effects of treatment diffusion among major regional trading partners. Expanded domestic weight-management access primarily determines the scale of the U.S. food-demand shock, whereas extending adoption to Canada and Mexico changes bilateral trade more strongly than aggregate U.S. production or prices. This distinction is policy-relevant because access remains strongly conditioned by reimbursement, insurance, and affordability. U.S. public and employer coverage remains incomplete, Canadian reimbursement is narrower, and Mexican access depends more heavily on private purchase and out-of-pocket affordability[34,36,32,31]. Pharmaceutical regulation and reimbursement can therefore influence agricultural markets through both domestic treatment uptake and adoption among trading partners. Domestic access conditions primarily determine the scale of adjustment, whereas international diffusion helps determine its geographic incidence through trade. This also suggests an interaction with trade policy. Because trade absorbs part of the demand adjustment, tariffs, market access and other trade costs could alter how GLP-1-induced shocks are distributed between domestic production, imports and exports, although these interactions are not varied here.

The incidence of these cross-sector spillovers is uneven. Agricultural land rents decline substantially more than real wages or capital returns, indicating that factor-market adjustment is concentrated in agricultural land. Aggregate production responses may therefore conceal greater exposure among landowners, producers and processors concentrated in the most affected commodities. Environmental responses are similarly non-uniform. Production-side emissions decline across the food sectors examined, while some non-food sectors exhibit increases as production and resources are reallocated. Such responses arise through the economy-wide production, input, and trade linkages represented in GTAP-RD[37]. Reductions in food-sector

emissions therefore do not imply a corresponding reduction in aggregate U.S. emissions or a net environmental benefit.

Several sources of uncertainty affect the analysis. Future GLP-1 diffusion remains uncertain because efficacy, prices, coverage, eligibility, availability, and awareness continue to evolve. We therefore estimate U.S. diffusion probabilistically, propagate parameter uncertainty through the active-use module, and examine alternative access conditions and low-, middle- and high-diffusion pathways rather than impose a single forecast. This approach is consistent with evidence that pharmaceutical uptake depends on prescribing behavior, clinical learning, and professional networks[38,39]. Comparable historical series are unavailable for Canada and Mexico, so their projections are more assumption-dependent and treated as prior-predictive scenarios. Treatment persistence is also uncertain, which we address by distinguishing first-time adoption from active use through discontinuation and reinitiation dynamics informed by available evidence[40,41]. Category-specific dietary evidence remains incomplete. Controlled and emerging demand studies document heterogeneous food responses, but no study identifies a complete GLP-1 response across the food basket[5–7,2]. We therefore construct RCT-anchored, evidence-constrained food-basket pathways rather than claim structurally identified category effects. Finally, the economy-wide results remain conditional model projections rather than causal forecasts. GTAP-RD allows production, prices, factor use, and trade to adjust jointly along an evolving SSP2 baseline[37], but trade-policy interactions, adoption beyond North America, heterogeneous regional responses, and broader environmental effects remain for future work.

These results point to a near-term connection between GLP-1 treatment expansion and U.S. agricultural markets. Under plausible access and diffusion pathways, changes in food demand generate sizable adjustments in production, trade and agricultural land by 2030, with agricultural

land rents particularly exposed. Regulatory and access conditions therefore matter not only for health outcomes but also for the scale of demand shocks reaching agriculture, while trade and factor markets determine where those shocks are absorbed. Agricultural sector projections that omit rapid growth in GLP-1 use may consequently understate an emerging source of structural change in food demand. Incorporating treatment access and diffusion into agricultural analysis is increasingly important for anticipating where these adjustments will occur and who will bear them.

Methods

Analytical framework and scenario design

We use a linked three-stage framework to trace how GLP-1 diffusion translates into economy-wide food-system outcomes from 2026 to 2030 (Fig. 5). First, a Bayesian Generalized Bass Model projects first-time treatment adoption in the United States, Canada, and Mexico under alternative market conditions[42], and treatment discontinuation and reinitiation convert these flows into annual active treatment prevalence[40]. Second, active treatment prevalence is combined with RCT-anchored, evidence-constrained per-user dietary responses to construct country-, year- and food-category-specific population food-demand pathways[5–7]. Third, these externally constructed demand pathways are introduced recursively into GTAP-RD, a recursive-dynamic computable general equilibrium model, through annual changes in the corresponding household-demand pathways and evaluated relative to an SSP2 baseline[37]. This framework allows the specified demand changes to propagate endogenously through production, prices, trade, input use, and factor markets. Full specification of the diffusion model, dietary calibration, and economy-wide implementation is provided in Supplementary Sections 5–7.

The counterfactual design varies three dimensions. Treatment conditions contrast current eligibility and access conditions, in which market potential reflects the adult population with obesity (BMI ≥30) and country- and year-specific practical access, with expanded weight-management access, in which eligibility extends to the population with overweight (BMI ≥25, including obesity) and practical access broadens over time. Within each eligibility and access condition, low, middle and high diffusion pathways represent alternative trajectories for affordability, accessibility, and awareness and therefore alter the speed at which adoption approaches the corresponding market potential without changing that scenario-specific ceiling. Geographic scope contrasts U.S.-only diffusion, in which the resulting food-demand pathways are imposed only in the United States, with North America-wide diffusion, in which country-specific pathways are imposed simultaneously in the United States, Canada, and Mexico. Detailed construction of market potential and the diffusion pathways are provided in Supplementary Sections 1 and 6.3–6.8.

The implications extend beyond the immediate dietary effects of GLP-1 medicines. Our results show that changes in treatment eligibility, reimbursement, affordability, and prescribing access can alter the scale of food-demand shocks reaching agriculture, while diffusion among major trading partners changes where those shocks are absorbed. Agricultural land is particularly exposed, with land rents responding substantially more than wages or capital returns. Pharmaceutical access and diffusion should therefore be considered in agricultural outlooks when treatment use becomes sufficiently widespread to affect aggregate food demand. More broadly, the results identify a concrete channel through which changes originating in health markets can propagate through food demand, trade, and agricultural factor markets.

Projecting active GLP-1 treatment prevalence

We project first-time GLP-1 adoption among adults in the United States, Canada, and Mexico through 2030 using a Bayesian Generalized Bass Model (GBM). The Bass framework represents diffusion through innovation and imitation processes, while the generalized specification allows time-varying market conditions to alter the rate at which adoption approaches its potential market[43,42]. This structure is well suited to pharmaceutical diffusion, where uptake evolves nonlinearly as clinical experience, access, and market conditions change[38,44]. For the United States, the model is estimated in a Bayesian framework using a historical adoption series through 2025 and literature-informed priors, generating posterior distributions for the diffusion and market-effort parameters[45]. Model specification, historical-series construction, priors, estimation, and diagnostics are reported in Supplementary Sections 6.1–6.7 and Table S11.

For each country and year, the model separates market potential from the speed of diffusion toward that potential. Under current eligibility and access conditions, market potential combines the adult population with obesity (BMI ≥30) with country- and year-specific practical access to treatment. Under expanded weight-management access, eligibility extends to adults with overweight (BMI ≥25, including obesity) and is combined with a broader practical-access trajectory reflecting regulatory availability, insurance or reimbursement, prescribing access and market availability. Within each access condition, low, middle, and high diffusion pathways vary affordability, accessibility, and awareness and therefore alter the rate of approach toward the scenario-specific ceiling without changing that ceiling. For the United States, projection uncertainty is propagated from the estimated posterior distribution. Because comparable historical adoption series are unavailable for Canada and Mexico, these countries are simulated using literature-informed prior-predictive distributions for the diffusion parameters, with the market-

effort coefficients anchored to the corresponding U.S. posterior medians. Full scenario construction and uncertainty propagation are provided in Supplementary Sections 6.3–6.8.

Because the GBM projects first-time adoption rather than active treatment use, projected adoption flows are passed through a stock-flow adjustment for treatment discontinuation and reinitiation. New adopters enter the active-user stock, continuing users remain active subject to discontinuation, and prior users can reinitiate without being counted again as first-time adopters. This produces annual active treatment prevalence, which is the population measure subsequently used to scale the per-user dietary responses[4]. The active-use recursion and calibration of discontinuation and reinitiation are detailed in Supplementary Section 6.9; reinitiation parameters are informed by observed treatment restart patterns among U.S. adults with overweight or obesity[40].

Constructing population food-demand pathways

We construct per-user dietary responses by combining clinical evidence on total energy intake with complementary evidence on changes in food composition. Randomized controlled trials provide the aggregate anchor for reductions in energy intake among GLP-1 users, while experimental, survey, purchase, and demand studies inform the relative response across food groups[5–7,46,10,13,2]. FAO Food Balance Sheets provide country-specific baseline caloric composition and support mapping into nine aggregated GTAP food categories, consistent with their established use for characterizing national food and calorie availability[47]. Because category-

[4] First-time adoption is combined with discontinuation and reinitiation to derive annual active treatment prevalence. When constructing the population-level caloric-intake shock, we assume that all current active users have the same per-user dietary response, regardless of whether they are first-time or reinitiating users. The RCT-anchored average caloric-intake change is therefore scaled by total active treatment prevalence rather than by initiation status.

specific effects are less precisely identified than the overall reduction in intake, these responses are treated as RCT-anchored, evidence-constrained scenario inputs rather than independently identified category-specific causal effects. The evidence base, calibration procedure, and resulting per-user responses are reported in Supplementary Section 5 and Table S3.

Per-user responses are scaled by projected active treatment prevalence, rather than first-time adoption, to construct country-, year- and food-category-specific population demand pathways.. For country r, food category c and year t,

$$D_{crt} = A_{rt}\delta_{cr}$$

where A_{rt} is active treatment prevalence, δ_{cr} is the calibrated per-user dietary response and D_{crt} is the resulting aggregate household-demand change. Because GTAP household demand is not age-stratified, adult active-treatment prevalence is used as the scaling share. The resulting pathways are constructed outside GTAP-RD and introduced as exogenous household quantity-demand counterfactuals, consistent with food-system scenario approaches that impose externally specified dietary changes and determine subsequent market adjustment endogenously[26,28]. Full construction and implementation are provided in Supplementary Sections 5 and 7.3.

Economy-wide baseline and counterfactual simulations

We evaluate economy-wide adjustment using GTAP-RD, the recursive-dynamic version of the Global Trade Analysis Project computable general equilibrium model[37]. GTAP-RD links production, private and public demand, factor markets, investment, and bilateral trade, allowing prices, production, sourcing, trade, and factor returns to adjust jointly following a change in household demand. We use Version 11 of the GTAP Data Base, with a 2017 reference year[48], aggregating 160 regions into the United States, Canada, Mexico, and the rest of the world and 65 sectors into 16 sectors. Nine food sectors are directly matched to the GLP-1 dietary responses,

while other agricultural, energy, manufacturing, and service activities remain endogenous to preserve input-output and trade linkages. Model structure and aggregation are detailed in Supplementary Section 7.1, Fig. S8 and Table S13.

From the 2017 benchmark, we recursively advance the economy to 2030 under a Shared Socioeconomic Pathway 2 baseline using projected population, labor supply, and real GDP growth, with aggregate factor-augmenting productivity adjusting endogenously to reproduce the prescribed GDP trajectory[49]. Investment contributes to subsequent capital stocks, so each annual equilibrium carries forward prior investment and factor-market adjustments. Baseline construction and dynamic closure are described in Supplementary Section 7.2.

GLP-1 counterfactuals retain the same SSP2 trajectory but introduce the externally constructed country-, year-, and food-category-specific pathways as exogenous changes in private-household quantity demand. The 2026 simulation introduces the initial demand change, while subsequent annual simulations introduce the year-to-year increment in the target pathway rather than reapplying the full demand change. Conditional on these imposed household quantities, production, prices, import sourcing, bilateral trade, intermediate-input use, and factor allocation adjust endogenously. Outcomes are evaluated relative to the corresponding SSP2 baseline. Full counterfactual implementation and model closure are reported in Supplementary Section 7.3.

Modeled outcomes and interpretation

We report sectoral farmgate prices, domestic production volumes, aggregate imports and exports, bilateral trade flows, land use, real wages, real capital returns, agricultural land rents, and production-side CO_2 and total greenhouse-gas emissions[37]. Land use measures the quantity of agricultural land allocated across activities, while land rents measure its real factor return; wages and capital returns are likewise expressed in real terms. Bilateral trade spillovers are measured as

386 percentage-point differences between deviations from baseline under North America-wide and
387 U.S.-only diffusion. Variable definitions are provided in Supplementary Section 3 and Table S2,
388 with diffusion sensitivities reported in Supplementary Section 4.

389 Unless otherwise stated, outcomes are reported as 2030 percentage deviations from the
390 corresponding SSP2 baseline, incorporating the recursively linked adjustments from 2026 to 2030.
391 Production-side emissions reflect changes in production and intermediate-input use captured by
392 GTAP-RD and do not represent life-cycle, consumption-based, or pharmaceutical-sector
393 environmental footprints. Because the GLP-1 diffusion and food-demand pathways are externally
394 specified while all scenarios retain the same underlying SSP2 trajectory, the results are conditional
395 counterfactuals rather than causal estimates or unconditional forecasts of future market outcomes.
396 Counterfactual interpretation and environmental accounting are detailed in Supplementary
397 Sections 7.3–7.4.

Figures

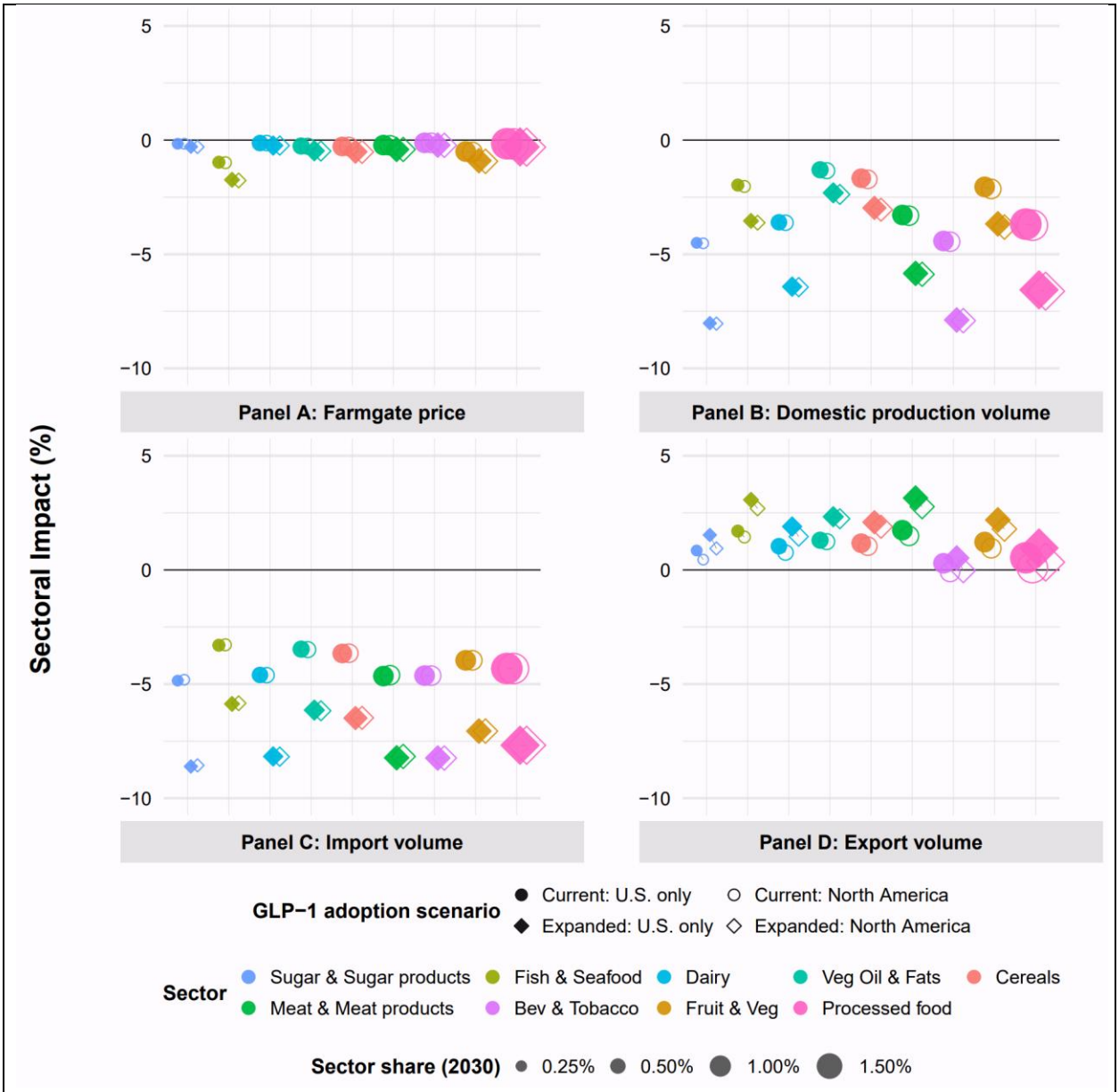


Fig. 1 | Cumulative sectoral deviations from the 2030 baseline in the U.S. under middle-adoption pathway across different scenarios. Panels A to D report farmgate prices, domestic production volume, import volume, and export volume, respectively. Together, the nine food-related sectors shown account for approximately 7% of total U.S. domestic production value in the 2030 GTAP baseline. Marker size represents each sector's relative share, and sectors are ordered from smallest to largest from left to right. For each sector, filled and hollow circles represent sector-specific percentage changes relative to the baseline under current clinical coverage with U.S.-only and North America-wide GLP-1 adoption, respectively. Filled and hollow diamonds represent the corresponding changes under expanded weight-management

access with U.S.-only and North America-wide GLP-1 adoption, respectively. Positive values indicate increases relative to the baseline, whereas negative values indicate contractions.

399

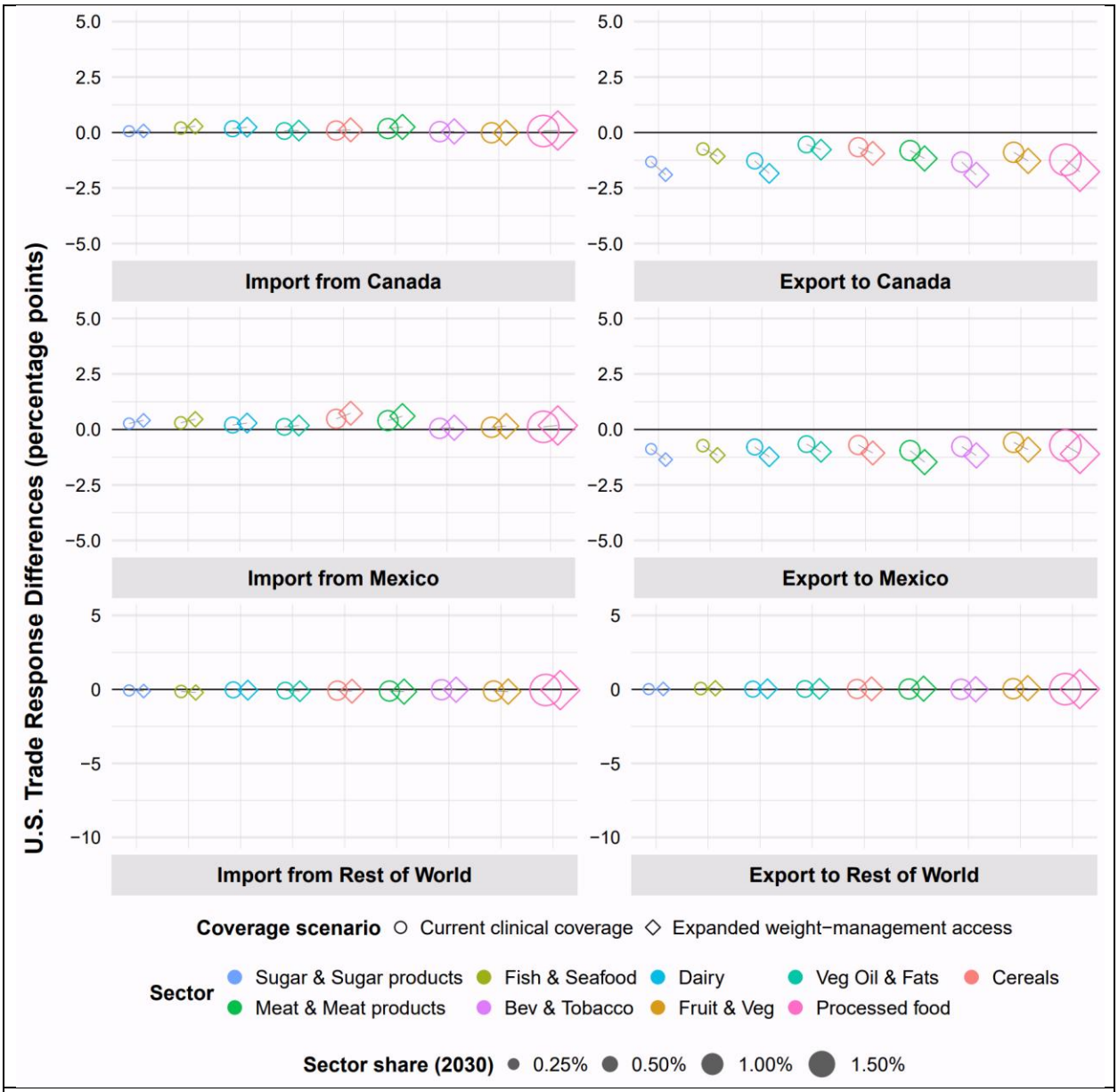
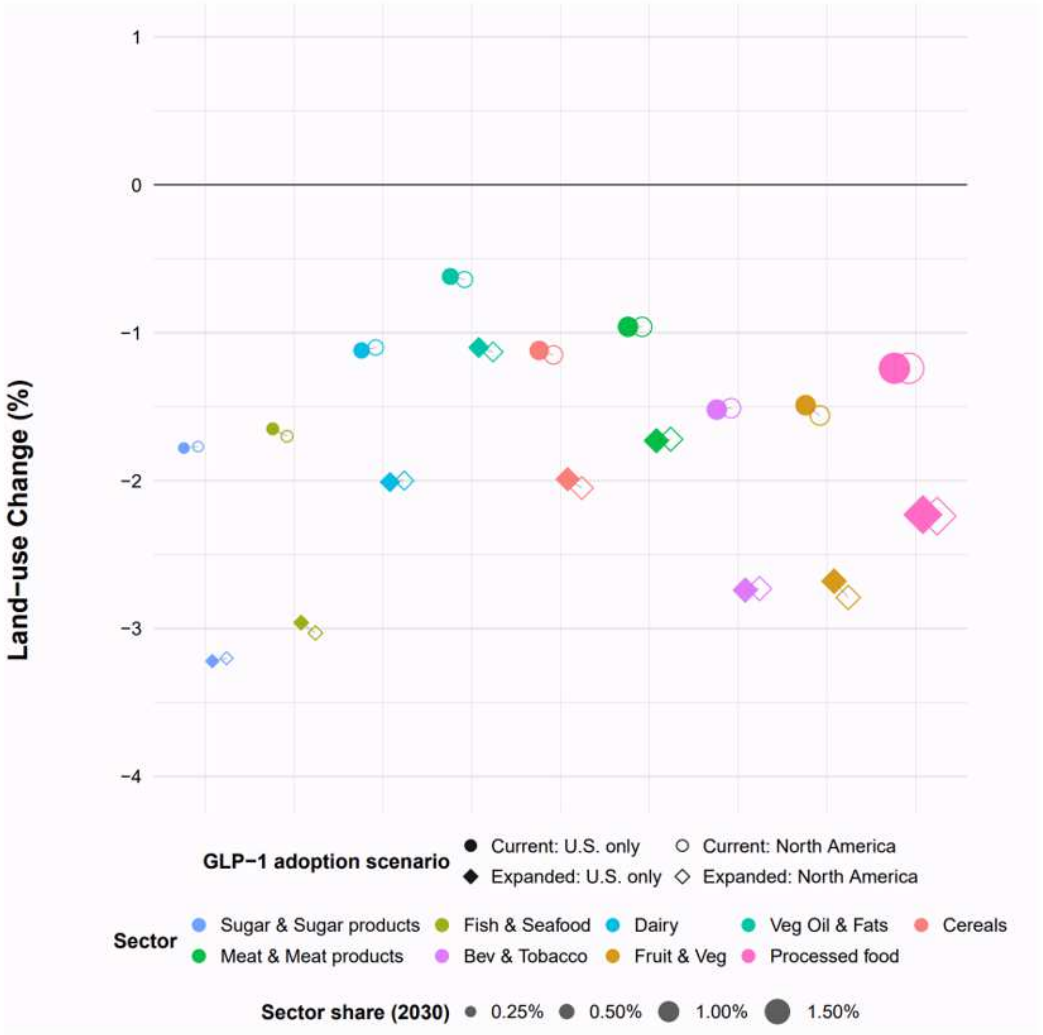
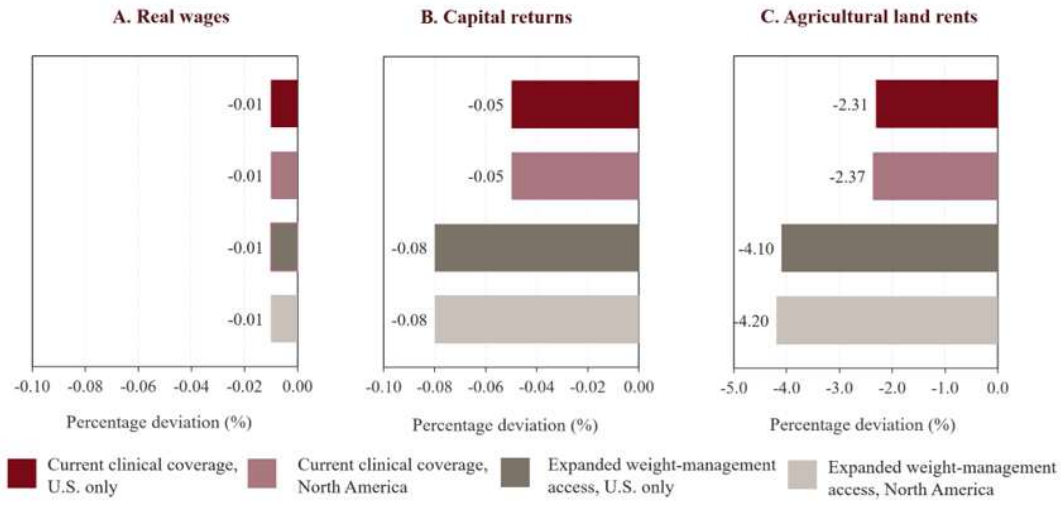


Fig. 2 | Differences in U.S. cumulative import and export responses relative to the 2030 baseline between North America-wide and U.S.-only GLP-1 adoption scenarios under the middle-adoption pathway. Panels report percentage-point differences in U.S. imports from and exports to Canada, Mexico, and the rest of the world. Together, the nine food-related sectors shown account for approximately 7% of total U.S. domestic production value in the 2030 GTAP baseline. Marker size represents each sector's relative share, and sectors are ordered from smallest to largest from left to right. For each sector, circles and diamonds represents the North America-wide minus U.S. only deviation from 2030 baseline under the middle adoption path for current clinical coverage and expanded weight-management access, respectively. Positive values indicate larger deviations in U.S. imports or exports under the North America-wide scenario relative to the U.S.-only scenario, while negative values indicate smaller trade flows under North America-wide adoption.



Panel A: Land-use Change



Panel B: Return to Factors

Fig. 3 | Cumulative land-use and factor-return deviations from the 2030 U.S. baseline under low- and high-adoption pathways. Panel A reports cumulative percentage changes in land use across nine food-related sectors, which together account for approximately 7% of total U.S. domestic production value in the 2030 GTAP baseline. Marker size represents each sector's baseline share, and sectors are ordered from smallest to largest from left to right. Filled and hollow circles represent current clinical coverage with U.S.-only and North America-wide GLP-1 adoption, respectively, while filled and hollow diamonds represent expanded weight-management access under U.S.-only and North America-wide adoption. Positive values indicate increases relative to the baseline, whereas negative values indicate contractions. Panel B reports cumulative percentage deviations in real wages, capital returns, and agricultural land rents under the corresponding coverage and geographic-adoption scenarios for the low- and high-adoption pathways. Across scenarios, changes in real wages and capital returns are small, while agricultural land rents exhibit substantially larger declines, particularly under expanded weight-management access.

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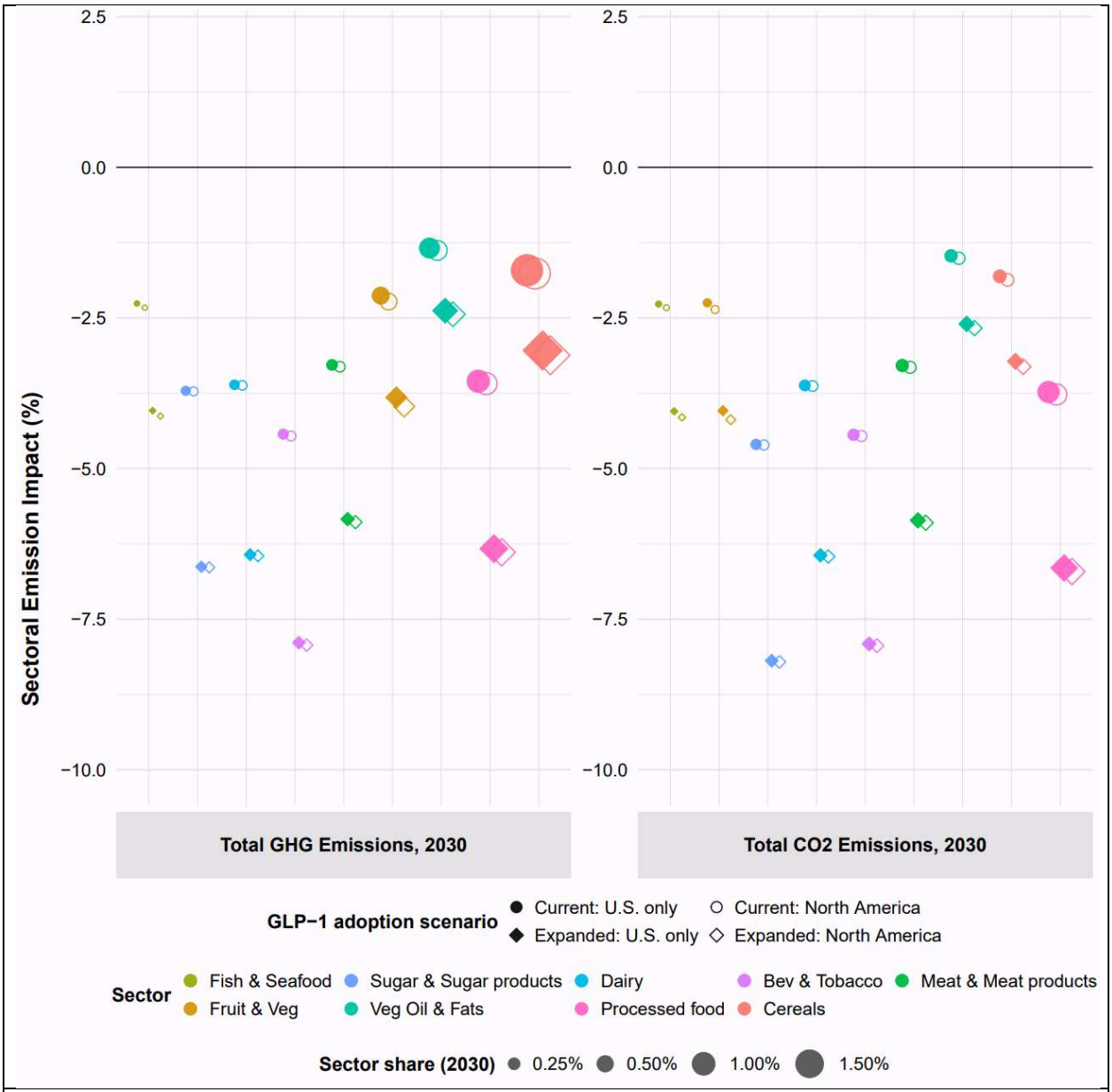


Fig. 4 Cumulative sectoral emissions deviation from the 2030 baseline under the middle-adoption pathway across different scenarios. The left panel reports total GHG emissions, including CO2, and the right panel reports CO2 emissions only. Together, the nine food-related sectors shown account for approximately 4.5% and 2.2% of total U.S. GHG emissions and CO2 emissions from production, respectively, in the 2030 GTAP baseline. Marker size represents each sector's relative share, and sectors are ordered from smallest to largest from left to right within each panel. For each sector, filled and hollow circles represent sector-specific percentage changes relative to the baseline under current clinical coverage with U.S.-only and North America-wide GLP-1 adoption, respectively. Filled and hollow diamonds represent the corresponding changes under expanded weight-management access with U.S.-only and North America-wide GLP-1 adoption, respectively. Positive values indicate an increase relative to the baseline, while negative values denote a contraction.

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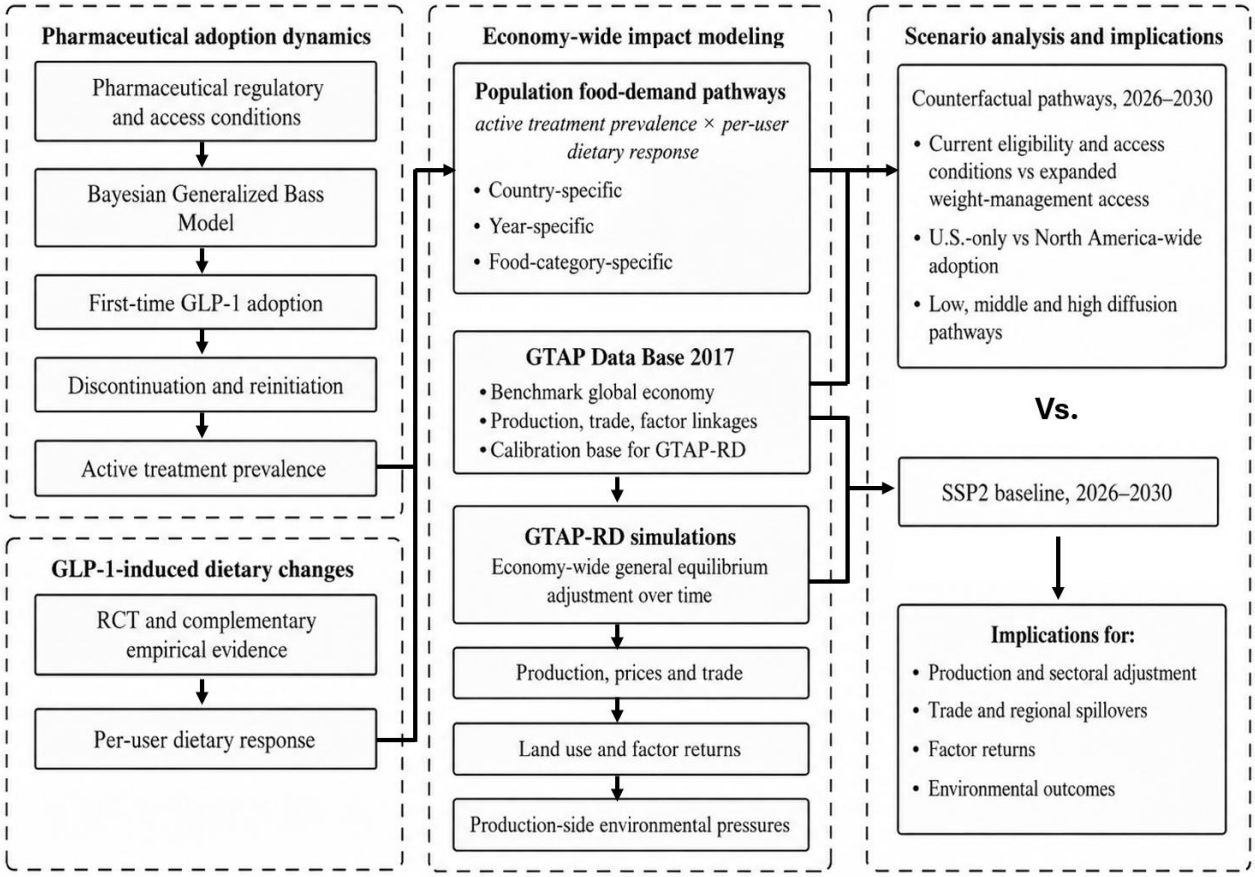


Fig. 5 | From GLP-1 diffusion to food-system outcomes: conceptual and modeling framework. Pharmaceutical adoption dynamics and GLP-1-induced dietary responses are developed in parallel and combined to construct country-, year- and food-category-specific population food-demand pathways. A Bayesian Generalized Bass Model projects first-time GLP-1 adoption under alternative regulatory, eligibility, and access conditions, while discontinuation and reinitiation convert first-time adoption into annual active treatment prevalence. Clinical randomized controlled trial and complementary empirical evidence are used to construct per-user dietary responses. Population food-demand pathways are obtained by combining active treatment prevalence with per-user dietary responses. GTAP-RD is calibrated to the 2017 GTAP Data Base and used to simulate an SSP2 baseline and corresponding GLP-1 counterfactual pathways from 2026 to 2030. Counterfactual pathways vary treatment eligibility and access, diffusion, and geographic scope, and are evaluated relative to the corresponding SSP2 baseline. The model quantifies resulting changes in production, prices, trade, land use, factor returns, and production-side environmental pressures. Arrows indicate the direction of information flow and model implementation.

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Supplementary Files

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- BayesianGBMAdoptionRateEstimation.txt
- ResultsPlotsMid.txt
- SupplementaryMaterials.docx
- ResultsPlotsLowHigh.txt