Minimum Slaughter Weight Regulation in Cattle Markets: Evidence from Argentina

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Abstract

A minimum slaughter weight forbids slaughtering animals below a legal threshold, a rule meant to raise meat production. We evaluate it in a Faustmann competitive equilibrium with endogenous breeding, a binding land constraint, and two technologies, calibrated to Argentina. With a single technology, discounting makes producers slaughter below the supply-maximizing weight, so a moderate floor raises supply. The supply gain is small, and once the transition through the cattle cycle is priced, the floor delivers no welfare gain. With pasture and feedlot sharing the market, equilibrium slaughter weights are 408 and 346 kg. A uniform 420–450 kg floor can cut welfare by 13.2–18.8% of revenue in present value where cattle is the dominant land use, because feedlot output losses dominate pasture gains. Argentina's floor did not bind the representative producer, so the 2026 repeal carried effectively zero welfare cost and a tighter one would have been harmful. As middle-income agriculture turns dual, a capital-intensive segment beside a land-intensive one, a uniform instrument written for a single technology misfires once that structure takes hold.

Keywords: minimum slaughter weight, optimal slaughter timing, beef supply regulation, welfare analysis, Argentina

JEL codes: Q18, L51, O13

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1 Introduction

For eighteen years, Argentina made it illegal to slaughter cattle below a minimum weight. Beef is central to the country, the world's sixth-largest producer and its largest consumer per head,[1] so the rule reached a large and politically visible sector. It rested on a simple idea. Animals slaughtered young are numerous but yield little meat. The founding measure recorded that calves were 15.8% of the head slaughtered but only 9.4% of the beef produced, and reasoned that holding them back would raise *the supply of beef through greater weight and yield*.[2] In its final form the floor required a carcass of 165 kg for males and 140 kg for females, about 300 kg live.[3]

The idea is not obviously wrong, which is what makes it worth examining. Producers sell their animals well before maturity, which to an eye that counts only kilograms looks like growth left on the table. They are not erring. Each added kilogram takes longer to put on while the animal keeps occupying land and tying up capital, so it pays to sell well short of the biological maximum. A minimum weight raises output only if it pushes producers past that private optimum, toward the weight at which the whole herd yields most. In 2026 Argentina took the opposite view and repealed the floor in the name of free commerce, holding that producers themselves are best placed to choose *the optimal time of slaughter*.[4]

A minimum weight is the sharpest form of a broader family of output-side instruments. Carcass grading, conformation and size penalties, and quality standards are common in livestock markets and push the same way, rewarding heavier or better-finished animals at slaughter.[5] Argentina's is a rare case where the pressure took an explicit, legally binding form, which makes its welfare consequences unusually easy to identify. They have not been analyzed structurally.

This paper asks three questions. First, can a weight floor increase beef supply? Second, does any supply increase translate into a welfare improvement once transition dynamics enter? Third, how do the answers change when the livestock sector runs on more than one production technology?

[1]USDA Foreign Agricultural Service livestock and poultry data (2024); CICCRA monthly bulletin (2024).

[2]The figures and the quoted rationale are from the considerandos of Resolution 645/2005, the immediate predecessor that suspended the slaughter of calves.

[3]Resolution 68/2007 of the then-Secretaría de Agricultura, Ganadería, Pesca y Alimentos continued an earlier suspension of light-animal slaughter, Resolution 645/2005, which barred the commercial slaughter of calves, adding a phased live-weight floor and an 85 kg half-carcass minimum. Resolutions 26/2018 and 74/2019 recast the floor in carcass terms and set the 165 kg male and 140 kg female threshold in force at repeal. At the 55–58% dressing-percentage range typical of Argentine cattle (Garriz INTA; Tonelli, Valor Carne 2020), the male threshold corresponds to 285–300 kg live weight. We use 300 kg in the calibration, the strictest live-weight equivalent within this range, and even at this upper bound the floor does not bind in either sector.

[4]Resolution 98/2025 deemed the floor unnecessary in the current context.

[5]Uruguay's INAC classification sorts carcasses by sex, dentition, and conformation but sets no legally binding minimum carcass weight on the internal market. Brazil has no national minimum weight law, but the bonus and penalty grids applied by JBS, Marfrig, Minerva, and other ABIEC members function as de facto thresholds. EU Regulation 1308/2013 codifies the EUROP grid (Annex IV Part A) for carcass conformation and a separate young-bovine category system (Annex VII Part I).

Our analysis adapts the Faustmann rotation model from forestry (Faustmann, 1849; Clark, 2010), which formalizes the optimal harvest timing of a growing biological asset. Later slaughter lengthens the fattening pipeline and crowds out breeding stock on a fixed land endowment. Aggregate beef supply is hump-shaped in the slaughter age, rising as animals grow heavier but eventually declining as herd crowding dominates weight gains.

We develop a continuous-time model that nests the individual slaughter-timing decision inside a competitive equilibrium with endogenous prices, breeding-stock dynamics, and a binding land constraint. Relative to the canonical Faustmann setting, it adds three features that matter for regulation: an endogenous herd size, a maturation pipeline for replacement stock, and competition for land between breeding and fattening.

We establish three results. The first identifies a *discounting wedge*. The competitive equilibrium slaughter age sits below the steady-state welfare optimum, which in turn falls below the throughput peak. The wedge arises because the individual producer accounts for the return forgone on capital tied up in each growing animal, while a steady-state welfare comparison does not. This wedge creates a *supply-enhancing zone* of moderate weight floors that raise supply above the unregulated equilibrium. Under our baseline calibration, the zone spans 408–435 kg and yields a peak supply gain of about 0.5%.

The second result shows the supply-enhancing finding fails once transition dynamics enter. The flow-welfare comparison omits the capital charge a present-value planner bears along the path between steady states, so a steady-state gain need not survive once that path is priced. Using a delay differential equation calibrated to a roughly 10-year cattle cycle, we simulate the repeal of a binding floor and decompose the present value into a one-time backlog windfall, transition costs during herd adjustment, and a permanent steady-state change. The backlog windfall dominates, transition costs absorb a quarter to a half of it, and the present-value-optimal binding floor delivers a gain below 0.001% of annual revenue.

The third result overturns the first two once the sector holds two technologies. Extensive pasture operations (roughly 65% of Argentine slaughter) grow animals slowly on land with low holding costs, while intensive feedlots (roughly 35%) grow them fast in confinement with high holding costs and negligible land.[6] When both technologies share a common beef market, a uniform floor falls disproportionately on feedlots, which reach their privately optimal weight at a lower level and operate past their unconstrained throughput peak. At a hypothetical 420 kg floor, pasture supply rises by 0.3% but feedlot output falls by 32%, producing an 11% aggregate supply decline and a present-value welfare loss of 13.2% of unregulated two-sector revenue. The loss reaches 18.8% at a 450 kg floor and rises further at heavier ones. It persists through the cattle cycle rather than

[6]MAGyP (Ministerio de Agricultura, Ganadería y Pesca de la Nación, 2024) and USDA-FAS (U.S. Department of Agriculture, Foreign Agricultural Service, 2025) livestock reports, 2024.

fading, so pricing the transition deepens the cost instead of erasing it. The sign holds across the empirically relevant ranges of all eight model parameters. The magnitude is an upper bound, largest where cattle is the dominant land use and where feedlots comply by extending confinement rather than finishing the extra weight on pasture.

In Argentina, the 300 kg floor never bound the representative producer in either sector, as the slaughter record confirms (Section 4.3).[7] Tighter alternatives at 420, 450, or 480 kg reduce aggregate welfare once feedlots are included. The case for deregulation is unambiguous within our framework. Brazil, Uruguay, and Paraguay combine the same two technologies in different proportions, so the diagnosis transfers to regional debates over grading thresholds and carcass-size minima, wherever the feedlot share is large enough to drive the throughput asymmetry and cattle is the dominant land use. As middle-income agriculture modernizes, a capital-intensive segment emerges alongside the traditional land-intensive one, and a uniform instrument written for a single technology misfires once the sector turns dual.

Our analysis draws on and contributes to three strands of literature. The first is the Faustmann rotation tradition. The Faustmann model (Faustmann, 1849) has been applied to aquaculture (Bjørndal, 1988), bioeconomics (Clark, 2010), and forestry (Płotkowski et al., 2016). Cattle production differs from forestry because the producer manages a self-replenishing breeding herd rather than a fixed stand of trees. The framework therefore requires endogenous herd size and competition for land. Several studies have examined optimal cattle replacement and marketing decisions (Yager et al., 1980; Frasier and Pfeiffer, 1994) and aggregate herd inventory dynamics (Rucker et al., 1984; Schmitz, 1997), but none place the slaughter-timing decision inside a market equilibrium with regulation.

The second strand treats cattle as capital goods with biological growth options. Jarvis (1974) pioneered this approach using Argentine data and derived the retention effect that links higher beef prices to delayed slaughter, a partial-equilibrium prediction we recover and qualify in Proposition 2. Rosen (1987) provided the conceptual framework linking biological lags to aggregate dynamics, and Rosen et al. (1994) developed the full rational-expectations cattle-cycle model in an aggregate single-sector economy without a land constraint or regulatory instrument. Our framework keeps the Faustmann slaughter-timing decision at the individual level but places it within a competitive equilibrium with binding land and a two-sector extension, and we use an adaptive rather than fully rational-expectations replacement rule to close the transition dynamics. We trade expectational

[7] Our calibration targets the representative producer and does not speak to the left tail of the empirical slaughter-weight distribution. The 300 kg-equivalent (165 kg carcass) floor is far below the model's representative slaughter weights of 408 kg pasture and 346 kg feedlot, so the regulation never binds at the means. But individual operations in the left tail (light-steer specialists, distressed sales, and informal-channel slaughter) would have faced a binding constraint, so the regulation is not strictly non-distortionary at the operation level. A full distributional analysis using SENASA microdata is beyond the scope of this paper, but the welfare-neutrality result we report is correctly understood as applying to the modal Argentine producer rather than to the universe of operations.

discipline for tractability and for the ability to introduce a uniform weight-floor regulation in closed form, leaving the rational-expectations extension along the lines of Rosen et al. (1994) to future work.

The third strand concerns agricultural development and regulatory economics in Latin America. A minimum slaughter weight is a minimum standard applied to output per animal, and the literature on minimum quality standards (Leland, 1979; Ronnen, 1991) shows their welfare effects are ambiguous and hinge on producer heterogeneity. That literature works through asymmetric information about unobservable quality, whereas our mechanism needs none. Weight is observable, yet a uniform floor still reduces welfare because it binds two production technologies unequally, falling hardest on the one whose unconstrained optimum is lowest. Bustos et al. (2016) show how agricultural technical change reshapes structural transformation in dual economies, a framing directly relevant to the pasture/feedlot heterogeneity we exploit. Adamopoulos and Restuccia (2014) quantify the productivity costs of farm-size distortions, and Anderson and Valdés, eds (2008) documents the long history of implicit and explicit taxation of Latin American agriculture. Both bear on the size of the welfare losses we report. Within the Argentine livestock literature, Rossini et al. (2017) document how export restrictions and price controls affected Argentine cattle markets, and Reca and Lema (2016) estimate long-run beef demand for Argentina over 1950–2012 (the source for our $\eta = 0.36$). The closest prior analysis of our specific policy is Benito Amaro (2024), who evaluates the 2007–2025 floor in a static partial-equilibrium model and argues, on theoretical grounds, that a binding floor depresses calf prices and lowers total output. We add a structural general-equilibrium model with endogenous breeding stock, a binding land constraint, technological heterogeneity across pasture and feedlot, and transition dynamics, and we confront the policy with the slaughter record, which shows the floor sat far below observed weights throughout its life. Together these let us quantify the counterfactual welfare cost of tighter floors and the welfare-neutrality of the 2026 repeal, which a partial-equilibrium argument cannot deliver.

Section 2 builds the Faustmann model with endogenous breeding and a binding land constraint. Section 3 derives the discounting wedge, the transition dynamics, and the two-sector extension. Section 4 calibrates the model to Argentina and shows the floor never bound the representative producer. Section 5 reports the three quantitative results, Section 6 establishes their robustness, and Section 7 concludes.

2 Model

We develop a model of a competitive beef market in continuous time, $t \in [0, \infty)$. A representative cattle producer manages a breeding herd and a fattening pipeline on a fixed land endowment, choosing how many calves to retain for breeding replacement and when to slaughter fattening animals. A minimum slaughter weight regulation constrains harvest timing. By the end of the section the model reduces to three equations in three unknowns, the beef price, the slaughter age, and the rental rate of land.

2.1 Environment

Let $w : [0, \infty) \to \mathbb{R}_+$ denote the live weight of an individual animal as a function of a, its age since entry into the fattening pipeline. Argentine calves are weaned at six to eight months, so a counts from weaning and $w(0) = w_0$ is the weaning weight rather than birthweight.

Assumption 1 (Individual growth)**.** *$w \in C^2$, $w(0) \equiv w_0 > 0$, $w'(a) > 0$, $w''(a) < 0$ for all $a > 0$, and $\lim_{a\to\infty} w(a) = W_\infty < \infty$.*

Weight is strictly increasing and strictly concave, and the boundedness condition ensures that the marginal product of time eventually falls below any positive hurdle rate, guaranteeing a finite optimal slaughter age (Proposition 1).[8]

The herd consists of two classes. The *breeding stock* $S \geq 0$ comprises adult cows that wean $\varphi > 0$ calves per unit time, counting both sexes and net of pre-weaning mortality, and leave the herd at rate $\delta > 0$ through culling and involuntary loss. *Fattening animals* are calves that enter a growth pipeline and are slaughtered at a chosen age. At each instant a fraction ψ of the calf crop is retained as replacement heifers and the rest enter fattening.[9] The breeding stock evolves according to

$$\dot{S} = \left(\psi\,\varphi - \delta\right) S, \tag{1}$$

and a retained calf requires a maturation period $\tau_m > 0$ before it becomes a productive cow.

Young stock therefore sits in two pipelines. Write N_r for the head of replacement heifers still maturing and N_f for the head of animals still fattening. Each maturing heifer incurs a direct rearing cost $h_r^d > 0$ per unit time, each fattening animal a direct holding cost $h_f^d > 0$, and each breeding cow a direct cost $h_s^d > 0$. Cows that leave the breeding herd are sold for meat at the constant live weight $w_{\text{cow}} > 0$. We write c for aggregate beef supply, the flow of live weight brought to market per unit time, and Section 2.3 expresses N_r, N_f, and c in terms of the breeding stock and the slaughter age.

Total land is fixed at $L > 0$. Breeding cows require ℓ_s, replacement heifers ℓ_r, and fattening animals ℓ_f hectares per head, while land left out of cattle earns a constant agricultural rent $R > 0$

[8] In the calibration we adopt the shifted von Bertalanffy specification $w(a) = W_\infty - (W_\infty - w_0)\, e^{-\kappa a}$, with $w_0 > 0$, $W_\infty > w_0$, $\kappa > 0$, and $w_0 \approx 160$–200 kg at Argentine weaning weights. This satisfies Assumption 1, and all analytical results require only that assumption.

[9] Only heifers can replace cows, so ψ is bounded above by the female share of the calf crop rather than by one. At the calibration the rate that holds the herd constant is 0.31, which retains about three fifths of the heifer calves, and ψ peaks at 0.40 along the fastest herd rebuild we simulate.

per hectare, so the outside use absorbs any amount of land at the same return. Writing L_g for the hectares the cattle sector absorbs,

$$L_g \;\equiv\; \ell_s S \;+\; \ell_r N_r \;+\; \ell_f N_f \;\leq\; L. \tag{2}$$

Whenever this constraint binds, it imposes a trade-off between keeping animals longer and maintaining herd size.

Market-level demand follows a downward-sloping inverse demand function $p = P(c)$, $P' < 0$, where p denotes the beef price per kilogram of live weight. In the calibration we use the isoelastic specification $P(c) = Ac^{-1/\eta}$ with demand elasticity $\eta > 0$.[10]

The policy instrument is a minimum live weight at slaughter, $w(a) \geq \bar{w}$. Since w is strictly increasing (Assumption 1), it is equivalent to an age floor $a \geq \bar{a} \equiv w^{-1}(\bar{w})$. We apply the floor to fattening animals only. Cull cows come to market at the fixed weight w_{cow}, which lies below the tighter counterfactual floors we examine, so a floor enforced on every animal would bind them too and would raise the cost we measure. Restricting it to the fattening margin is the conservative choice.

2.2 The producer's problem

The producer takes as given the market price p, the discount rate $\rho > 0$, and an effective holding cost $h > 0$ per unit time that charges each animal both its direct cost and the rental value of the land it occupies. Because land rents at a competitive rate the producer cannot influence, the herd problem separates into one independent problem per animal, and we state it that way. Section 2.4 closes the land market and splits h into its two components.

The value of a weaned calf placed in the fattening pipeline and slaughtered at age a is

$$V(a;\, p, h) \;=\; p\, w(a)\, e^{-\rho a} \;-\; \frac{h}{\rho}\left(1 - e^{-\rho a}\right). \tag{3}$$

A calf enters the pipeline at no out-of-pocket cost, since it comes from the producer's own herd, so V measures what a weaned calf is worth as beef rather than a profit net of its own price. Its opportunity cost is the alternative use of the same calf, which the retention condition below prices.

Proposition 1 (Optimal slaughter age)**.** *Under Assumption 1, for any $p > 0$ and $h > 0$ such that*

[10] We model a closed economy. Argentine beef exports (about 25% of national production) face Hilton quota restrictions on the EU channel and other trade frictions during the capital-control period (Rossini et al., 2017). These frictions limit the absorption of short-run supply shocks, so the domestic price movements along the transition path overstate those of a perfectly integrated export market, and greater openness therefore lowers the loss we measure. Section 6 prices the output gap at a fixed world price and reports how much the loss falls.

$p\,w'(0^+) > \rho\,p\,w_0 + h$, there exists a unique interior optimum $a^*(p,h) > 0$ satisfying

$$p\,w'(a^*) \;=\; \rho\,p\,w(a^*) \;+\; h. \tag{4}$$

The second-order condition holds strictly.

Proof. Differentiating (3): $dV/da = [p\,w'(a) - \rho\,p\,w(a) - h]\,e^{-\rho a}$. Define $F(a) \equiv p\,w'(a) - \rho\,p\,w(a) - h$. At $a \downarrow 0$, $F(0^+) = p\,w'(0^+) - \rho\,p\,w_0 - h > 0$ by hypothesis. As $a \to \infty$: $w'(a) \to 0$ while $\rho\,p\,w(a) + h \to \rho\,p\,W_\infty + h > 0$, so $F(a) \to -(\rho\,p\,W_\infty + h) < 0$. Since $F'(a) = p\,w''(a) - \rho\,p\,w'(a) < 0$, F is strictly decreasing. By continuity, there exists a unique $a^* > 0$ with $F(a^*) = 0$. The SOC is $d^2V/da^2|_{a^*} = F'(a^*)\,e^{-\rho a^*} < 0$. □

Equation (4) is the *individual fattening condition*, the single-rotation rule for an animal entering the pipeline at given price p and effective holding cost h. Dividing by $p\,w(a^*)$ yields $w'(a^*)/w(a^*) = \rho + h/(p\,w(a^*))$, so slaughter occurs when the proportional growth rate falls to the hurdle rate (Faustmann, 1849; Clark, 2010; Bjørndal, 1988). The hurdle has two parts, the return ρ forgone on the capital tied up in the animal and the holding cost per dollar of animal, and each pushes the optimum down. The hypothesis of Proposition 1 is the same comparison made at entry, that the calf clears the hurdle at weaning and is therefore worth growing at all, and at the calibrated parameters it clears it by a wide margin, 1.26 per year against 0.39. Three comparative statics follow.

Proposition 2 (Comparative statics of a^*)**.** *Under the conditions of Proposition 1,* (i) $\partial a^*/\partial p > 0$*,* (ii) $\partial a^*/\partial h < 0$*, and* (iii) $\partial a^*/\partial \rho < 0$*.*

Proof. Let $F(a,p,h,\rho) \equiv p\,w'(a) - \rho\,p\,w(a) - h$, with $F_a = p\,w''(a^*) - \rho\,p\,w'(a^*) < 0$. (i) $F_p = w'(a^*) - \rho\,w(a^*) = h/p > 0$; by the IFT, $\partial a^*/\partial p = -F_p/F_a > 0$. (ii) $F_h = -1 < 0$; $\partial a^*/\partial h = 1/F_a < 0$. (iii) $F_\rho = -p\,w(a^*) < 0$; $\partial a^*/\partial \rho = -F_\rho/F_a < 0$. □

Part (i) is the *retention effect* of Jarvis (1974). Higher beef prices delay slaughter by raising the return to additional growth. Section 2.5 qualifies it, because a higher price also raises the cost of holding land.

The optimal slaughter decision delivers two values that close the producer's problem at the herd level. The maximized NPV per fattening animal is the *fattening value*

$$V_f(p,h) \;\equiv\; p\,w(a^*)\,e^{-\rho a^*} \;-\; \frac{h}{\rho}\big(1 - e^{-\rho a^*}\big). \tag{5}$$

Breeding stock lives for many rotations, so we value it at constant prices and holding costs, the configuration a stationary herd delivers (Section 2.3). A mature breeding cow is an asset. She yields calves worth $\varphi\,V_f$ a year, carries an effective holding cost h_s per unit time, and leaves the herd at rate δ, in which case her carcass is sold, so her value J satisfies $\rho J = \varphi V_f - h_s + \delta (p\, w_{\text{cow}} - J)$, or equivalently $(\rho + \delta) J = \varphi V_f - h_s + \delta\, p\, w_{\text{cow}}$.

A calf retained as a replacement becomes worth J only after τ_m years of rearing at effective holding cost h_r per unit time, so its value at retention is $J_0 = e^{-\rho\tau_m} J - (h_r/\rho)(1 - e^{-\rho\tau_m})$. A calf sent to fattening is worth V_f. At an interior optimum the producer must be indifferent between the two uses, $J_0 = V_f$, and that indifference is what allocates the calf crop between beef and breeding. Defining the *maturation-adjusted parameters*

$$\alpha \;\equiv\; (\rho + \delta)\, e^{\rho\tau_m} - \varphi, \qquad \Gamma \;\equiv\; \frac{\rho + \delta}{\rho}\big(e^{\rho\tau_m} - 1\big), \tag{6}$$

the asset equation and the indifference condition combine into the *replacement condition*

$$(\rho + \delta)\, e^{\rho\tau_m} V_f \;+\; h_s \;+\; \Gamma\, h_r \;=\; \varphi V_f \;+\; \delta\, p\, w_{\text{cow}}. \tag{7}$$

A cow must earn what she costs, both measured per year. Building one takes two outlays, the calf given up at retention and the rearing spent over the following τ_m years. Carried forward to the date she first calves, these are worth $e^{\rho\tau_m} V_f$ and $(h_r/\rho)(e^{\rho\tau_m} - 1)$, and their sum is both what she cost to produce and, by the indifference condition, her value J. Each half carries the same annual charge $\rho + \delta$, the return on the capital tied up plus the rate at which she leaves the herd, and those two charges are the first and third terms on the left. So $\Gamma\, h_r$ is a charge on money already spent rather than the annual rearing expense h_r, which stops the moment she joins the herd. She also costs h_s a year to keep. Against all of this she weans φ calves a year, each worth V_f in its best alternative use, and leaves at rate δ with a carcass worth $p\, w_{\text{cow}}$, which is where the depreciation charged on the left comes back.[11] Collecting the V_f terms gives the compact form $\alpha V_f = \delta\, p\, w_{\text{cow}} - h_s - \Gamma\, h_r$ used in Section 3, in which α is the cow's annual capital charge net of her calf output, both expressed in fattening values. When $\tau_m = 0$ the rearing pot vanishes, so $\Gamma = 0$ and $\alpha = \rho + \delta - \varphi$, recovering the standard form.

Assumption 2 (Viability)**.** *$\varphi > \delta$ (biological viability) and $V_f > 0$ in equilibrium.*

Assumption 3 (Fattening profitability)**.** *If $\alpha > 0$, then $\alpha\, \max_{a>0}\big[w(a)\, e^{-\rho a}\big] > \delta\, w_{\text{cow}}$.*

The first assumption keeps the sector alive. A herd with $\varphi \le \delta$ shrinks whatever the producer does, and $V_f \le 0$ would mean no calf is worth fattening, so the market would not operate. The second is stated conditionally because the sign of α is not determined by theory. It binds only in the fast-depreciating case $\alpha > 0$, where salvage from cull cows must cover breeding and rearing

[11] At the baseline calibration of Section 4 the two sides balance at 655 \$/cow/yr, a cost side of 206 + 317 + 132 against an earnings side of 457 + 198. The cow's two halves are $e^{\rho\tau_m} V_f = 793$ and a rearing pot of 507, summing to $J = 1{,}300$, while the annual rearing expense h_r is 238 against a capital charge $\Gamma\, h_r$ of 132.

costs, and it is slack in the high-fecundity case $\alpha < 0$, where breeding costs exceed salvage but calf production compensates. The calibration puts the economy in the second, with $\alpha \approx -0.36$, and all results hold under both.

Conditions (4) and (7) are the producer's problem in full, one fixing when an animal is sold and the other how many calves become cows. Both take the price and the holding costs as given, and the rest of this section determines them.

2.3 The stationary herd

The regulation we study changes a permanent regime, so the natural object of comparison is a herd that reproduces itself at constant size. A stationary herd requires $\dot{S} = 0$ in (1), hence a replacement rate $\psi^* = \delta/\varphi$, which lies in $(0, 1)$ by Assumption 2. Retention then exactly offsets culling, $\psi^* \varphi\, S = \delta\, S$, and Section 3.4 prices the path between two such herds.

Both classes of young stock sit in pipelines that are entered at a constant rate and left after a fixed delay, so each holds its entry flow multiplied by the time spent inside. Heifers enter at the cull rate $\delta\, S$ and stay τ_m years, so the maturation pipeline holds

$$N_r \;=\; \delta\, S\, \tau_m. \tag{8}$$

The calves not retained enter fattening at rate $b \equiv (1 - \psi^*)\, \varphi\, S = (\varphi - \delta)\, S$ and are harvested at age a. The same accounting gives a pipeline of $b\, a$ head, and because each animal leaves it weighing $w(a)$, a beef flow of $b\, w(a)$ per unit time,

$$N_f \;=\; b\, a, \qquad c_f \;=\; b\, w(a). \tag{9}$$

Cows exiting the breeding herd contribute $c_{\text{cull}} = \delta\, S\, w_{\text{cow}}$, so total beef supply combines fattening output and cull cows:

$$c \;=\; b\, w(a) \;+\; \delta\, S\, w_{\text{cow}}. \tag{10}$$

We set fattening mortality to zero for tractability.[12]

Equation (10) is exact in a stationary herd rather than an approximation, because entry into fattening is a constant flow and every cohort chooses the same slaughter age. The first of these abstracts from the concentrated calving season of Argentine cow-calf operations. The second follows from the model itself, since all cohorts face the same price and solve the same individual problem

[12] In Argentine pasture systems, annual fattening death losses are 2–4%. A constant mortality rate $m > 0$ would replace b with $b\, e^{-ma}$ and add m to the effective discount rate. Weight-dependent holding costs ($h(a) = h_0 + h_1\, w(a)$) similarly increase the hurdle rate by h_1/p. Both extensions leave qualitative results unchanged, and the calibration absorbs these effects into the average holding cost.

(Section 2.2), so a single a indexes the entire population. Together they make the standing fattening herd uniform on $[0, a]$ with density b, which is what turns the discrete rotation of one animal into the continuous herd flow $b\, w(a)$.

Seasonal calving would make headcount and beef flow oscillate within the year around these means and would leave unchanged the annual averages the calibration targets. When the herd is not stationary neither property holds, because ψ departs from ψ^* and past entry differs from current entry, and Section 3.4 handles the two channels this opens, carrying the breeding history in a delay differential equation and pricing the release of the non-uniform fattening pipeline as a backlog.

Each breeding cow also carries the heifers needed to replace her. Define $\hat{\ell}_s \equiv \ell_s + \ell_r\, \delta\, \tau_m$ as the effective land per breeding cow including this rearing overhead,[13] so that the land requirement (2) collapses to $L_g = S\,[\hat{\ell}_s + \ell_f\,(\varphi - \delta)\, a]$. Slaughter age and herd size compete for the same hectares, and that competition is what the rest of the model turns on.

2.4 The land market

Land trades in a competitive rental market at a rate μ_L per hectare per year that producers take as given, and by duality that rate is also the shadow value of the land constraint (2). Hectares left out of cattle earn the agricultural rent R, so clearing the land market requires $L_g \le L$, $\mu_L \ge R$, and $(\mu_L - R)(L - L_g) = 0$. Either cattle absorbs the whole endowment and bids the rental rate above the outside use, or some land goes to agriculture and the two rates equalize. Land is owned inside the economy, so μ_L is a transfer between producers and landowners and only the outside return R is a resource cost, which is why the welfare accounting of Section 3.2 nets out the rent and keeps R. Which of the two cases obtains is a property of the calibration rather than a model primitive, and Table 2 shows that at our parameter values cattle absorbs everything, with μ_L well above R.

The rental rate is what turns the direct costs of Section 2.1 into the effective holding costs the producer of Section 2.2 faces, one per animal class,

$$h \;=\; h_f^d + \mu_L\, \ell_f, \qquad h_s \;=\; h_s^d + \mu_L\, \ell_s, \qquad h_r \;=\; h_r^d + \mu_L\, \ell_r.$$

At the calibration the land component is the larger of the two by a wide margin.[14] Through h the rental rate enters the individual fattening condition (4), and this is where the single-rotation rule of Section 2.2 becomes the full Faustmann rotation of forestry, with $\mu_L\, \ell_f$ playing the role of the site value, entering as the annual rent on the land the animal stands on rather than as its capitalized price. It also qualifies the retention effect of Proposition 2. A higher beef price delays slaughter at a fixed

[13] At the calibration $\hat{\ell}_s = 2.5 + 1.8 \times 0.2 \times 2 = 3.22$ ha, so the replacement pipeline adds 29% to the land a cow occupies.

[14] $\mu_L = 115$ \$/ha/yr against a direct fattening cost of $h_f^d = 35$ \$/head/yr, so $h = 150$ and roughly three quarters of what it costs to hold an animal is the rental value of the hectare it stands on rather than feed and veterinary care.

holding cost, but it also raises μ_L and hence h, which pushes the other way, and at the calibration the first channel still wins so the partial-equilibrium sign survives. Land rent is therefore not a detail of the cost accounting. It is most of what makes waiting expensive, and it is the channel through which the slaughter decision and the size of the herd are linked.

2.5 Aggregate supply and equilibrium

The land constraint binds at our parameter values, so we derive aggregate supply in that case and state the equilibrium below for both. When the constraint binds, so that $L_g = L$, the breeding stock is pinned down by the slaughter age,

$$S(a) \;=\; \frac{L}{\hat{\ell}_s + \ell_f\,(\varphi-\delta)\,a}, \tag{11}$$

so later slaughter crowds out breeding stock, $S'(a) < 0$, and stationary beef supply as a function of slaughter age becomes

$$c(a) \;=\; \frac{L\left[(\varphi-\delta)\,w(a) + \delta\,w_{\text{cow}}\right]}{\hat{\ell}_s + \ell_f\,(\varphi-\delta)\,a}. \tag{12}$$

Write this as $c(a) = L\,N(a)/D(a)$, with $N(a) \equiv (\varphi-\delta)\,w(a) + \delta\,w_{\text{cow}}$ the weight produced per breeding cow, fattening output plus cull cow output, and $D(a) \equiv \hat{\ell}_s + \ell_f\,(\varphi-\delta)\,a$ the land required per breeding cow including the fattening pipeline.[15] Supply is the ratio of the two, and weight per cow is bounded while land per cow is not, so the ratio eventually falls.

Lemma 1 (Non-monotonicity of aggregate supply)**.** *Under Assumption 1, suppose the initial growth rate satisfies*

$$w'(0^+)\,\hat{\ell}_s \;>\; \left[(\varphi-\delta)\,w_0 + \delta\,w_{\text{cow}}\right]\ell_f. \tag{13}$$

Then (i) *$c(a) > 0$ for all $a \geq 0$ and $c(a) \to 0$ as $a \to \infty$, and* (ii) *there exists a unique throughput-maximizing age $\hat{a} > 0$ such that $c'(a) > 0$ for $a \in (0, \hat{a})$, $c'(\hat{a}) = 0$, and $c'(a) < 0$ for $a > \hat{a}$.*

Proof. (i) Positivity is immediate. As $a \to \infty$, $N(a)$ is bounded while $D(a) \to \infty$, so $c(a) \to 0$.

(ii) The sign of $c'(a)$ coincides with that of $G(a) \equiv N'(a)\,D(a) - N(a)\,D'(a)$. Since $D' = \ell_f(\varphi-\delta)$ is constant, $G'(a) = N''(a)\,D(a) = (\varphi-\delta)\,w''(a)\,D(a) < 0$: G is strictly decreasing. At $a = 0$: $G(0) = (\varphi-\delta)[w'(0^+)\,\hat{\ell}_s - ((\varphi-\delta)\,w_0 + \delta\,w_{\text{cow}})\,\ell_f] > 0$ by (13). As $a \to \infty$: $N'D \to 0$ while $ND' > 0$, so $G(a) \to$ a negative constant. By the IVT and strict monotonicity, there exists a unique $\hat{a} > 0$ with $G(\hat{a}) = 0$. □

[15] Divided by the endowment, $c(a)/L$ is beef per hectare per year. At the calibration it is 67 kg of live weight, which at Argentine dressing percentages is the 39 kg of carcass per hectare reported in Table 2.

Two opposing forces produce the hump. Later slaughter yields heavier animals, and it lengthens the pipeline and crowds breeding stock off the fixed land endowment. Condition (13) says the first force wins at the start, since dividing it by $\ell_f\,\hat{\ell}_s$ gives $w'(0^+)/\ell_f > N(0)/\hat{\ell}_s$, a comparison of the beef an extra year of fattening produces per hectare against the beef a breeding cow produces per hectare. It is the requirement that $c'(0) > 0$, and it holds at the calibration by a factor of more than four.[16] Below $\hat{a}$ the weight gain dominates, above it the crowding does.

Definition 1 (Competitive steady-state equilibrium)**.** A *competitive steady-state equilibrium* is a tuple $(p^*,\ a^*,\ S^*,\ \psi^*,\ \mu_L^*)$ such that:

(i) *Faustmann:* $p^*\,w'(a^*) = \rho\,p^*\,w(a^*) + h_f^d + \mu_L^*\,\ell_f$.

(ii) *Replacement:* Equations (5) and (7) hold at the effective holding costs of Section 2.4 evaluated at μ_L^*.

(iii) *Breeding balance:* $\psi^* = \delta/\varphi$.

(iv) *Land:* $L_g^* = S^*\left[\hat{\ell}_s + \ell_f(\varphi - \delta)\,a^*\right]$ with $L_g^* \le L$, $\mu_L^* \ge R$, and $(\mu_L^* - R)(L - L_g^*) = 0$.

(v) *Market clearing:* $p^* = P\big(S^*[(\varphi - \delta)\,w(a^*) + \delta\,w_{\text{cow}}]\big)$.

When land binds, condition (iv) sets $S^* = L/D(a^*)$, so ψ^* and S^* follow from a^* and the equilibrium reduces to three unknowns (p^*, a^*, μ_L^*) and three equations: the Faustmann condition, the replacement condition, and market clearing. When it slacks, $\mu_L^* = R$ and the replacement condition determines S^* instead. The calibration of Section 4 places the economy in the binding case, and the rest of the paper works there.

3 Equilibrium Characterization and Regulation

Section 2 reduced the model to three equations in three unknowns. This section solves them, first for the unregulated economy and then under a binding weight floor, and ranks the outcomes against a steady-state welfare criterion. Two extensions close the section, the path the economy travels between steady states and a second production technology selling into the same market.

[16] $w'(0^+)\,\hat{\ell}_s = 227 \times 3.22 = 732$ against $[(\varphi - \delta)\,w_0 + \delta\,w_{\text{cow}}]\,\ell_f = 160$.

3.1 Unregulated benchmark

To characterize the unregulated equilibrium, define the market-clearing price and the Faustmann-consistent land rental rate as functions of a:

$$p(a) \equiv P\big(c(a)\big), \tag{14}$$

$$\mu_L(a) \equiv \frac{p(a)\left[w'(a) - \rho\, w(a)\right] - h_f^d}{\ell_f}. \tag{15}$$

Because μ_L depends on a through $p(a)$ and $w'(a)$, the effective holding costs h, h_s, and h_r become functions of a. Substituting into the replacement condition yields a single equation in the unknown a,

$$\Phi(a) \equiv V_f\big(p(a),\, h(a)\big) - \frac{\delta\, p(a)\, w_{\text{cow}} - h_s(a) - \Gamma\, h_r(a)}{\alpha} = 0, \tag{16}$$

which equates the fattening value of a calf to the breeding value of retaining it as a replacement cow.

Proposition 3 (Unregulated equilibrium)**.** *Under Assumptions 1–3 and condition* (13)*, there exists an unregulated equilibrium slaughter age* $a_I^* > 0$ *solving* $\Phi(a_I^*) = 0$*, with*

$$p_I^* = P\big(c(a_I^*)\big), \quad \mu_{L,I}^* = \frac{p_I^*\left[w'(a_I^*) - \rho\, w(a_I^*)\right] - h_f^d}{\ell_f}, \quad S_I^* = \frac{L}{\hat{\ell}_s + \ell_f(\varphi - \delta)\, a_I^*}. \tag{17}$$

Proof sketch (existence analytical, uniqueness numerical). The function Φ is continuous on $(0, \bar{a}_{\max})$. Near $a \downarrow 0$, the land rental rate is high, suppressing the breeding value. Near $\bar{a}_{\max}$, supply vanishes and prices diverge, reversing the ranking. In both the high-fecundity ($\alpha < 0$) and fast-depreciating ($\alpha > 0$) cases, Φ changes sign, and the intermediate value theorem delivers existence. Uniqueness is a numerical claim that we verify for all parameterizations tested in Sections 4–6, including demand elasticities $\eta \in [0.25, 0.80]$, discount rates $\rho \in [0.03, 0.15]$, and growth rates $\kappa \in [0.40, 1.00]$.[17] The full existence argument is in Appendix A. □

At a_I^* a weaned calf is worth exactly as much sent to fattening as kept as a replacement. The herd size, the beef price, and the rental rate of land all follow from that one age.

[17] A sufficient condition for uniqueness with isoelastic demand is that Φ is monotone on the relevant domain. We verify this numerically rather than imposing an *a priori* lower bound on η, because monotonicity depends on the interaction of all model parameters.

3.2 Steady-state welfare and the discounting wedge

To rank slaughter ages we use a flow criterion. Steady-state flow surplus at slaughter age a (with the land constraint binding, $L_g = L$) is

$$W(a) \;=\; \int_0^{c(a)} P(x)\,dx \;-\; S(a)\left[h_f^d\,(\varphi-\delta)\,a + h_r^d\,\delta\,\tau_m + h_s^d\right], \tag{18}$$

where the first term is gross consumer benefit and the second is total direct operating costs (land opportunity costs $R\,L$ cancel in pairwise comparisons when $L_g = L$). Define the *flow-welfare optimum* $a_P \equiv \arg\max_a W(a)$.

Assumption 4 (Fattening cost dominance)**.** $h_f^d\,\hat{\ell}_s > \ell_f\,(h_r^d\,\delta\,\tau_m + h_s^d)$.

The fattening holding cost, weighted by the land overhead per breeding cow, dominates the combined breeding and rearing costs weighted by land per fattening animal. The calibration satisfies the inequality with $112.7 > 42.8$.[18]

Proposition 4 (Discounting wedge)**.** *Under Assumptions 1–4, when $\rho > 0$ and the capital-opportunity gap dominates the operating-cost correction at the competitive equilibrium (a condition verified numerically at the baseline calibration and across the robustness sample of Section 6 for $\rho \in [0.03, 0.15]$ and $\kappa \in [0.40, 1.00]$), the ordering*

$$a_I^* \;<\; a_P \;<\; \hat{a} \tag{19}$$

holds.

Proof sketch. ($a_I^* < a_P$). At the CE, the individual Faustmann condition includes the capital opportunity cost $\rho\,p\,w(a_I^*) > 0$. The flow-welfare criterion $W(a)$, which compares permanent regimes, omits this term. Under the calibration, the capital-opportunity gap $\rho\,p\,w(a_I^*)$ dominates the operating-cost correction from crowding, so $W'(a_I^*) > 0$ and the social marginal benefit of delay exceeds the social marginal cost at the privately optimal age. Across the robustness sample in Section 6, the same ranking holds.

($a_P < \hat{a}$). At $\hat{a}$, $c'(\hat{a}) = 0$, so the consumer-benefit term in W' vanishes. The remaining cost term reduces (after cancellation) to the requirement $h_f^d\,\hat{\ell}_s > \ell_f\,(h_r^d\,\delta\,\tau_m + h_s^d)$, which is Assumption 4. Hence $W'(\hat{a}) < 0$ and W reaches its maximum strictly before $\hat{a}$. The full proof is in Appendix A.□

Two remarks about this wedge. First, a_P is not the social optimum in a present-value sense. The flow-welfare criterion $W(a)$ compares *permanent* steady states and nets out only real resource

[18] $h_f^d\,\hat{\ell}_s = 35 \times 3.22 = 112.7$ with $\hat{\ell}_s = \ell_s + \ell_r\,\delta\,\tau_m = 2.5 + 1.8 \times 0.2 \times 2 = 3.22$, against $\ell_f\,(h_r^d\,\delta\,\tau_m + h_s^d) = 1 \times (32 \times 0.2 \times 2 + 30) = 42.8$.

costs. This criterion ignores the capital charge that any planner with the same discount rate would apply along a transition. The discounting wedge $a_I^* < a_P$ is a statement about the position of the competitive equilibrium relative to an illustrative steady-state benchmark, not a claim of inefficiency. The three weights are a modified golden rule, a golden rule, and a gross-output maximum. The competitive weight a_I^* charges both the discount rate and the holding cost. Removing the discount rate raises the optimum to the golden-rule weight a_P, and removing the holding cost as well gives the throughput peak $\hat{a}$. Both higher weights drop a cost the competitive producer rightly bears, so the ordering reflects discounting and operating costs, not a market failure. The calibrated dynamic model of Section 5.2 finds the best binding floor's present-value gain below 0.001% of revenue. Second, under the calibration, $a_P - a_I^* \approx 0.204\,\text{yr}$ ($\approx$16 kg), a modest gap that leaves limited scope for steady-state supply enhancement.

3.3 Regulation

When a minimum weight floor binds ($\bar{a} > a_I^*$), the slaughter age is exogenous at $\bar{a}$ and the equilibrium reduces to a sequential system relative to the unregulated benchmark.

Proposition 5 (Regulated equilibrium)**.** *Suppose $\bar{a} > a_I^*$. Then the following hold.*

(i) $c_R = c(\bar{a})$ *and* $p_R = P(c(\bar{a}))$.

(ii) $S_R = L/[\hat{\ell}_s + \ell_f(\varphi - \delta)\,\bar{a}]$.

(iii) *The land rental rate $\mu_{L,R}$ is the unique solution to the replacement condition (7) at $a = \bar{a}$ and $p = p_R$, which is linear in μ_L.*

Proof. Parts (i)–(ii) follow from (12) and (11) with $a = \bar{a}$. For (iii), the replacement condition is linear in μ_L, and collecting terms yields a unique solution. □

The regulated equilibrium has a recursive structure: supply determines price, price together with the replacement condition determines the land rental rate, and no fixed-point iteration is required. Three steady-state implications follow directly. Slaughter weight rises ($w(\bar{a}) > w(a_I^*)$), the breeding herd contracts ($S_R < S_I^*$), and the fattening-to-breeding ratio rises ($N_{f,R}/S_R > N_{f,I}^*/S_I^*$). Regulation therefore tilts the herd toward the fattening pipeline and away from the breeding stock, since each animal stays longer and crowds cows off the fixed land base.

Proposition 6 (Comparative statics in the floor)**.** *For $\bar{w}$ in a neighborhood of $w(a_I^*)$ such that the floor binds,* (i) $\partial a_R/\partial \bar{w} > 0$, (ii) $\partial S_R/\partial \bar{w} < 0$, *and* (iii) $\partial c_R/\partial \bar{w}$ *has the sign of $c'(\bar{a})$, which is positive for $\bar{a} < \hat{a}$ and negative for $\bar{a} > \hat{a}$.*

Proof. (i) $a_R = w^{-1}(\bar{w})$ and $w' > 0$, so $\partial a_R/\partial \bar{w} = 1/w'(\bar{a}) > 0$. (ii) S_R is strictly decreasing in $\bar{a}$. (iii) $\partial c_R/\partial \bar{w} = c'(\bar{a})/w'(\bar{a})$, and the sign follows from Lemma 1. □

Proposition 7 (Non-monotone supply response)**.** *When $\bar{a} > a_I^*$,* (i) *if $a_I^* < \bar{a} \le \hat{a}$, supply increases and price falls, and* (ii) *if $\bar{a} > \hat{a}$ and $c(\bar{a}) < c(a_I^*)$, supply decreases and price rises.*

Proof. Both parts follow from Lemma 1 and the monotonicity of inverse demand ($P' < 0$), because higher supply implies lower price and conversely. □

Case (i), in which a binding floor *increases* supply and *lowers* price, is the supply-enhancing zone. Empirical relevance depends on the position of the unregulated equilibrium relative to $\hat{a}$.

Proposition 8 (Three zones)**.** *Define $\Delta W(\bar{a}) \equiv W(\bar{a}) - W(a_I^*)$. Under the conditions of Proposition 4,* (i) *if $a_I^* < \bar{a} \le a_P$, then $\Delta W(\bar{a}) \ge 0$ (the regulation improves flow welfare, with the gain maximized at $\bar{a} = a_P$), and* (ii) *there exists $a_0 > a_P$ with $W(a_0) = W(a_I^*)$ such that $\Delta W > 0$ for $\bar{a} \in (a_I^*, a_0)$ and $\Delta W < 0$ for $\bar{a} > a_0$. The partition is analytical, contingent on numerical uniqueness of a_0, which holds across the full robustness sample of Section 6.*

The proof (in Appendix A) shows that $\Delta W(a) \to -\infty$ as $a \to \infty$ under isoelastic demand with $\eta \le 1$, and applies the IVT. The partition into three zones follows: (a) *welfare-improving and supply-enhancing* ($a_I^* < \bar{a} \le a_P$), (b) *past the flow-welfare optimum* ($a_P < \bar{a} < a_0$), and (c) *welfare-reducing* ($\bar{a} > a_0$).

3.4 Transition dynamics

The three-zone partition characterizes welfare across permanent regimes but ignores the cost of the path between them. The flow criterion $W(a)$ omits the capital charge $\rho\, p\, w(a)$ that a present-value planner bears along any transition, so a regulation that improves the long-run steady state need not improve present-value welfare once that charge is counted. Whether the steady-state gain survives is a quantitative question we address with the dynamic model below.

Consider the repeal of a binding floor $\bar{a}$ at $t = 0$. The economy moves from $(p_R, \bar{a}, S_R)$ toward (p_I^*, a_I^*, S_I^*). Along the transition, the slaughter age satisfies the Faustmann condition at current prices (a myopic approximation valid when the fattening horizon is short relative to herd cycles), and the maturation delay τ_m turns the breeding stock equation into a delay differential equation:

$$\dot{S}(t) \;=\; \psi(t - \tau_m)\, \varphi\, S(t - \tau_m) \;-\; \delta\, S(t). \tag{20}$$

For the quantitative analysis we approximate the replacement decision with an adaptive gap-closing rule,

$$\psi(t) \;=\; \mathrm{clip}_{[0,1]}\Big(\frac{\delta}{\varphi} \;+\; \lambda\, \frac{S_I^* - S(t)}{S_I^*}\Big), \tag{21}$$

where $\lambda > 0$ is calibrated to match about a 10-year cycle period[19] and the clipping operator enforces feasibility $\psi \in [0, 1]$ during the backlog phase when the gap $|S_I^* - S(t)|/S_I^*$ may be large.[20] The rule captures the core mechanism (oscillatory adjustment generated by the maturation delay τ_m) without requiring the full forward-backward solution of a rational-expectations DDE. Both the canonical rational-expectations model of Rosen et al. (1994) and the heterogeneous-expectations alternative of Aadland (2004) deliver qualitatively similar dynamics, and a full rational-expectations extension is left to future work.[21] Combined with the maturation delay, the adaptive rule generates damped oscillatory dynamics.

The transition unfolds in three phases.

Phase 0 (Impact). At repeal, the optimal slaughter age drops to $a^*(p(0^+), h(0^+)) < \bar{a}$. Animals in the pipeline aged above $a^*(0^+)$ form a *backlog*,

$$M_0 \;=\; (\varphi - \delta)\, S_R \int_{a^*(0^+)}^{\bar{a}} w(s)\, ds, \tag{22}$$

processed over a period $\Delta t_b = M_0/\chi$, where χ is the slaughter throughput in kilograms of live weight per year. Clearing this backlog temporarily depresses prices.

Phase I (Herd rebuilding). After the backlog clears, $S(0^+) = S_R < S_I^*$. To expand the herd, the producer retains extra calves ($\psi > \delta/\varphi$), reducing the fattening entry flow and keeping supply below its long-run level, with prices elevated above p_I^*.

Phase II (Convergence). The breeding stock, replacement rate, slaughter age, and price converge to the unregulated steady state with damped oscillations whose period is governed by λ and τ_m. At the calibrated values ($\lambda = 0.7600$, $\tau_m = 2\,\text{yr}$), the period is about 10 years, consistent with the observed Argentine cattle cycle. The PV welfare results hold across the tested range of λ (Appendix B).

Pricing this path at ρ gives a present value that need not agree with the steady-state ranking of Section 3.2, because the windfall from releasing held animals and the cost of rebuilding the herd both fall outside the flow criterion.

[19] The 10-year target matches the calibrated cycle period of the heterogeneous-expectations cattle-cycle model of Aadland (2004) for U.S. data and the most recent observed Argentine cycle of 2008–2018 (Expoagro Edición YPF Agro, 2025), within the 5–13 year range observed for Argentine cattle cycles in recent decades (Calzada et al., 2021). Detailed dynamic analyses of the Argentine cattle sector are provided by Jarvis (1986) and Arceo (2017).

[20] Across all simulated repeal scenarios in Section 5.2, the unclipped rule remains within $[0, 1]$ except for brief excursions during the backlog phase ($t < 0.5$ yr). Clipping produces a maximum welfare deviation below 0.01 percentage points relative to the unclipped numerical solution.

[21] With rational expectations, the DDE becomes a forward-backward system whose solution requires global methods. The qualitative insight that τ_m generates oscillatory dynamics would survive, but amplitude and speed of convergence might differ. The steady-state results are unaffected by the transition rule, and the headline near-zero PV gain we report is a numerical property of the calibrated dynamic model that is robust across the tested adjustment speeds $\lambda \in [0.2, 1.5]$.

3.5 Two-sector model

Argentine beef production employs two technologies that share a common output market, an extensive pasture sector (≈65% of national slaughter) and an intensive feedlot sector (≈35%).[22] They differ in growth rate, holding cost, land intensity, and effective discount rate, yet face the same price and the same uniform weight floor. Feedlots purchase weaned calves and finish them in confinement, with faster growth ($\kappa^{FL} \gg \kappa$), higher holding cost ($h_f^{FL} \gg h_f^d$), negligible land, and no breeding stock. The feedlot growth function takes the same von Bertalanffy form as in Assumption 1 but with the sector-specific rate κ^{FL}, and we write $w(\cdot)$ for both sectors with the parameterization clear from context. Each animal solves the Faustmann condition at the common market price, yielding $a^*_{FL} \ll a^*_I$. With K_{FL} head-slots at full capacity, feedlot throughput and supply are

$$c_{FL}(p) \;=\; \frac{K_{FL}\, w\big(a^*_{FL}(p)\big)}{a^*_{FL}(p)}. \tag{23}$$

Definition 2 (Two-sector competitive equilibrium)**.** A *two-sector competitive equilibrium* is a price p^* and slaughter ages (a^*_I, a^*_{FL}) such that (i) the pasture sector satisfies conditions (i)–(iv) of Definition 1 (Faustmann, replacement, breeding balance, and land), (ii) the feedlot satisfies the Faustmann condition at p^*, and (iii) the common beef market clears with $P(c_{\text{past}}(p^*)+c_{FL}(p^*)) = p^*$.

The feedlot reaches its privately optimal weight below the pasture optimum, and the driver is its high holding cost rather than its faster growth. For the shifted von Bertalanffy curve the Faustmann optimum has the closed form $w^* = (\kappa W_\infty - h/p)/(\kappa + \rho)$, which rises in the growth rate ($\partial w^*/\partial \kappa > 0$) and falls in the effective holding cost h/p and the discount rate. Faster growth on its own would therefore push the feedlot's optimal weight *above* the pasture's, so only a much higher cost of holding the animal can reverse the ranking.[23] A uniform floor therefore binds the feedlot first and forces it past its unconstrained throughput peak.

Proposition 9 (Asymmetric binding)**.** *In the two-sector model,* (i) *whenever the feedlot's effective holding cost is high enough that its Faustmann optimum lies below the pasture's, $w(a^*_{FL}) < w(a^*_I)$, a uniform floor binds the feedlot first.* (ii) *Feedlot throughput $w(a)/a$ is strictly decreasing for all $a > 0$, so any binding floor strictly reduces feedlot output.*

Proof. (i) The Faustmann condition for sector $j \in \{\text{past}, FL\}$, $w'(a^*_j) = \rho_j\, w(a^*_j) + h_j/p$, has the closed-form solution $w(a^*_j) = (\kappa_j W_\infty - h_j/p)/(\kappa_j + \rho_j)$ for the shifted von Bertalanffy curve.

[22] SENASA livestock reports, 2018–2023. The feedlot share has grown from roughly 20% in 2005 to 35% in 2023.

[23] At the calibration of Section 4 the feedlot's effective holding cost is $h^{FL}/p \approx 340$ per head-year against 60 for pasture, which pulls its optimal weight down to 346 kg against the pasture's 408. A higher feedlot discount rate deepens the gap but is not necessary, and the two-sector welfare loss moves only from 13.2 to 11.9% of revenue as ρ^{FL} falls from 0.12 to 0.08 (Appendix B).

The optimal weight rises in the growth rate, $\partial w^*/\partial\kappa = (\rho W_\infty + h/p)/(\kappa+\rho)^2 > 0$, and falls in the effective holding cost h/p and the discount rate. Faster growth alone would raise the feedlot's optimal weight above the pasture's, so the ranking is a holding-cost effect rather than a growth effect, and a higher feedlot discount rate reinforces it. (ii) Feedlot throughput per slot is $\theta(a) = w(a)/a$, with $\theta'(a) = [w'(a)\,a - w(a)]/a^2 < 0$ for every $a > 0$, because strict concavity gives $w(a) = w(0) + \int_0^a w'(s)\,ds > w'(a)\,a$. Hence any binding floor that forces $a > a^*_{FL}$ strictly reduces feedlot throughput. □

The supply-enhancing zone of Proposition 7 holds for the pasture sector in isolation. Whether it survives aggregation depends on how much capacity the floor exposes on the feedlot side.[24] Two-sector flow welfare is $W^{2S} = \int_0^{c_{\text{past}}+c_{FL}} P(x)\,dx - C_{\text{past}} - C_{FL} + R\,(L - L_g)$, where C_{past} and C_{FL} denote total direct operating costs for the pasture and feedlot sectors. Whether the feedlot's throughput loss outweighs the pasture's supply gain turns on magnitudes rather than signs, since Proposition 7 and Proposition 9 push in opposite directions. Section 4 calibrates both sectors and Section 5.3 settles the comparison numerically.

4 Calibration

Argentina runs a national herd of about 53 million head, and its scale and dual production structure make it a natural setting for the regulation we study.[25] We calibrate the model to Cuenca del Salado, Argentina's primary cow-calf zone in the Pampa Deprimida, where heavy clay soils and seasonal flooding leave cattle as the dominant land use (Arelovich et al., 2011). The single-sector calibration uses externally set parameters from public data and two internally calibrated ones, the demand scale A and the von Bertalanffy growth rate κ, which pin the equilibrium price and the slaughter-weight target. We then extend it to the feedlot sector and the two-sector joint equilibrium.

4.1 Single-sector calibration

Table 1 reports the externally set parameters and the internally calibrated growth rate κ with their data ranges and sources.[26] The effective calving rate $\varphi = 0.65$ matches the Cuenca del Salado

[24] Sector-specific policies exempting feedlots could in principle exploit the pasture supply enhancement, but differentiation introduces monitoring and enforcement challenges.

[25] Production of about 3.1–3.2 million tonnes in recent years (CICCRA; U.S. Department of Agriculture, Foreign Agricultural Service, 2025). Stock of 52.8 million head at the start of 2024 (Ministerio de Agricultura, Ganadería y Pesca de la Nación, 2024). Per capita beef consumption of about 47 kg in 2023–2024, the highest globally (CICCRA, OECD).

[26] The internally calibrated parameters are the demand scale A (pinning $p^* = 2.50$ \$/kg) and the von Bertalanffy growth rate κ (pinning the slaughter-weight target via the Faustmann condition given W_∞, w_0, and τ_m). Table 2 accordingly lists three calibration targets across the two stages, the equilibrium price and the pasture slaughter weight

benchmark of Arelovich et al. (2011, p. 77), sitting between the 55% national average (pulled down by marginal NOA and Patagonia regions) and the productive cría benchmark. The breeding-stock exit rate $\delta = 0.20$ corresponds to the standard Argentine recommendation of 20% culling per year, equivalent to five calves per cow over the productive life (Melo, 2003). The maturation period $\tau_m = 2.0$ yr reflects the time from weaning to first calving for Angus/Hereford heifers (Arelovich et al., 2011; U.S. Department of Agriculture, Foreign Agricultural Service, 2025). The shifted von Bertalanffy growth parameters ($W_\infty = 542$ kg, $w_0 = 181$ kg, $\kappa = 0.63\ \text{yr}^{-1}$) draw on Goldberg and Ravagnolo (2015), who fit five growth functions to 22,743 weight records of 5,284 Aberdeen Angus pasture-fed cows in extensive Río de la Plata systems.[27] Direct holding costs from Fillat et al. (2024) INTA Pergamino exclude land opportunity cost and are deflated to constant USD. The agricultural rental rate $R = 45$ \$/ha/yr represents the alternative-use rent in Cuenca del Salado, where heavy clay soils limit cropping. The higher cattle rental rates of 200–800 \$/ha reported by Cámara Argentina de Inmobiliarias Rurales (2025) for Salado livestock leases correspond to the model's rental rate μ_L, not to R. Total land is normalized to $L = 100{,}000$ ha, and all results are reported in rates or ratios invariant to this choice. The demand elasticity $\eta = 0.36$ matches the long-run beef demand estimate of Reca and Lema (2016) for Argentina over 1950–2012. Land per category (ℓ_f, ℓ_s, ℓ_r) follow standard INTA stocking-rate recommendations for the zona cría and yield a model stocking rate of 0.63 head/ha consistent with empirical observations for the Pampa Deprimida. To compare with MAGyP census data, which count all animals from birth, we add pre-weaning calves ($\tau_{\text{wean}} = 0.5$ yr) and breeding bulls (3% of cows) when computing herd-level moments, with their land use absorbed into ℓ_s so the adjustment is purely accounting.

The demand scale A in $P(c) = Ac^{-1/\eta}$ is calibrated to target $p^* = 2.50$ \$/kg live weight (deflated long-run average, Mercado de Liniers and BCR Rosario, 2010–2023).[28] The iterative procedure

in the single-sector calibration and the feedlot daily gain in the two-sector calibration, with the remaining moments untargeted and two structural facts.

[27] Goldberg & Ravagnolo's Richards model (the AIC-BIC winner) yields an asymptotic weight of 542 kg for *cows*. In British breeds under extensive systems, castrated males (novillos) typically reach mature weights at or above mature cow weight (Garriz INTA), so using 542 kg as the steer asymptote W_∞ is a conservative *lower bound*, biasing the calibration toward smaller discounting wedges and therefore against finding the floor binds. The post-weaning entry weight $w_0 = 181$ kg corresponds to Goldberg's WW (weaning weight) mean and falls within the 170–200 kg Argentine entry range reported by U.S. Department of Agriculture, Foreign Agricultural Service (2025). The growth rate $\kappa = 0.63$ is internally calibrated to match the slaughter-weight target given W_∞, w_0, and τ_m. No peer-reviewed von Bertalanffy fit exists for Argentine pasture-finished steers specifically.

[28] Prices are converted to constant USD using the parallel-market exchange rate (the CCL rate), which better reflects the cost of imported inputs and the opportunity cost of exports during Argentina's capital-control period (2011–2023). Using the official exchange rate would yield a lower target ($\approx$1.70 \$/kg). Because direct holding costs are nominal, the welfare loss as a share of revenue depends on the price target. At the baseline $p^* = 2.50$ the two-sector present-value losses are 13.2, 18.8, and 26.6% at floors of 420, 450, and 480 kg. At the official-FX target $p^* \approx 1.70$ they are larger, at 17.9, 22.2, and 28.5%, and at $p^* = 3.50$ they are 7.2, 15.9, and 27.8% (Appendix B). The CCL target is the conservative choice, since the official-FX price raises the loss at every floor, and every binding floor reduces welfare at all three price levels.

Table 1: Calibrated parameters.

Parameter	Description	Value	Data range	Source
Biological				
φ	Effective calving rate	0.65	0.55–0.65	Arelovich et al. (2011) (Cuenca del Salado)
δ	Breeding exit rate (yr^{-1})	0.20	0.15–0.20	Melo (2003); Jarvis (1974)
τ_m	Maturation period (yr)	2.0	1.5–2.0	Arelovich et al. (2011); USDA-FAS (2025)
W_∞	Asymptotic weight (kg)	542	449–600	Goldberg and Ravagnolo (2015) cow proxy (lower bound)
w_0	Post-weaning entry weight (kg)	181	165–200	Goldberg and Ravagnolo (2015) WW; Arelovich et al. (2011)
κ	Growth rate (yr^{-1})	0.63	0.55–0.70	Internally calibrated (slaughter-weight target)
w_{cow}	Cull cow weight (kg)	395	386–410	MAGyP (2024), cow median
Costs ($/head/yr)				
h_f^d	Fattening holding cost	35	30–50	Fillat et al. (2024) INTA Pergamino
h_s^d	Breeding cow cost	30	25–40	idem
h_r^d	Replacement heifer cost	32	28–40	idem
Land				
ℓ_f	Land per fattening head (ha)	1.0	0.8–1.5	INTA stocking rate (cow-calf zone)
ℓ_s	Land per cow (ha)	2.5	2.0–3.5	idem
ℓ_r	Land per heifer (ha)	1.8	1.5–2.5	idem
L	Total land (ha)	100,000	–	Normalization
Economic				
ρ	Discount rate	0.06	0.05–0.08	Jarvis (1974); Sapelli (1993)
R	Agricultural rent ($/ha/yr)	45	33–56	Cámara Argentina de Inmobiliarias Rurales (2025); IDECOR (2025)
η	Demand elasticity	0.36	0.30–0.45	Reca and Lema (2016)
Census comparison				
τ_{wean}	Pre-weaning period (yr)	0.5	0.5–0.6	INTA standard
bull ratio	Bulls per cow	0.03	0.03–0.04	INTA standard

solves the equilibrium, updates $A = p_{\text{target}} \cdot (c^*)^{1/\eta}$, and converges in one iteration with isoelastic demand. We set the demand elasticity to $\eta = 0.36$, the long-run own-price elasticity of Argentine beef demand estimated by Reca and Lema (2016) for 1950–2012.[29] Table 2 reports the model fit. Three moments are targeted, the equilibrium price, the pasture slaughter weight, and the feedlot daily gain. The stocking rate, extraction rate, meat yield, and cow share are untargeted moments the calibration must also reproduce. The extraction rate, cow share, and meat yield are genuine overidentifying restrictions on the independently sourced biology, while the stocking rate mainly re-expresses the land inputs ℓ_f, ℓ_s, ℓ_r.

Every moment falls within its empirical range, with the feedlot slaughter weight modestly above. The four untargeted moments match the benchmarks, with a stocking rate of 0.63 head/ha, an extraction rate of 26.4% (beef slaughter relative to standing herd), a meat yield of 39 kg carcass/ha/yr, and a cow share of 40.6% (Ministerio de Agricultura, Ganadería y Pesca de la Nación, 2024; Arelovich et al., 2011). Structurally, $\alpha \approx -0.36 < 0$ places the economy in the high-fecundity regime. The land rental rate $\mu_L \approx 115 > R = 45$ $/ha/yr indicates a binding land constraint, reflecting the land-scarce conditions of Cuenca del Salado, where heavy clay soils and seasonal flooding limit crop alternatives.[30] The regulatory floor of 300 kg (Ministerio de Agricultura, Ganadería y Pesca de la Nación, 2019) does *not* bind, and the equilibrium slaughter weight exceeds it by 108 kg.

4.2 Two-sector and dynamics

The feedlot technology adopts the same growth function with a faster rate $\kappa^{FL} = 1.95\ \text{yr}^{-1}$, consistent with average daily gains of 1.3–1.6 kg/day on well-designed diets documented by Pordomingo (2013, p. 11).[31] Feed and confinement overhead imply a higher holding cost $h_f^{FL} = 850$ $/head/yr, equivalent to 2.32 $/head/day or 1.61 $/kg gain at the calibrated 1.44 kg/day, within the 1.68–5.07 $/head/day direct-cost range reported by Valor Carne (2014) for Argentine feedlots of 1,000–4,000

[29] This elasticity is a market (uncompensated) own-price concept, the object that enters the consumer-surplus integral $\int_0^c P(x)\,dx$. Published Argentine estimates vary widely. A household-survey QUAIDS model (Pace, Berges and Casellas, INTA, 2014) puts the uncompensated beef elasticity near 0.8–1.0 and the compensated near 0.2–0.3, while Reca and Lema (2016) report 0.36 for the long-run aggregate. Our value lies toward the inelastic end of this range, which amplifies the price response and so the measured loss. Even at the more elastic $\eta = 0.80$ the two-sector loss remains 12.2 and 17.2% at the 420 and 450 kg floors (Section 6), so the result holds across the plausible range of demand elasticities.

[30] $R = 45$ in the calibration represents the agricultural alternative rent in Cuenca del Salado, not the cattle rental rate. Cattle rentals in Salado per Cámara Argentina de Inmobiliarias Rurales (2025) range 200–800 $/ha and correspond to the model's rental rate μ_L, not to R. The wide gap reflects the binding land constraint. Marginal hectares are worth more in cattle than in alternative use.

[31] We retain $w_0 = 181$ kg for the feedlot entry weight because the underlying von Bertalanffy function is defined from post-weaning. Argentine feedlots in practice receive animals at 200–280 kg of recría, but relative to the function's origin this corresponds to a few months of additional aging along the same $w(a)$ curve. What identifies the feedlot sector here is the high κ^{FL} (fast conversion) together with h_f^{FL} and ρ^{FL}, not the entry weight.

Table 2: Model fit. Three moments are calibration targets: the equilibrium price (via the demand scale A), the pasture slaughter weight (via the growth rate κ), and the feedlot daily gain (via κ^{FL}). The stocking rate, extraction rate, meat yield, and cow share are untargeted moments. The remaining rows are deterministic functions of the targets. All fall within their empirical ranges except the feedlot slaughter weight, which is modestly above. Feedlot rows from Section 4.2.

Moment	Model	Data range	Status	Source
Equilibrium price ($/kg live)	2.500	–	Target (A)	BCR Rosario
Pasture slaughter weight (kg)	408	393–414	Target (κ)	MAGyP (2024); USDA-FAS (2025)
Pasture slaughter age (yr post-weaning)	1.57	1.5–2.5	Implied by κ	MAGyP young-steer series
Stocking rate (head/ha)	0.63	0.50–0.80	Untargeted	INTA cow-calf zone
Extraction rate (%)	26.4	24–28	Untargeted	MAGyP slaughter/stock (2024)
Meat yield (kg carcass/ha/yr)	39	35–60	Untargeted	Arelovich et al. (2011) (39 kg/ha avg)
Cow share of herd (%)	40.6	40–50	Untargeted	MAGyP herd composition (2024)
Feedlot finishing age (yr)	0.31	0.25–0.50	Implied by κ^{FL}	Pordomingo (2013)
Feedlot slaughter weight (kg)	346	300–340	Implied by $\kappa^{FL\dagger}$	MAGyP feedlot slaughter (2024)
Feedlot ADG over finishing window (kg/d)	1.44	1.3–1.6	Target (κ^{FL})	Pordomingo (2013) (p. 11)
α sign (high-fecundity)	negative	–	Structural	$\varphi > (\rho + \delta)e^{\rho\tau_m}$
$\mu_L > R$ (land binds)	115 > 45	–	Structural	Cuenca del Salado is land-scarce

†Model 346 kg against the 300–340 kg industry range, modestly above. A feedlot optimum above the range widens the gap to any binding floor, so it biases the two-sector loss downward.

head/yr capacity. In the welfare aggregation h_f^{FL} enters as a slot-occupancy cost, $K_{FL}\, h_f^{FL}$ per occupied head-slot-year, because pen capacity, labor, and overhead are committed whatever the cycle length, so a binding floor that cuts turnover 44% leaves total feedlot slot cost unchanged. A heavier animal consumes more feed per day, so this fixed-slot charge understates the feedlot cost of a floor and the computed loss understates the feedlot channel. Land use is negligible ($\ell_f^{FL} = 0.01$ ha/head), and the effective discount rate $\rho^{FL} = 0.12$ matches the cost of capital reported explicitly by Grünwaldt and Guevara (2011) for Argentine feedlot operations, sitting above the 5–8% range used for pasture breeding in Table 1. Feedlot capacity K_{FL} is calibrated to reproduce the observed 35% feedlot share of national slaughter (SENASA 2018–2023, MAGyP 2024; Ministerio de Agricultura, Ganadería y Pesca de la Nación, 2024), yielding $K_{FL} \approx 3{,}263$ head-slots at the $L = 100{,}000$ ha normalization. The resulting finishing age of 0.31 yr and live slaughter weight of 346 kg align with industry benchmarks of 90–180 day finishing periods and with the young-steer category that dominates the Argentine feedlot segment.

In the two-sector joint equilibrium both sectors sell into a common market and the demand scale A is recalibrated to the same price target $p^* = 2.50$ \$/kg. The resulting pasture/feedlot shares (65/35%) match SENASA data, and both sectors' slaughter ages are virtually identical to their single-sector counterparts. Finally, we calibrate the adjustment speed λ in (21) to match the roughly 10-year period of Argentina's cattle cycle. Bisection over the simulated period yields $\lambda = 0.7600$, producing damped oscillations consistent with empirical cattle-cycle dynamics.

4.3 The floor in the slaughter record

The calibration implies that the floor never bound the representative producer, since the equilibrium weights of 408 kg on pasture and 346 kg in feedlots sit well above the 300 kg live-weight floor. The national slaughter record bears this out. Figure 1 plots the average carcass weight of Argentine cattle from 1990 to 2026 against the floor in force at repeal, 165 kg for males and 140 kg for females. The mean ran between 209 and 236 kg throughout, and over the 2017–2026 decade for which the series splits by sex, males averaged 237 to 256 kg and females 204 to 215 kg. In every year of the floor's 2007–2025 life the average carcass cleared the male floor by 70 to 90 kg and the female floor by 65 to 75 kg. The regulation never came near the weights actually brought to market.

A weight floor is a per-animal constraint, so its bite depends on the left tail of the weight distribution rather than the mean. Even the category averages clear it. Table 3 reports the 2024 composition of slaughter and the average carcass weight of each category. The two lightest large categories, young steers (42% of head) and heifers (29%), averaged 236 and 191 kg against floors of 165 and 140 kg, and the lightest category mean of all, that of heifers, still exceeds its floor by 51 kg. No category average binds. A binding constraint existed only within the left tail of each

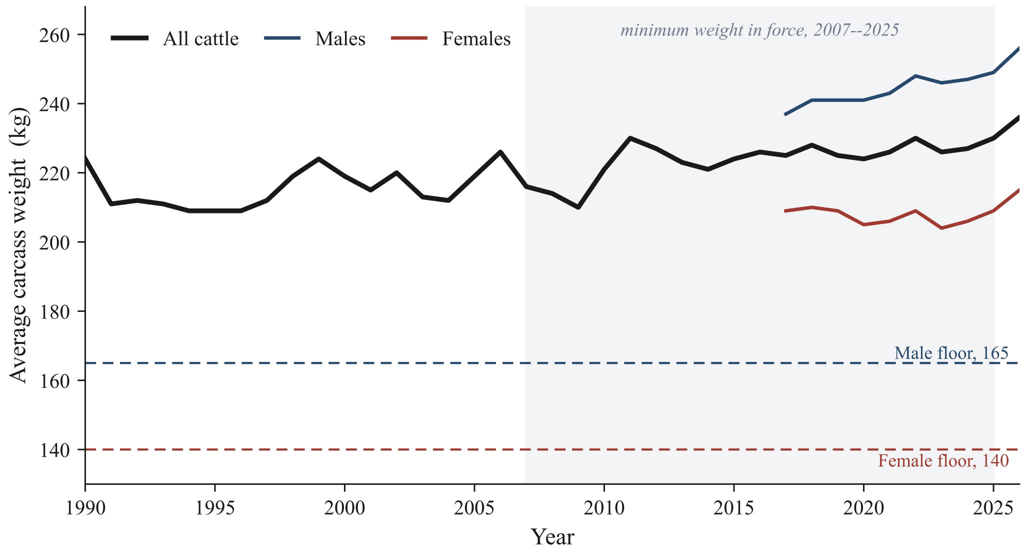

Figure 1: Average carcass weight of Argentine cattle, 1990–2026, against the minimum slaughter weight in force at repeal (165 kg for males, 140 kg for females on a carcass basis, equal to 300 and 254 kg live at a 55% dressing percentage). The shaded band marks the floor's enforcement period. The all-cattle series is the full-year average. The by-sex series (2017–2026) and the 2019–2026 total are accumulated through May and coincide with the full-year average where they overlap. Sources: MAGyP annual livestock indicators (1990–2018) and the MAGyP/DNCCA monthly slaughter report (2017–2026).

category, among the light steers, distressed sales, and informal-channel animals that a representative calibration does not resolve. A generous bound keeps this tail small. The affected animals are at most 9.4% of beef output, the calf share the founding measure recorded. Forcing even an animal privately slaughtered at birthweight up to the floor costs at most 15% of its revenue. The two bounds together put the left-tail welfare cost below about 1.4% of unregulated revenue, and below 0.2% at realistic light-animal weights.

The closest prior study of this policy, Benito Amaro (2024), argues on theoretical grounds that a binding floor depresses calf prices and lowers total output. The slaughter record locates where that argument applies. Because the floor sat 50 to 90 kg below the weights producers already chose, it imposed no cost on the modal producer, and the 2026 repeal lifted a constraint that did not bind. The live policy question is therefore not the floor Argentina had but the tighter floors it could have imposed, which the next section quantifies.

Table 3: Slaughter composition and average carcass weight by category, 2024. Every category average exceeds its sex-specific floor. Categories follow the Argentine classification (novillito, vaquillona, vaca, novillo, toro, and macho entero joven). Source: MAGyP/DNCCA bovine production report, 2024.

Category	Sex	Share of slaughter (%)	Avg. carcass (kg)	Floor (kg)
Young steer	M	42.1	236	165
Heifer	F	29.0	191	140
Cow	F	18.8	210	140
Steer	M	7.2	295	165
Bull	M	1.5	340	165
Young bull	M	1.4	229	165
All categories		100.0	228	

The all-cattle average is the report's stated figure. The head-weighted mean of the rounded category rows is about 224 kg.

5 Quantitative Results

We answer the three questions of the introduction in sequence. Section 5.1 asks whether a floor can raise supply, Section 5.2 whether any gain survives once the transition is priced, and Section 5.3 what changes when the sector holds two technologies.

5.1 Single-sector benchmark

The calibrated model places the competitive slaughter weight below the steady-state benchmarks. Competitive producers slaughter at 408 kg, at age $a_I^* = 1.574$ yr post-weaning. The weight that maximizes steady-state flow welfare is 424 kg ($a_P = 1.778$), and aggregate supply peaks at 435 kg ($\hat{a} = 1.935$). The ordering $a_I^* < a_P < \hat{a}$ of Proposition 4 holds at the calibration. The discounting wedge $a_P - a_I^*$ is 0.204 yr, about 16 kg or ten weeks of growth. Producers who discount at $\rho = 0.06$ stop short of the steady-state optimum because they price the capital tied up in each growing animal, a charge the steady-state comparison omits.

Figure 2 plots aggregate supply against slaughter weight. Supply rises with weight to 435 kg and falls beyond, as heavier animals lengthen the fattening pipeline and crowd breeding stock off the fixed land. Because the competitive weight sits at 408 kg, on the rising side, a floor between 408 and 435 kg pushes producers up the curve and raises supply, by at most 0.5% at the peak. This supply gain is the strongest form of the case for a weight floor, and the model grants it in full.

Argentina's floor never reached this zone. The 300 kg live-weight equivalent of the carcass threshold sits 0.94 yr below the equilibrium slaughter age, a slack of 108 kg. The regulation did not bind the representative producer. The floors worth weighing are the tighter counterfactuals, 420,

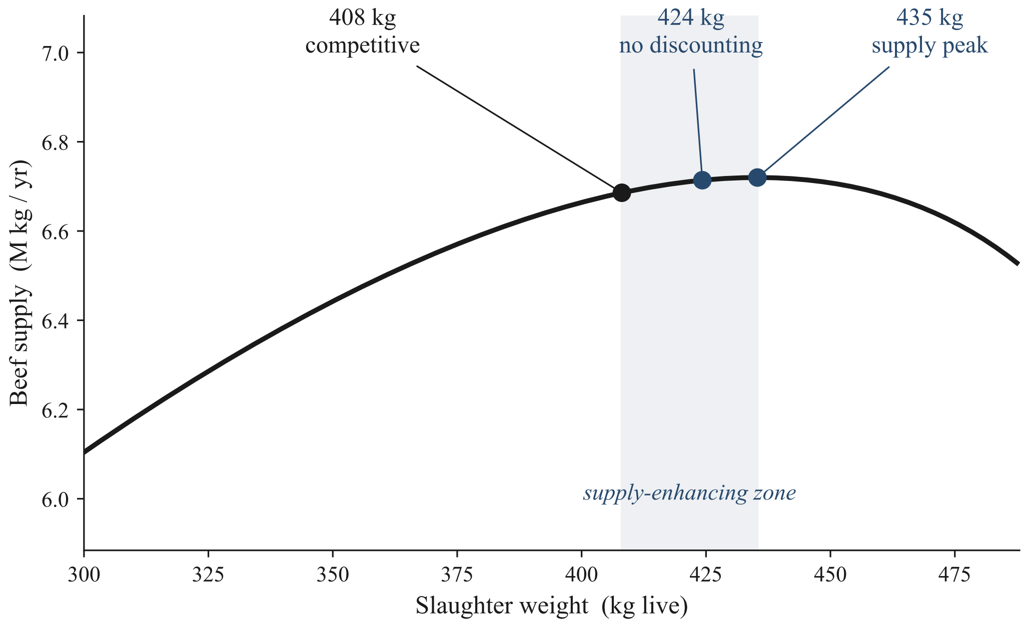

Figure 2: Aggregate beef supply is hump-shaped in slaughter weight. Competitive producers slaughter at 408 kg, on the rising side of the hump. The steady-state flow-welfare optimum is 424 kg and the supply peak 435 kg. A floor inside the shaded supply-enhancing zone (408–435 kg) raises output by at most 0.5%.

450, and 480 kg, priced in the rest of this section.

Flow welfare confirms the zone is narrow. Inside it the steady-state gain from deregulation is slightly negative, about −0.17% of revenue near 424 kg, because a floor there marginally raises flow welfare. The effect is small, and it rests on a comparison of permanent regimes that ignores the cost of moving between them.

5.2 Transition dynamics

Section 3 set out the path between regimes as the delay differential equation (20). We now simulate the repeal of a binding floor over the cattle cycle, at the calibrated adjustment speed $\lambda = 0.7600$, and ask whether the steady-state gain survives once the capital charge along that path is counted.

Figure 3 traces the repeal of floors at 420, 450, and 480 kg. At repeal the optimal slaughter age drops, and animals held above it flood the market as a backlog. The price collapses to about 0.25 \$/kg during the brief backlog window, far below the long-run 2.50 (panel a). Once the backlog clears the breeding herd sits below its long-run level, so producers retain calves to rebuild it, supply stays below trend, and the price overshoots. The maturation delay turns this adjustment into a damped oscillation of about a ten-year period, the observed Argentine cattle cycle (panel b).

Figure 4 prices this path. It plots the welfare gain from repeal over time, the flow difference

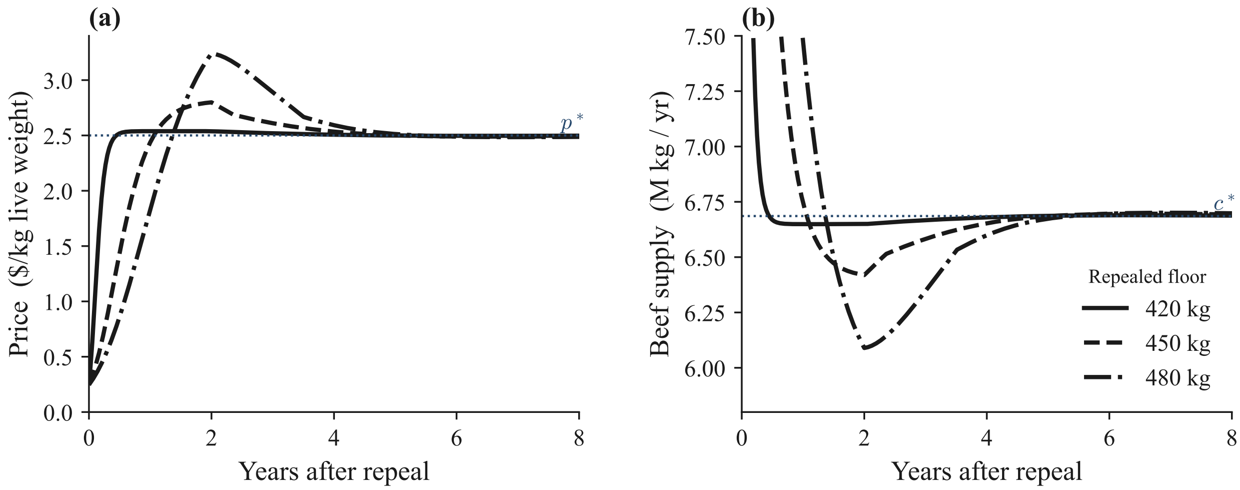

Figure 3: Transition after repeal of weight floors at 420, 450, and 480 kg. Panel (a): the price collapses to about 0.25 $/kg during the backlog window, then overshoots before converging to $p^* = 2.50$. Panel (b): aggregate supply, with the $t = 0$ backlog spike (to about 15 M kg) off scale, dips during herd rebuilding and converges with a damped oscillation of about a ten-year period.

between the deregulated economy and the one that keeps the floor. At every floor the gain is a windfall concentrated in the first months, when animals held above the unconstrained weight reach the market, and it decays toward zero as the herd rebuilds. Only the highest floors leave a small positive residual once the cycle settles, and even there the discounted sum is modest.

Table 4 decomposes the present-value gain from repeal into the one-time backlog windfall, the transition cost during herd rebuilding, and the permanent steady-state change. Panel A reports the single sector. The backlog windfall accounts for almost all of the gross magnitude at every floor, while the long-run component stays near zero, between −0.09 and +0.19% at the 420 and 450 kg floors. Searching over binding floors, the present-value-optimal floor coincides with the unregulated weight and gains below 0.001% of revenue. What the steady-state comparison records as a permanent improvement is a transitory windfall from releasing held animals.

If technology is uniform, the case for a weight floor collapses. The supply-enhancing zone is real, but pricing the transition reduces the best attainable gain to a rounding error.

5.3 Technological heterogeneity

Argentine beef production combines two technologies that sell into one market. Extensive pasture, about 65% of national slaughter, grows animals slowly on land and reaches its private optimum at 408 kg. Intensive feedlots, about 35%, grow animals quickly in confinement and reach theirs at 346 kg. A uniform floor above 346 kg binds the feedlot first and forces it past the weight at which its throughput peaks.

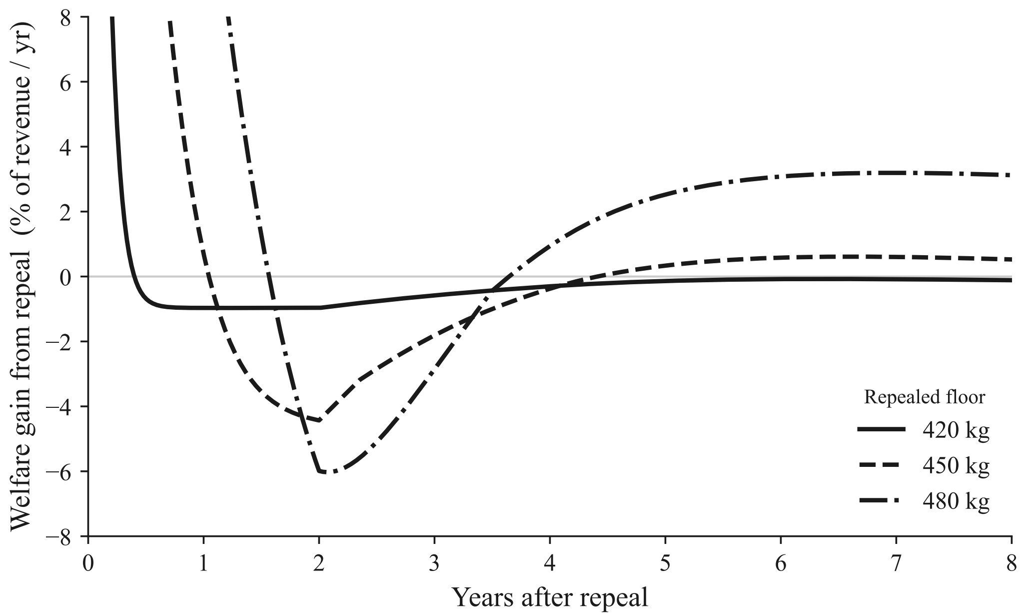

Figure 4: Welfare gain from repeal over time, single sector, for floors of 420, 450, and 480 kg. The gain is a front-loaded backlog windfall, off scale at $t = 0$, that decays toward zero as the breeding herd rebuilds. Discounted over the cattle cycle it sums to the present-value totals of Table 4 Panel A (+0.07, +1.03, +3.91% of revenue), almost all of it the one-time backlog.

Figure 5(a) decomposes the supply response. A uniform 420 kg floor raises pasture supply 0.3% but cuts feedlot output 32%, so aggregate supply falls 11%. The feedlot loss is an output loss, not only a throughput loss. Each animal leaves 21% heavier (346 to 420 kg), but the floor slows the line so much that head turnover falls about 44%, and the two combine to a 32% drop in kilograms produced. Feedlot throughput $w(a)/a$ declines monotonically past the private optimum (Proposition 9), so every binding floor reduces feedlot output. Pasture still operates on the rising side of its hump for floors up to about 435 kg, and above that pasture too moves past its peak, which only deepens the aggregate loss.

The aggregate contraction meets inelastic demand. With $\eta = 0.36$, the 11% supply cut clears at a 38% higher price, and consumers lose the area between the demand curve and the equilibrium price over the lost output. Producer revenue rises 23%, and the pasture land rental rate captures most of it, climbing from 115 to 164 \$/ha/yr at 420 kg, but that rent gain is a transfer from consumers and cancels in total surplus. What survives is a genuine efficiency loss. The floor leaves feedlot capacity fully occupied yet produces 11% less beef in aggregate, output forgone on resources the regulation keeps employed but renders less productive. In present value, discounted at $\rho = 0.06$ and annuitized as a share of unregulated two-sector revenue, the loss is 13.2% at 420 kg, 18.8% at 450, and 26.6% at 480. This net figure sets a large consumer-surplus loss against a smaller producer gain, at 420 kg a 36.3% consumer loss and a 23.1% producer gain, both as shares of revenue. At the

Table 4: Present-value welfare decomposition (% of annual revenue). Positive values are gains from deregulation. The single-sector cost of a floor is a transitory backlog effect. The two-sector cost is structural, dominated by the permanent long-run component.

Floor $\bar{w}$	Backlog ($t < 1$ yr)	Transition (1–10 yr)	Long-run ($t > 10$ yr)	Total
Panel A. Single sector				
420 kg	+0.30	−0.15	−0.09	+0.07
450 kg	+1.11	−0.27	+0.19	+1.03
480 kg	+1.86	+0.51	+1.54	+3.91
Panel B. Two sector				
420 kg	+1.18	+4.94	+7.04	+13.16
450 kg	+2.00	+6.71	+10.08	+18.80
480 kg	+2.76	+9.28	+14.59	+26.63

Notes: Annuitized present value at $\rho = 0.06$, with identical phase windows across panels. Rows may not sum due to rounding. In the single sector the backlog windfall dominates and the long-run component is near zero at the 420 and 450 kg floors, while in the two sector the long-run component is about 54% of the total at every floor.

calibrated feedlot growth rate these floors require 203, 256, and 330 days of confinement, against the 90–180 day finishing window the calibration matches in Section 4.2. The 480 kg column therefore describes the confined technology run well beyond its operating envelope, where daily gain falls to about 0.9 kg. In practice an operator would re-background the animals on pasture rather than finish an eleven-month cohort, a least-cost adaptation whose effect on the measured loss we bound in Section 6.

Transition dynamics reinforce the loss rather than offsetting it. Panel B of Table 4 repeats the decomposition for the two-sector economy. Where the single-sector cost of a floor is a transitory backlog effect, the two-sector cost is structural. The permanent long-run component accounts for about 54% of the present-value total at every floor, 10.1 of 18.8 percentage points at 450 kg. The transition adds to this permanent cost rather than offsetting it, because both sectors release backlogs on repeal and the feedlot backlog clears quickly.

The 13.2 to 18.8% band at 420–450 kg holds feedlot capacity fixed. A sustained binding floor depresses feedlot per-slot profit and drives capacity out, so the regulated economy runs below full capacity. If the repeal is credited with an immediate return to full capacity, the 450 kg present-value gap rises from 18.8% at fixed capacity to 25.9% when 30% of capacity has exited and 32.0% at a 50% exit. These figures assume capacity re-enters at once on repeal, so they trace the gross regulated-to-unregulated gap rather than a sharpened cost, and sluggish re-entry would lower the realized gain and spread it over time.

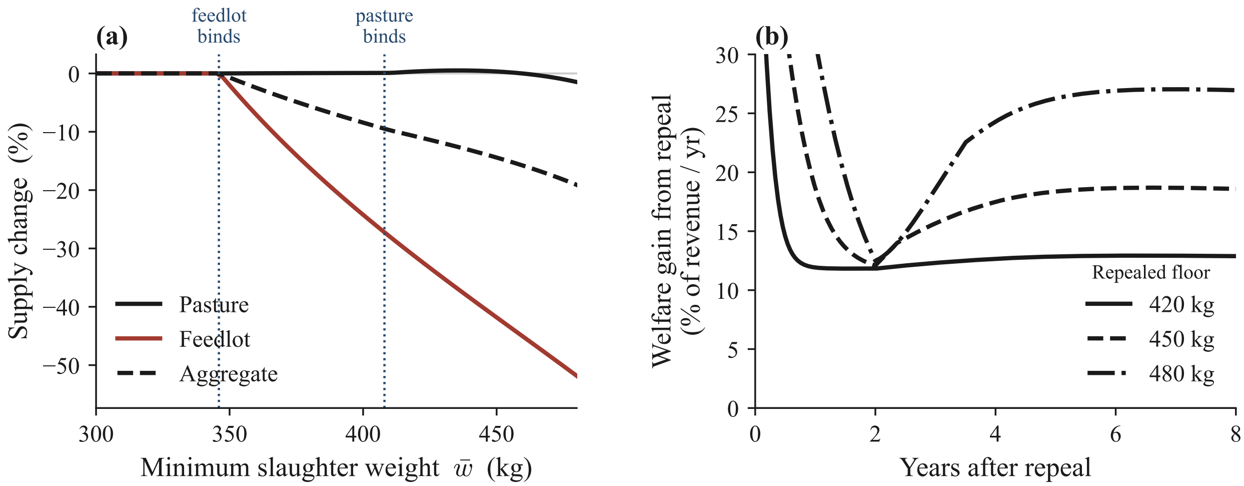

Figure 5: A uniform floor in a two-technology market. Panel (a): supply change by sector. The feedlot (red) binds first at 346 kg and its output collapses, while pasture (black) holds near zero until 408 kg. Aggregate supply (dashed) falls throughout. Panel (b): the welfare gain from repeal over time. After the early backlog window, off scale here, the gain settles to a permanent level of 13.2% of unregulated revenue at a 420 kg floor, 18.8% at 450, and 26.6% at 480. Unlike the single sector, where the cost is a transitory backlog, the two-sector cost is structural and survives in the long run.

The three results settle Argentina's weight-floor question. The 300 kg threshold codified by Resolution 74/2019 (Ministerio de Agricultura, Ganadería y Pesca de la Nación, 2019) never bound either sector, so the repeal effective 1 January 2026 (Ministerio de Agricultura, Ganadería y Pesca de la Nación, 2025) carries no welfare cost in the model. Every binding alternative we examine reduces welfare once feedlots enter. A uniform floor moves two margins in opposite directions. On the intensive margin of weight per animal it nudges pasture timing toward the steady-state optimum, a small gain. On the extensive margin of animals processed per unit of capacity it forces the feedlot far past its optimum, a large loss. One instrument cannot serve both, and the loss on the second margin dominates.

6 Robustness

The two-sector welfare cost is a durable property of the model, not a knife-edge feature of the baseline. The gain from deregulation is strictly positive in all 24 cells of an eight-dimension sensitivity grid that varies the demand elasticity, the feedlot share, the feedlot growth rate, the feedlot holding cost, the feedlot discount rate, the maturation period, the calving rate, and the agricultural rent, and it stays within the same order of magnitude as the baseline throughout. Because each cell re-pins the price target and the feedlot share, the three pasture-side dimensions (maturation period, calving rate, and rent) move the loss by less than a percentage point at 450 kg, so the binding stress tests are the demand elasticity, the feedlot share, and the three feedlot parameters. Stacking every loss-minimizing direction jointly (feedlot share 0.20, $\kappa^{FL} = 2.4$, $\eta = 0.80$, $h_f^{FL} = 613$, and $\rho^{FL} = 0.08$) drives the gain to its floor of +0.1% at 420 kg and +3.7% at 450 kg, still positive but narrowly so at the lightest floor.

The single-sector discounting wedge $a_I^* < a_P < \hat{a}$ survives across the empirical ranges of the discount rate ($\rho \in [0.03, 0.15]$) and the growth rate ($\kappa \in [0.40, 1.00]$). A conservative recalibration leaves the two-sector losses essentially unchanged, at +12.9, +18.4, and +25.9% at the three floors. The two-sector present-value loss stays near 18 to 19% of revenue at 450 kg across the cattle-cycle adjustment speed $\lambda \in [0.2, 1.5]$, and it converges under refinement of the simulation step.

Feedlot capacity exit pushes the loss the other way. Crediting the repeal with a return to full capacity, the 450 kg present-value loss rises from 18.8% to 25.9% when 30% of capacity leaves, though sluggish re-entry would temper that figure. The baseline thus sits inside a band that favorable parameters carry down to roughly 0–4% and adverse ones, heavier floors or capacity exit, carry up to roughly 26–32%, with the deregulation gain strictly positive throughout. Appendix B reports the full grid, the parameter sweeps, the conservative recalibration, the capacity-exit scenario, and the convergence check.

Openness pushes the same way as a more elastic demand. Valuing the closed-economy output gap at a fixed world price, rather than along the steep domestic demand curve, replaces the price spike with a flat valuation and cuts the present-value band to about 11.5, 15.9, and 20.8% of revenue at the 420, 450, and 480 kg floors. This reprices the closed-economy allocation rather than solving a full price-taking equilibrium, in which slaughter ages and the herd would also adjust, so it isolates the demand-curvature channel.

The measured loss depends on how feedlots comply. The headline holds the feedlot technology fixed and adds the required weight in the pen, the most costly path. A least-cost alternative exits each animal at its feedlot optimum and finishes the last kilograms on pasture. Priced as a steady-state reallocation, this cuts the loss to near zero, below about 2% of revenue at 420 and 450 kg, because grass adds the weight cheaply while the feedlot keeps full throughput, at the cost of drawing down the binding land the breeding herd already competes for. We keep the in-pen figure as the benchmark. Feedlots sit near feed grain rather than grass, capacity and contracts are committed over the cycle we price, and routing finished animals to distant pasture operations carries coordination and transport costs the reallocation ignores. The pasture-finishing value is therefore a lower bound, and the true cost lies between it and the in-pen benchmark, nearer the benchmark the more segmented the two technologies are.

7 Conclusion

The three results of this paper build from theory to policy. Private discounting drives a wedge between the competitive slaughter age and the steady-state flow-welfare optimum, and that wedge creates a window in which a moderate weight floor raises beef supply. Once transition dynamics are priced in, no binding floor in that window delivers a present-value welfare gain above 0.001% of annual revenue, so the theoretical scope for welfare-improving regulation collapses to a rounding error even in the single-sector benchmark. The two-sector extension then overturns the exercise outright. A uniform floor applied to a market that combines extensive pasture and intensive feedlot technologies generates welfare costs of 13.2–18.8% of unregulated revenue in present value at floors of 420–450 kg, with heavier floors costing more still. Pricing the cattle cycle deepens these losses rather than offsetting them. The supply-enhancing zone is real, it is small, and it vanishes once the regulated market contains more than one technology.

The two-margin asymmetry generalizes. A uniform floor helps the pasture sector on the intensive margin of weight per animal and forces the feedlot past its throughput peak on the extensive margin, and the same conflict arises for any output-side instrument that binds two technologies unequally. A heterogeneous industry cannot be regulated as if it were homogeneous. The economic rationale for minimum slaughter weights is not wrong, but it is partial, and it applies to only one of the two coexisting technologies.

Argentina provides a clean test case for this logic. The 300 kg floor codified by Resolution 74/2019 (Ministerio de Agricultura, Ganadería y Pesca de la Nación, 2019) (with antecedents in Resolutions 645/2005, 68/2007, and 26/2018) never bound during its enforcement period, with model-implied equilibrium slaughter weights of 408 kg for pasture producers and 346 kg for feedlots. Resolution 98/2025 (Ministerio de Agricultura, Ganadería y Pesca de la Nación, 2025), which repealed the floor effective 1 January 2026, carries effectively zero welfare cost in our framework, consistent with its stated rationale of free commerce. The counterfactual exercise is more informative than the baseline repeal itself. Every binding alternative we examined (420, 450, and 480 kg) reduces aggregate welfare once feedlots enter the model. The result holds across all eight robustness dimensions of Appendix B. Even in the single-sector benchmark, the present-value-optimal binding floor coincides with the unregulated equilibrium weight and delivers a welfare gain below 0.001% of revenue. Any attempt to give it teeth would have made Argentine beef policy costly.

These findings carry beyond Argentina, with caveats. Brazil, Uruguay, and Paraguay combine the same extensive pasture and intensive finishing segments, but the feedlot share differs sharply, and our two-sector result applies most directly where the feedlot share is large enough to drive the throughput asymmetry (Proposition 9) and where cattle is the dominant land use, so the land constraint binds. The robustness grid (Appendix B) covers feedlot shares as low as 0.20, so a uniform floor where pasture dominates generates smaller but still negative effects, while in zones where cropping competes for the land the mechanism weakens to about 0.4–1.1% of revenue. Because feedlots cluster near feed grain, often where land is less scarce, the sector-wide cost is a spatial average whose level depends on how feedlot location lines up with the binding land constraint. The configuration we analyze is live across the region, though its quantitative bite varies with the technological mix. Commodity sectors in middle-income economies are increasingly dual, a modern capital-intensive segment alongside a traditional land-intensive one, and policy instruments inherited from the single-technology era misfire once that structure takes hold. In our setting the welfare cost rises with the modern segment, from 7.0% of revenue at a 20% feedlot share to 20.3% at 50%, a cross-sectional pattern consistent with the productivity effects of agricultural technical change in Bustos et al. (2016) and the long history of sub-sectoral policy distortions in Latin American agriculture (Anderson and Valdés, eds, 2008). The welfare costs we document, 13.2 to 18.8% of unregulated revenue at 420–450 kg, are first-order for a sector of this size, and valuing the lost output at world prices rather than thin domestic demand still leaves about 12 to 16%, the relevant range for the region's export-oriented producers.

Minimum slaughter weight regulation rests on a theoretical foundation narrower than its practical reach. The discounting wedge it is designed to exploit is genuine, but the welfare gains it can generate are negligible in the most favorable single-sector setting and strongly negative once the regulated industry contains more than one production technology. Our result joins a growing literature showing that agricultural policy instruments designed under homogeneity assumptions fit poorly when the economy is heterogeneous, whether across rural structures (de Janvry and Sadoulet, 2010) or across farm and sectoral technologies (Adamopoulos and Restuccia, 2014). The question is not whether uniform weight floors improve welfare, which our analysis settles in the negative, but how to design instruments that correct a distortion in one technology without creating a larger one in another. Sector-specific instruments that target only the pasture margin could in principle exploit the supply-enhancing zone, though the achievable gains (below 0.5% of supply) would have to be weighed against the additional monitoring and enforcement costs that differentiation introduces. Whether differentiated instruments can recover those small gains is an open empirical question, and a distributional analysis of the slaughter-weight left tail with producer-level SENASA records is the natural next step, since that tail is where a binding floor actually operates. Within our framework, the case against uniform floors in dual industries is strong.

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Data Availability Statement

This study uses no newly generated or proprietary data. All calibration targets are drawn from the publicly available sources cited in Tables 1 and 2. The equilibrium solver and the delay-differential-equation simulation that generate every quantitative result and figure will be archived in a public repository, with the repository link included on acceptance.

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A Proofs

Proof of Proposition 3 (Unregulated Equilibrium)

We proceed in four steps: define the domain, sign Φ near the lower boundary, sign Φ near the upper boundary, and apply the intermediate value theorem.

Step 1 (Domain). Define $g(a) \equiv w'(a) - \rho\, w(a)$, which is strictly decreasing ($g' = w'' - \rho\, w' < 0$ since $w'' < 0$ and $w' > 0$) with $g(0^+) = w'(0^+) - \rho\, w_0 > 0$ (satisfied at the calibrated parameters) and $g(a) \to -\rho\, W_\infty < 0$ as $a \to \infty$. Let $a_\rho \equiv g^{-1}(0)$ denote the unique root of g. Define $\bar{a}_{\max} \equiv \sup\{a > 0 : \mu_L(a) \geq R\}$, where $\mu_L(a) = [p(a)\, g(a) - h_f^d]/\ell_f$. At $a = 0$: $\mu_L(0) = [P(c(0))\, g(0^+) - h_f^d]/\ell_f$, which is positive when initial growth is sufficiently fast. As $a \to \infty$: $g(a) \to -\rho\, W_\infty < 0$, so $p(a)\, g(a) < 0$ for large a and $\mu_L(a) \to -\infty$. By continuity, $\bar{a}_{\max} \in (0, \infty)$ is well-defined. The function Φ is continuous on $(0, \bar{a}_{\max})$.

Step 2 (Boundary behavior of Φ near $a \downarrow 0$). As $a \downarrow 0$, the fattening value $V_f(a) \to p(0)\, w_0$ (the immediate slaughter value of the calf at its post-weaning entry weight). Define the breeding value $B(a) \equiv [\delta\, p(a)\, w_{\text{cow}} - h_s(a) - \Gamma\, h_r(a)]/\alpha$, where $h_s(a) = h_s^d + \mu_L(a)\, \ell_s$ and $h_r(a) = h_r^d + \mu_L(a)\, \ell_r$. Near $a = 0$, $g(0^+) = w'(0^+) - \rho\, w_0$ is bounded and strictly positive by Assumption 1 and the calibration. Therefore $\mu_L(0) = [p(0)\, g(0^+) - h_f^d]/\ell_f$ is bounded and strictly positive when $p(0)\, g(0^+) > h_f^d$, which holds at the calibration ($p(0) \approx 2.5$, $g(0^+) \approx 217$, $h_f^d = 35$, $\ell_f = 1$, giving $\mu_L(0) \approx 506$, well above $R = 45$). Write the numerator of B as $\mathcal{N}(a) = \delta\, p(a)\, w_{\text{cow}} - h_s^d - \Gamma\, h_r^d - \mu_L(a)\, (\ell_s + \Gamma\, \ell_r)$. Because $\mu_L(a)$ is strictly positive and bounded above zero on a neighborhood of $a = 0$, the term $-\mu_L(a)\, (\ell_s + \Gamma\, \ell_r)$ contributes a strictly negative bounded amount, and combined with $w_{\text{cow}}\, \delta\, p(0)$ being finite, $\mathcal{N}(a_\ell) < 0$ for $a_\ell > 0$ sufficiently small (the strict inequality requires the calibrated $\mu_L(0)\, (\ell_s + \Gamma\, \ell_r)$ to exceed $\delta\, p(0)\, w_{\text{cow}} - h_s^d - \Gamma\, h_r^d$, which it does at all calibrated parameters).

High-fecundity case ($\alpha < 0$): $B(a_\ell) = \mathcal{N}(a_\ell)/\alpha > 0$ (negative over negative). Since $w_0 \ll w_{\text{cow}}$, we have $V_f(a_\ell) \approx p(0)\, w_0 < B(a_\ell)$, so $\Phi(a_\ell) = V_f(a_\ell) - B(a_\ell) < 0$.

Fast-depreciating case ($\alpha > 0$): $B(a_\ell) = \mathcal{N}(a_\ell)/\alpha < 0$ (negative over positive). Since $V_f(a_\ell) \approx p(0)\, w_0 > 0 > B(a_\ell)$, we have $\Phi(a_\ell) > 0$.

Step 3 (Φ changes sign near $\bar{a}_{\max}$). Both $V_f(a)$ and $B(a)$ are affine in the price $p(a)$. Since $V_f(p, h)$ is strictly increasing in p, $\partial V_f/\partial p > 0$. Using the Faustmann substitution $\mu_L(a) = [p(a)\, g(a) - h_f^d]/\ell_f$, the slope of the breeding value with respect to p at slaughter age a is

$$\frac{\partial B}{\partial p} = \frac{\delta\, w_{\text{cow}} - g(a)\, (\ell_s + \Gamma\, \ell_r)/\ell_f}{\alpha}.$$

High-fecundity case ($\alpha < 0$): for $a \geq a_\rho$ (where $g(a) \leq 0$), the numerator is positive, so $\partial B/\partial p < 0$

while $\partial V_f/\partial p > 0$. Hence $\partial\Phi/\partial p > 0$. As a approaches $\bar{a}_{\max}$ from below, $\mu_L(a) \downarrow R$ by definition of $\bar{a}_{\max}$ (which equals the boundary $\sup\{a : \mu_L \geq R\}$, the binding land-constraint locus). At this boundary, holding costs h_f, h_s, h_r all reach their floor values, V_f achieves its minimum on the interval, while B continues to decline as $p(a)$ rises with falling supply.[32] Combined with $\Phi(a_\ell) < 0$ from Step 2, the sign changes.

Fast-depreciating case ($\alpha > 0$): as a increases, $\mu_L(a)$ decreases, so $B(a)$ grows. By the fattening profitability assumption, $\partial V_f/\partial p > \partial B/\partial p$ at the NPV-maximizing age. For large a near $\bar{a}_{\max}$, B grows faster, yielding $\Phi(a_1) < 0$. Combined with $\Phi(a_\ell) > 0$, the sign changes.

Step 4 (Conclusion). In both cases, Φ is continuous and changes sign. The IVT delivers existence. Uniqueness is verified numerically.

Proof of Proposition 4 (Discounting Wedge)

($a_I^* < a_P$). Write $\beta \equiv \varphi - \delta > 0$ and $\text{cost}(a) = h_f^d\,\beta\,a + h_r^d\,\delta\,\tau_m + h_s^d$. Differentiating $W(a) = \int_0^{c(a)} P(x)\,dx - S(a)\,\text{cost}(a)$:

$$W'(a) \;=\; p(a)\,c'(a) \;-\; S'(a)\,\text{cost}(a) \;-\; S(a)\,h_f^d\,\beta.$$

Using $c(a) = S(a)\,[\beta\,w(a) + \delta\,w_{\text{cow}}]$ and $S'(a) = -S(a)\,\ell_f\,\beta/D(a)$, the supply derivative is $c'(a) = S(a)\,\beta\,w'(a) + S'(a)\,c(a)/S(a)$. Substituting and collecting terms:

$$W'(a) \;=\; S(a)\,\beta\left[p(a)\,w'(a) - h_f^d\right] \;+\; |S'(a)|\left[\text{cost}(a) - p(a)\,c(a)/S(a)\right].$$

At the competitive equilibrium $a = a_I^*$, the Faustmann condition gives $p\,w'(a_I^*) = \rho\,p\,w(a_I^*) + h_f^d + \mu_L\,\ell_f$, so substituting into the expression above,

$$W'(a_I^*) \;=\; S(a_I^*)\,\beta\left[\rho\,p\,w(a_I^*) + \mu_L\,\ell_f\right] \;-\; |S'(a_I^*)|\left[p\,c(a_I^*)/S(a_I^*) - \text{cost}(a_I^*)\right]. \tag{24}$$

The first term is strictly positive because $\rho > 0$, $p > 0$, $w(a_I^*) > 0$, and $\mu_L \geq 0$ with equality only if the land constraint slacks (and $\mu_L > 0$ whenever the constraint binds, Section 2.4). The second term is non-negative because revenue per breeding cow $p\,c/S$ exceeds direct operating cost per breeding cow at a viable equilibrium. We provide a sufficient analytical condition for $W'(a_I^*) > 0$. Define the *capital-opportunity intensity* $\Theta \equiv \rho\,p\,w(a_I^*) + \mu_L\,\ell_f$ and the *crowding intensity* $\Psi \equiv (p\,c(a_I^*)/S(a_I^*) - \text{cost}(a_I^*))$. Then:

[32] If supply $c(a)$ approaches zero before $\mu_L(a)$ reaches R, then $p(a) \to \infty$ under isoelastic demand and the same conclusion holds. In either case $\Phi(a)$ becomes positive near the right boundary.

Lemma 2 (Sufficient condition for the wedge). *A sufficient condition for $W'(a_I^*) > 0$ is*

$$\Theta \; > \; \frac{\ell_f}{D(a_I^*)}\,\Psi,$$

where $D(a_I^*) = \hat{\ell}_s + \ell_f\,\beta\,a_I^*$ is the land denominator. Equivalently, $\rho\,p\,w(a_I^*) + \mu_L\,\ell_f$ must exceed $\ell_f\,\Psi/D(a_I^*)$.

Proof of Lemma 2. Using $|S'(a_I^*)|/S(a_I^*) = \ell_f\,\beta/D(a_I^*)$, we can rewrite (24) as

$$W'(a_I^*) \;=\; S(a_I^*)\,\beta\left[\Theta - \ell_f\,\Psi/D(a_I^*)\right].$$

Since $S(a_I^*) > 0$ and $\beta > 0$, the condition $\Theta > \ell_f\,\Psi/D(a_I^*)$ is sufficient for $W'(a_I^*) > 0$. □

At the calibration the LHS is $\Theta \approx \rho\,p\,w(a_I^*) + \mu_L\,\ell_f \approx 0.06 \times 2.5 \times 408 + 115 \times 1 = 61.2 + 115 \approx 176$. The RHS is $\ell_f\,\Psi/D(a_I^*) \approx 1 \times 589/3.93 \approx 150$. The sufficient condition holds ($\Theta/[\ell_f\Psi/D] \approx 1.17$). Across the robustness sample of Section 6 ($\rho \in [0.03, 0.15]$, $\kappa \in [0.40, 1.00]$), this margin remains positive throughout.

($a_P < \hat{a}$). At $\hat{a}$, $c'(\hat{a}) = 0$. Writing $\text{cost}(a) = h_f^d\,(\varphi - \delta)\,a + h_r^d\,\delta\,\tau_m + h_s^d$ and $S(a) = L/D(a)$ with $D(a) = \hat{\ell}_s + \ell_f\,(\varphi - \delta)\,a$:

$$W'(\hat{a}) = |S'(\hat{a})|\,\text{cost}(\hat{a}) - S(\hat{a})\,h_f^d\,(\varphi - \delta).$$

Substituting and canceling common factors:

$$W'(\hat{a}) < 0 \iff h_f^d\,\hat{\ell}_s > \ell_f\,(h_r^d\,\delta\,\tau_m + h_s^d),$$

which is Assumption 4 (Fattening cost dominance). Hence W peaks before $\hat{a}$.

Proof of Proposition 8 (Three Zones)

(i) Since $W'(a_I^*) > 0$ (Proposition 4) and W peaks at a_P, $W(\bar{a}) \geq W(a_I^*)$ for $\bar{a} \in [a_I^*, a_P]$.

(ii) Write $\Delta W(a) = W(a) - W(a_I^*) = \int_{c(a_I^*)}^{c(a)} P(x)\,dx - \left[S(a)\,\text{cost}(a) - S(a_I^*)\,\text{cost}(a_I^*)\right]$, which is well-defined for all $a > 0$ even when the baseline consumer-surplus integral $\int_0^c P$ diverges (as it does for isoelastic demand with $\eta \leq 1$). As $a \to \infty$: $c(a) \to 0^+$, so the consumer-surplus difference $\int_{c(a_I^*)}^{c(a)} P(x)\,dx = -\int_{c(a)}^{c(a_I^*)} P(x)\,dx$ is negative and, under isoelastic demand with $\eta < 1$, diverges to $-\infty$. The cost term converges to $L\,h_f^d/\ell_f - S(a_I^*)\,\text{cost}(a_I^*)$, which is finite. Hence $\Delta W(a) \to -\infty$ as $a \to \infty$. Combined with $\Delta W(a_P) > 0$ from part (i) and continuity of ΔW, the intermediate value

theorem delivers $a_0 > a_P$ with $\Delta W(a_0) = 0$. For $\bar{a} \in (a_I^*, a_0)$, $\Delta W > 0$. For $\bar{a} > a_0$, $\Delta W < 0$. Uniqueness of a_0 is verified numerically across the robustness sample.

B Robustness

This appendix reports the sensitivity analysis summarized in Section 6.

Single-sector wedge. The discounting wedge $a_I^* < a_P < \hat{a}$ (Proposition 4) is preserved across the full empirical range of the discount rate $\rho \in [0.03, 0.15]$ and the growth rate $\kappa \in [0.40, 1.00]$. Higher ρ widens the wedge, and higher κ shifts all three thresholds while preserving the ordering.

Two-sector welfare grid. Table 5 evaluates the two-sector present-value welfare gain from deregulation across eight parameters, each at three values, varying the demand elasticity η, the feedlot share, the feedlot growth rate $\kappa^{FL} \in [1.5, 2.4]$, the feedlot holding cost $h_f^{FL} \in [613, 1100]$ \$/head/yr, the feedlot discount rate $\rho^{FL} \in [0.08, 0.16]$, the maturation period $\tau_m \in [1.5, 2.5]$ yr, the effective calving rate $\varphi \in [0.55, 0.75]$, and the agricultural rent $R \in [33, 100]$ \$/ha/yr within the marginal-frontier regime where the land constraint binds. A final row varies the price-target basis p^* from the official-FX 1.70 to 3.50, since the welfare share depends on the nominal price level.[33] In every cell the welfare gain is strictly positive and within the same order of magnitude as the baseline. Demand elasticity matters most. At the upper bound $\eta = 0.80$ the welfare cost still reaches 12.2% at $\bar{w} = 420$ kg and 17.2% at 450 kg, against the baseline 13.2 and 18.8%. Larger feedlot shares amplify the magnitude, because more capacity is exposed to the throughput-distorting effect of the floor. Between the feedlot binding threshold (≈ 346 kg) and the pasture threshold (≈ 408 kg) only the feedlot is bound, so the rising price induces pasture retention that partially offsets the feedlot contraction. Above 408 kg both sectors bind and the cost rises rapidly.

Adjustment speed. The transition adjustment speed λ that governs the cattle-cycle period is benign. At the calibrated baseline $\lambda = 0.7600$ the annuitized present-value gain from deregulating a $\bar{w} = 450$ kg floor is +1.02% of revenue, and it remains positive across the realistic range $\lambda \in [0.2, 1.5]$ at values between +0.54% and +1.26%. The sign flips only at extreme values ($\lambda \geq 1.8$) that imply implausibly short cattle cycles, at or below 7 years, well under the 10-year calibration target.

[33] For higher R values typical of productive Pampa Húmeda zones (e.g., $R \geq 200$ \$/ha/yr), the land constraint $\mu_L > R$ stops binding and the welfare-cost mechanism collapses to roughly 0.4–1.1% of revenue. The result we report applies to economies where cattle is the dominant land use, not to intramarginal zones where cropping competes effectively.

Table 5: Two-sector welfare gain from deregulation, in annualized present value, is positive across eight model parameters and the price-target basis.

	Tested values			ΔW at $\bar{w}$ = 420 kg (%)			ΔW at $\bar{w}$ = 450 kg (%)		
Dimension	Low	Base	High	Low	Base	High	Low	Base	High
η	0.25	0.36	0.80	+14.0	+13.2	+12.2	+20.4	+18.8	+17.2
Feedlot share	0.20	0.35	0.50	+7.0	+13.2	+20.3	+10.2	+18.8	+29.4
κ^{FL} (yr^{-1})	1.5	1.95	2.4	+21.1	+13.2	+7.0	+26.0	+18.8	+12.9
ρ^{FL}	0.08	0.12	0.16	+11.9	+13.2	+14.3	+17.6	+18.8	+19.9
h_f^{FL} ($/head/yr)	613	850	1100	+5.1	+13.2	+21.8	+11.2	+18.8	+26.6
τ_m (yr)	1.5	2.0	2.5	+13.2	+13.2	+13.2	+19.1	+18.8	+18.6
φ	0.55	0.65	0.75	+13.2	+13.2	+13.2	+18.4	+18.8	+19.3
R ($/ha/yr)	33	45	100	+13.2	+13.2	+13.1	+18.9	+18.8	+18.4
Price target p^* ($/kg)	1.70	2.50	3.50	+17.9	+13.2	+7.2	+22.2	+18.8	+15.9

Notes: Annuitized present-value welfare gain from deregulation, % of unregulated two-sector revenue (positive throughout). Each cell simulates the repeal of the floor over the cattle cycle at the calibrated adjustment speed $\lambda = 0.7600$. A and K_{FL} are recalibrated per cell to maintain the price target and, except in the feedlot-share row, the 35% feedlot share. The eight parameter rows hold $p^* = 2.50$, and the final row varies p^*.

Capacity exit. The baseline holds feedlot capacity K_{FL} fixed. A sustained binding floor depresses per-slot profit and drives capacity out, so the regulated economy runs below full capacity. Crediting the repeal with an immediate return to full capacity raises the annuitized $\bar{w} = 450$ kg gain from +18.8% of revenue at fixed capacity to +25.9% at a 30% capacity exit and +32.0% at a 50% exit. Because capacity is assumed to re-enter at once, these figures trace the gross regulated-to-unregulated gap, and sluggish re-entry would lower and spread the realized gain.

Conservative calibration and convergence. A perturbed calibration with $h_f^d = 45$ $/head/yr (midrange), $R = 50$ $/ha/yr (above median), and $\eta = 0.42$ (more elastic) narrows the equilibrium slaughter weight to 403 kg and the supply-enhancing zone to 403–435 kg. The discounting wedge is preserved, and the two-sector present-value welfare gains reach +12.9%, +18.4%, and +25.9% at $\bar{w}$ = 420, 450, and 480 kg, essentially unchanged from the baseline. The delay differential equation is solved by Euler discretization with step size $\Delta t = 0.005$ yr, and recomputing the $\bar{w} = 450$ kg repeal at $\Delta t \in \{0.001, 0.005, 0.01\}$ yields annuitized gains of +1.0213, +1.0215, and +1.0218% of revenue, a variation below 0.001 percentage points.